

Carbon Takeback Obligation

A Producers Responsibility Scheme on the Way to a Climate Neutral Energy System

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The content of the report is the sole responsibility of the authors of the report.

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A Brief Guide to a Carbon Takeback Obligation

1. The climate issue demands additional instruments

1.1 A rapidly declining carbon budget calls for “all hands on deck”

The Paris Climate Agreement sets out that the global temperature increase must be limited to a maximum of 2 degrees and preferably to no more than 1.5 degrees. Countries, businesses, and other NGOs are pursuing the (radical) reduction of greenhouse gas emissions.

However, when international and national climate policies are set alongside the insights gained from climate science and alongside current economic developments, several risks come to light that suggest that such goals will not be achieved:

- The 2-degree (or 1.5-degree) goal implies a carbon budget: global warming is determined by the concentration of greenhouse gases in the atmosphere. Given the current concentration in the atmosphere and given the inflow (emissions) and limited outflow (removal of greenhouse gases from the atmosphere), the 2-degree concentration level threatens to be exceeded. You can compare this with a bathtub that continues to fill up, even if the faucet is running slower (Figure 1);
- Eventually, we will not only need to turn off the faucet (zero emissions); we will also need to lower the water level by expanding the drain (net removal of greenhouse gases from the atmosphere: so-called negative emissions).

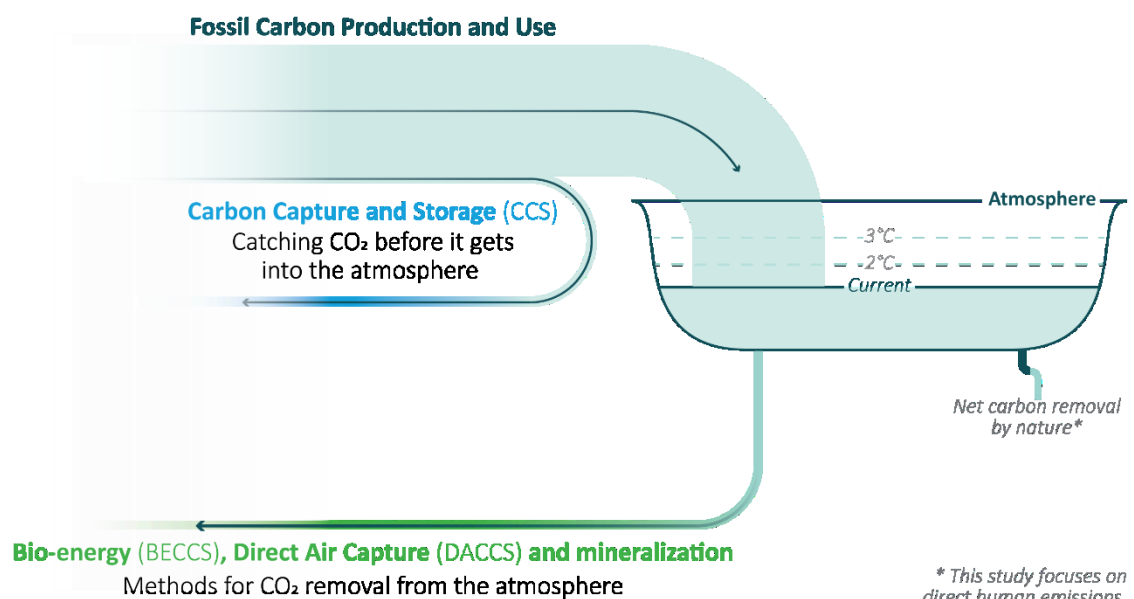


Figure 1: The carbon budget can be regarded as a bathtub filling with water: global warming is determined by the concentration of greenhouse gases in the atmosphere (the water level in the tub).

1.2 In addition to focusing on emissions, we also need to focus on sources

Suites of policies commonly focus on emission-driven measures (“smokestack and exhaust control”) to be implemented via such instruments as the Emissions Trading System, vehicle emission standards, building standards, et cetera), and on *replacing* CO₂ emitting sources of energy by CO₂-free sources such as solar, wind, and geothermal energy.

However, as a result of the growing demand for energy, the demand for fossil fuels will continue as long as the supply of renewable energy is insufficient to meet the demand. This demand is met by producing new hydrocarbons that generate CO₂ emissions when utilized. All the hydrocarbon stock (from the geosphere) that is placed on the market will eventually – through incineration – turn into CO₂ and be released into the atmosphere. Currently, the worldwide volume of (fossil) carbon “in the pipeline” (concessions, in production, being processed, and in stocks) is already larger than what the carbon budget tolerates.¹ Little attention is focused on rendering fossil fuels CO₂-free, whilst no, or hardly any, incentives to this effect exist for private parties producing or importing fossil carbons (and carbon compounds).

1.3 Focus on both flows (emissions) and stocks (in the geosphere, biosphere, and atmosphere)

Limiting this *risk* of failure to achieve the climate goals calls for additional policy instruments that:

- Regulate *stocks*: geological carbon stocks, but also biotic stocks (carbon in natural systems, with a view to the atmospheric CO₂ “stock” to be contained);
- Regulate the “decarbonization” of carbon flows and value chains for as long as these are employed in the supply of energy and raw materials.

A more extensive mix of instruments will enable more comprehensive stocks and flows management, in order for the combination of policy instruments to tally with climate science insights (carbon budget): Figure 2, Supply side policies.

“This demand is met by producing new hydrocarbons that generate CO₂ emissions when utilized. All the hydrocarbon stock (from the geosphere) that is placed on the market will eventually – through incineration – turn into CO₂ and be released into the atmosphere.”

¹ Cf. Stockholm Environment Institute (2016). Fossil fuel production in a 2°C world: The equity implications of a diminishing carbon budget.

<https://mediamanager.sei.org/documents/Publications/Climate/SEI-DB-2016-Equity-fossil-fuel-production-rents.pdf>.

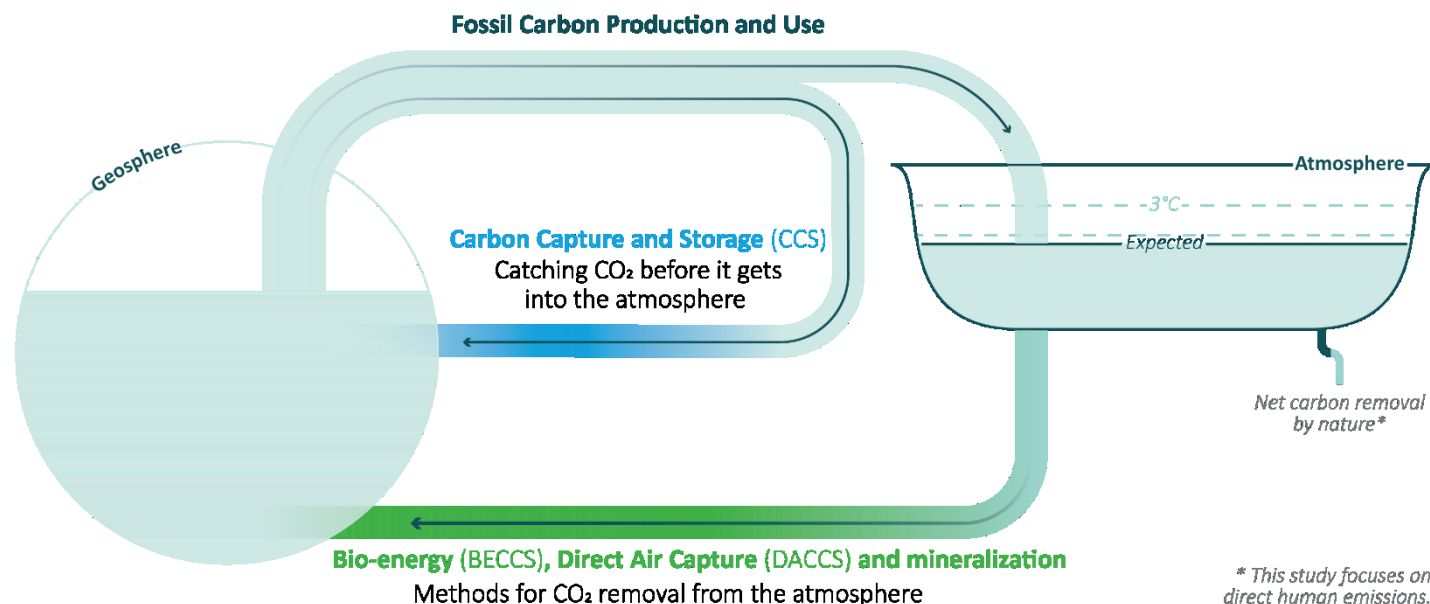


Figure 2: Supply-side policies would focus on water production; demand-side policies focus on waterflow into the bathtub

2. A Carbon Takeback Obligation (CTBO) is a promising additional instrument

2.1 A CTBO prevents fossil carbons from ending up in the atmosphere

A *Carbon Takeback Obligation (CTBO)* is a scheme to ensure that hydrocarbons placed on the market are, on balance, employed in a CO₂-free manner by the time net zero needs to be reached. This could be a significant instrument, supplementing the current set of instruments. This concept will be elaborated in this report: what is it, how does it work, how does it relate to other instruments, and what is required in the purview of its further development and application?

This report is also underpinned by Sounding Board Group discussions with a range of stakeholders, in order to secure, right from the start, input from various perspectives on the development of this instrument. In addition, insights have continuously been exchanged with researchers in such countries as the UK and the US, in order to tie in with international developments.

A Carbon Takeback Obligation (CTBO) is a new instrument that imposes regulations on newly produced carbon compounds to be employed as energy and raw materials. Such regulations may be based on voluntary commitments yet will be much more effective if they are binding.

2.2 The essence: requiring producers and importers to have CO₂ storage or sequestration secured before producing or importing fossil carbon compounds

The essence is that a producer or importer placing such carbon compounds on the market must ensure that the CO₂ that would be released during their use will be sequestered/stored rather than be released into the atmosphere. It is not, by definition, incumbent upon the producer or importer to carry out the sequestration/storage themselves, although it is permitted; their primary responsibility is to arrange for the possibility of storage/sequestration.

This can be achieved by contracting storage and/or sequestration facilities upon the production or import of (fossil) hydrocarbons; by purchasing carbon storage units (CSUs) from third parties; or by (collectively) setting up a storage company that generates sufficient CSUs. Options

include “permanent” CO₂ storage capacity in such geological reservoirs as depleted gas fields, but also storage in the form of minerals and materials. Another conceivable option would be sequestration in natural systems, but for the sake of clarity (and to guarantee permanence), the “like for like” principle appears to be the most valid: what comes from the geosphere must return to the geosphere, i.e., geological storage or mineralisation.

The carbon storage units are strictly linked to the actual volumes of CO₂ stored; production or import is only allowed after purchasing the equivalent quantity of CSUs from parties that store (or otherwise permanently sequester) CO₂. This ensures that for any volume of hydrocarbons placed on the market through production or through import, an equivalent volume of CO₂ is ultimately stored or sequestered and thus prevented from entering the atmosphere. The production, import or use of hydrocarbons will then no longer add CO₂ to the atmosphere.

2.3 CTBO is a source-oriented instrument that affects the entire value chain

The obligation is placed upon the producer or importer, and by its nature impacts the entire value chain.

The instrument could be named carbon cycle scheme, or “Carbon Producer Responsibility”, analogous to the existing producer responsibilities pertaining to such matters as the environment-friendly processing of packaging materials, vehicles, or household appliances. For example, packaging manufacturers are required to process in an environment-friendly manner any materials that will become waste further down the value chain, for which they also pay a fee to cover the costs of collection and recycling. Similarly, under a CTBO, producers and importers will pay a fee for the carbon storage units (CSUs), which enables storage/sequestration of CO₂.

Thus, the instrument can also be regarded as a *parafiscal levy plus obligation to implement* that is set down at the beginning of the chain, whose revenue must be sufficient to keep an increasing percentage of the CO₂ normally generated by that chain permanently out of the atmosphere.

In principle, the instrument can be employed for various carbon stocks whose use could result in CO₂ emissions into the atmosphere, such as fossil fuels – coal, oil, and gas – but possibly also for biotic carbon stocks.

3. A CTBO for gas is feasible and effective

3.1 Elaboration for natural gas

In consultation with the Sounding Board Group, we have chosen to elaborate the CTBO instrument for *natural gas*, geared to the situation in the Netherlands, which features an indigenous gas supply and international gas trade flows. In subsequent studies, the instrument can also be elaborated for other stocks. According to the energy scenarios, (global) demand for fossil fuels will continue for a prolonged period of time, with natural gas playing a prominent part in this demand.

Natural gas could be a significant initial field of application for a CTBO. The number of gas producers and importers is limited, whilst the production and import of gas is already subject to a range of regulations. Furthermore, the producers and importers command sufficient know-how and funds to carry out a CTBO, which would facilitate the introduction of an obligation at the beginning of the gas chain. Considering the gas volumes that will remain in circulation for the foreseeable time, storage will also be effected on a large scale, and via a limited number of easily auditable players.

3.2 A CTBO for natural gas will create options for climate-neutral gas

A CTBO for gas will enable the net CO₂ neutral production of indigenous gas and/or gas import as long as the supply of (indigenous) sustainable energy is insufficient and there is still a demand for natural gas.

The produced or imported volumes must be offset by the reservation of an equivalent volume of storage or sequestration capacity (Carbon Storage Units, CSUs). CSUs can be issued if the CO₂ is verifiably kept out of the atmosphere for a prolonged period of time (geological timescales). Conversely, the gas production or import volume allowance must correspond to the contracted volume of CO₂ capture and storage (or other form of sequestration). Production and

import are thus balanced with the actual storage and with the carbon budget principle.

These CSUs raise the cost price of the produced or imported gas, which will constitute an incentive for its efficient use. There is another potential effect: the carbon footprint of Dutch gas is generally lower than that of imported gas, whilst higher-footprint gas requires more CSUs. In addition to the increase in cost price, this will generate a price differentiation: the lower the carbon footprint, the lower the additional costs for CSUs. Dutch indigenous gas will thus be more competitive vis-à-vis imported gas (if and when upstream emissions are included under the CTBO), and with respect to imported natural gas it will encourage opting for natural gas produced with the lowest possible carbon footprint.

The purchase of CSUs when placing gas on the market will guarantee the realisation of appropriate volumes of CO₂ capture and storage (or alternative acceptable geological and mineral storage and sequestration methods). These will not necessarily involve the CO₂ physically originating from the same gas molecules; initially, it will logically involve CO₂ flows that are relatively cheaply captured and stored.

This will create a demand for CO₂ for storage, which will also make capture financially more attractive.

3.3 CTBO fits in alongside the current emissions trading system (and alongside other instruments)

A CTBO will generate an incentive supplementary to the effect of the emissions trading system (ETS). Businesses and sectors subject to this system are required to purchase and pay for emission rights. CCS will reduce their emissions, which means they will need fewer rights. However, they will incur expenses for CO₂ capture and storage. A Carbon Takeback Obligation will create a demand for CO₂ (and thus put a price on CO₂) because producers and importers of fossil carbon compounds will need to reserve CO₂ to be stored (CSUs). Thus, the CTBO and ETS schemes can be enforced alongside one another (as can other instruments, for that matter). At the current market prices for emission rights, CO₂ capture and storage projects still feature an uneconomically high price that needs to be covered by grants (the SDE++ subsidy scheme in the Netherlands) in order to enable their realisation. The demand for and thus the value of CO₂ via a CTBO will (sharply) reduce this uneconomic maximum and thus enable the substantiation of new CCS business cases.

Figure 3 presents the financial flows related to a carbon takeback obligation and the interaction with ETS.

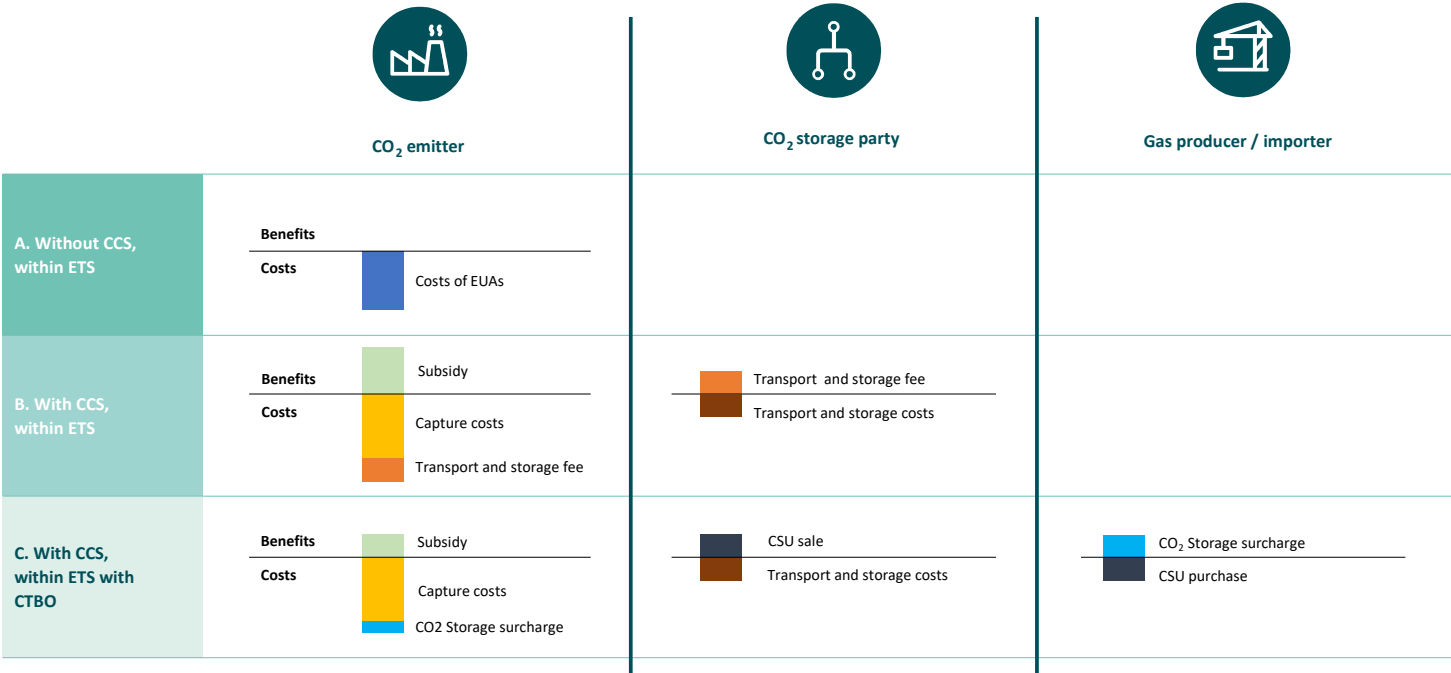


Figure 3: Financial flows related to a carbon takeback obligation, and the interaction with ETS

In the early stages of development, sufficient storage and sequestration capacity will be available. However, as utilisation increases, this capacity will decrease. The price of the CSUs will go up, which will be an incentive to cut down on the consumption of gas. In the beginning, sufficient CO₂ will also be available to be contracted for storage/sequestration, but this supply will diminish over time as well. This may also drive up the price of CSUs and foster the exploration of alternative sources of CO₂, such as Direct Air Capture (DAC) – capturing CO₂ directly from the atmosphere – which will lower the concentration of CO₂. Underground storage or sequestration of CO₂ that is retrieved from the atmosphere (via DAC or biomass) is referred to as negative emissions. In most of the scenarios studied by the IPCC, such negative emissions will be essential in several decades’ time if we want to limit global temperature increase to below 2 degrees and especially if we are aiming for a maximum of 1.5 degrees. The CTBO system is anticipating this development.

3.4 A CTBO has several effects, the most important of which is reducing the risk of exceeding the carbon budget

All in all, therefore, a CTBO will produce the following effects:

- An incentive to reduce gas consumption;
- As long as gas is needed: an advantage for low carbon footprint gas;
- In connection with this for the Dutch situation: a potential advantage for indigenous gas vis-à-vis imported gas with a higher footprint;
- Actual realisation of CO₂ storage and/or sequestration, pursuant to the apparent requirements according to a large proportion of the IPCC scenarios in which the Paris goals are met;
- Application of the polluter pays principle: the gas value chain is responsible for funding its own CO₂ neutrality;
- Eliminating CO₂ from energy flows whose CO₂ would otherwise end up in the atmosphere, and which would reduce the carbon budget;

- Development of an instrument that, after gaining practical experience with natural gas, can also be applied to other carbon flows;
- Anticipating the future need for “negative emissions”, net removal of CO₂ from the atmosphere via, e.g., Direct Air Capture and BECCS;
- Incentive for innovative and cost-effective solutions for CO₂ reduction in the (gas) chain;
- Impetus for the hydrogen economy via “blue” hydrogen: hydrogen (H₂) from natural gas (CH₄) can be utilised, whilst the carbon dioxide (CO₂) is returned to the geosphere.

Example: The implications of a CTBO for gas value chains

The imaginary Gazeuse gas company is producing gas in the Netherlands. Its licence to operate North Sea gas field K45L comes with a carbon takeback obligation: Gazeuse must contract a volume of CO₂ storage units (CSUs) equivalent to the emissions that incineration of this gas would produce. Another company, CarbonStore Ltd, owns storage capacity which it sells to Gazeuse. If the Gazeuse company would have storage capacity of its own, it could itself generate CSUs, but it is also at liberty to purchase CSUs / storage capacity on the market.

Yet another company, ChemoCarb, has flows of CO₂ that are currently being released into the atmosphere. It now captures the CO₂ and provides it to CarbonStore for storage. CarbonStore sells CSUs to companies like Gazeuse and others who need CSUs to meet their CTBO. The gas Gazeuse produces is subsequently sold, possibly via a trading company, to whomever needs it.

Gazeuse will obviously attempt to pass on the additional costs of the CSUs to its buyers. In the event of a voluntary CTBO, this will not be easy: only a few will be prepared to pay a premium for gas produced under a CTBO. A compulsory system (obligation), however, will subject the entire (Dutch, and over time, preferably also the international) gas market to the CSU-related increase in cost price. This will make it easier to pass on the costs of the CSUs. This implies a gas price increase.

The company GasImp, that imports gas must also arrange CSUs. The volume needed is co-dependent on its carbon footprint: the CO₂ emissions generated in the chain during extraction and transport prior to the gas arriving in the Netherlands (CO₂ equivalents to be exact; all greenhouse gases expressed in the global warming potential of CO₂). The subsequent mechanism is identical to that of indigenous production, albeit that gas with a higher footprint will require more CSUs. For the gas market, consequently, the production and utilisation of Dutch gas would be more profitable – assuming that all other factors such as taxes remain constant – than the import of gas extracted elsewhere.

4. A carefully developed roadmap is essential

This report outlines a CTBO model, elaborated for (Dutch) natural gas. As any new instrument in the policy toolbox, it will not be completed overnight. The foundations have been laid but a subsequent development path is still required. To this end, we have drawn up an outline of a roadmap. It is important in this respect that each step must be carefully completed in order to enable the parties involved to help develop this instrument. In addition to improvements and refinements, this will help maintain broad support. Furthermore, this process will allow time to prepare political decisions.

It would seem feasible to aim for launching a pilot in 2023, preparations for which could start presently.

This means:

- 2021: In-depth analysis of /study on the operation of the CTBO instrument: further details, exploration of legal aspects, further exploration of the relation to other instruments, preferably including a model / simulation of its performance;
- 2022: Preparations for pilot, during which several businesses review the potential impact of a CTBO on their choices and considerations, including the calculation of the financial consequences, on the basis of their actual data;
- 2023: Implementation of pilot.

In parallel, the following activities could take place in the period up to 2023:

- Further substantiation, in concert with other countries preparing and considering a CTBO; knowledge exchange, collaboration;
- Exploration of a more comprehensive application: in addition to natural gas, other fossil fuels and possibly biotic stocks.

These steps could constitute the basis for the further substantiation – within legal and financial frameworks – of the instrument and the required organisational context (organisations and roles with respect to the CTBO). This will enable preparations for political decisions. A conceivable time frame would be to have decision-making be possible by 2024.

In the implementation phase, following a successful pilot phase, the storage (CSUs) – new fossil hydrocarbons ratio could be gradually increased. A key goal is to have each new volume of fossil hydrocarbons eventually offset by 100% storage. Subsequently, the requirement could be raised to more than 100%, thus resulting in negative emissions (active removal of CO₂ from the atmosphere).

5. Conclusions

This report outlines the development of a new instrument, the Carbon Takeback Obligation (CTBO), which is elaborated for natural gas.

The findings, also underpinned by discussions with the Sounding Board Group, can be summarised as follows:

- The current instruments mainly focus on emissions and do not address the sources: the volumes of fossil carbon compounds that – to all appearances – will continue to be produced for a prolonged period of time;
- This entails the risk of exceeding the carbon budget, i.e., the volume of CO₂ that can still be released into the atmosphere if global warming needs to be limited to 2 or 1.5 degrees;
- This risk can be mitigated by placing new fossil hydrocarbons on the market only upon securing the storage or other form of sequestration of the CO₂ that would be released during their incineration. A Carbon Takeback Obligation would provide such security;
- A CTBO can be substantiated as an effective instrument that enables climate-neutral extraction and utilisation of natural gas; raises the price of gas and thus further promotes the transition towards renewable sources; fosters the use of indigenous gas with a low carbon footprint over the use of imported gas with a higher footprint; and puts a value on stored CO₂;
- A CTBO can exist alongside other emission-driven instruments, such as the European emissions trade system;
- The further development of the CTBO, in accordance with a series of careful steps outlined in a roadmap, is recommended in order to pursue an implementable instrument as an essential supplement to the current mix of instruments.



Een beknopte gids voor een producentenverantwoordelijkheid voor koolstof (Carbon Takeback Obligation CTBO)

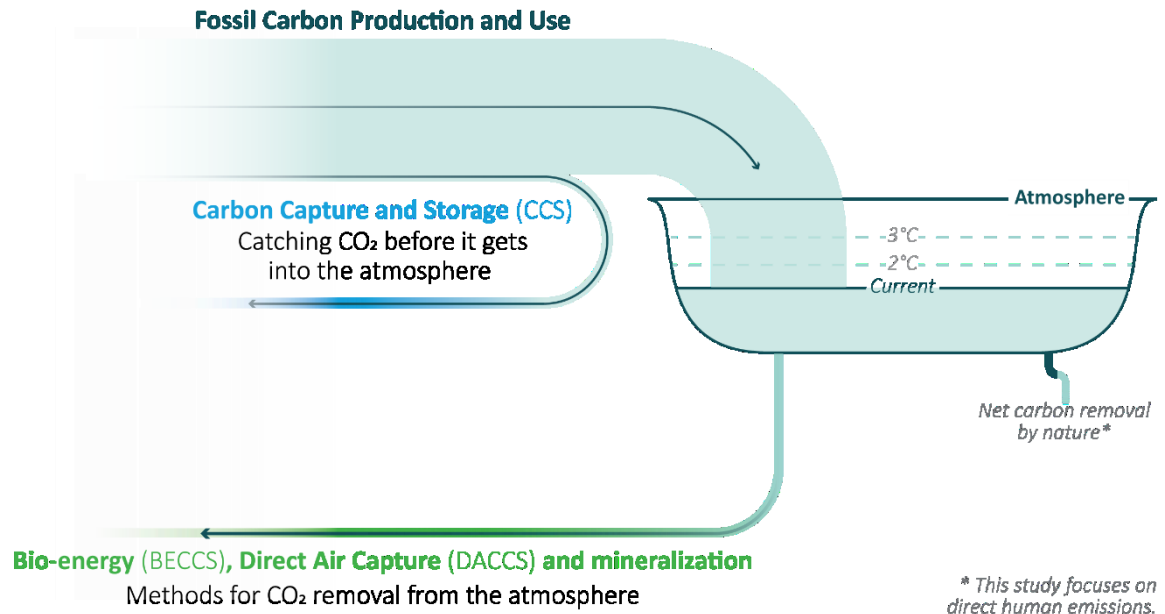
1. Het klimaatvraagstuk vraagt extra instrumenten

1.1 Een snel slinkend koolstofbudget betekent alle hens aan dek

In het Klimaatakkoord van Parijs is afgesproken de opwarming tot maximaal 2 graden, en liefst 1,5 graden, te beperken. Landen, bedrijven en andere niet-gouvernementele organisaties werken aan (verregaande) reducties van de uitstoot van broeikasgassen.

Maar als het internationale en ook nationale klimaatbeleid tegen de inzichten uit de klimaatwetenschap en de huidige economische ontwikkelingen wordt gehouden, dan blijkt dat er risico's zijn dat de doelstellingen niet worden gehaald:

- De twee(of 1,5-)-gradendoelstelling impliceert een *koolstofbudget* (carbon budget): het is de *concentratie* van broeikasgassen in de atmosfeer die de opwarming bepaalt. Gegeven de huidige concentratie in de atmosfeer en gegeven de instroom (emissies) en beperkte 'uitstroom' (verwijdering van broeikasgassen uit de atmosfeer), dreigt overschrijding van het 2 graden concentratieniveau. Vergelijk een badkuip die vol blijft lopen ook als de kraan minder hard loopt (Figuur 1)
- Op termijn moet niet alleen de kraan dicht (emissies naar nul) maar moet ook de waterspiegel dalen door de afvoer te vergroten (netto verwijdering van broeikasgassen uit de atmosfeer, zogeheten negatieve emissies).



Figuur 1: De atmosfeer als koolstofbadkuip. Het koolstofbudget is te zien als een vollopende badkuip: de opwarming wordt bepaald door de concentratie van broeikasgassen in de atmosfeer (het waterpeil in de badkuip).

1.2 Naast sturing op emissies is ook sturing op bronnen nodig

In de gangbare beleidspakketten ligt de nadruk op het sturen op emissies ('sturen op schoorstenen en uitlaten') via instrumenten als het emissiehandelssysteem, normstelling voor de uitstoot van auto's, verminderen van de uitstoot door de gebouwde omgeving, etc.), en op het *substitueren* van energiebronnen die tot CO₂-uitstoot leiden door bronnen die CO₂-vrij zijn, zoals zon, wind, geothermie.

De doorgroeiende vraag naar energie echter betekent ook blijvende vraag naar fossiele brandstoffen zolang het aanbod van hernieuwbare energie onvoldoende is om de vraag te dekken. In deze vraag wordt voorzien door nieuwe koolwaterstoffen op de markt te brengen die bij toepassing CO₂-uitstoot veroorzaken. Elke koolwaterstofvoorraad (uit de geosfeer) die op de markt wordt gebracht zal uiteindelijk via verbranding CO₂ worden en in de atmosfeer komen. Er is wereldwijd momenteel al meer (fossiele) koolstof 'in de pijplijn' (concessies, in productie en in bewerking/voorraden) dan het koolstofbudget toelaat.² Er is weinig aandacht voor het

CO₂-vrij maken van fossiele brandstoffen, en marktpartijen die koolstof(verbindingen) produceren of importeren zijn ook weinig of niet onderhevig aan prikkels (incentives) die dat bevorderen.

1.3 Stuur op stromen (emissies) én voorraden (in geosfeer, biosfeer en atmosfeer)

Om dit *risico* op het niet halen van de klimaatdoelstellingen te beperken zijn aanvullende beleidsinstrumenten nodig die:

- Sturen op *voorraden* ('stocks'): geologische koolstofvoorraden, maar ook biotische voorraden (koolstof in natuurlijke systemen met het oog op de 'voorraad' CO₂ in de atmosfeer die moet worden beperkt)
- Sturen op de 'ontkoling' van koolstofstromen en -ketens ('flows') zolang deze in de energie- en grondstoffenvoorziening worden ingezet.

Met een uitgebreidere instrumentenmix is meer integraal 'stocks and flows management' mogelijk, zodat de combinatie

² Cf. Stockholm Environment Institute (2016). *Fossil fuel production in a 2°C world: The equity implications of a diminishing carbon budget*.

<https://mediamanager.sei.org/documents/Publications/Climate/SEI-DB-2016-Equity-fossil-fuel-production-rents.pdf>.

van beleidsinstrumenten klopt met de inzichten uit de
klimaatwetenschap over het carbon budget. Zie figuur 2:
Supply side policies.

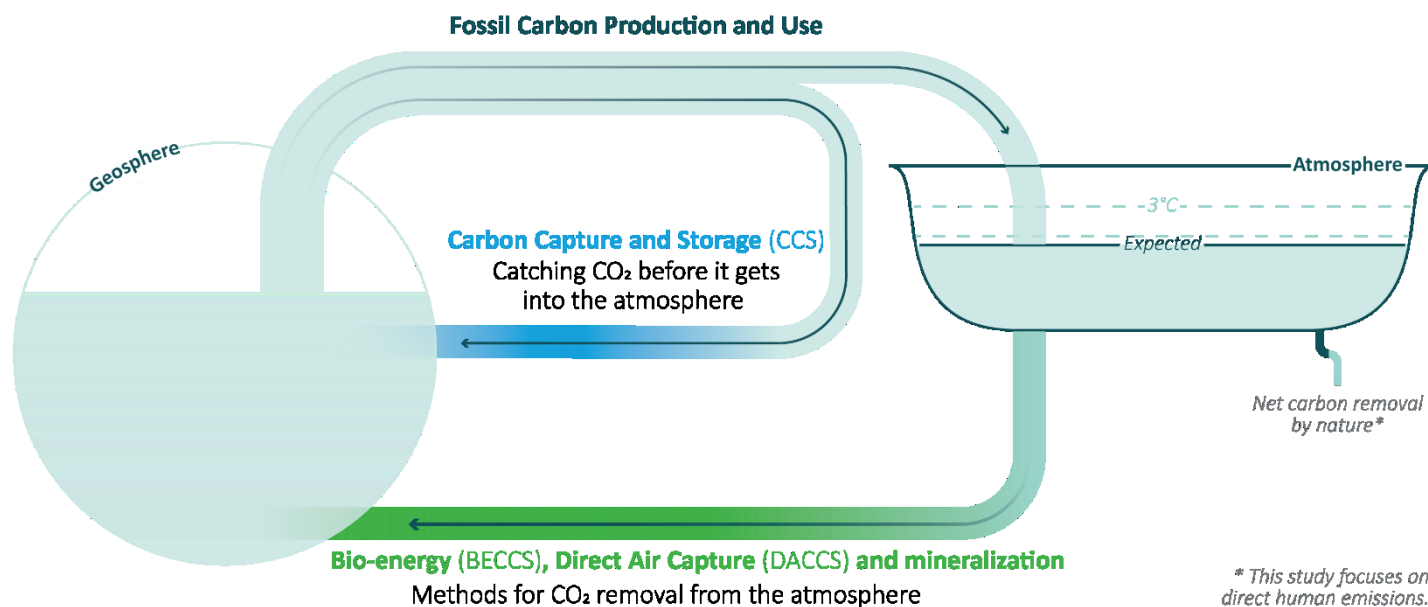


Figure 2: Supply-side policies would focus on water production; demand-side policies focus on waterflow into the bathtub

2. Een carbon takeback obligation (CTBO) is een kansrijk aanvullend instrument

2.1 Een CTBO regelt dat fossiele koolstof niet in de atmosfeer komt

Een *carbon takeback obligation* (CTBO) is een regeling die ervoor zorgt dat op de markt gebrachte koolwaterstoffen uiteindelijk per saldo CO₂-vrij worden toegepast. Dit kan een belangrijk instrument zijn aanvullend op het huidige instrumentarium. Dit idee werken we in dit rapport uit: wat is het, hoe werkt het, hoe verhoudt het zich tot andere instrumenten, en wat is nodig om het instrument verder te ontwikkelen en toe te passen.

Dit rapport is mede opgesteld op basis van discussies in een Klankbordgroep met uiteenlopende stakeholders, om ervoor te zorgen dat van meet af aan vanuit verschillende perspectieven over de ontwikkeling van dit instrument kon worden meegedacht. Daarnaast zijn steeds inzichten uitgewisseld met onderzoekers in o.a. het VK en de VS, om aan te sluiten bij de internationale ontwikkelingen.

Een Carbon Takeback Obligation (CTBO) is een nieuw instrument dat regels stelt aan nieuw op de markt gebrachte koolstofverbindingen die als energie en grondstoffen worden ingezet. Dat kunnen vrijwillige aangegane verplichtingen zijn, maar de effectiviteit is veel groter als het verplichtende regels zijn.

2.2 De kern: stel verplicht dat producenten en importeurs opslag of vastlegging van CO₂ geborgd hebben voor ze fossiele koolstofverbindingen produceren of importeren

De kern is dat een producent of importeur die dergelijke koolstofverbindingen op de markt brengt er voor zorg dient te dragen dat een toenemend percentage van de CO₂ die bij gebruik vrij zou komen, wordt vastgelegd/opgeslagen in plaats van in de atmosfeer wordt geloosd. De producent of importeur hoeft niet per se zelf de vastlegging/opslag uit te voeren, al mag dat wel, maar regelt primair dat de mogelijkheid van opslag/vastlegging er is.

Dat kan door direct bij productie of import van (fossiele) koolwaterstoffen opslag- en/of vastleggingsmogelijkheden te contracteren, of carbon storage units (CSU's) van derden te kopen, of (gezamenlijk) een opslagbedrijf op te zetten dat voldoende CSU's genereert. Het kan hierbij gaan om 'permanente' opslagcapaciteit voor CO₂ zijn in geologische reservoirs zoals uitgeproduceerde gasvelden, of wellicht in de vorm van mineralen en materialen. Ook vastlegging in natuurlijke systemen is denkbaar, maar voor de helderheid (en om permanentie te kunnen garanderen) lijkt het 'like for like'-principe het meest verdedigbaar: wat uit de geosfeer komt, moet naar de geosfeer terug; geologische opslag of mineralisatie, derhalve.

De opslageenheden ('carbon storage units') zijn hard gekoppeld aan de daadwerkelijke hoeveelheden opgeslagen CO₂; productie of import mag alleen als de verplichte hoeveelheid CSU's is aangekocht van partijen die CO₂-opslag doen (of anderszins blijvend vastleggen). Zo kan worden geborgd dat tegenover elke hoeveelheid koolwaterstoffen die op de markt wordt gebracht, door productie of door import, een oplopend percentage CO₂ wordt opgeslagen of vastgelegd, en daarmee buiten de atmosfeer blijft. Productie of import en gebruik van koolwaterstoffen voegt dan uiteindelijk géén CO₂ meer toe aan de atmosfeer.

2.3 CTBO is een brongericht instrument dat doorwerkt in de gehele keten

De verplichting wordt bij de producent of importeur neergelegd, en werkt naar zijn aard door over de gehele waardeketen.

Koolstofketenregeling zou de Nederlandse naam van het instrument kunnen zijn. Of 'Producentenverantwoordelijkheid koolstof', analoog aan de bestaande producentenverantwoordelijkheden die onder meer milieuvriendelijke verwerking van verpakkingen, auto's of witgoed regelen. Verpakkingsproducenten bijvoorbeeld zijn gehouden hun materialen, die elders in de keten afval worden, milieuvriendelijk te verwerken, en betalen daar ook een bijdrage voor waaruit de kosten voor inzameling en recycling worden betaald. Analoog betalen producenten en importeurs bij een CTBO een bijdrage voor de carbon storage units (CSU's) die opslag/vastlegging van CO₂ mogelijk maakt.

Het instrument is zo ook te zien als een *bestemmingsheffing plus uitvoeringsverplichting* die aan het begin van de keten wordt vastgesteld, zodanig dat de revenuen voldoende zijn om een toenemend percentage van de door die keten normaliter gegenereerde CO₂ blijvend uit de atmosfeer te houden.

Het instrument kan in beginsel toegepast worden op verschillende koolstofvoorraden die bij gebruik tot emissies van CO₂ naar de atmosfeer kunnen leiden, zoals de fossiele brandstoffen kolen, olie en gas, maar mogelijk ook voor biotische koolstofvoorraden.

“Het instrument is zo ook te zien als een bestemmingsheffing plus uitvoeringsverplichting die aan het begin van de keten wordt vastgesteld, zodanig dat de revenuen voldoende zijn om een toenemend percentage van de door die keten normaliter gegenereerde CO₂ blijvend uit de atmosfeer te houden.”



3. Een CTBO voor gas is uitvoerbaar en effectief

3.1. Uitwerking voor aardgas

In overleg met de Klankbordgroep hebben we ervoor gekozen het instrument CTBO uit te werken voor *aardgas*, toegepast op de Nederlandse situatie, waarin er binnenlands gas is, en er internationale gashandelsstromen zijn. In latere onderzoeken kan het instrument ook voor andere voorraden worden uitgewerkt. Energiescenario's laten zien dat de (wereld)vraag naar fossiele brandstoffen nog lang blijft bestaan, en dat aardgas daarin een prominente rol vervult.

Toepassing op aardgas kan een belangrijk eerste toepassingsgebied voor een CTBO zijn. De hoeveelheid gasproducenten en importeurs is beperkt en overzienbaar, en gasproductie en import is al aan diverse regels gebonden. En ze hebben voldoende kennis en financiële middelen om een CTBO uit te kunnen voeren. Dat maakt het makkelijk aan het begin van de gasketen een verplichting te introduceren. Ook de opslag zal, gegeven de gasvolumina die voorlopig nog in omloop zijn, grootschalig zijn via een overzichtelijk aantal goed controleerbare spelers.

3.2. Een CTBO voor aardgas maakt klimaatneutraal gas mogelijk

Een CTBO voor gas maakt het mogelijk om uiteindelijk netto CO₂-neutraal binnenlands gas te produceren en/of te importeren zolang er nog onvoldoende aanbod van (binnenlandse) duurzame energie is, en er nog vraag naar gas resteert.

Tegenover de geproduceerde of geïmporteerde hoeveelheid moet een overeenkomstige hoeveelheid opslag- of vastleggingscapaciteit worden gereserveerd (Carbon Storage Units, CSU's). CSU's kunnen worden verstrekt als de CO₂ verifieerbaar langdurig (geologische tijdschalen) uit de atmosfeer wordt gehouden. Omgekeerd kan slechts een hoeveelheid gasproductie of -import worden toegestaan die overeenkomt met de gecontracteerde hoeveelheid CO₂-afvang en -opslag (of andersoortige vastlegging). Daarmee worden productie en import in balans gebracht met de daadwerkelijke opslag, en met het beginsel van het carbon budget.

Deze CSU's verhogen de kostprijs van het geproduceerde of geïmporteerde gas, wat een positieve prikkel is voor efficiency bij gebruik. Er is nog een tweede mogelijk effect: de carbon footprint van Nederlands gas in het algemeen lager is dan van geïmporteerde gas, waardoor voor gas met een hogere footprint meer CSU's nodig zijn. Daarmee ontstaat naast de kostprijsverhoging een prijsdifferentiatie: hoe lager de carbon footprint, des te lager de meerkosten voor CSU's. Dat maakt binnenlands gas competitiever ten opzichte van geïmporteerde gas (als en wanneer de upstream emissies van import gas meegerekend gaan worden onder de CTBO-regels). En bij geïmporteerde aardgas stimuleert dit het gebruik van aardgas geproduceerd met een zo laag mogelijke carbon footprint.

De aankoop van CSU's bij het op de markt brengen van gas garandeert dat er een passende hoeveelheid CO₂-afvang en -opslag (of alternatieve toegestane geologische en minerale opslag- en vastleggingsmethoden) wordt gerealiseerd. Dat is niet per se de CO₂ die fysiek van dezelfde gasmoleculen afkomstig is, het zullen initieel logischerwijze die CO₂-stromen zijn die zich relatief goedkoop laten afvangen en opslaan.

Er ontstaat zo vraag naar CO₂ voor opslag, waardoor afvang ook eerder financieel aantrekkelijk wordt.

3.3. CTBO past naast het huidige emissiehandelssysteem (en naast andere instrumenten)

De prikkel die een CTBO veroorzaakt komt bovenop het effect van het emissiehandelssysteem (ETS). Bedrijven en sectoren die daaronder vallen moeten rechten kopen om te mogen emitteren, en betalen daarvoor een prijs. Als zij CCS toepassen emitteren ze minder en hebben ze dus minder rechten nodig, ze maken dan wel kosten voor CO₂-afvang en -opslag. Als een Carbon Takeback Obligation werkzaam is, ontstaat er vraag naar CO₂ (en daarmee een prijs) omdat producenten en importeurs van fossiele koolstofverbindingen CO₂ moeten reserveren om op te kunnen slaan (CSU's). CTBO en ETS (en overigens ook andere instrumenten) kunnen zo naast elkaar bestaan. Bij de huidige marktprijzen voor emissierechten hebben CO₂-afvang en -opslagprojecten nog steeds een onrendabele top die met subsidies (SDE++) moet worden afgedekt om doorgang te kunnen vinden. De vraag naar en daarmee waarde voor CO₂ via CTBO zal die onrendabele top (sterk) verkleinen en zo nieuwe businesscases voor CCS sluitend kunnen krijgen.

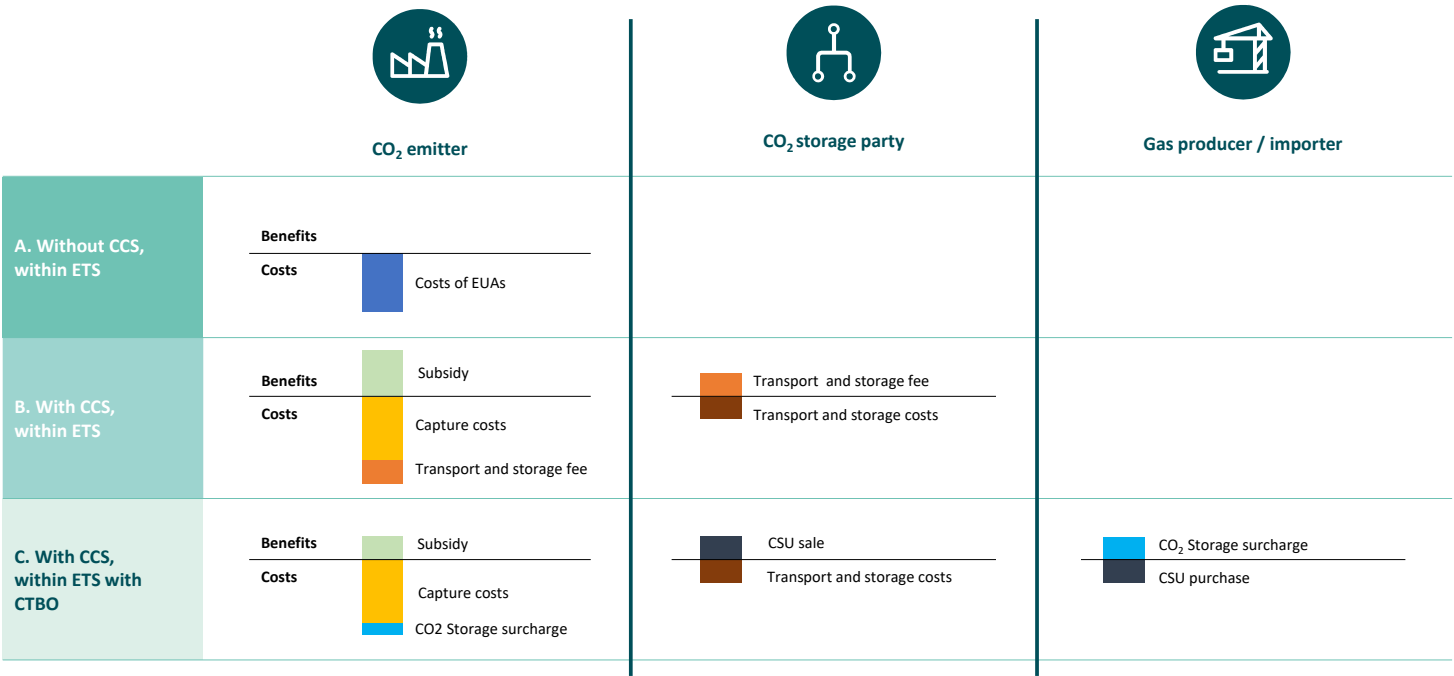


Figure 3: Financial flows related to a carbon takeback obligation, and the interaction with ETS

Figuur 3 laat zien hoe de financiële stromen lopen in relatie tot een carbon takeback obligation en wat de interactie is met het emissiehandelssysteem (ETS).

In het begin van de ontwikkeling zal er voldoende opslag- en vastleggingscapaciteit beschikbaar zijn, maar die neemt af als er meer gebruik van wordt gemaakt. Dat verhoogt dan de prijs van de CSU's, wat er toe aanzet minder (CO₂-vrij) gas te gebruiken. In het begin zal er eveneens voldoende CO₂ beschikbaar zijn om voor opslag/vastlegging te contracteren, maar ook dat neemt af. Ook dat kan voor hogere prijzen van CSU's zorgen, en kan stimuleren dat naar alternatieve bronnen van CO₂ wordt gezocht zoals Direct Air Capture (DAC), directe 'vangst' van CO₂ uit de atmosfeer, wat de CO₂-concentratie verlaagt. Als uit de atmosfeer gehaalde CO₂ (via DAC of biomassa) wordt opgeslagen in de ondergrond of vastgelegd zijn dat negatieve emissies. In de meeste scenario's die in het IPCC zijn bestudeerd zijn deze negatieve emissies over enkele tientallen jaren noodzakelijk wil de opwarming tot onder de 2 graden, en zeker tot onder de 1,5 graad, beperkt blijven. Het CTBO-systeem sorteert daarop voor.

3.4 Een CTBO heeft verschillende effecten; de belangrijkste is het beperken van het risico dat het koolstofbudget overschreden wordt

Al met al heeft een CTBO dus als effecten:

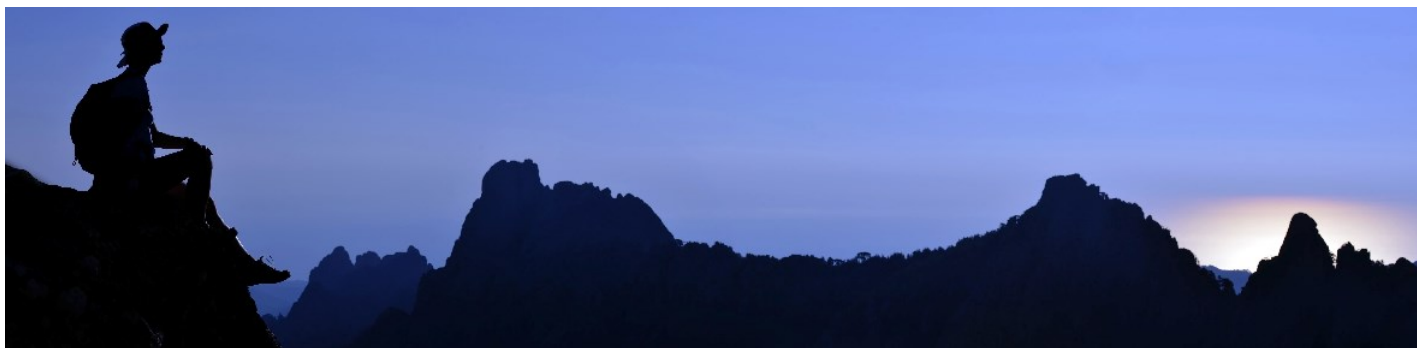
- Een stimulans om minder gas te gebruiken
- Zolang gas nodig is: een voordeel voor gas met een lage carbon footprint
- Hiermee samenhangend een potentieel voordeel voor binnenlands gas ten opzichte van geïmporteerd gas met een hogere footprint
- Daadwerkelijke realisatie van CO₂-opslag en/of -vastlegging, conform wat nodig lijkt te zijn in een groot deel van de IPCC-scenario's waarin de Parijs-doelstellingen haalbaar zijn,
- Toepassing van het vervuiler betaalt principe: de gasketen zelf bekostigt de eigen CO₂-neutraliteit
- CO₂-vrij maken van energiestromen waarbij de CO₂ anders in de atmosfeer zou belanden, en waardoor het koolstofbudget afneemt
- Ontwikkeling van een instrument dat na praktijkervaring met aardgas ook op andere koolstofhoudende stromen kan worden toegepast
- Voorsorteren op de latere noodzaak voor 'negatieve emissies', netto-verwijdering van CO₂ uit de atmosfeer via bijvoorbeeld 'Direct Air Capture' en BECCS
- Stimulans voor innovatieve en kosteneffectieve oplossingen voor CO₂-reducties in de (gas)keten
- Impuls voor de waterstofeconomie via 'blauwe' waterstof: waterstof (H₂) uit aardgas (CH₄) kan worden benut, de koolstof (CO₂) wordt in de geosfeer teruggebracht.

Kader: Wat een CTBO voor gasketens betekent

Een denkbeeldig gasbedrijf Gazeuse produceert gas in Nederland en krijgt gekoppeld aan de concessie voor het produceren van gasveld K45L op de Noordzee tevens een carbon takeback obligation. Gazeuse moet dan een hoeveelheid CO₂-opslageenheden (CSU's) contracteren die overeenkomen met de emissies die het verbranden van dat gas zou opleveren. Een andere maatschappij, CarbonStore, heeft bijvoorbeeld opslagcapaciteit ter beschikking en verkoopt capaciteit aan Gazeuse. Als Gazeuse zelf opslagcapaciteit heeft, kan het bedrijf zelf CSU's genereren, maar het heeft ook de vrijheid de CSU's/opslagcapaciteit op de markt te kopen.

Nog een ander bedrijf, ChemoCarb, heeft stromen CO₂ die nu in de atmosfeer worden geloosd, en die na afvang van de CO₂ deze overdraagt aan CarbonStore voor opslag. CarbonStore verkoopt de CSU's die dit oplevert aan bedrijven zoals Gazeuse die CSU's nodig hebben om te mogen blijven produceren (of importeren). Het geproduceerde aardgas wordt verder, mogelijk via een handelsbedrijf, gewoon verkocht aan wie het nodig heeft.

Gazeuse zal natuurlijk proberen de extra kosten voor de CSU's door te berekenen aan de afnemers. In geval van een vrijwillige CTBO zal dat niet meevallen, slechts een enkeling zal bereid zijn een premium te betalen voor gas dat voldoet aan een CTBO. Maar in het geval van een verplicht systeem ('obligation'), dan wordt de gehele (Nederlandse, en op zeker moment liefst ook internationale) gasmarkt aan de kostprijsverhoging door CSU's blootgesteld. Dan kan doorrekening van de CSU-kosten eenvoudiger plaatsvinden. Dat impliceert een prijsverhoging van gas.



Als een ander bedrijf, GasImp, gas importeert, dan moeten eveneens CSU's worden geregeld. Hoeveel er nodig zijn hangt mede af van de carbon footprint, de CO₂-emissies die in de keten bij winning en transport zijn ontstaan voor het gas in Nederland is aangekomen (CO₂-equivalenten om precies te zijn, alle broeikasgassen uitgedrukt in de opwarmingskracht van CO₂). Het verdere mechanisme is hetzelfde als bij productie uit eigen bodem, zij het dat er voor gas met een hogere footprint meer CSU's moeten worden geregeld. Dat maakt het voor de gasmarkt – als alle andere factoren zoals belastingen gelijk blijven – aantrekkelijker om Nederlands gas te produceren en in te zetten dan om elders gewonnen gas te importeren.

4. Een zorgvuldig ontwikkelpad (routekaart) is nodig

Dit rapport schetst hoe een CTBO eruit kan zien, en werkt dat uit voor (Nederlands) gas. Het gaat om een nieuw instrument in de beleidsgereedschapskist, dat niet van de ene dag op de andere gereed is. De basis ligt er, maar een verder ontwikkelpad is nog nodig. Daarvoor is een beknopte routekaart opgesteld. Van belang daarin is dat de stappen zorgvuldig worden doorlopen, zodat betrokkenen de gelegenheid hebben mee te ontwikkelen aan dit instrument, en zowel verbeteringen en verfijningen alsook draagvlak ontstaat. Daarmee is er ook tijd voor het voorbereiden van politieke beslissingen.

Haalbaar lijkt te mikken op een pilot in 2023, die vanaf heden tot dan kan worden voorbereid.

Dat betekent:

- 2021 Verdiepende analyse/studie over de werking van het instrument CTBO: nadere detaillering, verkenning juridische aspecten, verder uitdiepen van de verhouding met andere instrumenten, liefst ook een modellering/simulatie van de werking
- 2022: Voorbereiden pilot, waarin enkele bedrijven op basis van hun feitelijke gegevens doordenken en doorrekenen hoe een CTBO zou uitvallen voor hun keuzes en afwegingen

- 2023: Uitvoering pilot

Parallel vinden tussen heden en 2023 verdere activiteiten plaats:

- Verder vormgeven samenwerking met andere landen die een CTBO voorbereiden en overwegen; kennisuitwisseling, samenwerking.
- Onderzoek naar verbrede toepassing, naast aardgas ook andere fossiele en mogelijk ook biotische voorraden

Op basis van deze stappen kan het instrument en de benodigde organisatorische context (organisaties en rollen t.a.v. de CTBO) dan verder worden vormgegeven in een juridisch en financieel kader. Daarmee kan politieke besluitvorming worden voorbereid. Denkbaar is dat in 2024 besluitvorming aan de orde is.

Voor de implementatie kan, na een succesvolle pilotfase, het percentage opslag (CSU's) tegenover nieuw fossiel stapsgewijs worden verhoogd. Van belang is dat op zeker moment tegenover elke nieuwe hoeveelheid fossiele koolwaterstoffen 100% opslag staat. Het is vervolgens mogelijk meer dan 100% voor te schrijven, waardoor negatieve emissies ontstaan (actieve verwijdering van CO₂ uit de atmosfeer).

5. Conclusies

In dit rapport ontwikkelen we een nieuw instrument, de Carbon Takeback Obligation (CTBO) en werken dat uit voor aardgas.

De bevindingen, mede op basis van de gesprekken met de Klankbordgroep, zijn samengevat:

- Het huidige instrumentarium stuurt vooral op emissies, en grijpt niet aan bij de bronnen, de hoeveelheden fossiele koolstofverbindingen die naar het zich laat aanzien nog langere tijd op de markt worden gebracht.
- Daardoor is er een risico dat het carbon budget wordt overschreden; dit is de hoeveelheid CO₂ die nog in de atmosfeer kan worden geloosd als de opwarming tot 2 of 1,5 graad beperkt moet blijven
- Dit risico kan worden verkleind door alleen maar nieuwe fossiele koolwaterstoffen op de markt te brengen als

geborgd is dat de CO₂ die bij de verbranding daarvan vrij zou komen wordt opgeslagen of anderszins vastgelegd. Een Carbon Takeback Obligation regelt dit.

- CTBO kan worden vormgegeven als effectief instrument, dat klimaatneutraal aardgaswinning- en gebruik mogelijk maakt, gas duurder maakt en daardoor de transitie naar hernieuwbare bronnen verder bevordert, binnenlands gas met een lage carbon footprint bevordert door geïmporteerd gas met een hogere footprint, en ervoor zorgt dat opgeslagen CO₂ een waarde krijgt.
- CTBO kan naast andere op emissies sturende instrumenten, zoals het Europese emissiehandelssysteem, bestaan.
- Verder ontwikkeling van CTBO, volgens een serie zorgvuldige stappen in een routekaart, is aanbevolen om toe te werken naar een implementeerbaar instrument, dat een noodzakelijke aanvulling op de instrumentenmix is.

1. Introduction

1.1. Reasons for this report

The world is searching for pathways and policy instruments that can make sure that the Paris climate targets can be met. As pointed out in general introduction chapter (“Brief Guide to a Carbon Takeback Obligation”) and further on in this report, quite some emphasis is placed on measures and instruments aiming at emissions. Meanwhile, the production and marketing of fossil fuels, that eventually end up as emissions, is currently not limited by climate restrictions. In this report we present an approach that regulates the carbon content of fossil hydrocarbons brought to the market. This instrument, a Carbon Takeback Obligation (CTBO), is elaborated in this report. This has been done by stakeholder-involved research, by researchers in interaction with a broad Sounding Board Group. The content of the report is the sole responsibility of the authors of the report. Sponsors and members of the Sounding Board Group agree that the report contains a fair representation of the discussions held in the stakeholder meetings and support the proposals for further investigations of the development of the CTBO as a potential policy tool for timely reduction of emissions from fossil energy use.

1.2. Current approaches

In the light of threatening climate change, the debate on key mitigation strategies has become quite intense. We see four main approaches. See also Appendix F.

1. Close down

One approach can be summarized by ‘keep it in the ground’, which states that there are more hydrocarbons in the earth’s crust than can ever be burnt if we want to keep warming below 2, let alone 1.5 degrees C above pre-industrial levels. These reserves are called ‘unburnable carbon’. On the basis of this analysis, a movement under the names of ‘keep it in the ground’, ‘fossil free’, ‘divest’, ‘non-proliferation treaty’, and other terms has gained momentum.

Counterarguments are that most future projections show a continuous growing global energy demand, that cannot fully be met by a growing production of renewable energy. Besides

that, energy companies act on a global market, and if one company decides to keep its reserves in the ground, another company immediately takes over. This dilemma can only be tackled by collective measures, e.g. taken by governments, to regulate all players, but the history of climate negotiations shows that this process requires lots of time. Decisions as to which resources and where need to be kept in the ground, and which ones can be exploited will probably lead to a geopolitical stalemate.

2. Outcompete

Another approach is trying to outcompete fossil fuels, by putting huge efforts in reducing the costs of renewables. Energy efficiency is, in spite of its potential still an underrated route. Indeed, in some e.g. very sunny and/or windy areas, the production costs of renewables equals those of fossil fuels.

Counterarguments are that this approach takes much time, resources and effort, while meanwhile the carbon clock is ticking, year after year fossil carbon is added to the atmosphere, that will soon reach a level that corresponds with 1.5 degrees and 2.0 degrees of warming. Besides that, cheap energy pushes energy demand, whereas lower demand would be recommendable, as all energy sources have their specific impacts.

3. Carbon Pricing and regulations

A third approach, which is currently the dominant strategy, in combination with the second approach, is regulating emissions, by means of standards and regulations and financial incentives like taxes and cap-and-trade-systems such as the ETS. The rationale is that it is not the exploration and production of fossil fuels that cause global warming, but the actual use of fossil fuels cause the emissions, that accumulate in the atmosphere.

In principle, this strategy could be sufficient. If all emissions are regulated and taxed enough, this would put a cap on emissions that would impact energy markets, and hence indirectly influence the profitability of production and the amount of fossil fuels that is ‘in the pipeline’ and brought to the market.

Counterarguments are, again, time and the ticking carbon clock, and the observation that carbon emissions are only partially regulated, and not so tight that fossil fuel production levels are being effectively influenced by emission reduction strategies. Politically acceptable carbon prices are often too low to be effective.

4. Clean up

There is a fourth way, maybe not a separate strategy but at least an add-on to the aforementioned approaches: a carbon takeback obligation. A carbon takeback obligation links production of hydrocarbons upstream with carbon removal downstream, in such a way that fossil fuels, as long as their use is inevitable, pay for their own decarbonization. The case for some form of mandatory carbon sequestration was originally made in 2009 by prof. Myles Allen.³ More recently the idea has been included in the ten-point action plan of the Net Zero All-Party Parliamentary Group in the UK.

A carbon takeback obligation:

- is a bridging instrument on the way to a (net) zero emissions system (and even beyond that point: negative emissions).
- links carbon flows entering the economy to carbon emissions leaving the economy and makes sure that when they leave, they will be kept out of the atmosphere
- allows for the production and use of additional hydrocarbons as long as they cannot be replaced fast enough by energy efficiency and renewables, or other carbon free sources, and guarantees that the unavoidable use of fossil carbon does not add unsafe amounts of carbon to the atmosphere.
- provides a carbon stocks and flows management scheme for managing carbon stocks and flows in the geosphere, the biosphere and the atmosphere that is currently lacking in the overall climate instruments portfolio. The CTBO is a science-based instrument building on the scientific understanding of the carbon cycle.
- is a risk hedging and management instrument ('safety net') and control button in the sense that its use can be adapted depending on the effectiveness of current strategies: e.g. the more effective the substitution of fossils by renewables is, the less stringent the carbon takeback obligation needs

to be. This can be done by setting an obligatory takeback percentage/'stored fraction', from low to a full 100%, or even higher to create an incentive for negative emissions.

In the end all four approaches are likely to be used in parallel. This report focusses on the fourth approach: cleaning up the remaining use of fossil carbon so that commitments made under the Paris agreement can be met independently of how quickly renewable energy can be scaled up.

We think a CTBO is the most promising policy tool to achieve that objective. There is no support in society for endless subsidies for carbon capture and storage (CCS). There is a big question therefore on what will happen after the SDE++ subsidies for CCS will end. It is very likely that more CCS will be required still. The CTBO addresses this concern in a way that gives investors confidence to continue investing and ensures that the costs of 'cleaning up' are carried by the partners in the gas value chain (including the customer) so that in the end the polluter no longer just pays to pollute (as with simple carbon taxes) but actually pays to clean up (emission reductions).

1.3. Overview of the Report

In Chapter 2 we start with a more in-depth look at what carbon management actually means. As the CTBO is all about carbon balancing it is important to have a shared understanding of basic carbon accounting and the most important carbon stock and flows. We also describe a vision of what this means for the longer-term when we have actually achieved carbon neutrality at an acceptable level of greenhouse gas concentrations in the atmosphere. This longer-term vision helps to understand the important role a CTBO could play, both in the short-term and in the longer-term.

In Chapter 2 we further discuss policy options, the difference between supply- and demand-side policies, and how a CTBO could complement existing policies. Finally, an overview is given of the different ways in which a CTBO can help lower the carbon footprint of natural gas (production, sale, use).

In Chapter 3 we present the results of a discussion on the objectives and boundary conditions for a CTBO. What do we want to achieve with a CTBO? What is the purpose? And what do the experts and stakeholders think are important boundary

³ More on the history of this idea on <https://carbontakeback.org/resources/>.

conditions for implementation? What needs to be safeguarded? What unwanted side-effects have to be avoided? Etc. These shared objectives and boundary conditions were then used (and further defined and improved) during subsequent discussions about the design choices.

There are many, many different ways in which a CTBO policy can be designed and implemented. Together with our Sounding Board Group we selected six design choices to be discussed in more detail. The preferred choices are presented in Chapter 4, and a more detailed description of these options can be found in Appendix B2. This also means that quite a few design options were not discussed in detail with the Sounding Board Group. Some of these other design options are listed and discussed by the project team in chapter 4.8.

Chapter 5 has been added to answer questions that often came up in discussions about the possible impacts of a CTBO. At this stage this is a qualitative assessment. In a next phase it is important to back that up with model simulation, expert input and where possible quantification.

Finally, in Chapter 6 we outline the different ingredients for a roadmap for further development of the CTBO. We also describe different approaches or strategies that could be considered.

It is important to mention that, except for Chapter 2 (which deals with carbon management in general for all carbon flows and stocks influenced by humans), the focus in most of the report is on *natural gas production, import and use* in the

Netherlands. In next steps, other applications can be worked out in more detail too.

In principle the CTBO could and should cover all fossil carbon use that:

- a) leads to CO₂ emissions in the Netherlands and that
- b) is *not* covered yet by other supply-side policies to reduce the emissions.

Natural gas is likely to be the fossil carbon that will be used the most and the longest still in the Netherlands, and at the moment there are no other supply-side policies yet for natural gas. That's why we are focussing on natural gas for this first exploratory study.

See further Chapter 4.8 and Appendix F.

To complete the report, six appendices have been added:

- A. The original project proposal
- B. Meeting reports and pre-reads
 - 1. Meeting reports (anonymized, Chatham House Rule)
 - 2. Pre-read document Design Options
- C. Sounding Board Group: a list of people and organizations that participated in one or more of the four stakeholder meetings
- D. CTBO Explained Note (July 2020)
- E. Who pays and how; interaction with ETS and non-ETS users
- F. Climate Policy Strategy, and how the CTBO fits in.

“Natural gas is likely to be the fossil carbon that will be used the most and the longest still in the Netherlands, and at the moment there are no other supply-side policies yet for natural gas. That's why we are focussing on natural gas for this first exploratory study.”

2. Carbon Management for a Net Zero Society

2.1. Carbon Stocks and Flows

Carbon management and accounting will become more and more important in the coming years. There are many ways in

which humanity can influence the main carbon stocks and flows. See Figure 4.

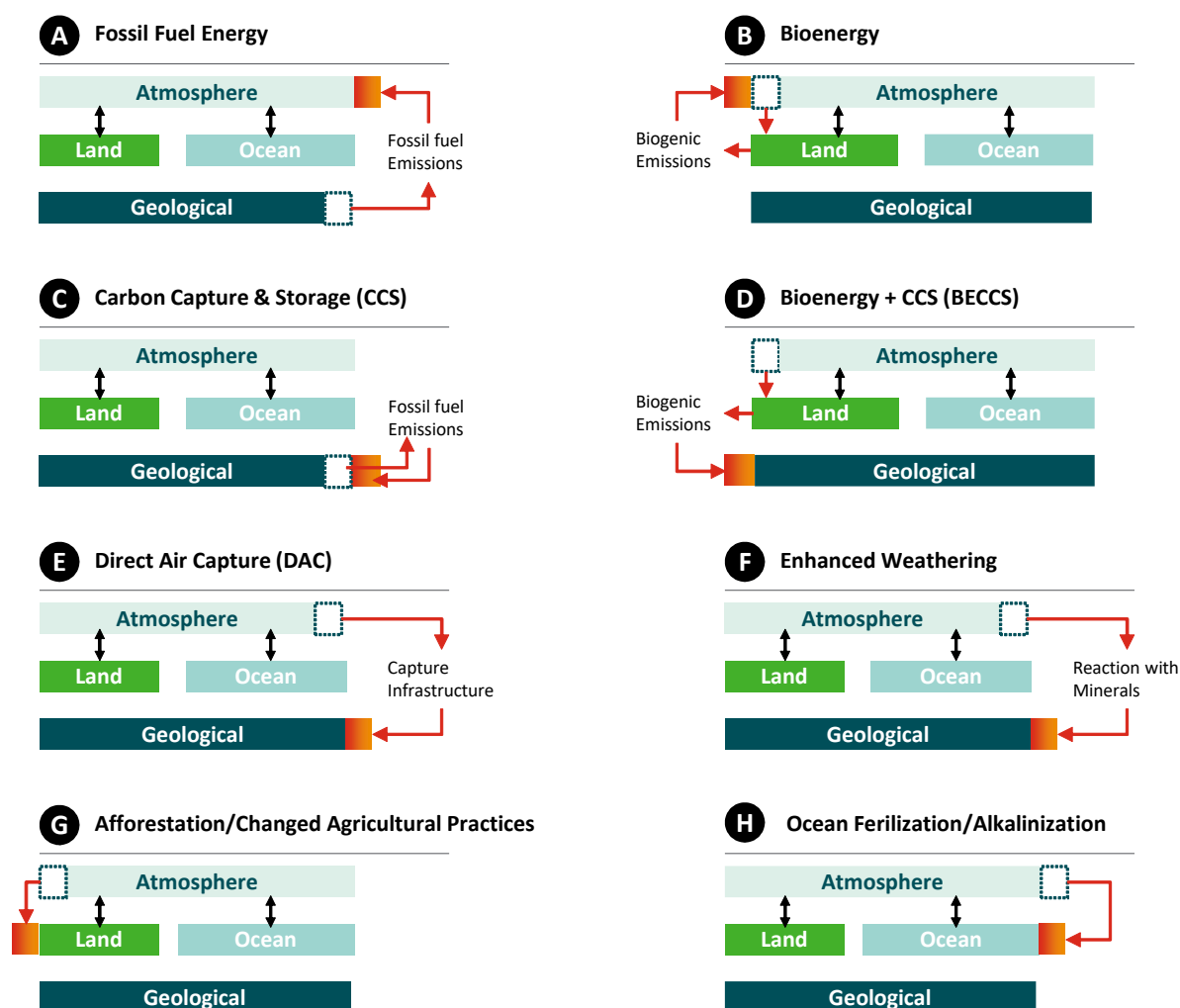


Figure 4. Human activities that impact on geospheric, biospheric, and atmospheric carbon stocks.⁴

⁴ Smith, P., Davis, S., Creutzig, F. *et al.* Biophysical and economic limits to negative CO₂ emissions. *Nature Clim Change* 6, 42–50 (2016). <https://doi.org/10.1038/nclimate2870>.

Until we started taking fossil carbon out of the ground the main carbon flows were between the atmosphere and the biosphere. This is called 'short-cycle' carbon as trees and crops grow and are harvested or die and the carbon gets released back into the atmosphere (or the soil). The production of fossil carbon (coal, oil, natural gas, limestone) has led to an additional flow of carbon from the geosphere to the atmosphere. This carbon was removed from the atmosphere millions of years ago and is therefore considered to be 'long-cycle'. As a result, carbon is accumulating in the atmosphere and the climate is changing.

Over the last few decades therefore we have started to measure, monitor, estimate, model, report, etc., the carbon flows and sometimes also carbon stocks. Examples of carbon flows are annual fossil carbon production and emissions. Examples of carbon stocks are fossil carbon reserves and carbon stored in forests and soil. The carbon budget is also an example of a carbon stock. It is an absolute amount of Carbon in the atmosphere that we should not exceed if we want temperature increases to be limited to relatively safe levels. Depending on temperature and level of confidence required the estimates vary but there is broad consensus that time is rapidly running out, especially since annual emissions are in fact still rising (pre-COVID). Figure 5 shows the Global Carbon Budget and what remains if temperature increase is to be kept to less than two degrees Celsius.

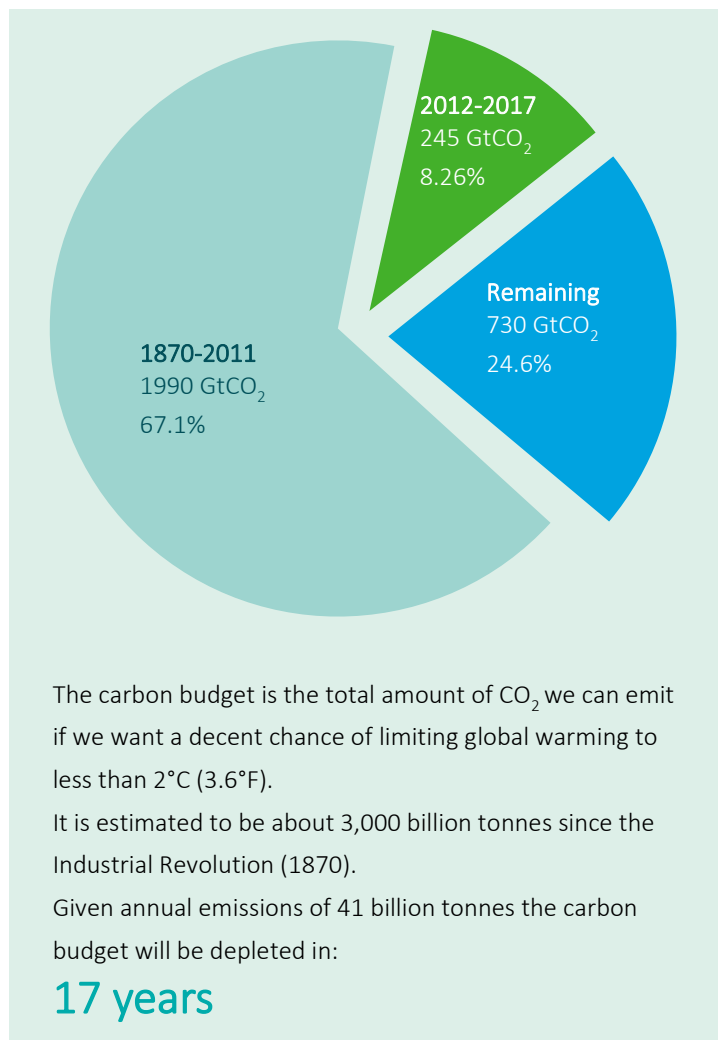


Figure 5: The Global Carbon Budget

Already this is a near impossible task. And the longer we wait, the more we will have to rely on carbon removals to get to net zero and remove excess (above safer budget) carbon from the atmosphere. See e.g. these scenarios from the 2018 IPCC 1.5 degrees C report.⁵

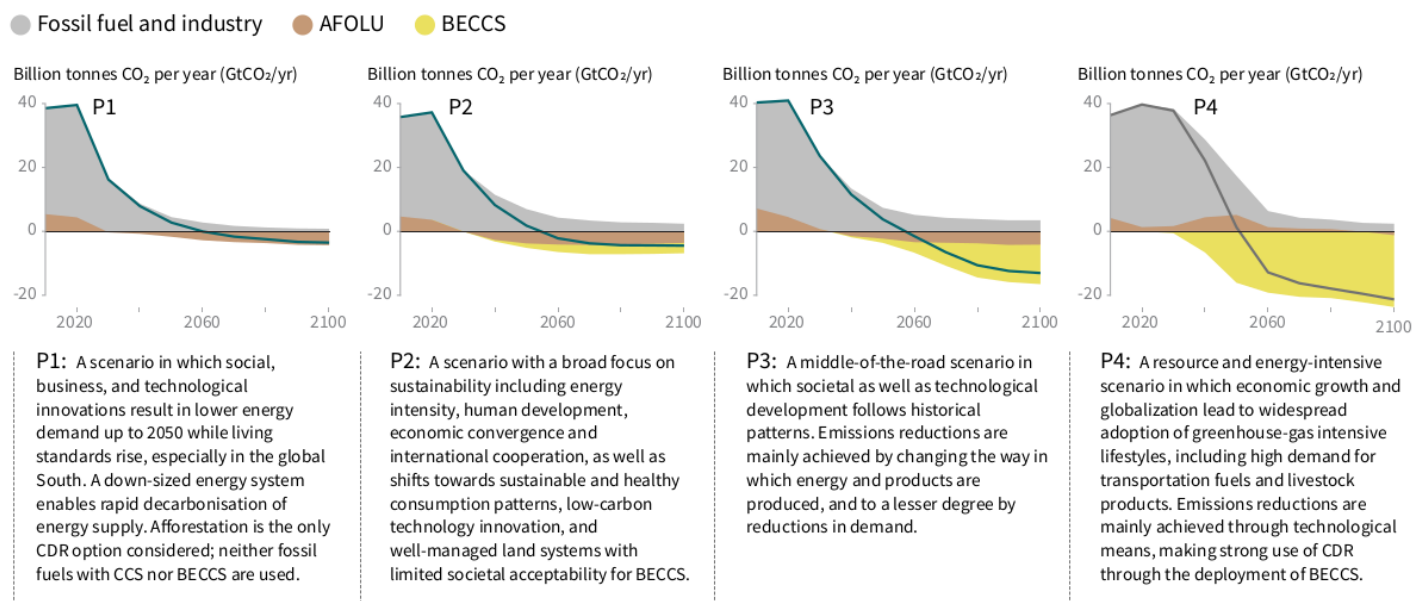


Figure 6: IPCC scenarios show different ways to develop without exceeding the carbon budget.

In the meantime, unabated fossil carbon use is still increasing in absolute terms even as the world is trying to scale up and integrate renewable energy production.

Considering all this, really only two of the approaches described in the introduction offer a solution to reduce the flow of fossil carbon to the atmosphere and stop it in time:

Close-down (a gradual reduction of production): somehow countries that have not succeeded in setting meaningful emission reduction targets despite trying for decades will succeed in agreeing who gets to produce how much fossil carbon still. There are only very few people who consider this a way forward that is likely to be successful.

Clean-up: the only alternative (if you take Paris commitments seriously) is to commit to clean-up fossil carbon emissions by rapidly increasing the amount of carbon captured and stored (and as always the two options can be combined of course).

The third option – Outcompete – i.e. the more rapid increase of renewables, nuclear, efficiency would effectively lead to a

rapid voluntary close-down of fossil carbon production for economic reasons: it is no longer needed and no longer attractive. Considering the expected growth in energy demand and the still small overall contribution of renewables this is unlikely to happen quickly enough.

Nevertheless, emission prevention should remain the first priority in order to minimise the need for carbon removal.

Note that including ‘clean-up’ costs in the price of fossil carbon products will effectively lead to a more rapid phase out of fossil carbon use as it will make it easier for renewables to outcompete them on price (and without subsidies).

2.2. Net-zero carbon future

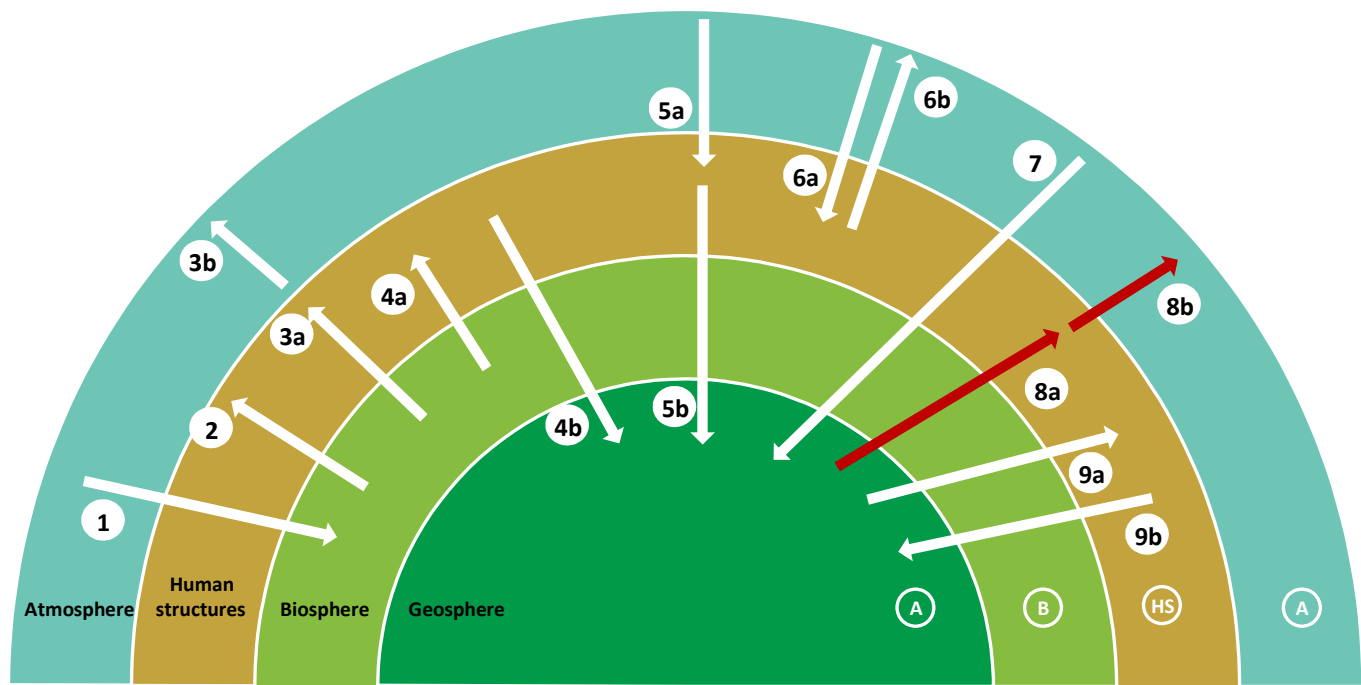
An important question when considering the introduction of a new policy mechanism like the CTBO is whether it is likely to be

⁵ Intergovernmental Panel on Climate Change (2018). Special Report – Global Warming of 1.5° C. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf.

needed only temporarily or could also be of value in the longer term.

To answer that question, we have looked at what will be needed when we get to net zero for the second time. Remember that the first time we get to net zero (hopefully around 2050) we will still need a period of net negative emissions to remove excess carbon from the atmosphere. When sufficient carbon has been removed (and ppm's have come down) we can go back to net zero and truly become a 'net-zero society'. By then we are likely to be in the next century. Fossil carbon use will be limited to niche applications, and carbon management will probably still be important but the only target to be met is to remain net zero.

Even then human beings will be moving carbon between different 'compartments' for economic reasons. Figure 8 shows the various human activities that could still be taking place and how they move carbon from one compartment (or sphere) to another. We have added 'human structures' to the compartments where carbon may be (temporarily) stored. Human structures can be pipelines or factories, but could also be products such as timber used for construction and carbon stored in cement. In order for carbon to be considered safely stored in these human structures they would have to meet certain standards for monitoring, verification and reporting.



Nr	Activity	Nr	Activity
1.	Growing forests (reforestation)	6.	DAC+CO2 for synthetic fuel
2.	Timber use construction	7.	Mineralization
3.	Biomass use for energy	8.	Unmitigated fossil carbon use
4.	Bioenergy + CCS	9.	Fossil carbon use with CCS
5.	Direct Air Capture (DAC) + CCS		

Figure 7: The Impact of Human Activities on Carbon Stocks and Flows

In a net-zero society the amount of carbon in the atmosphere has to remain stable.

What does this mean for the main carbon stocks and flows:

1. Atmosphere: any carbon emission will have to be offset by a carbon removal. A way to manage that is to issue carbon removal certificates (CRUs) for any activity that removes carbon from the atmosphere and to require the surrender or retirement of such a certificate for any activity or product that still causes carbon emissions to the atmosphere. Note that it is irrelevant if this carbon is of fossil or of bio-origin. *Carbon into the atmosphere has to be balanced by carbon removal from the atmosphere.*
2. Biosphere: any land owned and/or exploited for commercial purposes should include a requirement to maintain carbon stocks. Carbon storage (bio) certificates (b-CSUs) could be issued when carbon stocks are increased. Land use changes that would reduce carbon storage could only be approved when sufficient (bio) carbon storage certificates can be purchased and surrendered to compensate for the reduction in carbon

storage. Governments would need to do the same for public land (nature areas, etc).

3. Geosphere: production of fossil carbon will be very small (limestone for cement is probably still needed). The same principle as for bio-carbon stocks applies: production can only be approved when sufficient (geo) carbon storage certificates (g-CSUs) are surrendered/retired to balance the carbon produced. Carbon storage certificates are generated by permanent storage of (any kind of) carbon in the geosphere. Examples are geological storage (CCS, DACCS, BECCS, black carbon) and mineralization (enhanced weathering for example) and maybe some forms of carbon re-use.

If we now look at the human activities as shown in Figure 7 we can give an overview of the carbon accounting consequences of each of these activities. This is done in Figure 8. Some activities will generate CSUs or CRUs and other activities will be required to purchase and surrender CSUs or CRUs.



Net Zero Carbon Accounting

A Atmosphere
 HS Human Structures
 B Biosphere
 G Geosphere

b-CSU Carbon Storage Unit 1 ton of CO₂: short-term carbon storage in the biosphere

g-CSU Carbon Storage Unit 1 ton of CO₂: long-term carbon storage in the geosphere

CRU Carbon Removal Unit 1 ton of CO₂ removed from the atmosphere

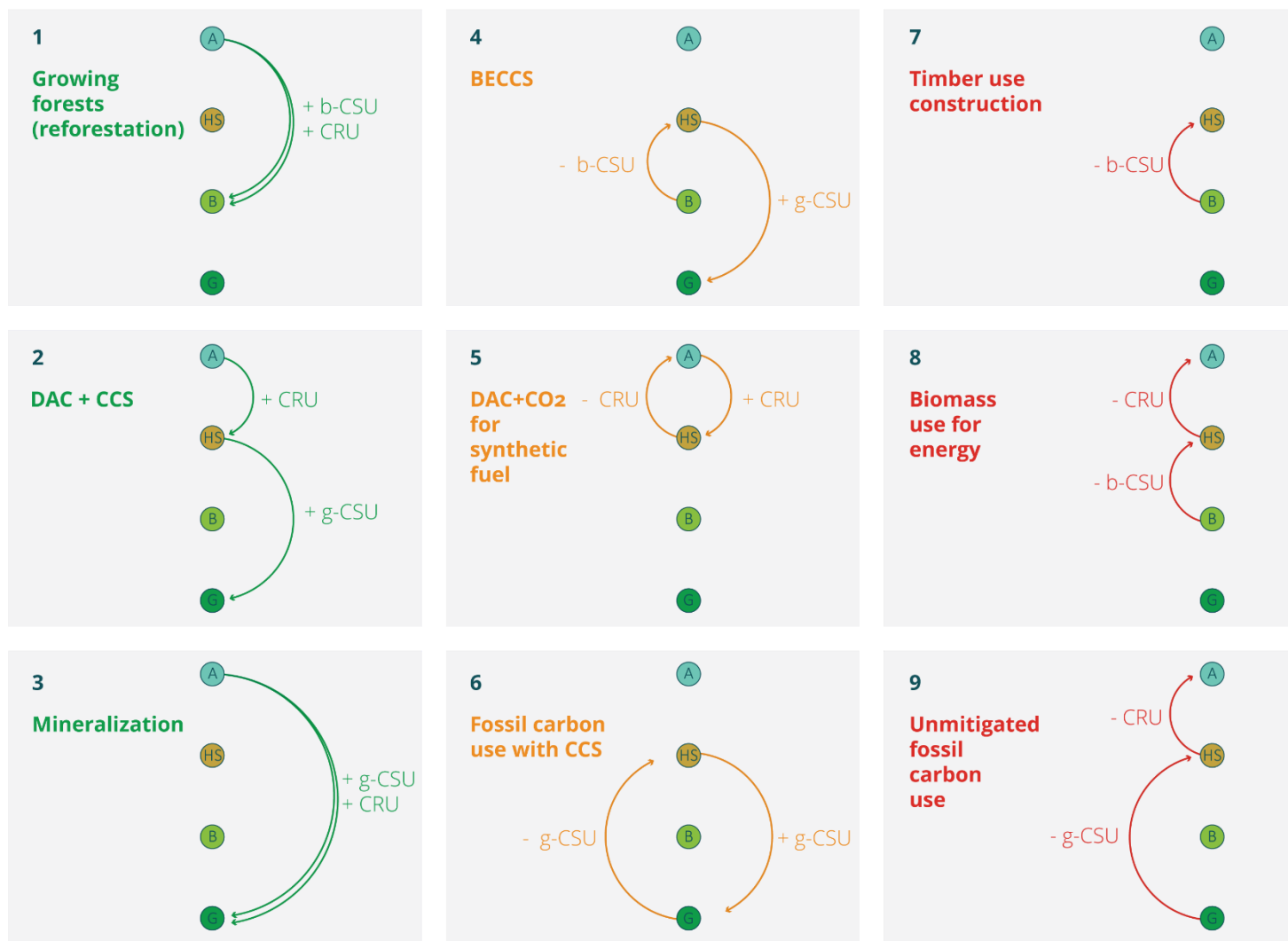


Figure 8: Carbon accounting impacts of various human activities

By regulating the flows in and out of all three main carbon stocks (bio-stock, geo-stock and atmospheric stocks) and requiring all three of them to be 'balanced' it is possible to ensure with reasonable confidence that the amount of carbon in the atmosphere will stay constant.

Regulating all three (instead of only atmospheric emissions/removals) has the following advantages:

- It makes the overall carbon accounting more accurate by providing cross-checks. For example, if carbon removals and additions to the atmosphere are in balance, but this is not the case for bio- and/or geo-stocks then there is likely to be an error somewhere.
- It makes the management and conservation of carbon stocks (biosphere, geosphere) a separate responsibility that is valued through tradeable storage certificates *separate from and in addition to* the emissions and carbon removal accounting systems and certificates. This is in line with public sentiment today. Many stakeholders feel that companies producing oil and gas have a responsibility to not produce 'too much' (from a carbon budget perspective) and similarly, many stakeholders feel strongly that forests and healthy ecosystems need to be valued separately and in addition to their contribution to emission reductions. CSUs provide a mechanism to do so.
- It makes it possible to have separate certificates for geological or other permanent storage and for short-cycle biosphere storage. This will make it possible to limit flows from biostocks to geostocks and vice-versa: e.g. to not allow fossil carbon production to be compensated by planting more trees.
- It will mean that CO₂ emissions to the atmosphere will be treated the same whether they come from fossil carbon or biomass; in both cases carbon removal certificates will be required to be surrendered/retired. This could help resolve the 'accountancy trick' accusations that biomass use is up against at the moment: agreed accounting rules mean that emissions of wood products that are used for energy are accounted for in the country where the wood is harvested (in the Land Use, Land Use Change and Forestry sector) and *not* in the country where the biomass is used for energy production. This is often portrayed (incorrectly) by opponents of biomass use for energy as an 'accounting trick'. Under the proposed 'net-zero accounting principles' the company (country) harvesting trees would need to surrender b-CSUs, and the company (country) burning the wood would need to surrender CRUs.

- Requiring (bio-) storage certificates to be surrendered at the time of production would ensure that production of biomass is always preceded by additional storage. From re-growth to pre-growth. This may help to resolve another important point of contention, the carbon debt. It can help provide more confidence in claims and certificates for sustainable biomass (net-growth of forests).

In this imaginary net-zero future a Carbon Take Back Obligation would still be valuable. It may be better to call it a Carbon Balancing Obligation then. It would be the same for geological carbon stocks as for biosphere carbon stocks: *production/removal of carbon from the stocks would only be allowed after more carbon was stored in the respective stores as evidenced by CSUs.*

2.3. Policy options

In general, governments currently apply three main policy options – which are linked to the approaches we described in 1.1 and 2.1:

1. Regulations and standards; e.g. efficiency standards for equipment, energy labels for buildings, etc.
2. Economic signals; e.g. carbon pricing (taxes or cap and trade)
3. Research and Development; innovation incentives

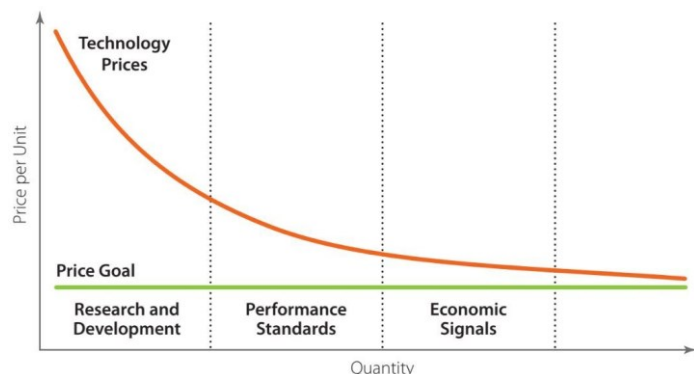


Figure 9: Phasing policy options: as the price of a new technology comes down the policy preference shifts from R&D support to regulations and standards and ultimately to economic signals to encourage further uptake by the market.

Lately, there has been increasing interest in a fourth option: so-called flex-regs (flexible regulations). These are basically a hybrid between more traditional regulations and the market mechanisms associated with carbon pricing. A good example is the fleet-standards for cars in the EU. A traditional standard would be a standard that would need to be met for each car. But the fleet standard sets a standard for all cars combined and allows manufacturers to find the cheapest way of meeting that standard on average.⁶

The main advantages of flex-regs are that they tend to be easier to implement politically than meaningful carbon taxes, and that they are more suitable for achieving so-called deep carbonization.

It is generally acknowledged that a mix of policies will be needed and that as technologies mature the emphasis should switch from R&D via standards to economic signals. See Figure 9.

⁶ For more info on flex-regs:
<https://institute.smartprosperity.ca/sites/default/files/mark-jaccard.pdf>.

Supply-side versus demand-side policies

Another important topic for climate policies is where to focus in the value chain:

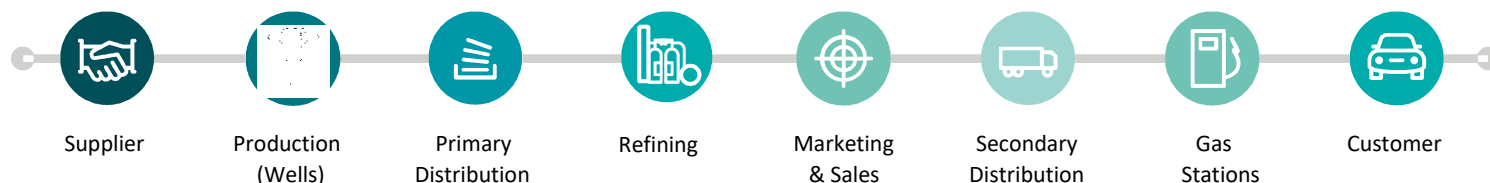


Figure 10: Finding the right entry point for policy instruments in the value chain

Policies that focus ‘upstream’ in the value chain are called ‘supply-side’ policies, and those that focus on the end-users are called ‘demand-side’ policies. Note that all of the players in the above value chain are also end-users of energy and as such e.g. an oil producer or transport company will also be subject to policies that regulate their own carbon emissions. Traditionally, the vast majority of climate regulations are focussed on the demand-side: on the users of fossil energy (fuel efficiency standards, Paris agreement, climate laws, emission targets, ETS, etc). Examples of supply-side policies are fairly rare still but are becoming more common for coal production and oil and gas production with a large environmental footprint or risk (e.g. tar sands and Arctic oil and Groningen gas). The majority of scientific papers on supply-side policies talk about the need for bans on fossil fuel

production. Not much research has been done on more creative ways to restrict upstream production like e.g. a CTBO.. Supply-side policies are in principle a good idea. The further ‘upstream’ you implement a policy the easier it tends to be because there are fewer players (100 companies produce 70% of all fossil carbon use) and because the effect will be felt in the whole value chain.⁷

Using the bathtub metaphor, we are currently focussed on managing the waterflow going into the bathtub. Supply-side policies would be focussed further upstream where the water is being produced. See Figure 11:

⁷ For more arguments on the benefits of combining supply and demand-side policies, see e.g. Green, F. and Dennis, R. (2018). Cutting with both arms of the scissors: the economic and political case for restrictive supply-side climate

policies. Climatic Change. ISSN 0165-0009.
<https://core.ac.uk/download/pdf/157800521.pdf>.

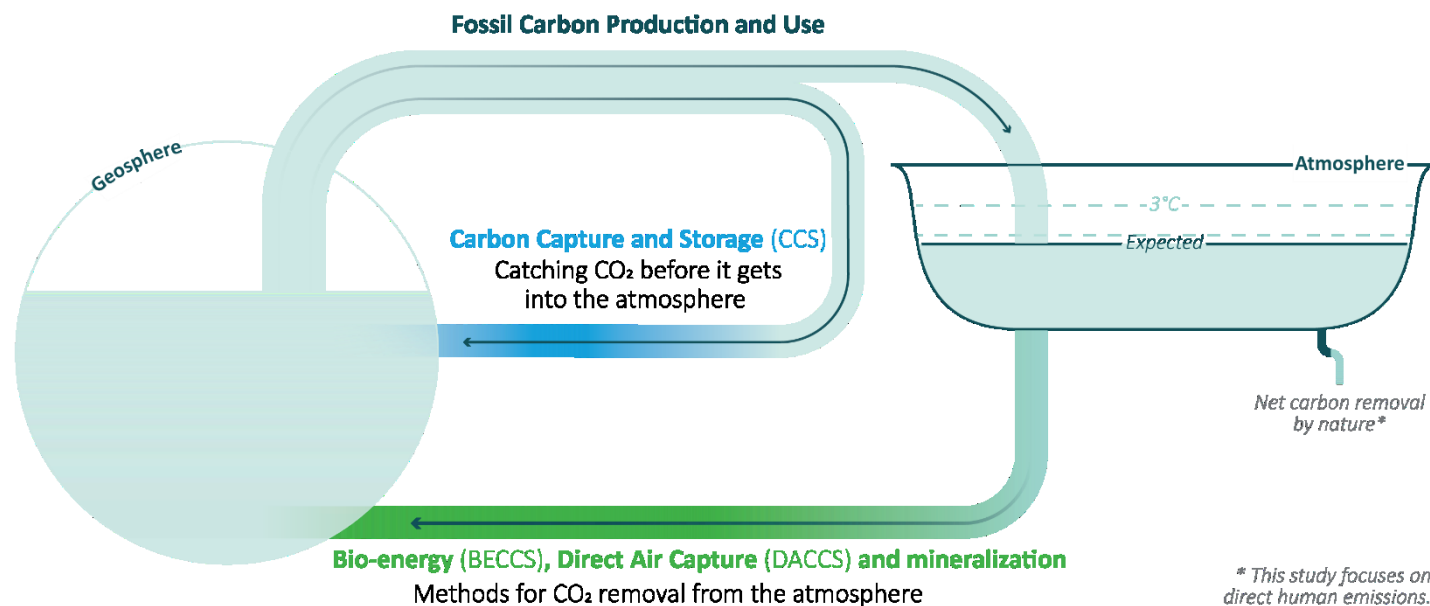


Figure 11: Supply-side policies would focus on water production; demand-side policies focus on waterflow into the bathtub

For fossil carbon over 80% of the climate impact typically occurs at the end of the value chain when the user burns the product. Upstream decisions on coal, oil and gas production assume that the downstream ‘emission problem’ will be resolved through climate laws, regulations, etc. So far this has not been the case as the policies implemented are not in line with the ambition levels. As a result, there now is a widening gap between planned production and responsible levels of emissions. See the UNEP Production Gap Report 2019 for more details.⁸

This disconnect between emission reduction commitments and ambitions, and actual plans for fossil energy production and use is leading to more and more court cases. Precedents are being set where judges refuse production permits on the basis of there being no firm plans for future emissions. A Carbon Take Back Obligation could help resolve this as production is in fact made conditional on an increasing percentage of carbon storage.

The permit for a coalmine in Hunter Valley, Australia, was refused partly on ground of the climate change impact of the coal that would be produced. The judgement stated that: “A consent authority cannot rationally approve a development that is likely to have some identified environmental impact on the theoretical possibility that the environmental impact will be mitigated or offset by some unspecified and uncertain action at some unspecified and uncertain time in the future.”⁹

⁸ United Nations Environment Programme. Production Gap Report 2019. <https://www.unenvironment.org/resources/report/production-gap-report-2019>

⁹ The Guardian (2019). Court rules out Hunter Valley coalmine on climate change grounds. <https://www.theguardian.com/australia-news/2019/feb/08/court-rules-out-hunter-valley-coalmine-climate-change-rocky-hill>

2.4. Carbon Take Back Obligation

A Carbon Take Back Obligation is a pragmatic and progressive supply-side climate policy that makes fossil carbon production dependent on adequate measures being in place to ensure emissions will be captured and stored in line with the required emissions reductions.

Initial take back percentages will be low, but they will gradually increase to 100% in the year that a country commits to be net zero. Companies that permanently store CO₂ will get Carbon Storage Units (CSUs) which are needed and purchased by companies that want to produce fossil carbon.

A CTBO as proposed in this study has the following characteristics:

- It would cover all natural gas use in the Netherlands. The initial focus on natural gas is explained further in chapters 1.2 and 4.8.
- The CTBO would be placed as high up in the value chain as possible: on domestic gas produced and on imports of natural gas.
- Oil, coal and cement would probably follow at a later stage. See 4.8
- The increase of the storage percentage (and the year it reaches 100%) should provide assurance that remaining emissions of continued fossil energy use will be 'Paris-compliant'.
- Natural gas produced/imported under a Paris-compliant CTBO can and will have a premium value over natural gas produced without a CTBO. This is not relevant for the national market (all gas sold is by definition 'CTBO-gas') but it is relevant for the purchase of import gas (see 2.5).
- Carbon storage certificates would be issued for every unit (ton) of carbon permanently stored.
- Geological storage and mineralization (still to be demonstrated at scale) are the most likely options for permanent storage at the moment.
- These Carbon Storage Units (CSUs) can be traded. Producers and importers who do not generate their own CSUs could purchase them from e.g. a carbon storage company that specialises in permanent carbon storage.
- For every ton of carbon produced or imported CSUs will need to be surrendered and retired. This is very similar to the way emission allowances (EUAs) have to be

surrendered for every ton of CO₂ emitted. Ultimately 1 ton of carbon production will require 1 ton of carbon storage.

- Key 'design choices' have been discussed in the Sounding Board and are discussed in more detail in Chapter 4.

From the discussions in the Sounding Board Group it became clear that it is important to clarify what a CTBO is and what it is not:

- Above all, it is a mechanism to make sure that an increasing percentage of the CO₂ from the fossil carbon that we still use the coming decades is captured and permanently stored. CCS as a mitigating technology is behind on what it is supposed to deliver in most Paris-compliant scenarios. A CTBO can help speed that up.
- A CTBO will put limits on carbon production on the basis of how much has been stored.
- **CSUs have no direct emission reduction value.** The value of a CSU is that it allows you to produce/import/sell fossil carbon; some have therefore suggested that it could also have been named a Carbon Production Allowance.
- In general the company that captures the CO₂ that is being stored will be claiming the emission reductions. This value is covered by the ETS for large emitters. CSUs are used to balance carbon removed from stocks by production/import of fossil carbon; they cannot be used to offset emissions.

A CTBO-policy is consistent with the Extended Producer Responsibility principle that is applied to encourage or force producers to take responsibility for the waste caused by or after the use of their products. There are many examples already where a customer pays a surcharge to make sure that, after use, the product or waste is safely recycled and/or disposed of.

A CTBO policy is also consistent with how carbon 'produced' from sustainable forests is managed already (or should be): carbon can only be taken out (harvested) if there is sufficient carbon being added (new and growing trees) so that there is no net reduction of stored carbon. Good forest management means growing more trees and storing more carbon so that you can sustainably harvest more carbon.

A CTBO will change the dynamics in the CCS value chain. At the moment, CO₂ waste is the problem of the end-user of fossil carbon. They are expected to reduce their emissions and (if

they choose CCS) to pay for the full value chain of capture, transport and storage. Producers may act as storage provider, but that is a voluntary choice and they would expect to get paid for that. Many current producers are also hoping to sell or transfer their nearly depleted assets to the government or others for future use as CO₂ storage reservoirs.

With a CTBO, market dynamics change. The producers and importers will need CSUs to be allowed to continue producing and selling their products. This means they will have more of an incentive to help keep the costs down by making the CCS value chain as efficient as possible. They will need to start ‘hunting’ for cheap CO₂ to be stored. The recent trend towards more cooperation in the value chains will be accelerated by the introduction of a CTBO. But now both parties (supplier and user and storage provider) have a shared interest in making this work. Because ultimately, if there would be insufficient carbon stored, there is the risk that supply will become restricted by the lack of progress on carbon storage. This would clearly harm both the supplier and the user of the fossil carbon product.

All this cooperation and the longer-term policy certainty of a slowly increasing obligation will lead to innovation and cost reductions in the overall CCS value chain. To some this ‘risk of success’ is a concern, as it could create a so-called ‘lock-in’ of fossil carbon use while at the same time emission reduction targets are being met in a cost-effective way without continued subsidies. See 3.3 for a further discussion of the lock-in risk.

2.5. Different kinds of gas

To make a CTBO work it will be important to be able to sell natural gas products (gas, hydrogen) for different prices depending on how it has been produced. Premium prices can be achieved either by regulation (e.g. if all gas sold in a country

has to be covered by a CTBO) and/or by certification (e.g. blue or clean hydrogen) and customers that are prepared to pay more for premium products. Some examples are discussed in more detail below.

GAS TYPES

A

 Atmosphere

HS

 Human Structures

B

 Biosphere

G

 Geosphere

b-CSU

 Carbon Storage Unit 1 ton of CO₂: short-term carbon storage in the biosphere

g-CSU

 Carbon Storage Unit 1 ton of CO₂: long-term carbon storage in the geosphere

CRU

 Carbon Removal Unit 1 ton of CO₂ removed from the atmosphere

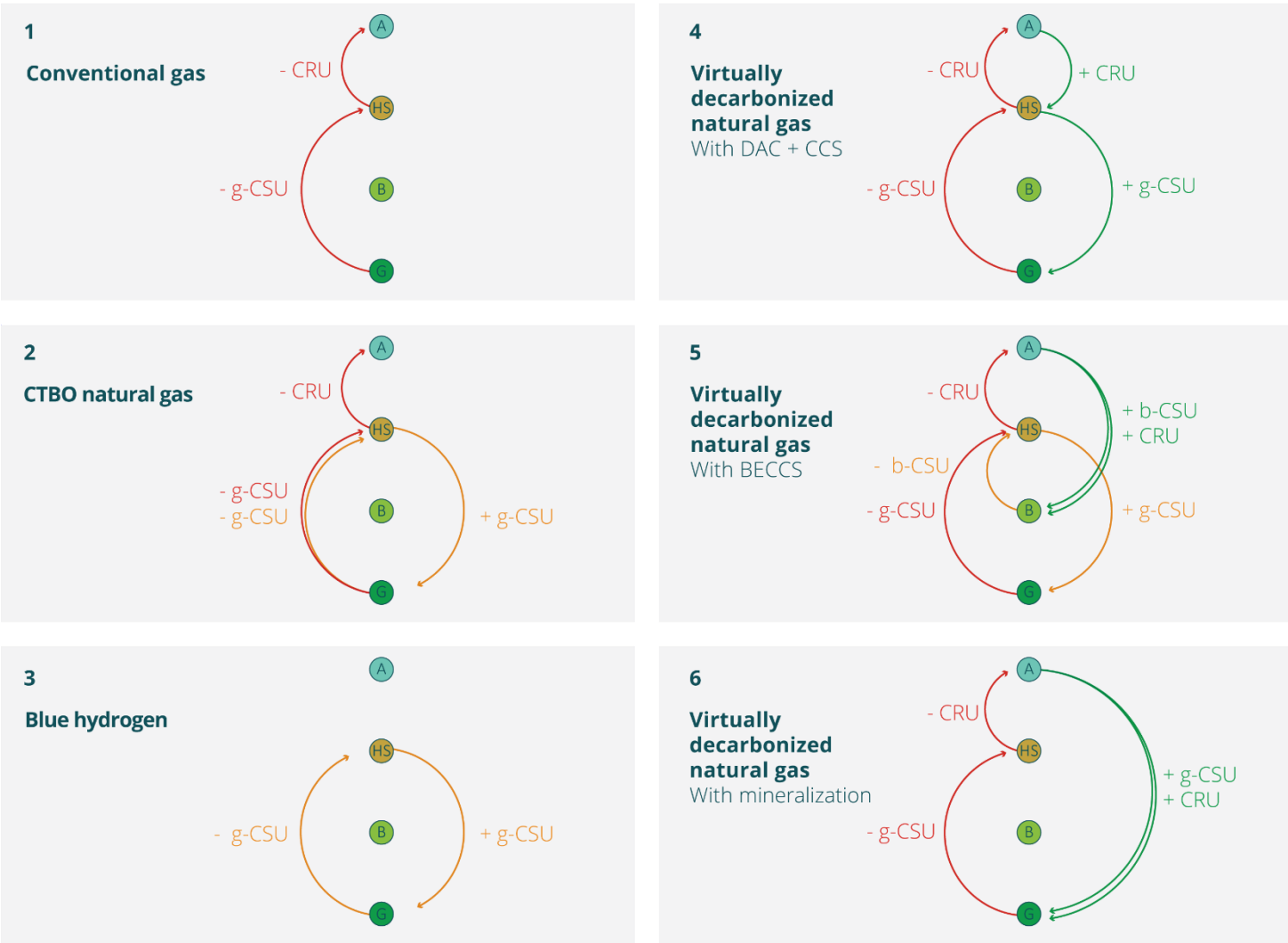


Figure 12: Natural gas can be used and decarbonized in different ways

1. Conventional gas

Most of the natural gas used today is simply burned by the customer and the CO₂ is emitted. Some customers have made emission reduction commitments and some are part of the ETS.

In this situation it is not clear when the user or the gas sector as a whole will be net zero. There are no policies in place yet to make sure we get to net zero in 2050. This creates uncertainty both for investors and for governments.

2. CTBO natural gas

After introduction of a CTBO the gas sector as a whole will be on a path to net zero. Individual users may move more quickly (if they capture and store their CO₂) or more slowly (dispersed users), but all will have to be net zero on the agreed date.

- a) Domestic produced natural gas: CTBO-gas is considered of superior (climate) value as the suppliers commit to taking care of an increasing percentage of the waste of the use of their products. The customer will pay a carbon storage surcharge that ensures that more and more of the emissions (from all the users in a country) will be captured and stored. By 'socializing' the storage costs of a few projects (initially) over ALL the natural gas sold by producers and importers, the initial price premiums will be very small (see example text box chapter 4.5).
- b) Imported natural gas: anyone importing natural gas into the Netherlands will have to purchase and surrender CSUs to be allowed to sell that gas on the Dutch market. The hope is that more countries will be implementing Paris-compliant CTBOs. If, for example, Norway would also have implemented a Paris-compliant CTBO then no additional CSUs would be required to sell this gas on the Dutch market. From this it follows that gas produced under a CTBO will have a premium value over natural gas imported from countries (e.g. Russia, USA) that do not yet have a CTBO policy in place.

3. Blue hydrogen

Actual decarbonised gas: blue hydrogen (or ammonia).

A producer can decide to convert the natural gas into hydrogen (and store the CO₂), in effect selling a 'decarbonised'

fossil carbon product. There could be a commercial advantage in 'cutting out the middle man', and generating the CSUs instead of paying for them on an open market. The hydrogen can be certified as low-carbon hydrogen under the EU Certifhy scheme.¹⁰ Customers wanting to reduce their overall carbon footprint should be willing to pay a premium price for this hydrogen as it will significantly reduce their scope 1 emissions if they switch from gas to hydrogen, and their scope 2 emissions if they switch from grey hydrogen to blue hydrogen.

4. Virtually decarbonized natural gas with DAC + CCS

5. Virtually decarbonized natural gas with BECCS

In the future it is expected that there will be a certification system also for carbon removal from the atmosphere. Examples of technologies that could remove carbon (CO₂) from the atmosphere are Bio-Energy with CCS (BECCS) and Direct Air Capture with CCS (DACCS). A natural gas producer could generate both carbon storage units and carbon removal credits by doing DACCS, and then sell 'virtually decarbonised gas' by selling gas bundled with carbon removal credits. The CSUs he would need for himself to meet the CTBO. This could be interesting in the future for users that find it difficult to switch to other forms of energy. Aviation is often mentioned as an example.

At the moment this is not possible (no formal Carbon Removal Certification schemes in place yet).

6. Virtually decarbonized natural gas: With mineralization

Another future possibility for selling virtually decarbonised gas would be to pay for enhanced weathering (mineralization) projects. The gas production company can use the CSUs from these projects to meet their CTBO (and therefore be allowed to take gas out of the ground), and they can sell the CRUs with the natural gas so that their customers can surrender these CRUs when they burn the natural gas. This will of course significantly raise the costs of using natural gas, so this would only be interesting (like DACCS) for customers that have no alternative options available to them yet.

¹⁰ See <https://www.certifhy.eu/>

3. Objectives and boundary conditions

3.1. Introduction

In Chapter 1 we discussed the background for this study and the reasons for giving the Sounding board group sessions an important role in the study.

In the first Sounding Board Group session the focus was primarily on understanding what the Sounding Board Group members thought would be the main reasons to implement a CTBO. When discussing 'objectives' (what are we trying to achieve with this) it is inevitable that people also mention so-called 'boundary conditions': conditions that need to be satisfied as well, but are not the main objective.

3.2. Objectives

According to the Sounding Board Group a CTBO should have the following objectives:

1. A mechanism to ensure that the *emissions* from any remaining *fossil carbon* use are *net zero* by 2050
2. A simple and transparent mechanism to ensure that *new decisions* that involve fossil carbon (new production, use, investments) include the necessary *conditions* to be *Paris-compliant*
3. A mechanism that will provide a sustainable and *broadly supported business model for CCS or other permanent removal*. For broad support a clear and simple narrative is required.

Ad1: There was a shared concern in the group about the lack of progress in phasing out unabated fossil carbon use. Over the last 40 years fossil carbon has provided between 80 and 85% of all energy. This percentage has been remarkably stable. There also was a shared acknowledgement that full electrification of the economy (with renewables) will not be possible within the Paris agreement timeline, globally nor nationally. Despite the tremendous growth of renewable energy the use of fossil carbon world-wide is still growing at the moment. As a result, emissions keep going up instead of going down.

A Carbon Takeback Obligation could be regarded as a safety net or insurance policy to make sure that if we do not manage to replace fossil energy quickly enough that then at least we will make sure that the emissions will go down fast enough. A CTBO is a very direct way of ensuring this will be the case. Any country serious about their net zero targets should be implementing a CTBO to ensure that unmitigated use of fossil carbon is gradually phased out.

More certainty about reaching net zero on time is therefore considered a very important benefit of implementing a CTBO.

Ad2: Another reason why a CTBO could be helpful is that it offers decision makers a way to add firm conditions to continued support for the use, production, investments, etc, in fossil carbon energy, and be confident that this can be done without exceeding Paris-compliant targets. It is clear that the world cannot go cold-turkey on fossil carbon use. Most countries also do not want to depend completely on the Middle-East and Russia for their fossil energy supplies. Therefore, there will have to be further investments in the fossil carbon value chains over the next decennia. At the moment, however, these investments are more or less unconditional and do not consider the carbon budget the world has left to stay within safe limits for climate change.

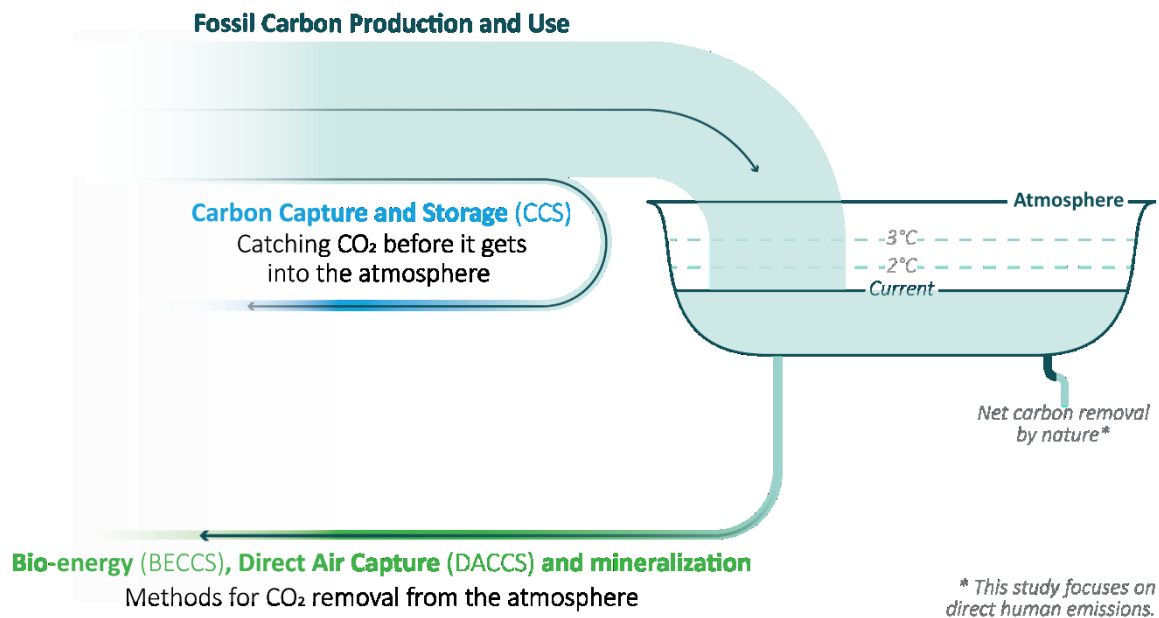


Figure 13: The atmospheric bathtub

The bathtub metaphor is often used to illustrate this. We continue to open the tap without doing anything to keep the water level from rising, and neither do we have a plan on how to take care of the by now inevitable overflow.

In a permanent net-zero society where temperatures are more or less stable, all carbon added to the atmosphere will have to be removed from the atmosphere also in more or less the same timescale. Net additions of water/carbon will lead to rising water/ CO₂ levels and rising temperatures.

As explained in Chapter 2 the current focus is on regulating emissions (water going into the bathtub). A CTBO would add the upstream water storage reservoir to this picture. Decisions to take water out of the storage reservoir can only be made if it is certain that sufficient water can be captured and put back into the tank. This can be done by catching the water/ CO₂ before it gets into the tub/atmosphere (point source CCS) or by taking it out of the tub/atmosphere using DAC or biomass or mineralization, and to bring it back to the water storage tank/geosphere.

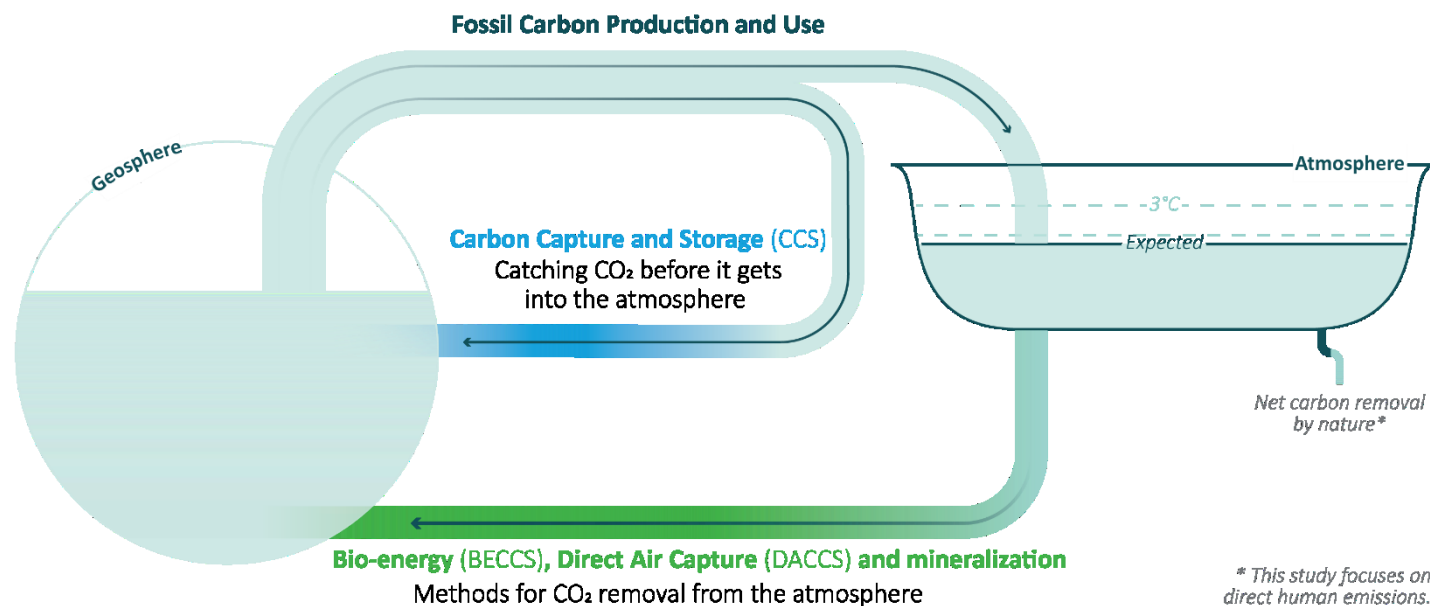


Figure 14: Managing the carbon bathtub by controlling upstream water production

By managing the water levels in the reservoir responsibly it becomes far more likely that overflowing of the bathtub can be avoided or minimised. In fossil carbon terms: if fossil carbon producers can show they are (helping with) catching and storing an increasing percentage of the carbon they produce, then this would be an important contribution to not exceeding safe carbon budgets.

This will open up a third way: companies, governments and investors can commit to only do/allow/support the production/import/use of fossil carbon that is subject to a Paris-compliant CTBO. Instead of a black and white choice (yes or no against fossil energy) there is now a third option: a 'conditional yes', with the condition being a CTBO. Or alternatively this can be formulated as a 'conditional no': fossil carbon use is no longer permitted unless a Paris-compliant CTBO is in place.

Going back to that quote from the judge in Australia (see 2.3): "A consent authority cannot rationally approve a development that is likely to have some identified environmental impact on the theoretical possibility that the environmental impact will be mitigated or offset by some unspecified and uncertain action at some unspecified and uncertain time in the future."

If the permit for the coal production would have included a CTBO, meaning that for every ton of carbon taken out of the ground the company would have to demonstrate an increasing amount of carbon was also being stored, then this might have been a different discussion. The judge asked for more certainty that the 'downstream' climate impact would indeed be mitigated. A CTBO could be a way to deliver that certainty *and* at the same time make sure no more fossil carbon is produced when insufficient storage is taking place.

Ad3: The third objective for a CTBO is to provide a broadly supported business model for CCS. At the moment the most important barrier for scaling up CCS is the lack of a good business case. The producers and importers who sell the fossil carbon do not really have any formal responsibility for the emissions of their products, and for the users of the products purchasing emission allowances is often cheaper than capturing and storing the CO₂. For the many small users of fossil carbon there is no real possibility to capture and store CO₂. In the "CCS Routekaart" ("CCS Roadmap") it was identified as one of the remaining obstacles: the lack of longer-term policies that would ensure that there is a sustainable business

case to continue with CCS after the first (SDE++ subsidised) start-up projects.¹¹

There was consensus in the group that the two sub-objectives (business case, societal support) are closely linked and crucial for CCS. Considering the large revenues that are still generated in the fossil energy supply chain (for both companies and governments) it was considered important that the additional costs of a CTBO should not continue to be compensated by subsidies (after the start-up projects that receive SDE++ support). On the other hand, it was also considered important that users of fossil carbon products were aware of the additional costs for storing more and more of the carbon emissions. See design choice 'who pays and how' (4.5).

During the discussions about the various design choices the importance of keeping the narrative simple and clear ("if you take it out of the ground you also have to put it back into the ground") was mentioned on several occasions and therefore explicitly added to the 3rd objective. A CTBO formalises the moral responsibility that oil- and gas-companies already have (and share with other beneficiaries in the value chain) for the climate impact of their products. By making carbon takeback mandatory a level playing field is maintained (for sales within a country) and costs can in principle be passed on to customers/users with a carbon storage surcharge. Note that this surcharge will be very small in the beginning as total storage costs of a few projects are effectively shared and paid for by all gas users (see 4.5).

The net benefits for the taxpayer/government could be positive:

- The SDE++ pays the difference between actual costs and the ETS-price. Actual costs will come down if a storage provider can recover storage costs from producers and importers. Therefore SDE++ payments could come down.
- A CTBO may further help the discussion about more production from the North Sea fields (in line with what was agreed in the 'Noordzee Akkoord' (North Sea Agreement), and instead of increasing imports from USA or Russia); the remaining reserves are not that large but they could reduce our dependence on import gas (with high carbon footprints) and allow facilities to remain operational awaiting possible

re-use for hydrogen or CO₂ storage. Additional national production would be better for the taxpayer than more import.

- Subsidies for other CO₂ reduction technologies are also dependent on the 'onrendabele top' (contract for difference) and therefore will benefit from slowly increasing gas prices (due to adding a CTBO carbon storage surcharge). Less subsidies will be required for a shorter period of time.

3.3. Boundary Conditions

For the purpose of this study boundary conditions are defined as all conditions mentioned by stakeholders that would have to be met for them to be able to consider supporting a CTBO. They are typically *not* the reason for doing the CTBO (those are covered under 'objectives') but they are still very important for broad societal support and/or for making sure the policy/regulations will be as efficient and effective as possible.

From the first meeting the following boundary conditions emerged:

1. A CTBO should not slow down the transition (lock-in fossil energy, delay renewables)
2. A CTBO should not make NL less attractive for investments
3. General boundary conditions: fair, transparent, no perverse incentives, low leakage risk, cost effective, no/few legal barriers, public support, low admin costs, etc.

These conditions are not very surprising, and indeed very similar to the conditions discussed for many other new policies, programmes, targets, etc. Below each one will be discussed in a bit more detail.

Ad1: There is a real concern that any policy that targets the cleaning up of fossil carbon use may lead to prolonged use of fossil carbons and thereby slow down the transition to more sustainable forms of energy. There are clearly different perspectives among stakeholders about whether or not this is an issue and/or even a showstopper. Some feel that, as long as the objective of rapid emission reductions is achieved, then this should not be a showstopper. Others feel that phasing out fossil carbon use is as important (or more?) than reducing the emissions; they therefore do not support measures that could prolong the use of fossil carbon, even if these same measures would ensure that the emissions from that fossil carbon use are

¹¹ Ministry of Economic Affairs and Climate Policy (2018). Roadmap CCS ("Routekaart CCS"). Attachment to Letter to House of Representatives.

<https://www.rijksoverheid.nl/documenten/publicaties/2018/03/05/routekaart-ccs>

reduced in line with Paris objectives. Although it is too early to make definitive statements one way or another (will a CTBO cause some degree of a lock-in) based on the work so far, a few relevant observations can be made that will shed some light on this question:

- **Baseline choice:**
In discussions it became clear that different stakeholders have different baseline scenarios against which they assess the possible impact of a CTBO on the speed of the transition.
 - If you assume that without a CTBO and corresponding growth in CCS the same emission reductions will be realised by accelerated renewable energy, green hydrogen and other more sustainable options, then you could see the CTBO as prolonging the use of fossil carbon.
 - If you take a typical Paris-compliant scenario as your baseline, that scenario will assume a rapid rise in CCS deployment. A CTBO can then be considered as necessary tool in the climate policy toolbox that is needed to make that rapid rise a reality.
 - If you take any of the more ‘real-life’ energy use forecasts (what experts think will actually happen over the next few decades; see e.g. DNV Energy Transition Outlook) then a CTBO is likely to put the brakes on the continued, fairly unrestrained use of unabated fossil carbon energy, and it will actually help accelerate the shift to alternative sources of energy.
- When a CTBO is made mandatory for all natural gas used in the Netherlands (as preferred by the Sounding Board; see 4.3) then it will be possible to add a carbon storage surcharge to the price of natural gas. This will influence the market in exactly the same way as if an upstream carbon tax were to be imposed on *all* natural gas sold in NL. The expectation of the impact of such a price increase is that it will reduce consumption and/or encourage switching to alternative energy sources.
- Compared to an upstream carbon tax a CTBO is more likely to deliver the required emission reductions and is also less likely to increase so-called ‘carbon entanglement’ that is created by governments having become dependent on large revenues from fossil carbon sales. In the Netherlands for example government revenues from fossil energy use are still a factor 4 or 5 higher than so-called subsidies. In case of a carbon tax the polluter pays to pollute (in many cases) and adds to the government revenues from fossil carbon use. In case of a CTBO the higher price results from the additional costs for the polluter to clean-up. Considering the urgency of climate change it is important to go back to the original intent of the ‘polluter pays principle’, and that was that the polluter had to pay for cleaning up the pollution he created.
Less carbon entanglement will make it easier for the government to make decisions that shorten the remaining time that we use fossil carbon (as we have seen e.g. in the recent case of the Groningen gas field: as production declined, the importance of the gas field for the government’s revenues declined, and more drastic decision making could follow).
- Finally, when discussing ‘lock-ins’ it is important to distinguish between lock-in of production and lock-in of energy users. Lock-in on the production side should be less of a concern than lock-in on the infrastructure and user (equipment) side:
 - On the production side there is fairly high level of agreement that the main energy carriers in the future will be electricity (as much as possible) and hydrogen. A CTBO will incentivize producers to consider whether or not they still want to sell the ‘raw product’ (natural gas) or whether it is more attractive to start selling electricity or hydrogen made from natural gas (with carbon storage to meet CTB obligations). As soon as there is sufficient green electricity and hydrogen at competitive prices then the fossil carbon production will be phased out. By then, the Netherlands will be importing most of its natural gas, and therefore the risk of a long lock-in period should be small. Most scenarios have green hydrogen overtaking blue hydrogen (in volume) somewhere between 2040 and 2050.
 - It is generally considered to be much more difficult to change-out all the end-user equipment (engines, turbines, boilers, heaters, etc) to a new energy source or carrier. Therefore, it is important that the transition of end-users of natural gas to hydrogen or electricity is not delayed. Any new equipment purchased or installed should be electric or suitable for hydrogen use (even if it will first still use natural gas). As green hydrogen will not become available at scale until the mid-2030s

production of blue hydrogen (triggered by a CTBO) will in fact speed up the rate at which end-users can switch to their preferred energy carrier of the future (electricity or hydrogen).

Considering all the above, it is unlikely that a CTBO would lead to a lock-in. It is in fact more likely that a CTBO would accelerate a move away from fossil carbon use as a commitment to an increasing CTBO is a clear signal that prices will continue to increase as more and more carbon capture and storage will be required.

Nevertheless, below are a few suggestions of complementary policies that could help minimise the risk of lock-in:

- The most effective complementary policy will be to help users switch to electricity or hydrogen use more quickly. Phasing out dispersed use of fossil carbon has to be a number one priority (also for health reasons). As soon as green alternatives become more abundant they can replace hydrogen and electricity made from fossil carbon (with CO₂ storage).
- If fossil carbon use would be deemed to be declining too slowly then the CTBO percentage could be increased more quickly and even above 100%. Suppose that in 2050 fossil carbons are used in a 'climate neutral' way but their level of use is considered to be too high or unsustainable (for whatever reasons) then the CTBO percentage could be increased to 120% for example. This would effectively make fossil carbon producers and users (financially) responsible for part of the carbon removals (negative emissions) that will be required after 2050. And would at the same time further increase the costs of using fossil carbon and therefore help phasing out the remaining use of fossil carbon more quickly.

Ad2: From a social-economic perspective it is important that any additional Dutch policies will not lead to companies taking their business (and employment) elsewhere. This would of course also not be good from an emissions perspective as it would merely move emissions elsewhere.

A CTBO can affect three groups in different ways:

1. Producers/importers (who are subject to a CTBO and have to purchase CSUs)
2. Companies/industry using fossil carbon

3. Small users/consumers

The discussion about companies moving away (or investing less) always hinges on two questions:

- Can the additional costs (resulting from the policy) be passed on to their clients? Under the ETS sectors at significant risk of carbon leakage have been identified for example, and they receive (part of) their emission allowances (EUAs) for free. These companies compete directly on the international market with companies all over the world.
- Can the government compensate in another way so that prices do not have to be increased?

The CTBO for natural gas use in the Netherlands would be a mandatory commitment or policy (see design choice discussion in Chapter 4.3). This means that in principle there is a level playing field for selling gas to both small and larger customers. The question is: would this make the Netherlands more or less attractive to invest in?

Note: as with all policies it is best if the whole world would do the same. This is unlikely in the short term, and therefore we have assumed that in the short-term (up to 2030 or even 2040) the Netherlands (and possibly the UK and Norway) would be alone in implementing this policy, but with the intention of getting others to join as soon as possible. Fossil carbon and CSUs could be freely traded between countries that have imposed similar Paris-compliant CTBOs.

As the impact of a CTBO on gas prices will be quite low initially (see box Chapter 4.5) it is very likely that the CTBO costs can be passed on to customers as a 'carbon storage surcharge'. As the surcharge increases this may become an issue if other countries do not join.

The government then has a few mitigating options:

- Discontinue the CTBO. For example, if other countries are not joining because there simply is no need to continue with CCS (breakthroughs with renewable, nuclear, storage technologies) and fossil carbon emissions are decline rapidly enough without CCS, then it would make sense to discontinue the CTBO policy and compensate companies that have made significant investments based on a longer-

term CTBO policy. A luxury problem from a climate change perspective.

- However, if CCS is still needed and the CTBO is working the way it should in reducing fossil carbon emissions then the government may want to consider alternative ways of keeping the CTBO going whilst ensuring that companies continue to invest in the Netherlands. One option would be to reduce the additional Dutch carbon tax that is currently being implemented for large emitters. A CTBO can be argued to be very similar in impact to a carbon tax, and therefore it would make sense not to implement both (a NL carbon tax AND a CTBO surcharge).
- For individual consumers the government has been increasing gas prices quite regularly and more increases are expected. Here the government could do the same: use the CTBO storage surcharge as a way of continuing the increase of gas prices *instead of* continuing to increase the taxes on natural gas for consumers. From a social equity perspective it is important to ensure basic energy needs remain affordable also for low-income households.

In conclusion, we think the risk of companies moving away (or investing less) is small and can be further mitigated by the government if needed.

In this context it is also important that a CTBO could make the Netherlands *more* attractive for companies if:

- A CTBO, together with investments in a low-carbon hydrogen infrastructure and incentives for users to switch from gas to hydrogen, could make it interesting for producers to switch from selling natural gas to selling hydrogen. As this is expected to be a growing world-wide activity it may be of interest to companies to further develop and improve related technologies in the Netherlands. See also Chapter 5.2.
- A CTBO could help with societal acceptance for the development of Dutch gas resources as it will demonstrate how this can be consistent with emission reduction targets.
- For large industries (users) there may also be upsides:
 - The gap between the ETS price and total CCS costs will come down when storage costs are paid by producers and importers and effectively socialized over ALL gas users. Therefore, it will be possible to realize emission reductions (through CCS) at a lower cost. This could

make the Netherlands an interesting place for industries producing fairly easy to capture CO₂ (hydrogen, ammonia, etc).

- Many of these industries now have net zero targets and ambitions. For their operations in the Netherlands this will be taken care of as the CTBO will ensure that there will be no remaining net emissions by 2050. If all countries would do the same companies would not have to worry anymore about how to meet their targets. They would still need to decide whether they want to switch to other energy carriers or continue burning gas and capture their CO₂. As the carbon storage surcharge increases and ETS prices will rise there will be a moment in time that it will be cheaper to take action.

Ad3: General boundary conditions: fair, transparent, no perverse incentives, low leakage risk, cost effective, no/few legal barriers, public support, low admin costs, etc.

The general boundary conditions mentioned are mostly conditions that are relevant for the design of good and effective climate policies in general.

For such an important topic (effective climate policy) there is surprisingly little information available on what the key characteristics are of effective climate policy. One of the few good resources on this is the book by Hal Harvey (Designing Climate Solutions). In it he defines four performance standards and five requirements (for economic signals) that can be used to evaluate whether or not a specific climate policy idea could be effective. Below is our assessment of how the CTBO performs against these criteria.

Performance standards:

1. Long-term certainty to provide business with fair planning horizons
A CTBO will by design increase to 100% by a certain year. This could be different years for different countries (similarly as that emission reductions need to start and go faster in some countries than others). It could also be different for coal, oil and gas (e.g. 2040 for coal, 2050 for oil and 2060 for gas).
2. Continuous improvement
Again, by design, a CTBO will lead to continuous reduction of emissions as the CTBO percentage increases to 100%.
3. Focus on outcomes, not technologies
A CTBO focusses on emission reductions (outcome). In the Sounding Board there has been a discussion on different

technologies that qualify for generating CSUs (see Chapter 4.4). The criterium that was considered to be most important was that storage had to be safe and permanent (tens of thousands of years). That does limit the number of technologies that can be used to geological storage and mineralization and possibly also some CCU options leading to permanent storage (e.g. by converting CO₂ into building materials). Many different technologies can be used to capture the CO₂: CCS, BECCS, blue hydrogen, Direct Air Capture and storage.

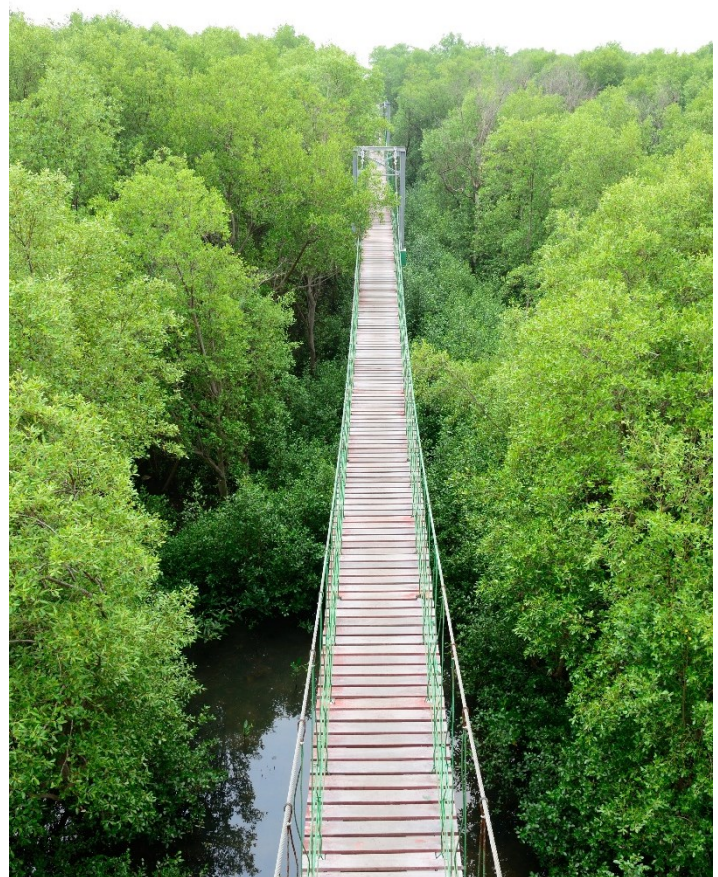
4. Prevent gaming via simplicity and avoiding loopholes. If a CTBO can be kept as simple as currently discussed and proposed, then it will be a fairly robust policy measure. Fiscal metering for production and import of fossil carbon is all in place, and checked for economic reasons. All carbon stored is planned to be carefully monitored for emission reduction purposes already. All necessary data should therefore be available. It is easier to administrate, monitor and verify than emissions regulations and less sensitive to leakage, waterbed, rebound, etc.

Economic signals:

1. Use a price finding mechanism
A CTBO means that there will now be demand for CO₂ storage for two reasons: producers/importers need CSUs to be allowed to continue production and import of natural gas, and industries will want to start capturing and storing more and more CO₂ as emitting CO₂ becomes more expensive. As CSUs can be traded and EUAs can be traded there will be an interaction between the two markets and a choice has to be made if price finding is left to market forces or some price collars will be used to limit extreme fluctuations. Either way, a price finding mechanism will be used (see also Chapter 4.7 and Appendix F).
2. Eliminate unnecessary soft costs
Administration should be fairly simple as the basic numbers are already being monitored and collected. This is one of the reasons for not including CCU (yet) and nature based solutions: new monitoring and verification procedures and standards will need to be developed to better assess the amounts stored and the level of permanence of these options.
3. Reward 'production', not investment
Only actual storage will be rewarded with CSUs. Companies will have to surrender CSUs every year based on how much fossil carbon they have produced (or imported). This is very similar to the way the ETS works: companies have to surrender EUAs for their emissions every year.
4. Capture 100% of the market and go upstream
The CTBO by design (see Chapter 4.2) focusses as far

upstream as possible. Roughly hundred companies are responsible for 70% of the world's fossil energy production. If these companies could all support and commit to a CTBO policy then already 70% of all carbon would be covered. The further downstream a policy (carbon tax or carbon take back) is implemented the more complicated it gets (more companies and individuals involved) and the higher the risk of not capturing 100% (or most) of the market and of the total carbon produced (see Chapter 2.3 and 4.8 point 3).

5. Ensure economic incentives are liquid
Storage certificates should become liquid as more technologies become accredited to deliver them and as more countries join. Additional tools like Market Stability Reserves and banking and borrowing over longer time-periods can further help to keep the CSU-market liquid and avoid large price fluctuations.



4. Design choices

4.1. Introduction

There are many different ways in which a CTBO can be designed and implemented. We have referred to these different options as 'design choices'. There are no right or wrong choices as long as the agreed objectives and boundary conditions can be met. We choose (based on preferences of the Sounding Board members) six design choices for more detailed discussion in the meetings. The results of these discussions are presented in this chapter. As pre-read for these discussions short introductions were prepared for each option detailing the various options and considerations. These pre-reads can be found in Appendix B2.

When discussing design choices a distinction should be made between the longer term, when a CTBO is fully operational and there is a fully functioning market for CSUs, and the ramp up phase.

How we get from now to this end-game is described in Chapter 6.

4.2. Placement of the Obligation

There was a high degree of consensus in the group that the obligation should be placed as high as possible in the value chain. This means placement on whoever produces or imports fossil carbon for sale on the Dutch market. Important reasons given were:

1. It supports the objective of a broadly supported business model. The attendees agreed that placement at the producer keeps the 'narrative' as simple and attractive as possible: when you take carbon out of the ground you also become responsible for making sure waste carbon gets stored again.
2. Environmental integrity: the main objective of getting to net zero emissions depends on including all carbon produced. The closer to the wellhead the obligation is placed the lower the risk of 'upstream' emissions being missed.
It will make decision-making on more or longer gas production in the Netherlands dependent on sufficient

deployment and capacity for CO₂ storage; no more unconditional natural gas production.

3. Fairly easy to implement and administer (most data available already, limited number of players).
For broad acceptance it was also considered to be important that there are no supply-side climate policies yet. Given the urgency of the climate problem, it makes sense to consider adding supply-side policies/regulations. There are already quite a few regulations for the 'demand-side' (emissions requirements, ETS, CO₂ taxation, efficiency standards, etc.) and adding more requirements would therefore not make sense and would likely be resisted.

An additional consideration that was mentioned was that the expertise (and assets) needed for CO₂ storage can be found with oil- and gas-producers. This will incentivize them to make sure CO₂ storage is done as efficiently as possible.

In conclusion therefore, it was agreed that the CTBO should apply to all natural gas sold on the Dutch market (see 4.8 for discussion on oil and coal and cement), and should be placed as high up in the value chain as possible: on producers and on importers of natural gas.

4.3. Voluntary vs Mandatory

To get to net zero (objective 1) and to keep a level playing field (boundary condition 2) it is important that a CTBO is made mandatory for all gas sold in the Netherlands. This will also allow a transparent passing on of storage costs to the customer in the form of a 'carbon storage surcharge' (see Chapter 4.5). By making it mandatory for all gas sold in the Netherlands a CTBO can also be regarded as an alternative for an upstream carbon tax which is sometimes argued for. Similar to an upstream tax, it will raise prices and it will therefore encourage users of natural gas (ETS and non-ETS users) to implement efficiency measures and/or to switch to other energy sources. The main difference is that when a CTBO is implemented there is more certainty of actual emission reductions: the polluter pays to clean-up (the carbon storage surcharge is used to store waste carbon) instead of just paying a tax.

Implementing a mandatory obligation takes time however, and therefore it may be interesting for companies to make a voluntary Carbon Takeback commitment in the meantime. This could be done for example by accepting Extended Producer Responsibility for the collection and disposal of the waste product of using natural gas. This needs to be evaluated in more detail (see Chapter 6).

4.4. Allowable Technologies

To keep the narrative clean and simple (net zero means: carbon in = carbon out) there was a strong preference in the group to only allow geological storage as a source of CSUs. Later on, it was agreed that also other forms of storage could be allowed (e.g. mineralization) as long as the same level of permanence can be demonstrated.¹² Where the CO₂ comes from was not considered important; it could be of fossil origin, biological origin (bio-energy) or taken out of the atmosphere by Direct Air Capture. As long as it is placed in permanent storage it should qualify for generating CSUs that can be used to meet the CTBO.

Conversely, this means that carbon storage in the biosphere (trees, soil) will not qualify for CSUs for fossil carbon production.

The dominant issue in the discussion of this design choice was the integrity of the CTBO mechanism:

1. Environmental integrity: CSUs should only be given when it is certain that the carbon will stay out of the atmosphere for a very long time,
2. Ethical/moral integrity: compensating (and justifying) continued fossil carbon production with 'planting trees' doesn't feel right to many stakeholders
3. Societal support integrity: being able to keep the 'narrative' (carbon in = carbon out) simple and honest is essential for support.

In conclusion therefore, only geological storage and (probably) mineralization are considered to be 'allowable technologies' for generation of CSUs as needed under a CTBO.

Note that for DACCS and BECCS to become full operational Carbon Removal (emission reductions) also still need to be certified and properly included in emission regulations (such as ETS).

4.5. Who pays and how

Making producers and importers responsible for waste disposal will add to their operating costs. Because the amount of CO₂ stored is small in the beginning and the total amount of gas sold is still large the actual additional costs (per m³ gas produced or sold) will be very small. See BOX. The closer the CTBO percentage gets to 100 the larger the price impact will become.

Most members of the Sounding Board considered it important that the customers of natural gas are made aware of the additional costs due to carbon storage. The example was given of the 'verwijderingsbijdrage' (removal fee) that used to be paid separately when buying household appliances or electronic goods. By adding a slowly increasing 'carbon storage surcharge' to all invoices, customers will be made aware of why and how fast their gas bills are rising. This will encourage customers to look for alternatives.

Alternative options, where more of the costs are absorbed by companies and/or the government (who still has large revenues from fossil carbon production and consumption) were considered to be in contradiction with the 'polluter pays' principle and therefore also possibly a risk for the boundary condition to not slow down the energy transition.

¹² Levels of permanence of other potential technologies should be comparable to underground storage. IPCC says the following about this: Will physical leakage of stored CO₂ compromise CCS as a climate change mitigation option? Observations from engineered and natural analogues as well as models suggest that the fraction retained in appropriately selected and managed geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1,000 years. For well-selected, designed and managed geological storage sites, the vast majority of the CO₂ will gradually be

immobilized by various trapping mechanisms and, in that case, could be retained for up to millions of years. Because of these mechanisms, storage could become more secure over longer timeframes.
(https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_summaryfor Policymakers-1.pdf).

Carbon Storage Surcharge

A ‘back-of-the-envelope’ calculation can be made of the required surcharge to pay for the CTBO. It is assumed (see Chapter 4.7) that when the market for CSUs is still immature that the price of the carbon surcharge will be determined simply by dividing storage costs over the total amount of gas used and charging all producers and importers accordingly.

For this rough calculation we use the 7 Mton CO₂ storage in 2030 as agreed (or estimated) in the Klimaatakkoord (Dutch Climate Agreement).

If a handover point (to the storage operator) is taken just upstream of the compressors at the coastline, then a rough conservative cost estimate for compression, transport, storage, would be around 40 Euro/ton, and therefore 280 M Euro per year. Note that later on, when CSUs have become fully tradeable, there is no direct relationship anymore with the actual storage scope and costs. See Appendix E.

If the total gas use in the Netherlands is 35 billion m³, then the storage surcharge per m³ would be 0.8 cent per m³ (0.008 Euro/m³). Note that this equates to a CTBO percentage of around 11%.

In 2050, when the CTBO is 100% around 1.8 Mton CO₂ has to be stored for every billion m³ of gas that is still being used. Storage costs will probably have dropped a bit then, but even if they remain the same the surcharge would still be only 7 cents per m³ (assuming the capture costs are paid for by the user).

With a CTBO it is highly likely that most of the natural gas still used in 2050 will be converted into hydrogen or electricity and the CO₂ storage costs will be internalized and become part of the production costs. Continued dispersed use of natural gas (e.g. in houses) would have to be offset by carbon removal (DAC or BECCS).

It is expected that DAC costs can be brought down to around 200 euro/ton CO₂. If a conservative total cost of 280 Euro/ton is assumed for DAC plus storage then this would equate to a ‘storage surcharge’ of 50 cents per m³ for dispersed gas users.

To put this all into perspective it is interesting to have a look at the current surcharges (government revenues) for natural gas use in the Netherlands:

Euro/m ³	2020	2021
Energy tax small users	0,4030	0,4218
ODE small users	0,0938	0,1030
Energy tax large users	0,0126	0,0128
ODE large users	0,0212	0,0232

This shows that the surcharges for carbon storage are relatively small for small users but will become significant more quickly (and therefore influence decision making) for larger users.

Consideration: instead of just continuously raising the taxes on natural gas use the government could consider partly replacing these increases with a slowly increasing storage surcharge. It would be interesting to investigate how this would impact public support for the continuously increasing gas prices.

4.6. Determining the storage percentage

There are different ways in which the carbon storage percentage can be determined. Ideally, restrictions on the supply side (CTBO) and the demand side (ETS, energy and carbon taxes) would be tightened at more or less the same rate so that the need for CSUs would more or less match the demand for CO₂ storage due to carbon capture by large emitters. See also Chapter 4.7.

For the Netherlands the amount of carbon captured will initially be determined primarily by the SDE++ subsidy and the commitments made as part of the climate agreement. This would lead to around 7 Mton of CO₂ stored in 2030. If the total gas use is still around 35 billion m³ per year (this leads to roughly 63 Mton/y of emissions) then the CTBO percentage could be set at around 10%.

For the long-term large investments that are needed to increase the amount of CCS it is important that there is clarity as soon as possible on how the CTBO percentage will change after that. A linear increase to 2050 would mean 4.5 % more every year! Resulting in a CTBO % of 55% in 2040 and 100% in 2050. As total natural gas use will decline and technology solutions and infrastructure will improve it can be argued that it will become easier and easier to increase the CTBO percentage. And therefore an argument could be made to ramp up more slowly in the 2030s (e.g. an average of 3% a year) and more quickly in the 2040s (e.g. an average of 6% per year). This would lead to a CTBO% of 40% in 2040 and 100% in 2050. For this situation the actual amount of carbon required to be stored would remain the same between 2040 and 2050 (due to declining use of natural gas).



Year	GAS USE bcm	CO ₂ Mton	%CTBO	Stored Mton CO ₂
2030	35	63	11	7
2040	25	45	40	18
2050	10	18	100	18

These numbers are given to illustrate the considerations that will influence the setting of the required Takeback percentage. The slower the percentage is increased, the more the carbon budget will be exceeded (even if net-zero is achieved in 2050), and the more carbon will have to be removed from the atmosphere after 2050. But a slower early increase (as shown above) will lead to a lower peak in the required maximum transport and storage capacity which reduces the overall costs.

The dominant objective for setting the CTBO percentage is the need to be net zero in 2050.

But also after 2050 there are choices: for example, the CTBO could be kept at 100% or the CTBO could be further increased so that continued fossil carbon use is further discouraged and will start contributing to net carbon removals until it is phased out. This could be a way of addressing the lock-in concern and boundary condition. See Chapter 3.3.

4.7. Price of CSUs

Price-finding for the CSUs can be done in different ways. A lot can be learned from experiences with cap-and-trade mechanisms as the same principles will apply.

For the longer term there was a preference in the Sounding Board to leave the price-finding to the market as much as possible. The increasing CTBO % will increase demand for CSUs and the continuous lowering of the ETS ceiling will increase the EUA price and therefore demand for storage services.

At times when there is more CO₂ captured than required for CSUs it is likely that CSU prices will go down as emitters will be inclined to pay part of the storage costs to ensure sufficient storage capacity is available (see Appendix E, case D).

On the other hand, if the amount of CO₂ captured would lag behind the amount of CO₂ requiring to be stored as a result of an ambitious CTBO then the price of the CSUs would rise as

storage companies would have to go ‘hunting’ for more CO₂ to store and may end up paying part of the capture costs also in

order to be able to store enough CO₂ (see Appendix E, case E).

This could actually result in a fairly stable investment climate for storage projects which is one of the objectives (working business model) and a boundary condition (keeping NL attractive for investments). This will need further investigation (modelling) in a next phase.

Options like banking and borrowing and a Market Stability Reserve (to limit price fluctuations) can further add to a well-functioning market for CSUs.

It should also be possible to link to other countries that have implemented a CTBO. On the other hand, it should not be allowed to purchase or use CSUs from countries that do not have a comparable CTBO-policy in place.

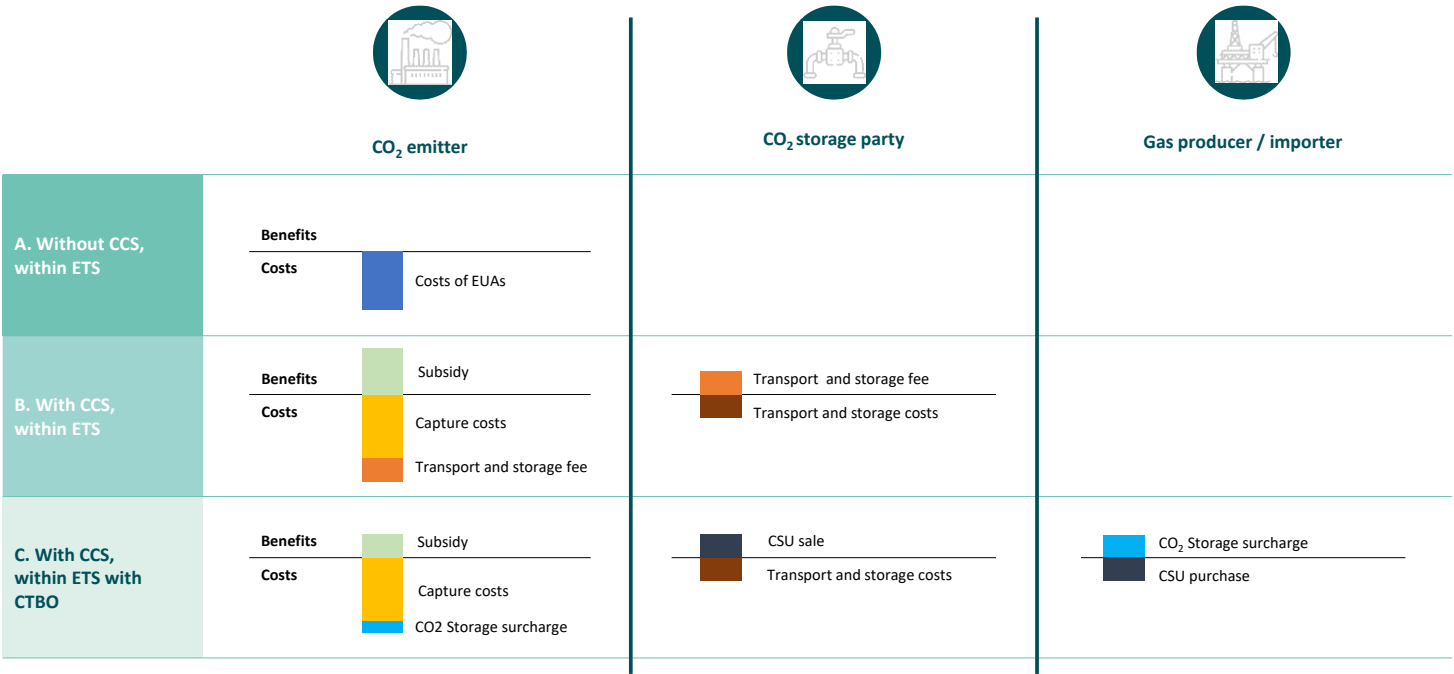


Figure 14: Start-up phase CTBO implementation: the price of CSUs is determined by the transport and storage costs (cost recovery).

For the shorter term, when volumes are still too small for a stable and functioning market, it is proposed that the price of the CSU is determined simply by dividing the total carbon storage costs by the number of CSUs. See Figure 14. The storage service provider would be recovering their costs by selling the CSUs they generated to all gas producers and importers (in proportion to their gas production or import volumes).

From 2030 onward an increasing percentage of CSUs can be sold on an open market. After 2035 it should be possible to buy and sell all CSUs on a fully functioning market.

Appendix E shows possible developments in the longer term as the CTBO percentage continues to increase towards 100% (how costs are shared).

The price of CSUs (start-up phase; cost recovery)

The price of CSUs can be expressed per ton of CO₂ stored or per ton of carbon stored. See below.

If storage costs are 40 euro per ton CO₂ in 2030, the price of a CSU will also be 40 Euro per ton of CO₂ stored and the price of a CSU would be around 147 Euro per ton of carbon stored (=40x44/12). The surcharge for storage, spread over 35 billion m3 gas, would be 0.008 Euro/m3 (the same as for the customer). After 2030 when CSUs are increasingly traded on the open market then the price is determined by supply and demand.

The theoretical maximum price of CSUs is determined by the cost of DAC plus storage. Any continued burning of natural gas after 2050 without carbon capture will need to be compensated for by atmospheric carbon removal and storage. The CSU price (if expressed in costs per ton CO₂) could therefore increase to 280 Euro/ton CO₂. If BECCS can also be used to generate carbon removal credits and provide carbon for storage then the maximum price would be significantly lower.

Two options for determining the number of CSUs required when producing 1 billion m³ of gas:

1 CSU = 1 ton of CO₂ stored

1 billion m³ of gas results in approximately 1.8 Mton CO₂.

Therefore a CTB percentage of 10 would require storage of 0.18 Mton CO₂ or 180,000 CSUs.

1 CSU = 1 ton of carbon stored

1 billion m³ of gas is roughly 0.65 Mton of gas (CH₄),

and contains roughly 0.49 tons of carbon (0.65x12/16)

Therefore a CTB percentage of 10 would require storage of 0.049 Mton carbon or 49,000 CSUs. Using tons CO₂ as the unit for CSUs has the advantage that this is the more familiar unit now.

Using tons C (carbon) has the advantage that it makes it clear that the purpose of CSUs is to monitor carbon stocks (and flows in and out), and will make it less likely that people will confuse CSUs with emission reductions (from an accounting perspective).

4.8. Other Design Choices

In practice, there are quite a few more design choices that will need to be evaluated and decided on when a CTBO is implemented. Seven examples are discussed briefly below. These have not been discussed in the Sounding Board and therefore represent the opinions of the project team.

1. Which carbon to include?

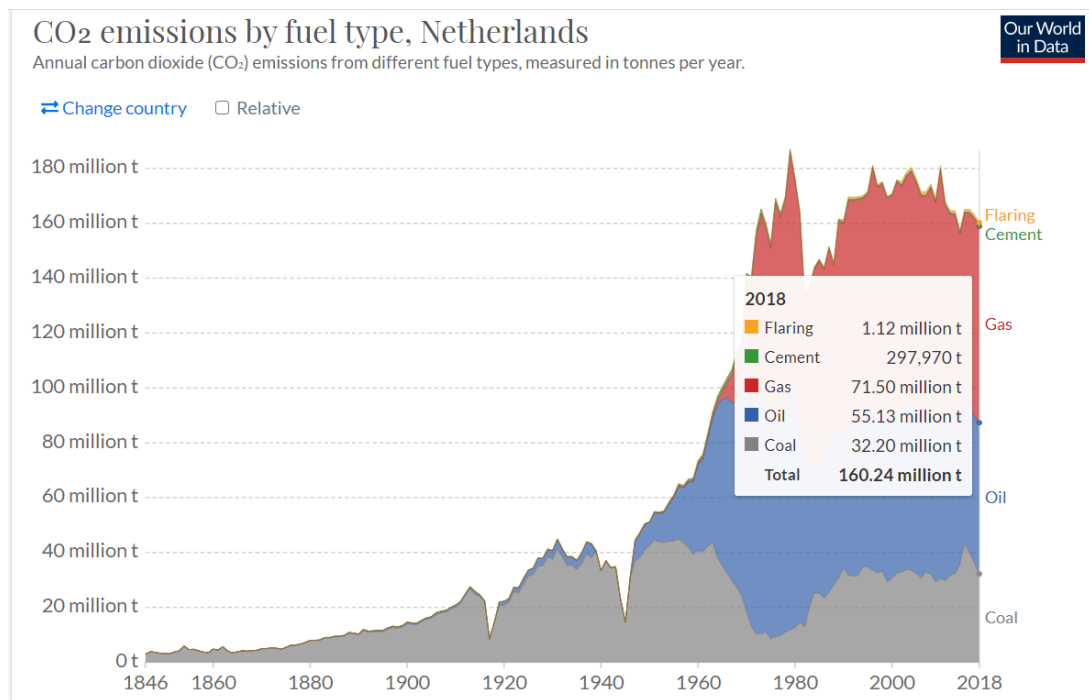


Figure 15: CO2 emissions by fuel type in the Netherlands

In principle all fossil carbon could be included: coal, oil, natural gas and limestone/cement. And ultimately, a ‘takeback obligation’ could even be applied to ensure bio-carbon stocks are managed in a similar and sustainable way.

As explained in Chapter 1.2 the criteria used for deciding which carbon to include are:

1. Does it lead to CO₂ emissions in the Netherlands and
2. Is this carbon use *not* covered yet by other supply-side policies to reduce the emissions

In the current proposal we have focused on natural gas for several reasons:

- There are already plans to phase out coal power plants. Therefore, it makes sense to exclude thermal coal. However, metallurgical coal for steel furnaces probably should be included under the CTBO. Import of this coal into

the Netherlands would then also require the purchase of CSUs.

- Most oil is used in the transport sector where there are regulations in place to gradually reduce emissions from this sector: e.g. the fuel quality directive and the emission performance standards for new vehicles (fleet standards). There is very little oil production left in the Netherlands. A more in-depth evaluation of the pros and cons of applying a CTBO on the import and sale of oil in the Netherlands should be part of any follow-up work. In the UK for example, the proposal of the Net Zero All Party Parliamentary Group to introduce a CTBO does include the fossil fuels used by airlines.¹³
- Emissions from cement are not significant in the Netherlands. Most of the emissions are upstream in the

¹³ Net Zero All-Party Parliamentary Group (2020). 10 Point Action Plan for COP26. <https://netzeroappg.org.uk/wp-content/uploads/2020/07/NZ-APPG-Letter-to-COP26-President-21st-July.pdf>

country of cement production. Therefore, it will be difficult to apply the CTBO to cement.

2. What is included in 'the storage costs'?

When there is a fully functioning market in CSUs the CSU-price is determined by the market as described in Chapter 4.7. This may vary from covering exactly the costs of storage in the early years, to very low prices when the EUA-price starts reaching levels where carbon capture is economic for many large point sources, to very high prices when there are no more carbon capture opportunities and carbon produced will have to be compensated for by carbon captured from the atmosphere and stored underground. That is the reason that the CTBO is still relevant, also when EUA prices are in principle high enough to cover full CCS value chain costs: to reduce or compensate *the emissions outside of the ETS* (buildings, smaller businesses, etc.).

For the first phase, in which there is no functioning market yet, a decision will have to be made which costs to include. It makes sense to include all costs made by the storage provider. In the cost estimate used in this study (40 Euro/ton) it is assumed that the storage provider (for example EBN) will be the owner and operator also of the onshore compressors. The reason for this is that the optimum transport pressure in the pipeline will partly depend on the pressure situation in the reservoir that is being filled. Another advantage could be that there is a real synergy opportunity for using the waste heat of the compressors to do Direct Air Capture and generate Carbon Removal Units (CRUs) and additional CSUs after all the good point sources have been fitted with carbon capture.

3. How to determine the carbon amount to which the CTBO should be applied?

Ideally one molecule of carbon is stored for every molecule of carbon produced by 2050. However, the actual measurement of produced carbon is not done consistently at the wellhead. The most reliable data comes from so-called 'fiscal metering' at the first point of custody transfer. At that point there will already have been some emissions between the wellhead and the point of custody transfer. For natural gas production this would be the point where an upstream operator transfers the gas to Gasunie. Similarly, for import gas there will have been upstream production emissions (due to energy use, leaks, flaring, etc.). There can be significant differences in these upstream emissions. It is well known that gas imported from

Russia or USA has a much higher carbon footprint than gas imported from Norway for example. For the integrity of the CTBO it should therefore be considered to develop a list of correction factors for gas from different sources and countries that could be used to determine the total amount of carbon to which the CTBO will be applied. For example, if Russian gas has a correction factor of 1.2 and for example the CTBO is 10%, then for every ton of carbon imported 0.12 CSU would have to be purchased (and retired). For Dutch or Norwegian gas the correction factor may be 1.05 and therefore 0.105 CSU is required per ton of carbon produced/imported. As this may lead to political difficulties and trade issues it will be a political decision to determine the best timing for proposing the introduction of a correction factor for different sources of import gas. Ideally this would be decided at EU level where these issues are already being contemplated.

4. What should be the penalty for non-compliance?

In recognition of the fact that CCS projects can take many years it is important that the banking and borrowing rules are quite flexible. However, in the end it is up to the producers and their customers to think ahead and make sure they do not get into situations where production may have to be restricted because of a lack of CSUs. A phased approach may be appropriate: allowing borrowing against planned CCS projects, followed by penalties at a level that it is more attractive to do more CCS (so probably around 100 Euro/ton or so), and ultimately by placing restrictions on production or import. The legal basis for this will need to be studied in more detail.

5. What about CO₂-EOR (injecting CO₂ into oil fields for Enhanced Oil Recovery)?

Although not important for the Netherlands (no CO₂-EOR opportunities), it is a question that is often asked. CO₂-EOR is subject to exactly the same rules as normal oil and gas production: if you take carbon out, you will have to store an increasing amount of carbon. The amount of CO₂ typically used per bbl produced comes fairly close to the carbon content of a bbl of oil. This means that if all that CO₂ would have been captured from the air with DAC that the oil production would be close to being carbon neutral (100% CTBO).

At the moment most of the CO₂ used for CO₂-EOR actually comes from geological stores of CO₂, and therefore oil from CO₂-EOR is no better than other oil (carbon footprint) and often worse because of the additional energy needed for CO₂-

EOR. Under a CTBO any CO₂ produced from geological reservoirs should be subject to a 100% CTBO (see also next point). We should discourage and avoid producing and using geological CO₂ for oil production.

In the end the demand for oil worldwide will decline because of a shift to electric vehicles. Producing oil while storing CO₂ (CO₂-EOR) will not increase global oil production. It is better to produce oil while also storing CO₂ than to just produce oil. If 50% of worldwide oil production would be done with CO₂-EOR then we would already be storing 7 Gton of CO₂ per year. A CTBO would make storing CO₂ (from CCS or DAC) mandatory for oil producers. This may lead to more CO₂-EOR (replacing other production) and may lead to different optimization of CO₂-EOR operations: focusing more on maximizing CO₂ stored instead of only on maximizing production of oil. This could lead to more storage per bbl produced. In the end it should not matter whether the CO₂ is stored in a different field or in a producing reservoir; what matters is that an increasing percentage of all carbon produced is stored again.

6. What about methane leaks/emissions and co-produced CO₂ emissions?

Methane emissions can and should be minimized as soon as possible. Co-produced CO₂ (produced together with oil or gas) should be captured and reinjected into the subsurface (like is done for Sleipner and Gorgon). Very often though this CO₂ is still vented to the atmosphere. Both issues (methane emissions and venting of co-produced CO₂) are typical 'upstream' issues: they occur during production. Both are examples of transferring carbon from a store to the atmosphere without any benefits (no energy is derived from this carbon transfer). Therefore, it is proposed to use a 100% CTBO for all upstream methane and geological CO₂ emissions.

7. What about exports?

The Netherlands has become an import country, so how to deal with exports is not an issue for the Netherlands. However, the question sometimes comes up for a country like Norway that exports much of its oil and gas production. In principle, the CTBO is implemented for *all fossil carbon use* in a country. That way it is possible to keep a level playing field. When exporting gas Norwegian gas has to compete with other gas in the international market. In principle therefore production of export gas would not be subject to a CTBO. It is also physically impossible because there are not enough good CO₂ sources in

Norway as they do not use a lot of their own natural gas production. Also in Norway therefore, a CTBO would mean that any oil or gas sold on the Norwegian market would require CSUs to be purchased/retired. When Norway exports gas to another country with a CTBO (e.g. the Netherlands) there are three options:

1. They can just sell standard natural gas, in which case whoever imports the gas will have to purchase CSUs in their own country (see Chapter 2.5)
2. They can sell CTBO-compliant gas by purchasing and surrendering CSUs (as is done for their domestically used gas).

They can physically take back an increasing amount of CO₂ for storage in Norway (e.g. as is discussed for the Magnum project in Eemshaven) and sell the CSUs this generates to the company importing gas into the Netherlands.

5. Impacts

5.1. Introduction

This CTBO study has focused on better understanding the perspectives of various stakeholder groups, and on developing shared objectives and what that could mean for the various design choices that need to be made. A next step could be to carry out some modelling work to assess what the possible impacts could be of a CTBO-policy (see recommendations). In this chapter we will do a preliminary *qualitative* assessment of possible consequences and impacts of the implementation of a CTBO.

Financial and economic impacts

In the table below we have made a qualitative assessment of possible financial implications for the various players in the fossil carbon value chain.

	costs	benefits	comments
Producers/ importers	Storage costs or cost of CSUs	CSS charged to customers	A stable Paris-compliant fossil carbon policy (CTBO) may offer room for more Dutch gas production and/or blue hydrogen.
Industry ETS	CSS (Carbon Storage Surcharge)	Lower cost of emission reductions through CCS; there will be demand for captured CO ₂ . Some cost recovery from customers	A CTBO will act as an upstream carbon tax for industry; and could replace the CO ₂ tax therefore
Non-ETS business	CSS	CSS cost recovery from customers	Would have the same effect as a CO ₂ tax on non- ETS businesses.
Households	CSS	Possibly a less quickly growing energy tax on gas use	CSS charges will be very small compared to other taxes

Government	It depends. Possibly lower energy tax increases for small users. Possibly no CO ₂ tax for industry.	SDE++ support for CCS projects will be smaller and shorter.	Much lower total costs of emission reductions compared to either continued subsidies for CCS or a transition without CCS.
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5.2. Technology and innovation

A CTBO will cause 'deployment-led' innovation in all CCS technologies. This is likely to lead to much more rapid cost reductions (see historical cases of legislation for lead in gasoline and NO_x/SO_x emissions).

- Areas where significant improvements are likely, are:
- Carbon capture: for post-combustion capture this is the most expensive part of the CCS value chain, and it is expected that significant cost reductions can still be achieved.
- Blue hydrogen: there are many different ways in which blue hydrogen can be produced, and most have not been optimized yet. At the moment it is often assumed that the cost of blue hydrogen is more or less constant (and mainly depends on gas prices), and that green hydrogen will get cheaper and cheaper. This is probably not correct. There are several promising technologies being developed at the moment that will get a boost from policies like a CTBO.¹⁴ TNO has done good work on pyrolysis but there has been limited commercial interest in the Netherlands compared to other countries.
- Gas power: post combustion (on existing plants) will become cheaper through improvement of capture technologies and because of economies of scale in transport and storage of CO₂. However, the real cost savings are likely to come from new technologies like

¹⁴ <https://proton.energy/>: subsurface gasification of oil/gas, on trial in Canada.
<https://energyvalley.no/wp-content/uploads/2019/04/Blue-Hydrogen.pdf> The Rotoreformer in Norway
<https://monolithmaterials.com/>: hydrogen and ammonia production using pyrolysis of natural gas
<https://hazergroup.com.au/>: natural gas splitting via Hazer process

<https://fuelcellsworld.com/news/gazprom-develops-climate-neutral-production-for-hydrogen/> and Gazprom is also working on this
<https://www.tno.nl/en/focus-areas/energy-transition/roadmaps/towards-co2-neutral-fuels-and-feedstock/hydrogen-for-a-sustainable-energy-supply/optimising-production-hydrogen/ember-methane-pyrolysis/>

NETpower and smart solutions like Circular Energy's plan (complementing offshore windpower).¹⁵

- Integrated solutions: the energy carriers of the future (electricity, hydrogen, ammonia) can be produced more efficiently if plants and processes can be integrated. E.g. the 'waste nitrogen' of a oxyfuel plant can be used as feedstock for ammonia production. The waste oxygen of green hydrogen production can be used as feedstock for an oxyfuel plant. Etc. A stable and predictable policy climate created by a slowly increasing CTBO may provide the right conditions for investing in these kind of developments.
- Carbon Removal technologies: atmospheric carbon removal technologies will likely get a boost as a result of a CTBO. After CO₂ has been captured and stored for the relatively easy point sources the only way to keep on producing and selling natural gas is by retrieving CO₂ from the atmosphere and permanently storing it (see 2.5). Technologies like those developed by Climeworks and Carbon Engineering¹⁶ could be used to directly capture the CO₂ from the atmosphere. Another option is storage of CO₂ from biomass use (for chemicals or energy). Considering the limited space for planting trees in the Netherlands, these technologies (DAC+ CCS, BECCS) are likely to be essential also in the so-called 'net-negative' phase (after 2050) when countries should be removing excess CO₂ from the atmosphere (due to overshoot of the Paris-compliant carbon budget limits).

5.3. Business models/commercial

A CTBO is likely to lead to different business models and commercial deals. For example, the following developments are quite likely:

- Producers of natural gas may prefer to convert the natural gas into hydrogen (or electricity) themselves (and store the CO₂) and sell low-carbon hydrogen instead of natural gas.
- Producers (or importers) may make direct deals with customers who are willing to capture their CO₂. Companies like Shell and BP, who have set targets to also reduce scope 3 emissions to zero, have committed to work with their customers to decarbonize the value chain. A CTBO will

formalize and incentivize such cooperation across the value chain.

5.4. Regulations: barriers and safeguards

A thorough evaluation of regulatory barriers was outside the scope of this study. The general barriers to CCS as identified in the CCS Routekaart also apply for the CTBO. A more specific check for the CTBO is one of the recommendations of this study. Questions that should be included in this check, are:

- Are there any regulatory barriers against producers of natural gas, not selling gas but selling hydrogen or electricity instead?
- Are there any regulatory barriers against imposing a CTBO on importers of natural gas for the Dutch market?
- Can a CTBO be interpreted (legally) as implementation of the 'Extended Producer Responsibility' principle, and therefore be seen as a necessity in the transition to a more circular economy?
- To what extent is there an overlap with other policy instruments (e.g. the CO₂-tax for industry and the energy tax), and if so, how can this best be resolved?

As mentioned in Chapter 2, complementary (safeguarding) policies may be useful to make sure that end-users switch to electricity or hydrogen as soon as possible. This will minimize the risk of 'user-lock-in' and allow a more rapid transition to green electricity and hydrogen as soon as those are available in large enough quantities.

5.5. North Sea production, decommissioning, storage

The North Sea is on the point of a large changes. Many offshore oil- and gas-installations are likely to be removed in the next ten years. And many windfarms are expected to be built.

There is a lot of uncertainty about how fast CCS will actually be scaled up and which offshore installations should be kept in place to enable offshore CO₂ storage. At the moment, there is

¹⁵ <https://netpower.com/>: Oxyfuel power plant
<https://www.offshorewindinnovators.nl/companies/clean-power-plant-to-balance-the-offshore-wind-farm-grid>: power-balancing proposal for NL could be helped by a CTBO

¹⁶ <https://www.climeworks.com/>
<https://carbonengineering.com/>

likely to be a need for so-called mothballing of platforms in the period between oil- and gas-production and the start of CO₂ storage. This will cost (taxpayer) money. Also, there will be discussions about decommissioning costs for platforms that are handed over to a CO₂ storage company.

A CTBO policy will give more certainty that CO₂ storage will continue also after subsidies for CCS are ended. And a CTBO may make it more likely that some of the remaining reserves (200 to 300 bcm) will be produced (thereby reducing the need for- and cost of mothballing). A CTBO policy will also give oil- and gas-producers more 'skin in the game': an effective transition to cost-effective CO₂ storage becomes a direct business interest (as they are the ones paying for the CSUs). This will change the dynamics on the commercial negotiations over decommissioning costs, mothballing costs and asset transfer costs. It is likely to lead to better, more efficient solutions, with lower overall costs for the taxpayer.

5.6. Public support & Paris compliance

Public support for climate policy depends on an ambitious plan to grow sustainable energy as quickly as possible, to reduce energy use as far as possible, and to minimize the impacts of remaining fossil energy use as much as possible. A firm CTBO policy can help with the latter. It will provide a clear and simple narrative on how continued use of natural gas 'fits in' with the commitments made in Paris and with national CO₂ reduction targets (and the Climate Law). This is very important for broad public and political support, and it also addresses some of the concerns of the Raad van State as expressed in their advice on the Klimaatakkoord.¹⁷

Demonstrating 'Paris compliance' is also becoming more and more important for companies and investors. A clear definition and agreement on what is needed to demonstrate 'Paris-compliance' for companies that still produce and/or use fossil carbon would be very useful for the companies themselves and for the investors in these companies. A CTBO could be very helpful in that respect.

Quote from one of the 'financial' stakeholders in the Sounding Board: "CTBO could be an excellent tool for oil and gas companies to set Paris-aligned targets for all their emissions (Scope 1,2, and Scope 3 (product emissions)) and (if applicable) to make their Net Zero Emissions Targets transparent. CTBO could be policy oil majors with Net Zero Emissions Targets could lobby for. Transparency, simplicity, accountability. CTBO could be a tool for shareholders to assess Paris-aligned targets and Net Zero Emissions Targets."

5.7. Energy Security

Over the last years it has become clear that there are far more fossil carbon reserves still in the ground than can be produced within safe limits of the remaining carbon budget. This should lead to a change in the way we view energy use and energy security. It means that remaining and usable fossil carbon reserves are determined by the carbon budget and by the carbon intensity of the reserves. It therefore makes sense to minimise coal use as soon as possible (low Energy Return on Carbon) and focus on gas with CCS for the remaining carbon budget. That will maximize how much fossil carbon can still be used within agreed carbon budgets.¹⁸

With a CTBO it is likely that CCS will increase more quickly (in line with requirements from Paris-compliant scenario's) than without a CTBO. This is likely to be good for energy security (of supply) for the following reasons:

- a) More diversity in primary energy sources that can still be used: more diversity means more resilience and less disruption if one of the energy sources would run into technical, political, economic or other limitations.
- b) Larger amounts of low carbon energy will be available sooner: by scaling up renewables and decarbonizing fossil energy use at the same time it might just be possible to get close to the required rapid reductions of emissions that are required to stay within carbon budgets.

¹⁷ Raad van State (Council of State) (2019). *Concept Klimaatsplan*. The emission reduction target for 2030 (49%) is, according to the Climate Act, an intermediate target. The ultimate goal, enshrined in the Climate Act, is a greenhouse gas reduction of 95% by 2050. Such a reduction, as necessary as it is enormous, does not simply require a multitude of individual measures, but rearranges production and consumption in all sectors of society and the economy. The draft Climate Plan still gives little evidence of that awareness and does not yet place the measures for 2030 sufficiently in the perspective of

2050. This and future Climate Plans must also provide (more) insight into when which measures are taken and how the implementation should proceed in the years up to 2030 and 2050 respectively.

<https://www.raadvanstate.nl/@118061/w18-19-0301-iv/>.

¹⁸See https://www.researchgate.net/publication/324153157_Implications_of_net_energy-return-on-investment_for_a_low-carbon_energy_transition



Appendix A: Original and approved project proposal (in Dutch only)

1. Inleiding

De huidige instrumenten die onderdeel zijn van het klimaatbeleid sturen op de *uitstoot* van CO₂, terwijl de productie en het gebruik van fossiele energie blijft groeien.

Wereldwijd is er een discrepantie tussen

- enerzijds de hoeveelheid broeikasgassen die nog in de atmosfeer kan worden geëmitteerd binnen een koolstofbudget dat past bij de 2-gradendoelstelling (of de 1,5 graden-streefwaarde) en
- anderzijds de hoeveelheid fossiele brandstoffen die nog gewonnen gaat worden en die zoals het er nu voor staat een veel grotere hoeveelheid koolstof representeert dan binnen het budget past.

De 50 grootste oliebedrijven in de wereld (private, maar met name ook staatsbedrijven) willen tot 2030 hun gezamenlijke productie met 35% uitbreiden terwijl in dezelfde periode de CO₂-emissies met 45% zouden moeten dalen¹⁹. Door deze productiestijging zou een substantieel deel van het carbon budget behorend bij 1,5°C worden verbruikt. De recente Emission Gap²⁰ en vooral Product Gap²¹ Rapporten laten de kloof duidelijk zien.

Omdat op mondiale schaal een hard plafond voor de broeikasgassenuitstoot ontbreekt, zoals het ETS in de EU, is sturing op CO₂-uitstoot een goed maar niet voldoende effectief middel om binnen het carbon budget en daarmee onder de 2 graden opwarming te blijven. Aanvullend instrumentarium is hard nodig. Een Carbon Takeback Obligation (CTBO) – een vorm van producentenverantwoordelijkheid voor koolstof die op de markt wordt gebracht – kan daar in helpen voorzien.

De essentie is dat bij het op de markt brengen van (fossiele) koolstof, de producent of leverancier een verantwoordelijkheid krijgt om ervoor zorg te dragen dat die koolstof niet in de atmosfeer komt. Technisch kan dat door met name CO₂-afvang en -opslag (CCS) te realiseren, maar in beginsel ook op andere manieren als daarmee een volume kan worden gehaald dat correspondeert met de in de Obligation geregelde hoeveelheden. Bestuurlijk-economisch kan zo'n Obligation bijvoorbeeld via een 'book and claim'-systeem (à la groene stroom) worden geregeld. Maar ook daar zijn alternatieve modellen voor denkbaar.

Het voorliggende voorstel beoogt om een verkennend en voorbereidend onderzoek en dialoog naar CTBO als een aanvullend instrument voor het klimaatbeleid uit te voeren. Conform de afspraken die zijn gemaakt op de voorbereidende bijeenkomst ('sponsorengroep') op 13 maart bij EBN in Utrecht, gaan we uit van een project dat door meerdere partijen wordt gefinancierd.

“De huidige instrumenten die onderdeel zijn van het klimaatbeleid sturen op de *uitstoot* van CO₂, terwijl de productie en het gebruik van fossiele energie blijft groeien. “

¹⁹ <https://www.theguardian.com/environment/2019/oct/10/oil-firms-barrels-markets>

²⁰ <https://www.unenvironment.org/interactive/emissions-gap-report/2019/>

²¹ <https://www.unenvironment.org/resources/report/production-gap-report-2019>

2. Carbon Take Back Obligation

Een Carbon Take Back Obligation (CTBO) kan een belangrijk aanvullend instrument zijn omdat het stuurt op *input* (de koolstofstromen die een economie binnenkomen), terwijl andere instrumenten op *output* (de emissies van broeikasgassen) sturen. CBTO helpt voorkomen dat er meer koolstof wordt geëmitteerd dan binnen het carbonbudget hoort. De gedachte erachter is analoog aan producentenverantwoordelijkheid voor bijvoorbeeld verpakkingen of witgoed, die regelt dat producenten die hun product op de markt brengen medeverantwoordelijk zijn voor een milieuvriendelijk gebruik en verwerking in de afvalfase. In geval van fossiele energiebronnen betekent dit (mede-)verantwoordelijk worden voor de koolstofemissies ('afval') die vrijkomen bij winning/transport/gebruik/verwerking.

Aangezien een groot deel van de fossiele grondstoffen verbrand wordt en CO₂ emitteert zou een belangrijk deel van de bekende en winbare fossiele voorraden 'in de grond' moeten blijven zitten wil er nog kans bestaan de opwarming onder de 2 graden te houden. In de meeste scenario's wordt daarom uitgegaan van een behoorlijke hoeveelheid carbon capture and storage (CCS) in de komende decennia om binnen het carbon budget te blijven.

Uitgangspunt is dat de theoretische winningsruimte voor fossiele brandstoffen afhangt van de klimaatdoelstelling (maximale opwarming en bijbehorend carbon budget), die de oplossingen zoals de inzet van CCS en het langdurig vastleggen van koolstof in materialen bepaalt. Als CCS niet of in zeer beperkte mate wordt toegepast, impliceert dat dus ofwel een lagere winningsruimte voor fossiele brandstoffen of het overschrijden van het carbon budget en dus niet halen van de klimaatdoelstelling.

Het is van belang instrumenten te ontwikkelen die regelen dat ondanks de verwachte wereldwijd vrijwel onvermijdelijk doorstijgende energievraag die vooralsnog ook fossiele brandstoffen zal omvatten, de klimaatdoelen toch nog gehaald kunnen worden. CCS of andere oplossingen direct gekoppeld aan de nieuwe winning van fossiele brandstoffen, aangeduid als Carbon Take Back Obligation, is hiervoor een kansrijk instrument, dat in een haalbaarheids- en definitieonderzoek en dialoogproces verder zou moeten worden verkend. Het zou invulling kunnen geven aan wat in het Routekaart CCS 'lange

termijn beleidszekerheid' genoemd werd. Dit werd door alle belanghebbenden een belangrijk punt gevonden (om te voorkomen dat ontwikkelingen stil zouden vallen na de eerste start-up projecten).

Vanuit het perspectief van leveringszekerheid kan een CTBO ook voordelen bieden aan eigenaren van fossiele bronnen omdat de randvoorwaarden waarbinnen verdere productie van fossiele energie mogelijk blijft duidelijker zijn. Dat geldt bijvoorbeeld ook voor bezwaren van een rechter in Australië over de opening van een nieuwe kolenmijn, die met een CTBO (als voorwaarde in een winningsvergunning) ondervangen zouden kunnen worden: "A consent authority cannot rationally approve a development that is likely to have some identified environmental impact on the theoretical possibility that the environmental impact will be mitigated or offset by some unspecified and uncertain action at some unspecified and uncertain time in the future."

In feite gebeurt momenteel met de broeikasgasemissies wat in Nederland jarenlang met stikstofemissies is gebeurd, namelijk vergunningverlening zonder dat duidelijk is hoe de emissies binnen overeengekomen grenzen gehouden gaan worden. Het is zeker denkbaar dat gelijksoortige rechtelijke uitspraken ook aan broeikasgasemissies gesteld gaan worden.

In het voorgestelde onderzoeks- en dialoogtraject worden kernvragen die met het idee samenhangen besproken, om uiteindelijk een beeld te krijgen van de haalbaarheid en praktische realiseerbaarheid van een CTBO, van de condities waaronder zo'n systeem kan functioneren, en van de schaalniveaus waarop het instrument inzetbaar is. Het voorstel en de werkzaamheden spitsen zich toe op Nederland (en zo mogelijk ook een of twee concrete casus in de Nederlandse situatie), maar de kennis en inzichten van elders worden wel benut, en omgekeerd kunnen de lessen uit de Nederlandse studie internationaal worden ingebracht. Het voorstel kan helpen om de nog resterende gasreserves in Nederland op een 'Parijs-conforme' wijze te benutten. Om dit te bereiken is het uiteraard ook van belang dat er een 'level playing field' blijft zodat de nederlandse producenten en gebruikers van fossiele producten kunnen blijven concurreren met buitenlandse aanbieders en concurrenten.

Vanuit de sponsorengroep worden verder de volgende aandachtspunten nog meegegeven (d.d. 13 maart):

- zorg dat de belangrijkste aannamen duidelijk zijn vanaf het begin
- de interactie van een CTBO met het ETS-systeem en/of CO₂-beprijzing is een belangrijk onderdeel van de verkenning
- onderzoek de mogelijke perverse incentives (welke onbedoelde effecten en/of misbruik zouden mogelijk zijn)
- schaal: bespreek de (on)mogelijkheden om dit op te schalen naar Noordzee-landen, Europees, globaal niveau

3. Voorstel haalbaarheids- en definitiefase

3.1. Hoofdpijnen

In dit onderzoek richten wij ons op het verder uitwerken van het instrument waarbij de vraag wordt beantwoord op welke wijze dit instrument, dat op input stuurt, een effectieve aanvulling kan zijn op andere outputgerichte instrumenten zoals het ETS, beprijzen van broeikasgasemissies en normeringen voor de uitstoot. Een belangrijke vraag is, in de verwachting dat we fossiele voorraden komende decennia nog nodig hebben, hoe we voorkomen dat de inzet van fossiel leidt tot een te grote toename van CO₂-emissies. Welke andere opties zijn er? Moeten we selectief zijn in het benutten van fossiele bronnen? Hoe valt te borgen dat op een deel van de nog te winnen fossiele brandstoffen CCS wordt toegepast? En hoe ziet het CTBO-instrument eruit dat hier effectief aan kan bijdragen?

We geven deze haalbaarheids- en definitiefase op onconventionele wijze vorm, niet als bureaustudie waarover wordt gerapporteerd op basis waarvan stakeholders dan hun opvattingen kenbaar maken, maar als interactief werkproces, waarbij stakeholders en experts van meet af aan worden betrokken en hun kennis inzetten om de kernvragen te beantwoorden.

CTBO is immers een nieuw instrument dat op verschillende manieren nog verder vormgegeven kan worden. Er zijn nog vele vragen over de verdere uitwerking van het instrument en over voor- en nadelen, risico's en kansen. Een belangrijk onderdeel van het haalbaarheidsonderzoek is om samen met een groep experts en belanghebbenden werkoverleg te hebben over zowel de doelstellingen van een CTBO (waarom zou je dit willen, oftewel Joint Value Finding) als de vormgeving

en effecten van een CTBO (hoe, wat, waar, scope, impact; Joint Fact Finding).

We richten ons in eerste instantie op Nederland in de Europese context (EU, emissiehandelssysteem), en op de fase na de initiële start-up-projecten (die vanuit de SDE++ gefinancierd zullen worden). Dit beleidsinstrument kan helpen aannemelijk te maken dat Nederland in 2050 klimaatneutraal kan zijn, zelfs als er nog in beperkte mate gebruik gemaakt zal worden van fossiele energie.

3.2. Aanpak

Dit wordt gedaan in 3 werkbijeenkomsten.

In de eerste bijeenkomst, gericht op joint value finding, zullen wij een voorstel doen voor onderwerpen die verder uitgewerkt zouden worden in de volgende bijeenkomst. Waarbij de onderwerpen en discussie tijdens de eerste bijeenkomst belangrijke input is voor de verdere uitwerking van een CTBO.

De eerste twee bijeenkomsten zijn verkennend gericht op het beter inzichtelijk maken van de drijfveren en eventuele zorgen (joint value finding) en om de inhoudelijke aspecten te bespreken en verder vorm te geven (joint fact finding).

In de derde bijeenkomst zal een concluderende notitie centraal staan waarin de volgende vragen beantwoord zullen worden:

- a) Zijn er voldoende gedeelde doelstellingen voor de CTBO als nieuw beleidsinstrument? Wat zijn de belangrijkste randvoorwaarden? (uitkomsten joint value finding)
- b) Hoe zou een CTBO er ongeveer uit kunnen zien voor Nederland? Welke kansen en bedreigingen ziet de groep van betrokkenen? Wat zijn mogelijke barrières? Wat voor aanpassing aan regelgeving is nodig? Etc. (uitkomsten joint fact finding)
- c) Zo mogelijk wordt aan de hand van een of twee casus bestudeerd hoe het instrument in de praktijk zou kunnen werken, en tot welke andere afwegingen en innovaties het zou kunnen leiden
- d) Een doorkijkje en advies over of en hoe verder: scope, doelstelling en randvoorwaarden voor eventueel vervolgonderzoek.

Voor elk van de 3 bijeenkomsten is er een korte telefonische conferentie met de kerngroep (co-sponsors) waarin de agenda en stukken voor de bijeenkomst worden besproken.

Voor de eerste bijeenkomst zullen ook nog een aantal voorbereidende 1-op-1 gesprekken gevoerd worden met sommigen van de deelnemers aan de klankbordgroep

In onderstaande tabel is dit overzichtelijk weergegeven:

Vorbereiding 1^e bijeenkomst	Voorgesprekken met klankbordgroepleden; Schrijven startnotitie & presentatie 1 ^e bijeenkomst; Telefonische conferentie sponsors: doorspreken agenda
1^e bijeenkomst	Kennismaking, verwachtingen; Toelichting achtergrond CTBO, supply-side policies, doelstellingen van de 3 bijeenkomsten en onderzoek iha; Begrijpen wat deelnemers zien als belangrijkste kansen en bedreigingen; Overeenkomen welke additionele info nodig is, welke feiten op tafel moeten komen, wat verder uitgezocht moet worden.
Vorbereiding 2^e bijeenkomst	Verslaglegging 1 ^e bijeenkomst; Informatie verzamelen te beantwoording van vragen uit bijeenkomst 1; Vorbereiding bijeenkomst 2, inclusief telecon sponsors.
2^e bijeenkomst	Presentatie antwoorden op de vragen uit de 1 ^e bijeenkomst; Verdere verdieping van ‘kansen en bedreigingen’; vertaling naar randvoorwaarden voor verdere uitwerking & implementatie (discussie); Doorkijkje ‘routekaart’: belangrijkste stappen/acties, volgorde; Overeenkomen welke additionele info nog nodig is.
Vorbereiding 3^e bijeenkomst	Verslaglegging 2 ^e bijeenkomst. Openstaande vragen beantwoorden; Concept eindnotitie opstellen; Werkbijeenkomst projectteam; Vorbereiding bijeenkomst 3, inclusief telecon sponsors.
3^e bijeenkomst	Presentatie en bespreking eindrapportage; Discussie of en hoe verder; Afspraken.
Eindrapportage	Omzetten concept eindrapportage in finale versie.

Deelname

Deelname aan het project is mogelijk:

- Als co-sponsor; wij voorzien 4 à 6 co-sponsors op basis van al gevoerde gesprekken
- Als klankbordgroeplid: op basis van voorgesprekken denken wij dat +/- 15 experts en belanghebbenden mee zullen willen denken in de drie klankbordbijeenkomsten.

Voor beide vormen van deelname geldt verder nog dat er ook ‘in natura’ kan worden bijgedragen door hulp/mensuren voor

het helpen beantwoorden van inhoudelijke vragen (joint fact-finding). Bv voorzien van inhoudelijke/wetenschappelijke experts in de klankbordgroep.

3.3 Uitvoering, kosten en planning

De werkzaamheden worden uitgevoerd door Margriet Kuijper Consultancy, RHDHV en De Gemeynnt. Margriet Kuijper zal als projectleider voor dit werk optreden en De Gemeynnt als opdrachtnemer.

Appendix B1: Meeting reports of the four Sounding Board Group (klankbordgroep) Meetings

First meeting June 2020:

CTBO klankbordgroep

Notulen 1e bijeenkomst – 8 juni 2020

1. Opening – Jan Paul van Soest

Tijdens de bijeenkomsten geldt de Chatham House Rule. Inzichten uit de bijeenkomsten mogen wel gedeeld worden, maar zonder deze toe te schrijven aan een persoon of organisatie.

2. Presentatie – Myles Allen: Achieving Net-zero by Decarbonising Fossil Fuels

The notes below are to complement the slides.

Professor of Geosystem Science and Head of the Climate Dynamics Group at [Oxford](#).

Well-known for his climate work especially on carbon budgets.

Already thought of something like a CTBO in 2009.

Myles' main messages:

- **Collaboration between countries is key.** The CTBO was *almost* adopted in the UK in 2015. But.... The big argument against this was: no one else is doing it so why should we? This is precisely why one country needs to start so others can join. Good to see NL picking this up.
- **Something like a CTBO is needed to limit global warming.** If you play around with the interactive chart in the IPCC report you can see what is needed to limit global warming. It becomes clear that you either need a global ban on fossil

fuels OR you need to find a way to dispose of large quantities of CO₂. There is no third way.

- **You can achieve the same climate goals by lower costs if you use a CTBO.** Some people say CTBO solutions are expensive – CCS for example. But if you introduce an obligation slowly, you can calculate the costs for every ton of CO₂. And then the costs are much lower than the CO₂ price needed in regular models. And the costs of a CTBO can be absorbed in the price and passed on to the customer.
- **CTBO could make a transformative contribution to a country's NDC.** It could be *the* big break for the next COP.

3. Q&A na presentatie – Myles Allen

Q. Surprised to see how low the costs are. Why has this not been implemented by any state or EU – what's the obstruction?

A. Myles presented this to MEPs in 2009. Net zero was not a generally accepted idea then and people thought that we would just phase out the use of fossil fuels. Until people accepted the net zero idea, there was no need to even consider a CTBO. We did study the CTBO in the 1.5 degree scenario. This will only become policy if people start realizing that we need this. The beauty of it is that it is not a government cost but it is paid for by the companies and the consumers of the products.

- Q.** How has the idea of a CTBO been received by oil companies?
- A.** It should be well received because it is better if the same rules apply to everyone (level playing field) then just one company trying to achieve net zero. Interest has recently picked up (with the growing numbers of net zero commitments)
- Q.** How can you make sure that there will not be a mishmash of policies but that CTBO is actually a policy instrument that has impact?
- A.** Even the most optimistic guesses of what nature-based solutions can realize in absorbing carbon are wrong. What the biosphere absorbs is roughly what the biosphere also emits. Any additional absorption is likely to be needed for events like melting permafrost, estimated to give an additional 10 gigatons per year.
- Q.** Would a CTBO only work when it is mandatory or also when it is applied voluntarily? Would Myles see a market for “Paris compliant” gas next to the TTF?
- A.** There is clearly a market and an appetite for voluntary offsets
- We need to explain to people that nature-based solutions cannot offset fossil based emissions
- There is only one certain way and that is geological storage of CO2 storage
- Q.** You show global slides - what would be the picture when you show EU - China - US?
- A.** At a regional level energy security becomes more important and implementation of a CTBO will allow increase energy security and reduce energy transition costs at a system level. Would be good to run models at a more regional level also.
- Q.** Do you dismiss carbon tax as a policy instrument?
- A.** A CTBO would work in addition to carbon pricing. A CTBO can more easily be scaled up when needed, because you are looking at a percentage of stored CO2 and are not responding to price fluctuations. A CTBO provides clear

boundaries and targets – giving investors and industry the longer-term certainty needed for innovation and investments.

4. Korte toelichting project | Discussie doelstellingen en randvoorwaarden – Margriet Kuijper

Onderstaande notulen zijn in aanvulling op de slides.

Veel betrokkenen zijn vooral geïnteresseerd in het debat en uitwisseling van standpunten.

Het werk van deze groep is gericht op een eerste verkenning van de CTBO als een policy option – niet om een brede analyse van meerdere beleidsopties te doen.

CTBO is een hybride beleidsinstrument om zover mogelijk aan het begin van de supply side in te zetten. Een gasproducent bijvoorbeeld is ervoor verantwoordelijk dat er bij (nieuwe) productie ook een oplossing is voor (een oplopend deel van) de CO2 uitstoot. Dit is dus uitdrukkelijk anders dan bij de stikstofaanpak waarbij de oplossing later wel zou komen.

Het is heel belangrijk om dubbeltelling te voorkomen. Zie notitie hierover. Een carbon balancing unit is vergelijkbaar met een renewable energy certificate zoals in de VS. Feedback op notitie is welkom om deze aan te scherpen en waar nodig duidelijker te maken.

Q&A en opmerkingen uit de chat.

Q. N.a.v. percentage CTBO: Als de gasproductie / het gasverbruik daalt - dan gaat de CTBO ook omlaag. Moet de CTBO niet uitgedrukt in absolute i.p.v. procentuele hoeveelheid?

A. Dat is precies een vraag om te beantwoorden - aan de ene kant voor investeringszekerheid - aan de andere kant over de hoeveelheid CO2 die je gaat afvangen.

Q. Wat is de interactie met EU ETS?

A. Zie ook notitie. Voor NL geldt dat als de CO2 wordt afgevangen op een installatie die onder ETS valt, dat de pijpleiding en de opslaglocatie dan ook onder ETS zullen vallen. Als CO2 transport via een schip gaat, valt dit nog niet onder ETS. Daarom wordt er nu ook aan gewerkt om

schepen die CO2 verscheppen (naar opslag) ook onder ETS te krijgen. Direct Air Capture en CO2-afvang bij bio-installaties vallen ook nog niet onder EU ETS.

Opm: Punt van leveringszekerheid en om die reden niet volledig uitfasen van fossiele brandstoffen is ook een sterk punt van CTBO. Diversificatie van energiebronnen is waarschijnlijk een verstandige strategie in een tijd van grote veranderingen.

Opm. Het mooie van het CTBO voorstel is dat de kosten aan het begin laag zijn en geleidelijk oplopen. In NL spelen zorgen om de offshore infrastructuur. NL kijkt de komende vijf jaar naar welke infrastructuur kan blijven staan en welke weg moet. Er is dus een sense of urgency om te weten welke infra je later nog wilt gebruiken en welke verwijderd en afgesloten kan worden.

Q. In hoeverre is er een levenscyclus perspectief nodig?

A. Voor subsidies voor emissiereducties van CCS projecten wel; daar moeten de netto reducties bepaald worden met/zonder CCS. Voor CTBO aan de bron/put is geen LCA nodig. Immers het doel is te kijken hoeveel koolstof er uit de bodem wordt gehaald en hoeveel erin opgeslagen wordt. Die verhouding is verder niet afhankelijk van wat er in de keten gebeurt. Als uiteindelijk 'carbon out = carbon in' is dan is het doel bereikt.

Q. Hoe richt je de timing in van carbon in = carbon out? Moet je eerst carbon eruit halen voor je nieuwe carbon mag uitstoten?

A. Dat zijn ontwerpkeuzes - liefst moet out en in dichtbij elkaar liggen. Maar in het begin moet je de markt eerst op gang krijgen - dan wil je misschien wat meer flexibiliteit bieden tussen vraag en aanbod.

Q. Wat is nou precies het verschil tussen removal en balancing certificaten: Als je 1 molecuul onder de grond stopt - wat dan?

A. Je genereert zowel een removal credit als een balancing credit. Onder ETS is dit in feite al geregeld; wie de CO2 afvangt en in de pijpleiding stopt (naar ETS opslag) krijgt de emissiereducties. Non-ETS : moet je een afspraak over maken. Waarschijnlijk dat degene die afvangt de removal

credits krijgt en degene die opslaat de carbon balancing credits.

Q. Waar ligt de obligation - de O van CTBO. De partij die opslaat wordt afhankelijk van industriële partijen voor aanvoer van CO2.

A. Klopt, daarom moet de markt zo groot en zo liquide mogelijk geprobeerd gemaakt te worden. Door bv met meerdere Noordzeelanden tegelijk een CTBO in te voeren. Ook kan de overheid sturen op min of meer gelijktijdig oplopen van de hoeveelheid afgevangen CO2 (mbv subsidieregelingen) en de hoeveelheden koolstof die opgeslagen moeten worden (door bepaling van snelheid van oplopen opslag % in de CTBO). Het beperkt toestaan van alternatieven (om aan de take back obligation te voldoen) is een derde optie om dit risico te beperken. Mogelijke alternatieven zouden kunnen zijn credits van nature-based solutions en/of opkoop (en retiring) van EUA's. Hoe dichter we bij 2050 komen des te kleiner zou dit risico moeten worden. Immers, iedereen die nog fossiel gebruikt in 2050 moet de CO2 afvangen en iedereen die nog CO2 produceert/importeert moet de 'koolstof uit' volledig compenseren met 'koolstof in'. Maar in de beginfase behoeft dit aandacht en meer flexibiliteit waarschijnlijk.

Goed kijken naar de business case voor de credits handel - price collar voor de prijs van carbon balancing units zou een optie kunnen zijn om het risico te beperken. (zie vb ETS in California; dit artikel, alhoewel out-of-date m.b.t. ETS prijzen, legt het wat en waarom van een price collar uit:

<https://energythas.wordpress.com/2013/05/28/putting-a-collar-on-carbon-prices/>)

Maar het zijn ook communicerende vaten, waardoor er een meer stabiel profiel voor hoeveelheid opgeslagen CO2 zou kunnen komen. Tot een zekere hoogte (price collar idee) zou je toe kunnen staan dat OF de opslagpartij een bijdrage doet aan de capture kosten (in een periode van lage ETS prijzen en dus relatief minder CO2 afvang) OF de afvangpartij een bijdrage doet aan de opslagkosten (in een periode van hoge ETS prijzen en dus veel CO2 afvang).

5. Afronding

Volgende bijeenkomst is Donderdag 9 Juli 2-4pm.

Bij voorkeur face-to-face; waarschijnlijk bij RHDHV in Amersfoort. Uiteraard in ruime zaal zodat we aan alle regels kunnen voldoen.

Graag even laten weten als je hier bezwaar tegen hebt.

Second meeting July 2020:

CTBO klankbordgroep

Notulen 2e bijeenkomst – 9 juli 2020,

RHDHV, Amersfoort & online

1. Opening

Gezien de beperkte opkomst (ondanks een veel hogere toezegging op datumprikker) stelt het projectteam voor om een extra bijeenkomst (waarschijnlijk begin Oktober) toe te voegen. Ook zal een LinkedIn Groep gemaakt worden waar tussentijds informatie kan worden gedeeld. De aanwezigen reageren positief op beide voorstellen.

2. Korte recap vorige bijeenkomst: doelstelling en randvoorwaarden

Zie bijgevoegde slides van/voor de bijeenkomst.

- Voor SDE++ gelden de zeef (toets op beschikbare alternatieven); plafond (max 7,2 Mton CCS) en horizon (na 2035 geen nieuwe SDE+ beschikkingen voor CCS).
- Florence School of Regulations heeft een studie over certificeren van fossiel en bio co2 gepubliceerd – Arendo zal die delen.

3. Discussie ontwerpkeuze 1: Placement obligation

- Er zijn verschillende opties voor het beleggen van de (primaire) verplichting, elk met voor en nadelen.
- Er zijn al rapporten waarin verschillende opties worden gekozen: bv Element UK legt de verplichting bij de emittent, KAPSARC legt de verplichting bij overheden.
- Als de verplichting bij de overheid ligt, kan dit bestaan naast andere verplichtingen.

- De verplichting kan onder Artikel 6 van Parijs komen te vallen – de exacte invulling is aan wat de verschillende actoren per land met elkaar overeenkomen.
- Als de verplichting bij de producent ligt, houdt dit de narrative het beste overeind.
- De verplichting bij de producer maakt ook een goede koppeling met de kennis van de upstream.
- Als producerende bedrijven verplicht zijn om de CTBO toe te passen, betekent dit niet per definitie dat ze de co2 zelf moeten opslaan.
- De CTBO kan op verschillende voorraden worden toegepast - kan voor fossiele energie maar kan ook voor bv kalksteen in de cement industrie.
- Uit de discussie tussen OGCI en Element is gebleken dat als de verplichting upstream ligt, deze administratief het meest overzichtelijk is.
- Goed om te beseffen dat als de verplichting upstream ligt, dit niet automatisch betekent dat de meerkosten ook allemaal bij upstream komen te liggen (kosten kunnen doorberekend worden bv).

- Als de verplichting downstream ligt, kan dit als bijkomend voordeel hebben dat dit bewustzijn stimuleert bij de consument (hoewel dat niet de eerste reacties waren rond bijvoorbeeld Shell en CO2 neutraal rijden – FH) en wellicht ook een premumprijs voor co2 neutrale energievoorziening.
- Kijk ook naar verplichting bij de bron versus verplichting bij import. De baseline voor beleid kan zijn dat wat er op de NL markt komt / wat er op de NL markt wordt gebruikt, onder een CTBO valt.
- De volledige LCA en footprint van producten blijft buiten beschouwing van deze groep / studie.

Conclusie:

Voorkeursoptie ‘placement obligation’:

- Zo hoog mogelijk in de waardeketen; hoe lager in de waardeketen des te meer koolstof is er al ‘verloren’ upstream. Bv bij import Russisch gas is er al een deel gebruikt/gelekt voordat het in Nederland komt.
- Voor NL betekent dit placement bij de producent en/of de importeur fossiele koolstof voor verkoop op NL markt.

Belangrijkste genoemde relevante doelstellingen en randvoorwaarden (zie slide 3 hand-out KBG2):

- Broadly supported business model: de aanwezigen waren het eens dat placement bij de producent de ‘narrative’ zo simpel en aantrekkelijk mogelijk houdt voor meerdere stakeholders
Net zero emissions: minder risico dat ‘upstream’ emissies gemist worden
- Maakt besluitvorming over meer/langer productie van gas in NL afhankelijk van voldoende inzet en capaciteit voor CO2 opslag
- Administratief het simpelst (en laagste kosten)

Plus nieuw genoemd argument: er zijn nog geen supply-side policies; gezien de urgentie van het klimaatprobleem is het logisch om additioneel beleid/regelgeving te overwegen voor ‘supply-side’. Er is al veel regelgeving voor ‘demand-side’ (emissies eisen, ETS, etc) en dus minder wenselijk om additioneel beleid te richten op de gebruiker. Je zou dit kunnen zien als onderdeel van de doelstelling ‘broadly supported

business model’, maar minimaliseren van overlappend beleid zou ook een aparte randvoorwaarde kunnen zijn.

4. Discussie ontwerpkeuze 2: Who pays and how

De vraag hier was of en hoe de additionele kosten van de CTBO zouden kunnen worden verhaald en/of gedeeld met andere partijen in de waardeketen.

Overheden hebben redelijk wat vrijheid om te variëren met hun overheidsaandeel. Heronderhandelen van de voorwaarden voor production permits zou mogelijk moeten zijn om bijvoorbeeld het overheidsaandeel te reduceren om CTBO te stimuleren. Voor nieuwe permits zou het aantrekkelijk gemaakt kunnen worden om meteen een hoger CTBO percentage te accepteren.

Je kunt de kosten doorberekenen aan de consument. Het is de vraag hoe transparant je wilt zijn over de kosten en hoe die wordt gereflecteerd in de prijs? Alle partijen die fossiele koolstof produceren/importeren voor verkoop op de NL markt zullen de CTBO krijgen.

Voor de bewustwording zou je het apart zichtbaar kunnen maken een tijdje; net als dat vroeger de ‘verwijderingsbijdrage’ apart werd genoemd als je een nieuwe koelkast kocht. (NB nu is het als verplichte ‘recyclingsbijdrage’ verwerkt in de prijs)

Bedrijven die op enig moment investeren, moeten voor decennia zekerheid hebben, terwijl beleid agv politieke veranderingen kan wijzigen. Een aandachtspunt bij implementatie. (dit zal verder worden besproken in de design choice on pricing of CBU’s).

In landen waar een CTBO plicht geldt zal gas een meerprijs krijgen. Het zou een soort kwaliteitskeurmerk kunnen worden. Als iedereen alleen nog maar CTBO-gas zou gebruiken dan zou aardgas net-zero zijn in 2050. Bij ‘gewoon aardgas’ houdt niemand in de gaten of er wel genoeg CO2 ook opgeslagen wordt. De kraan staat open zonder dat we hebben gecheckt of er hard genoeg gedweild wordt... Het is echter niet zo dat je minder emissies hebt of hoeft te rapporteren als je CTBO-gas gebruikt. Belangrijk om de carbon removal unit en de carbon balancing certificate heel goed uit elkaar te houden.

Conclusie:

Voorkeursoptie 'wie betaalt en hoe':

In navolging van het 'vervuiler betaalt' principe zou het de voorkeur hebben dat de uiteindelijke gebruiker van het product betaalt via een soort 'verwijderbijdrage' op de gasprijs.

Echter, om het 'level playing field' (voor bedrijven) en draagvlak (van burgers/consumenten) te behouden is het mogelijk noodzakelijk om de kostenverhoging deels te compenseren door verlaging van de overheidsinkomsten in de fossiele kootstof waardeketens in NL. In hoeverre dat nodig is zal verder onderzocht moeten worden in een eventueel vervolgonderzoek (routekaart actie).

Belangrijkste relevante doelstellingen en rvw:

Level playing field producenten/importeurs, vervuiler betaalt, NL aantrekkelijk voor investeerders.

5. Discussie ontwerpkeuze 6: Allowable technologies

- Technologie – er klinkt voorkeur om toegestane technologieën te beperken tot verschillende vormen van geological storage – ook weer om de narrative zuiver te houden.
- Om op te starten zouden bio opties kunnen helpen - maar NBS ook in de narrative betrekken, zal verwarrend werken.
- CO2 van bio-origine opslaan in geologisch reservoir zou wel teogestaan moeten zijn.
- Moeten we wel een keuze maken of voorkeur uitspreken voor een bepaalde technologie?
- Of moeten we het vrij laten en gaat het puur om wat en hoe er afgevangen en opgeslagen wordt (voldoende 'permanent')?
- In hoeverre moet je linken met andere initiatieven zoals Carbon farming?

- Als je eisen van permanentie heel strak formuleert, dan komt de conclusie vanzelf dat voor werking CTBO CCS de meest voor de hand liggende / beste optie is.

Conclusie:

Voorkeursoptie 'allowable technologies'

Om de narrative zuiver te houden (net zero= carbon in = carbon out) heeft het de sterke voorkeur van de groep om alleen geologische opslag toe te staan als bron van CBU's. Waar de CO2 vandaan komt is maakt verder niet veel uit (fossiel, bio, DAC).

Belangrijkste relevante doelstellingen en randvoorwaarden:

Integriteit van het mechanisme was hier doorslaggevend:

- Milieutechnische integriteit:(zeker weten dat emissies echt lang uit de atmosfeer blijven,
- Ethisch/morele integriteit: doorgaand fossiel gebruik afkopen met 'boompjes planten' voelt niet goed
- en draagvlak integriteit: het simpel en eerlijk kunnen houden van de 'narrative' (carbon in = carbon out) is essentieel voor draagvlak.

6. Afronding en afspraken

- Er zijn in deze bijeenkomst drie van de zes design choices besproken en niet iedereen kon hierbij aanwezig zijn. Margriet zal een medium kiezen om virtueel met elkaar te discussiëren over design choices, waarschijnlijk via een LinkedIn groep. Er is duidelijk behoefte aan illustraties of infographics om de werking van de CTBO en het verschil tussen CRUs en CBUs duidelijk te maken. Margriet en Femke doen een voorzet.
- Volgende meeting is 1 september.

Third Meeting September 2020

CTBO klankbordgroep

Notulen 3e bijeenkomst – 1 september 2020 – Online

1. Opening –

Vorige keer drie van de zes ontwerpkeuzes besproken:

Placement obligation; Who pays and how; Allowable technologies

Vandaag overige drie: Price of CBUs; Determining the storage %; Implementation strategy.

2. Korte recap vorige bijeenkomst: doelstelling en randvoorwaarden

Zie slides voor belangrijkste overwegingen per ontwerpkeuze.

Uit de groep kwam het volgende commentaar:

Placement obligation

- Hoe kan een gasproducent aan de benodigde CO2 komen om op te slaan? “Hoe zorg je ervoor dat mensen hun statiegeldflesje inleveren?”

Who pays and how

- In aanvulling op verwijderbijdrage – toen deze net werd ingevoerd voor apparaten, moest je die apart betalen, nu is die geïntegreerd in het product, dat kun je met een CTBO ook doen.
- Blauwe waterstof kan als testcase worden gebruikt voor de werking hiervan; integreren CTBO kan een trigger zijn voor de business case rond blauwe waterstof ipv aardgas.
- Met verlaging overheidsinkomsten in fossiele koolstof waardeketen kan de overheid een rol spelen om de opstart van de CTBO werking te faciliteren.
- Als de hogere kosten verdisconteerd worden in de afdracht naar de overheid, haalt dit de prikkel uit de markt bij de gebruikers

Allowable technologies

- Eensgezind geluid dat carbon removal echt geologische opslag moet zijn en niet bijv met NBS
- Verzoek om in het eindrapport goed duidelijk te maken welke lijn we volgen ten aanzien van permanente opslag.

3. Discussie ontwerpkeuze: Price CBUs

- Veel discussie over met collega's in UK - Myles Allen gaat ervan uit de volledige meerprijs op de certificates komt.
- Als de industrie nog maar net begint, zal de prijs hoger zijn maar de meerprijs valt ook aan het begin mee. Bij een CTBO van 10% is de meerprijs lager dan de CO2 prijs.
- De 1.9 mton bij optie 2 is omdat het om carbon out en carbon in gaat, niet om uitgestoten CO2.
- Vraag over optie 2: Als er een verplichting is, wat is dan de reden voor subsidie uit SDE++ ? Op dit moment is de cap 7 mton (de helft van 14 mton).
- Kan door invoering CTBO SDE++ dan ook omlaag? Vergelijkbaar met als EUA prijs omhoog gaat dat SDE++bijdrage omlaag gaat (onrendabele top).
- Bij bepalen prijsmechanisme opletten dat die niet conflicteert met het Klimaatakkoord en niet verwarring oproept, bijvoorbeeld rond verplichtingen en credits. Een koppeling met het Klimaatakkoord maakt het instrument Nederlands en niet exporteerbaar.
- Is het mogelijk om in een rekenmodel uit te werken hoe verschillende opties voor beprijzing uitpakt met SDE ++?
- Marktwerving is goed maar ook lastig als er nog geen markt is. Hoe kan deze tot ontwikkeling komen? Kan veiling zoals in California als voorbeeld dienen?
- Veiling kan zo werken dat de hoeveelheid CO2 die je van plan bent op te slaan bepaalt hoeveel olie / gas je kunt winnen.
- Algemeen: op termijn zoveel mogelijk aan de markt overlaten (hoe de totale CCS kosten verdeeld worden)

tussen afvanger en de opslagpartij), maar in beginfase mogelijk werken met quota, veilingen, omslagsysteem.

- Afweging scope 1 versus scope 3 emissies en daaraan gekoppeld de vraag waar de verplichtingen liggen en waar de kosten belegd. CTBO legt verplichting bij de producent maar het is ook belangrijk dat de industrieën die CO2 moeten afvangen anders gaan denken en naar alternatieven kijken voor CCS. Er moeten dus genoeg incentives blijven voor de industrie om na te denken over de beste manier om emissies te verminderen.
- Belangrijk om inzichtelijk te maken waar CTBO interfereert of interacteert met andere beleidsinstrumenten; dit zou adhv scenario's kunnen.
- Gas in combinatie met CTBO kun je framen als Paris compliant Gas, dat geeft de consument / bedrijf een keuze. Paris compliant kost meer maar kan de afnemer helpen om doelstelling te halen en bij positionering. De overheid kan als launching customer optreden en / of een verplichting overwegen om het marktmechanisme te sturen. NB als CTBO geldt voor al het gas dat in NL verkocht wordt (geproduceerd en geïmporteerd) dan is er in principe een mogelijkheid om een kleine prijsverhoging door te voeren (een 'opslag-opslag').
- [Chat] Zou je reductie-opgave als uitgangspunt kunnen nemen om zo de verbinding te leggen tussen upstream en downstream, CTBO en CO2 prijs?
- [Chat] Aan de markt overlaten meest voor het hand liggend, gezien vraag en aanbod zonder (verstoring) overheidsinterventie. Mogelijk dat SDE++ nog wel nodig is om projecten te realiseren (waarvoor evt. moet worden gecompenseerd of een verrekening moet plaatsvinden).

4. Discussie ontwerpkeuze: Determining the storage percentage

- Doorrekening CTBO uitgevoerd met verschillende curves om op net zero uit te komen en om binnen carbon budget te blijven (artikel wat binnenkort uitkomt van Myles Allen ea).
- Wat een verstandig opslagpercentage is, is ook afhankelijk van de ontwikkeling van je energiegebruik en manier van energieopwekking.
- Het kan politiek slim zijn om met een laag percentage te beginnen, maar ook niet te laag. Vooral belangrijk dat het voorspelbaar is. Dat is het mooie als een lineaire insteek

mogelijk is, dan weet je precies wat de ontwikkelingen zullen zijn over de jaren heen.

- Verplichting lijkt nodig – wellicht voorafgegaan door een proefperiode.
- “What happens when 100% is reached”? Is op dit moment een academische discussie. Maar eigenlijk weten we dat we naar negatieve emissies moeten. Dus mogelijk doorgroeien naar 150 of zelfs 200% zodat iedere partij die nog emissies heeft het dubbele moet opslaan (en dus verwijderen uit de atmosfeer).
- Microsoft wil historische CO2 compenseren, wellicht Apple en Google ook. Dat is dan een andere markt dan puur op basis van kosten voor compliance (zoals binnen ETS).
- Maak duidelijk hoe CTBO complementair werkt aan demand side instrumenten om emissies te reduceren. CTBO gaat uit van principe geen carbon out zonder carbon removal. Dat is anders dan een supply side maatregel als een upstream carbon taks. Met een upstream carbon tax loop je het risico dat de vervuiler wel betaalt maar het daarbij laat, dus onvoldoende incentives heeft om CO2 uitstoot te reduceren of uit de atmosfeer te halen.

5. Discussie ontwerpkeuze: Implementation strategy

- De vraag komt vaak op of het nou vrijwillig kan of verplicht moet. Vrijwillig kan: premium prices for premium products. Verplicht kan. Hybride oplossing is ook aantrekkelijk - stimuleren van vrijwillige pilots; stimuleren van vrijwillig gebruik van het instrument voor bestaande projecten; verplicht voor nieuwe productie en nieuwe importen.
- Als CTBO niet een verplichting is dan misschien geen obligation noemen maar een carbon takeback commitment.
- Hoe krijg je de markt op gang voor premium price producten en op basis van vrijwillige werking?
- Moeten we starten met vrijwillig en uitbouwen naar mandatory? Mandatory is waarschijnlijk wel nodig omdat je zekerheid nodig hebt voor grote investeringen. Vrijwillige implementatie kan mogelijk sneller effect hebben en handig zijn om te leren en het instrument te verfijnen. .
- Om andere landen te inspireren hetzelfde te doen, heb je succesvolle projecten nodig.
- Voor vrijwillige implementatie moet je weten welk marktpotentieel er is.

- Hoe zit het met huishoudens en kleinere gebruikers (niet-ETS)? Effect CTBO?
- Bedrijven zullen willen investeren als er een markt voor is of als marktimperfecties zijn weggenomen. Maar er is geen ruimte om dit te doen zonder zicht op rendement.
- Rendementseisen betekent voor NL O&G ook de keuze om door te produceren en te investeren, of te stoppen en velden in te sluiten. Beschikbaarheid infrastructuur wordt dan een issue.
- EZK kijkt naar aanvullende instrumenten om klimaatdoelen te halen, economisch herstel bevorderen (later groen maken), leveringszekerheid veilig stellen. CTBO is een mogelijk aanvullend instrument – goed om daar discussie over te hebben.
- Goed om in beeld te brengen de CO2-keten, geld-keten, interferentie met bestaande regelingen (SDE++, ETS).
- Volgende stap, op basis van de huidige inzichten een aantal situaties of scenario doorwerken om te laten zien hoe het in de praktijk gaat werken.
- Idealiter is CTBO een internationaal mechanisme. Bij de productie is het vaak internationale scope-3 emissies, buiten het ETS en is het vaak een uitstoot van een ander land. Zonder internationaal mechanisme is een level playing field alleen haalbaar voor de interne markt en moeilijk haalbaar voor export van productie.
- Overwegen dit als voorstel in te dienen tijdens COP26 in UK. In UK werkt Myles Allen hier ook aan.

6. Afronding en afspraken

- Volgende meeting in November: bespreking concept eindrapport.

Fourth meeting November 2020

CTBO klankbordgroep

Notulen 4e bijeenkomst – 19 november 2020

Agenda

- Bespreken conceptrapport en samenvatting (die zelfstandig leesbaar en publicabel moet zijn)
 - Tot eind volgende week (27 Nov) is feedback nog mogelijk, daarna gaan Margriet, JP en Evert naar afronding
 - Planning is einde van het jaar rapport naar buiten te brengen
- Bespreken wat KBG denkt over hoe een vervolg eruit kan zien

Intro Margriet

- Gedurende het studietraject veel internationale contacten gehad die wijzen op internationaal momentum oa richting COP26
 - Society of Petroleum Engineers (SPE) – CCUS taskforce

- Clean Air Taskforce / Bipartisan policy center
- Net Zero All Party Parliamentary Group – die hebben CTBO opgenomen als 1 van 10 aanbevelingen voor UK aan COP26
- Over het rapport
 - Content groeit na elk goed gesprek met leden KBG
 - Nu aandacht voor badkuip-illustratie – belangrijk omdat er nog vaak verwarring is over carbon management versus emissie management
 - Bath tub laat zien dat snelheid van handelen nodig is - om te voorkomen dat badkuip overstroomt
 - Met CTBO laat je zien dat je de stroom die naar de badkuip water toevoert, ook kunt beïnvloeden en wat de impact is als je verantwoordelijk bent voor de watertank van waaruit het water de badkuip instroomt

- Myles Allen noemt dit: hou door een CTBO in de gaten wat je "stored fraction" is - die moet 100% zijn in 2050
- Je carbon storage unit levert zo een "conditional licence to produce"

Feedback KBG leden

Algemeen:

- Alle lof voor rapport en auteurs
[CO2-heffing industrie / olie- en gassector](#)
- CTBO rapport komt op goed moment; in de Kamer is net gesproken over belastingplan en CO2-heffing, de Kamer is er nog niet uit met nationale CO2-heffing vs Europese heffing
- Politiek en overheid willen én actie zien op CO2-reductie maar willen niet de industrie het land uit jagen - de CTBO is een interessant instrument om dit dilemma aan te pakken, wellicht zou een CTBO zelfs een alternatief kunnen zijn voor CO2-heffing voor (een deel van de) industrie of specifiek voor de olie- en gassector; dat zou verder onderzocht moeten worden

Waken voor associatie met gas narrative

- Mogelijke overweging: de voorgestelde differentiatie op basis van herkomst (en GHG impact) van gas kan het implementeren van het instrument moeilijker maken (issues met buitenland)
- Alhoewel het correct is dat NL gas plusminus 20% minder CO2 uitstoot dan geïmporteerd gas, zou het jammer zijn als de CTBO hierop vast zou lopen. Mogelijk is zo'n 'grenscorrectie' later nog toe te voegen als dit soort 'border adjustments' meer algemeen toegepast gaan worden.
- Die discussie speelt op dit moment sowieso bijvoorbeeld over LNG uit VS; dus het kan ook een kans zijn om te CTBO te gebruiken juist voor de gewenste differentiatie in productie/transport-footprint van verschillende soorten gas.

Vragen voor volgende fase van studie:

- Interferentie met andere instrumenten als ETS en CO2-heffing; lock-in;

- Expliciet bespreken, ook nog voor de huidige fase: welk probleem lost dit nou op? Wat is het 'wenkende perspectief' van een CTBO?
- Hoe ga je om met CO2 die oorsprong heeft in olie (raffinaderijen) of kolen (hoogovens)?
- Zou goed instrument zijn om industrie in NL te houden en alternatief CO2 heffing voor met name upstream-bedrijven

Een CTBO zal waarschijnlijk leiden tot grotere economische efficiency van NL klimaatbeleid – dit zou expliciet benoemd kunnen worden in het rapport. Dit zou in een vervolgonderzoek verder uitgewerkt en gekwantificeerd kunnen worden (CTBO in vergelijking met andere beleidsinstrumenten).

Q : kunnen we dit in modellen vatten en kan dit iets zijn voor een volgende fase?

Narrative voor het instrument kan scherper: ingaan op kortetermijn-implicaties en langetermijn-benefits, en opletten dat het niet alleen een aardgasinstrument is. Gas is startpunt maar niet per se eindpunt.

Wellicht ondervangen door gasvoorbeeld heel duidelijk als een voorbeeld te presenteren en in te kaderen dat dit slechts een van de mogelijke toepassingen is. Bijvoorbeeld: het is de eerste stap naar negatieve emissies op lange termijn en op korte termijn is het een economisch efficiënte oplossing.

Discussie loopt in UK ook, demand side instrument vs supply side instrument. Olie-industrie bijv ziet fuel standards als supply side-instrument voor olie. Voor gas is er nog geen supply-side instrument.

Check tekst voor dubbelingen en visualiseer waar mogelijk en/of nodig.

Voeg uitleg vd opbouw van het rapport toe in de introductie.

CTBO interessant instrument van financiering /rechtvaardiging business case om investeringen te doen in nieuwe gaswinning. Maar CTBO kan helpen bij de business case. Wel sterk afhankelijk vd gasprijs.

Timeline is heel belangrijk: vrijwillig gaat misschien sneller dan een verplichting - first mover die de markt op gang gaat

brengen. Maar uiteindelijk zou het richting verplichting/geldig voor allen moeten gaan.

Cement - ook belangrijk om mee te denken ook al produceren we niet in NL we importeren we wel

Hoe bepaal je hoe snel het % moet oplopen

Permanency of storage - wat verstaan we daaronder - kan dat duidelijker in het rapport?

Hoe gaat de markt werken - hoe verhouden de storage prijs en de ETS-prijs zich tot elkaar - is dat iets wat in een volgende fase onderzocht kan worden?

We hebben een 'opvoedingsplicht': de snelheid waarmee we minder afhankelijk worden van gas (of olie) is niet afhankelijk van CTBO - dat wordt bepaald door ander beleid. Met name hoe snel we alternatieven op kunnen schalen (en efficiëntie verbeteren). Maar voor het gas dat we nog gebruiken moeten we ook zorgen dat we emissies reduceren. Daar kan de CTBO bij helpen.

Voor de offshore industrie, die in ons land in de laatste fase is, is een CTBO mogelijk een effectievere manier om bij te dragen aan de NL reductiedoelstellingen dan via een CO2-heffing.

Andere kijk op energietransitie en carbon management mag meer naar voren komen in het rapport - dit is een unieke oplossing en dat mag je op een nette manier meer tot uiting laten komen. Dat geeft een dilemma: presenteer je het meer als fundamentele gamechanger (met bredere impacts) of als beperkte 'add-on' om emissies fossiel tijdig te reduceren?

CTBO neemt voorschot op CO2-management voor alle scopes (1, 2 en 3)

Reactie op de opmerkingen en vragen:

- Welk probleem lost het op? We hebben doelstellingen uitgebreid besproken in de eerste KBG, maar moeten we nog duidelijker maken.
- We kunnen beter beschrijven hoe om te gaan met cement, kolen, olie: niet buiten sluiten maar eerst verder onderzoeken; en vermelden welk niveau de berekeningen in het gasvoorbeeld hebben ("sigarendoosje"), incl toelichting van de beperking tot 2030 voorbeeld.

- Meer of minder fossiel? Het primaire doel is niet om het gebruik fossiel te beïnvloeden (meer of minder); het doel is om zeker te stellen dat de uitstoot van resterend fossiel gebruik tijdig naar nul gaat; het verwachte effect is dat er een remmende werking van uit gaat maar dat weet je niet en dat is ook niet het primaire doel. Het CTBO % kan verder aangepast worden (zelfs tot meer dan 100%) indien er politiek draagvlak is voor meer 'remmende werking'.

Vervolgstappen - Evert - zie ook hoofdstuk 5

Opstartfase - zou op vrijwillige basis kunnen conform voorstel Ron

En dan kun je kijken hoe de reactie uit de markt is

De suggestie werd gedaan dat wellicht in de eerste fase een subsidie kan helpen voor die partijen die vrijwillig de CTBO toepassen (als de meerkosten niet door kunnen worden berekend aan klanten). In principe is dit echter juist niet de bedoeling. Uiteraard is er wel geld nodig om systemen (monitoring, certificering, etc) op te zetten en runnen.

Een CTBO kan een marktmechanisme tot stand brengen - commerciële incentive voor opslag

Maar mogelijk kan de hele organisatie eromheen wel gesubsidieerd worden. En via SDE is er natuurlijk al subsidie voor het opzetten van een deel van de fysieke infrastructuur - pijpleiding/schepen/etc.

Zouden we dit met hulp van economische modellen verder kunnen onderzoeken? Cornelis Zandt - TUE- PhD business modellen CCS helpt graag mee

Er was consensus dat er urgentie was om redelijk snel naar toepassing te gaan.

Enkele personen vroegen zich af of we fase 1 kunnen starten met een aantal partijen die een intentieverklaring uiten? Intentie om bij te dragen aan het verder onderzoeken en ontwikkelen van de CTBO, met het oog op zo spoedig mogelijke implementatie (indien verder onderzoek positief verloopt).

Afsluiting

Gaan rapportage afmaken

Uitwerking ontwikkelpad

Presentaties bij Nogepa en VEMW
Sponsoren gaan nadenken over mogelijk vervolg.

Appendix B2: Pre-read for meetings 2 and 3 on Design Options

Design Choices

1. Placement obligation	Where in the value chain: producer, supplier, consumer, government, combination
2. Who pays and how	This is more about cost-recovery: how can the additional costs of CSU's be (re-) covered?
3. Determining storage %	This is about the various options for setting the % of carbon produced/imported/used for which CSU's need to be surrendered. And also about what happens when net zero has been reached (after e.g. 2050)
4. Implementation	This is mainly about voluntary vs mandatory CTBO schemes
5. Price CSU	This is about options for controlling the CSU price, interaction with EU-ETS, etc.
6. Allowable technologies	This is about how CSU's can be generated: which technologies qualify as permanent storage.

Design choice

Placement of Obligation

Main options

- 1. Producer:**
Anyone taking carbon out of the ground will be required to ensure an increasing amount is also being stored. In our current proposal the obligation is placed on the producer (as high up in the value chain as possible). The main reason for this is that we think it is essential that additional fossil energy production has to be made conditional on additional storage. Supply-side decisions need to include concrete plans and commitments to increasing amounts of CCS. Also, producers have the capabilities to take back carbon. And, according to most stakeholders, they carry a lot of (historic) responsibility for the climate change issue and should take/get more formal responsibility for the waste caused by use of their products.
- 2. Supplier/importer:**
Anyone selling fossil carbon is required to purchase an increasing amount of CSU's to ensure an increasing amount of fossil carbon sold is 'balanced' by fossil carbon stored.
- 3. Customer (who emits the CO2):**
Anyone who still wants to use fossil carbon will have to contribute to waste collection (similar to the old 'verwijderingsbijdrage'; <https://www.milieucentraal.nl/energie-besparen/apparaten-en-verlichting/huishoudelijke-apparaten/verwijderingsbijdrage/>)
- 4. Government:**
The government could take on an obligation for an increasing percentage of carbon captured and stored. Similarly to what they have done eg on targets for renewable energy production. This does not mean they have to do/pay this themselves as they can delegate to others via regulations and permits. (see Design Choice: who pays)

5. Combination:

If the government takes on the formal obligation (eg under article 6 Paris Agreement) and delegates to others then this would ensure the strongest most stable commitment. In this paper it is suggested that a 'Club of Parties/countries' could take the lead on this:

<https://www.kapsarc.org/research/publications/a-mechanism-for-ccs-in-the-post-paris-era/>

If the CTBO is placed on the producer then it would make sense to also place a CTBO on other suppliers of fossil carbon on the Dutch market (level playing field) and also to ensure that in the end ALL fossil carbon still used in NL is balanced by permanent storage of fossil carbon. As NL production is reducing quickly it is not enough anymore to only target producers with a CTBO.

Pro's/con's options, considerations (link to objectives, boundary conditions where possible)

When considering pro's and con's of various options it is important to keep in mind that:

- a) When the obligation is not placed at the point of carbon extraction then a correction factor will have to be applied to account for upstream emissions. For example when gas is imported from Russia there will have been carbon emitted already (energy use, leaks, etc) before the gas is sold on the dutch market. Oil goes through a lot of transportation, storage and processing steps before it is sold as gasoline to a customer. This means that the lower down the value chain you impose a CTBO the more difficult it will be to accurately determine the correction factor that needs to be applied to make sure all carbon emissions associated with a product will be accounted for.
 - b) There are around 100 companies that produce over 70% of all fossil hydrocarbons. The further you go down the value chain the more companies and organizations are involved. At the point of emission almost every person is involved. From a policy design perspective it is therefore always easier and more efficient to aim as high up in the value chain as possible. This also reduced the risk of not all carbon being accounted for and covered by the CTBO (see point a) above)
-

Design choice

Who pays and how?

Main options

In the end the safe disposal of CO2 will increase the cost of fossil energy use. These increased costs have to be paid by one or more players in the value chain who benefit from the production and/or use of fossil carbon.

Whoever the obligation is placed upon will be paying the direct costs of CO2 disposal.

They have the following options for recovering (part of) those costs:

1. Producer: the producer can recover the costs of CSU's by:

- a) re-negotiating economic terms of production permits (reducing government take)
- b) getting permission to sell low-carbon hydrogen or electricity instead of natural gas (integrate value chain, reduce transfer costs); negotiate directly with customers interested in reducing scope 2 emissions
- c) if ALL gas sold in NL falls under a CTBO then costs can be passed on to the Dutch consumer (Paris-compliant gas, low-carbon hydrogen)
- d) if necessary (for level playing field) other levies may need to be reduced until other countries introduce CTBO's also (taxes, excise duties)
- e) producers may still be able to recover part of the cost from whoever needs to reduce their emissions by CCS; eg if ETS prices or carbon taxes would become very high then parties capturing the CO2 may be willing to also cover (part of) the costs of CO2 disposal. See also DC CSU price determination/management.
- f) Combination of the above (and how the costs are shared could even change over time)

2. Importer/supplier

- a) the CTBO applies for ALL natural gas sold on the Dutch market then the costs of compliance (purchase of CSU's) can be passed on to customers.
 - b) if they cannot raise their prices other levies would have to be reduced instead (see c above)
-

3. Customer

This is the current situation. Industry with large emission reduction ambitions and targets is expected to pay the full cost of capture, transport and storage (helped initially by SDE++ subsidies). Sometimes they can recover costs (local markets, low-carbon products), but often they sell intermediate products on international markets. In that case subsidies will be required. It will be difficult for the customer to recover costs from e.g. producer or whoever sells them the fossil carbon. The government is their only hope (if they cannot pass on costs to the customer). Therefore subsidies are likely to be required for a longer period if the CTBO is placed on the customer.

4. Government

If the government has an obligation to ensure an increasing % of the fossil carbon used is permanently stored then the government can set up a fund and purchase CSU's themselves, or they can use regulations to require other players in the value chain to do this. E.g. they can include this as a requirement in all fossil energy production licenses. Or, they can start by funding it themselves and transition to a market driven model later. The national commitments can be included also under Article 6 in the Paris Agreement, as suggested e.g. in this KAPSARC paper: <https://www.kapsarc.org/research/publications/a-mechanism-for-ccs-in-the-post-paris-era/>

Design choice

How to determine storage obligation (quantity, %)

Main options

At a simplified level the basic parameter that would be steering the required storage % is the remaining carbon budget. The lower the remaining carbon budget, the higher the % becomes until ultimately all carbon produced will need to be balanced by carbon stored.

At a more detailed level however, there are many different choices possible on how to achieve this. Below a few are mentioned and described:

1. Shape of the curve: linear (from 0 to 100% in the target net-zero year), starting slow & finishing fast, starting slow- fast in the middle-finishing slow (S-curve)
2. Adjustable or not: for example, if energy use (and fossil energy use) would increase more than expected then the CTBO % would need to increase more quickly too in order to stay within the carbon budget; and the other way around: if fossil energy use would reduce more quickly than expected the CTBO% could be relaxed. Or it could be decided that there will be no adjustments and carbon budget impacts will need to be resolved in another way by others (e.g. more negative emissions).
3. What happens when 100% is reached? Imagine that in 2050 we would succeed in storing as much carbon as we that we still take out of the ground. That would be a great achievement. What happens next is also important though for the transition and for climate change:
 - a. Stay at 100%; after 2050 fossil energy can only still be produced/sold/used if it is fully balanced by storing the same amount of carbon. As renewables become more and more available and the preferred choice, decarbonized fossil energy is likely to become obsolete without further regulations.
 - b. Enforced ramp down to zero fossil energy use after 2050; agree on a reasonable timescale (e.g. 25 years: in 2075) in which remaining fossil energy use will be phased out. This would complete the transition. 2050 is far in the future, and obviously this will depend on how much fossil energy is still needed/used in 2050, but also on all other impacts on SDG's of decarbonized fossil energy use vs alternative sources of energy and societal preferences.
 - c. If the fossil energy value chain (including safe CO2 disposal) is still competitive and required (without subsidies) in 2050 then it could also be considered to continue increasing the CTBO% up to e.g. 150% thereby forcing the industry to also store bio-carbon or CO2 from Direct Air Capture. This would allow some of the now more or less inevitable 'overshoot' of emissions to be reversed and would also result in a faster than ramp down (like option b) but with the added benefit of additional emission reductions.

Besides the above more general choices there will need to be rules for more specific issues also.

- CO2 production: geological CO2 production (co-produced with oil or gas, or specifically produced for CO2-EOR) serves no real purpose and should probably be subject to a 100% CTBO from the start (no slowly ramping up).
 - CH4 leaks, venting, etc.: same should apply for fossil carbon in the form of methane emissions (a 100% CTBO).
 - Existing vs new production: countries could decide that for new production they will impose more stringent CTBO requirements from the start (in return for better economic terms and conditions).
-

Design choice

Implementation: voluntary, mandatory, hybrid, etc.

Main options

As the need to reduce emissions and act 'in line with Paris commitments' becomes more and more part of decision making it should become easier to include the costs of CSU's (CTBO compliance) in the price of the product. In other words, ask a premium price for gas produced under a CTBO compared to gas produced without a CTBO. If the premium that customers are willing to pay is high enough then it may be possible to commit to a CTBO voluntarily.

Also, investors may rank companies that commit to a CTBO higher (ESG ranking) than companies that do not commit to a CTBO.

The options are fairly simple:

1. Voluntary system (backed up by certification maybe)
 2. Mandatory system (NL CTBO is regulated for fossil energy production/import asap)
 3. Hybrid solutions;
 - a. Encourage voluntary pilots; when the CTBO % is still low the total impact on price will be small and therefore more easily covered by premium prices. Aim for full mandatory introduction by e.g. 2030 (as SDE++ ramps down)
 - b. Voluntary scheme (opt-in) for existing permits/contracts, but mandatory for all new developments/permits and import contracts.
-

Pro's/con's options, considerations (link to objectives, boundary conditions where possible)

To assess these options in more detail it will be necessary to identify and assess possible legal and regulatory barriers for the introduction of a mandatory CTBO.

Design choice

How is the price of CSU's determined/managed?

Main options

See attachment D for a more detailed description of how a CTBO policy instrument will interact and complement the existing EU-ETS.

Ideally, the price of CSU's would be determined primarily by the costs of safe CO2 disposal. And the costs of carbon capture would be more or less covered by carbon pricing of emissions (carbon tax or ETS EUA's). This would be the case if the demand for the emission reductions due to storage (ERU's) is equal to the demand for carbon balancing units. In other words: if industrial emitters want to dispose of the same amount of CO2 as producers/emitters need to store to meet their CTB obligations.

When there is no balance between supply and demand for CO2 to be stored this would have the following consequences:

-
- if industry is offering more CO₂ than producers/importers need for their CSU's then industry is likely to pay for the additional storage, and the CSU price will go down
 - If industry is capturing less CO₂ than producers/importers need to store for CSU's then producers/importers are likely to offer to pay part of the capture cost in order to convince industry to capture more CO₂.

As we move closer to 'net-zero' targets there is less likelihood between an imbalance between the need for storage of captured emissions and the need for storage to balance carbon produced. Both will need to be close to 100%.

1. Government can initially adjust subsidies and CTBO percentages to get as close as possible to a balance between the demand for emission storage (from emitters) and the demand for carbon balancing (from producers/importers); transport and storage costs can simply be recovered by mandatory purchase of CSUs ('omslagsysteem')
 2. In a later stadium (no subsidies) the government will have less direct control and can choose between:
 - a. Letting market forces decide (see above); in the most extreme case this could mean that CSU prices rise to the full CCS cost (if industry is capturing far too little CO₂) or that CSU prices will go to zero (if industry wants to store a lot of CO₂).
 - b. Implementing some form of price control e.g. by implementing a 'bracket system' where the government will either (for a limited period) cover the risk of high CSU prices (contract for difference) or allow alternative CSU's to be purchased and used (until prices go down far enough again). See below.
 3. More extreme price fluctuations can also be minimized by:
 - a. By allowing the purchase of CSU's generated by alternative 'permanent storage' options (e.g. NBS)
 - b. By more flexibility in timing (e.g. allowing banking and borrowing)
 - c. By growing the 'CTBO club of countries': if more countries participate market liquidity will improve
-

Design choice

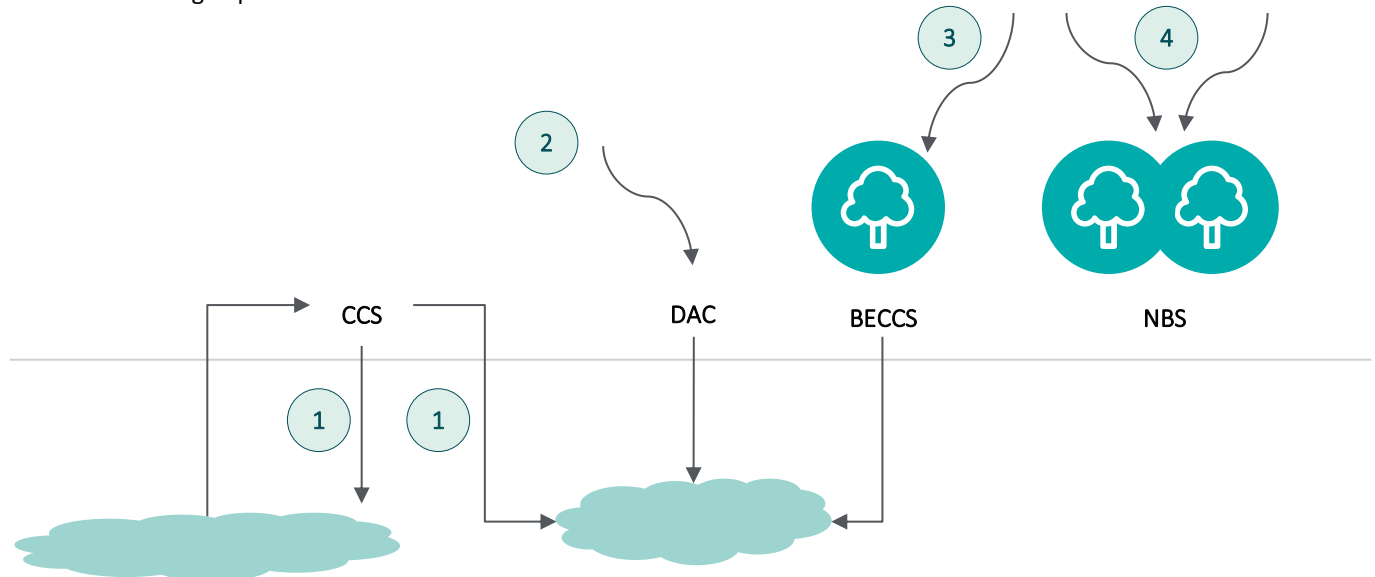
What technologies are allowed, and count as 'permanently stored'?

Main options

There is a wide variety of technologies that claim to be able to permanently store carbon and keep it out of the atmosphere. There are many reasons why people may prefer one option or the other; for the purpose of the CTBO we will only focus on the permanence of storage and not on other benefits (e.g. biodiversity for nature based solutions) or risks (biodiversity and land use for BECCS and for nature based solutions).

1. Geologic storage of fossil carbon: capture of fossil carbon (usually as CO₂) and storage in geological reservoirs. Carbon flows are relatively easy to monitor and verify, and storage (in suitable storage reservoirs) is expected to be safe for thousands of years. See e.g.: https://www.researchgate.net/publication/325720775_Estimating_geological_CO2_storage_security_to_deliver_on_climate_mitigation
 2. Geological storage of CO₂ captured from the atmosphere (DAC, Direct Air Capture). For some emissions sources it may be difficult to capture the CO₂ and it may become cheaper to capture the CO₂ from the atmosphere at a suitable location (close to cheap, renewable energy and close to good CO₂ storage reservoirs).
 3. Geological storage of bio-carbon: in this case the biomass (plant, forest) captures the CO₂ from the atmosphere and when this biomass is then used as input for the chemical industry or as energy source there is usually CO₂ released that can be captured. E.g. in California they plan to gasify biomass waste streams to make syngas and hydrogen and capture and store the CO₂.
 4. Nature based solutions for storing carbon: afforestation, reforestation, soil-carbon, biochar, etc. In general these options tend to have more co-benefits but they are also often shorter-term and less secure (the risk of the carbon being released again is quite high for some of these options, and sensitive to changing politics and changing climate).
-

Permanent storage options:



5. Other forms of permanent storage: there are a few technologies that have the potential to qualify for credits for permanent carbon storage. Pyrolysis of natural gas yields relatively stable carbon that could be stored e.g. in old mines. Enhanced weathering of olivine rocks could store CO₂ from the atmosphere. And CO₂ could be used in concrete production (and/or other re-use options) which may qualify as 'permanent storage'. Most of these options are still under development and very small scale.

The most stringent design choice would be that only the first option (bringing fossil carbon back in a geological reservoir before it is released) qualifies for CSUs.

The most lenient design choice would be that all technologies that permanently store any kind of carbon can qualify for CSUs.

And then there are a lot of in-between options whereby for example restrictions can be introduced: for example a maximum of 10 or 20% of CSUs from Nature Based Credits, or a maximum percentage of CSUs from stored carbon from biomass origin, or a specific or maximum time period during which Nature Based storage CSUs can be used.

Another restriction could be more technology based: for natural gas it is relatively easy to convert it into hydrogen or electricity (with carbon storage) and therefore more strict criteria can apply (e.g. not allowing nature based carbon storage CSUs), whereas for kerosene this is far more difficult and therefore a higher percentage of CSUs from NBS may be justified.

Pros/cons options, considerations (link to objectives, boundary conditions where possible)

In discussing these options it is important to keep in mind that NL has limited options (within our borders) for so-called negative emissions (or CO₂ removal). Therefore, it is probably prudent not to allow unlimited use of options like BECCS, DAC, forestation, etc, to balance the fossil carbon we still need and use.

For a good overview of CO₂ removal capacities (and possible quota's for EU countries to compensate for overshoot) see:

<https://www.nature.com/articles/s41558-020-0802-4>

Appendix C. Sounding Board Group

The authors are grateful for the advice of the Sounding Board Group. Sponsors and members of the Sounding Board Group agree that the report contains a fair representation of the discussions held in the stakeholder meetings and support the proposals for further investigations of the development of the CTBO as a potential policy tool for timely reduction of

emissions from fossil energy use. The content of the report is the sole responsibility of the authors of the report.

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Appendix D: CTBO Explained note

*This note was issued originally to explain the interface with ETS to participants
It has not been updated to reflect the more recent insights!*

CTBO explained: what it is, the difference with emission reductions, and some examples

The most important thing to understand about a CTBO is that its primary function is balancing and keeping the remaining fossil carbon stocks in line with agreed carbon budgets.

Ultimately, this means that whenever fossil carbon is taken out of the geosphere an agreed amount of carbon is also permanently stored in the geosphere (or elsewhere) and does not end up in the atmosphere. When these amounts are equal then 'net-zero' has been achieved for the remaining use of fossil carbon resources.

A CTBO will link decisions on more production (or import) to decisions on storage, and thereby prevent that we just keep producing more and more fossil energy when there is no certainty yet that emissions can and will be avoided (by verifiable capture and storage) or offset by other verifiable capture/storage options (by DAC, BECCS, nature based options, enhanced weathering, reuse with permanent storage, etc). This will enable governments that are serious about 'Paris' to explain how continued use (production and/or import) of fossil energy can be consistent with the net zero ambitions.

Carbon stocks and flows

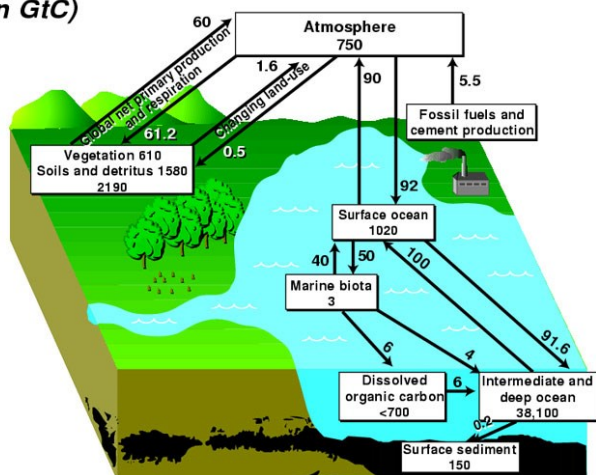
The picture on the right shows how carbon can move in and out of the atmosphere. In the carbon shuffle picture on the left are all the ways in which people (can) influence these flows.²²



²² Smith, P., Davis, S., Creutzig, F. et al. Biophysical and economic limits to negative CO₂ emissions. *Nature Clim Change* 6, 42–50 (2016). <https://doi.org/10.1038/nclimate2870>.

See Figure 4, Chapter 1 for a bigger image.

Global Carbon Cycle (in GtC)



To control the carbon in the atmosphere you need to:

1. control (measure/regulate/verify) the various flows (arrows) in and out of the atmosphere
2. decide on where you want to place the controls on these flows: e.g. the first arrow (fossil carbon to atmospheric carbon) is actually a quite long value chain: you can control this flow more upstream (at the point of extraction) or more downstream (point of emission) or both. Same with biomass: you can control at point of harvesting (upstream) or downstream (emissions) or both
3. decide on how flow-management targets are linked to stock-management objectives (like growing carbon stock in forests, limiting carbon stocks in atmosphere within agreed carbon budgets)

Supply- and Demand-side Climate policies

We know that the historic emissions from fossil energy use are the main reason for increasing GHG concentrations and climate change. It therefore made sense to focus on these emissions. That is what has happened in the Paris agreement, climate plans and ambitions, regulations, emission trading systems, etc. They all primarily target the users of fossil carbon at the point of emission to the atmosphere. These are considered demand-side policy measures as the responsibility to reduce emissions is placed on whoever purchases and uses (burns) the fossil energy.

An alternative approach increasingly gaining in popularity is to focus on managing the amount of fossil carbon taken out of the ground/geosphere. Instead of managing and regulating the flow of emissions you would be managing and regulating the

flow of fossil carbon taken out of and returned to the ground. Regulating what you can take out of the geological stocks is called a 'supply-side' policy. The best-known supply-side policy is the 'keep it in the ground' policy that is promoted by many environmental activists. This sounds simple but is in fact extremely difficult as it would require an agreement on who can still produce what and where, and it can produce unintended consequences. Consider what would happen, for example, if the Netherlands, UK, and Norway ceased all extraction of fossil fuels from the North Sea. Dirtier, less well-regulated production would ramp up in other countries to meet unchanged demand. Secure access to affordable energy is extremely important for security as well as for geopolitical relations, and therefore restrictions on production are unlikely to work as long as there still is demand for fossil energy. See also Attachment F.

This, and influence of the fossil energy producers, is probably why up until now all focus has been on where the emissions take place (through 'demand-side' policies), rather than on where fossil carbon is extracted and by whom (the domain of 'supply-side' policies). Decisions on levels of fossil carbon production are still overwhelmingly made based on expected future demand, and without any consideration of carbon budgets constraints. This is like turning the taps open wider when the bathtub is already close to overflowing and you have no idea whether you can catch and/or mop up any of the future overflow. What is badly needed therefore are agreements and regulations that will ensure that fossil carbon can only be taken out of the ground under very strict conditions.

A Carbon Take Back Obligation is a pragmatic and progressive supply-side climate policy that makes fossil carbon production dependent on adequate measures being in place to ensure emissions will be captured and stored in line with the required emissions reductions.

In the bathtub metaphor: you would only be allowed to put more water into the bathtub if you can show evidence of being able to catch (CCS) or mop up (DAC +CCS or BECCS or other permanent removals) a certain amount of water.

Any carbon that is permanently stored would be eligible for a Carbon Storage Certificate/Unit (CSU). Companies that want to produce or import and sell fossil carbons will have to purchase

and surrender sufficient CSUs to demonstrate that an increasing percentage of carbon produced is balanced by carbon being stored. It effectively puts a brake on production and supply because IF you cannot find (generate or purchase) sufficient CSUs then you will have to reduce production (or import/sales) of fossil energy. This forces producers (and governments handing out production permits) to think ahead about how they will make sure that they will either need fewer CSUs (by switching to clean energy sources) and/or have enough CSUs to keep producing/importing. In the end 'geological carbon stocks' will then be pro-actively managed to ensure that any removals will be balanced by newly sequestered carbon. Or alternatively, if no more fossil energy is needed, then production/import/use will be terminated.

This is very similar to how in a sustainably managed forest trees can only be harvested if the total carbon stock will not decline (in other words: carbon sequestered has to be more than carbon harvested). Another parallel is with the packaging industry, which increasingly in many countries now has a responsibility to ensure that an escalating percentage of packaging waste is collected and recycled and/or safely disposed.²³

Another comparison that could be made is with upstream carbon taxes. These are taxes that are imposed on the carbon content of oil/gas/coal produced at the point of 'first trade'. Such a tax is often proposed when an economy-wide carbon tax is the objective. An upstream CTBO effectively raises the price of fossil carbon the same way that an upstream carbon tax would. The advantage of a CTBO over a carbon tax is that instead of paying the government money the producer is investing in helping reducing the emissions. The polluter cleans up (and pays for that) instead of the polluter pays to be allowed to pollute.

Note that theoretically a CTBO is the only policy instrument you would need to get fossil energy emissions under control. However, what we propose for now is to **add** the CTBO to the already existing emission regulations and policies. We agree with the authors of this article that there is merit in doing both, managing supply and managing demand:

<https://link.springer.com/content/pdf/10.1007%2Fs10584->

[018-2162-x.pdf](#). That way all players in the fossil fuel value chain will have a legal responsibility to make sure emissions will go down, even if fossil energy continues to be needed and used. Considering our lack of success so far with only 'demand-side' policies (fossil energy production is still growing) and considering the urgency of the climate change problem, it is high time to add some new tools to the policy toolbox.

How will this work in practice?

As currently envisioned, a CTBO policy would be implemented at country or regional (e.g. North Sea countries) level. For example, the NL decides to implement a CTBO for all fossil carbon use in the Netherlands, starting for example in 2025 with a 5% CTBO and increasing to 100% in 2050 (the exact required percentages should be based on the calculation of the required sequestered fraction based on the remaining carbon budget). This means that companies that still want to produce or import fossil carbon will have to start thinking about what the cheapest way for them is to acquire Carbon Storage Certificates, before they are allowed to pump it up. This will probably lead to discussions with large point source emitters (with low capture costs) to see if they can be convinced to make their CO₂ available for storage. Also, as the hydrogen infrastructure develops it may become more interesting to sell (blue) hydrogen instead of natural gas.

With a CTBO in place, every ton of CO₂ put into a geological storage will create two sources of value:

Reduced or avoided emissions (and associated costs): when CO₂ is captured and put in a pipeline (or ship) to a storage location then this effectively reduces the emissions from the installation where the CO₂ is captured. The CO₂ pipeline and the CO₂ storage location both have to be registered as ETS installations also. This is a recognised method for emission reductions in the EU-ETS. This means that whoever captures the emissions will need (to purchase) fewer EU allowances.

Carbon Storage Certificate/Units (CSU's): these can be used or sold to other producers and importers of fossil carbon. CSU's are required to be surrendered when fossil carbon is produced or imported for use in a country (or region or group of countries). Just like EUAs (Emission Allowances under ETS) are required to be purchased and surrendered if you want to emit

²³ <https://europen-packaging.eu/policy/9-extended-producer-responsibility.html>

CO₂, CSUs will need to be purchased and surrendered if you want to produce/sell fossil carbon.

For large installations using fossil carbon the ETS regulations are adequate and only a carbon storage certification system needs to be added when implementing a CTBO. As the amount of CO₂ stored is already monitored and reported it will not take much effort to convert this into tons of carbon stored and to award Carbon Storage Units.

In the future however, there will be more diverse carbon management options and technologies. These will require further development of the regulations.

Current gaps in regulations (note that these gaps will need to be addressed independent of whether or not a CTBO-policy is implemented):

- emissions captured from non-ETS locations/installations, but fed into the ETS-pipeline
- CO₂ transport by ship or truck
- emissions captured from installations (ETS or other) using bio-energy
- CO₂ from Direct Air Capture (fed into ETS-pipeline); some form of certification is required for every ton of CO₂ that is removed from the atmosphere. We will call it a CRU (carbon removal unit) for now
- CO₂ sold for re-use but transported through ETS-pipeline
- CO₂ stored permanently in other ways than geological storage (eg mineralisation)

Below are some examples of how the CTBO could work in NL.

For the already planned projects a common access infrastructure model (Porthos, Athos) is planned and EBN will coordinate storage activities (even though they may subcontract the actual operational activities). For now, we will assume that this organisation model will be continued. However, we will also assume that initiatives by the oil/gas companies themselves are also possible still possible, e.g. offering CO₂ storage services directly to industrial emitters, or producing blue hydrogen themselves (and storing CO₂).

1. Fossil carbon use by large industrial emitters (ETS regulations) and stored by a storage provider (e.g. EBN)

Most of the projects being discussed at the moment fall in this category. Fossil energy is used by large emitters, they capture the CO₂, and it is stored by EBN/storage operator. Steel factories, refineries, chemical plants etc, are all planning to

capture a certain amount of CO₂ as part of the Dutch Climate Agreement.

Emission reductions: the emitter (who captures the CO₂ and puts it in the pipeline to storage) will have the right to the emission reductions. For ETS installations this, the 'classical CCS', has effectively been regulated already by requiring CO₂ pipelines and CO₂ storage locations to also register as an ETS and CCS Directive installations. If the emitter captures the CO₂ and transfers this via a pipeline to geological CO₂ storage then the emitter won't have to surrender, hence buy (or can sell) EU allowances for the CO₂ that is put in the pipeline instead of released to the atmosphere. Note that the emitter may also have an increase of emissions (scope 1 and/or scope 2) due to the additional energy needed for capturing the CO₂, which may influence how many EUAs he can sell in the end.

Carbon Storage (CSUs): EBN/storage operator will store the CO₂ and thereby create Carbon Storage Units. They can sell these to operators that produce natural gas (or companies that import fossil carbon) who need the CSU's to meet their Carbon Takeback Obligation.

Financial flows: Storage costs are paid for by EBN but recovered by selling CSU's. Operators and importers of natural gas recover costs by small increases in gas price. As everyone selling gas on the Dutch market has to show their gas complies with CTBO requirements there will be a level playing field in NL. Whoever captures the CO₂ pays for that; costs are (re)covered by avoided cost of emissions and SDE++.

Note that SDE++ contribution will decrease more quickly as part of the CCS costs are now paid by others upstream in the value chain (CSU's).

2. Fossil carbon use by large industrial emitters (falling under ETS regulations) and stored by an operator (oil/gas producer).

Emission reduction: same as above

Carbon Storage (CSUs): the operator will be the owner of the CSUs. He can use part of them to meet his own CTBO (for his oil/gas production) and he can sell the rest to other operators and/or importers of fossil carbon. The operator cannot claim any emission reductions nor can he claim a lower carbon content of the gas (or oil) he sells. Gas produced under a CTBO is likely to have a premium value though on the NL gas market and in any other country that has implemented a CTBO (see example 1 and 4)

Financial flows: The storage operator pays for the storage and

recovers costs by selling CSU's to others (assuming he does not need all of them when percentages are still low).

3. Natural gas used for (blue) hydrogen production by the producer:

Natural gas is produced and converted into blue hydrogen by the producer/operator. The producer sells low-carbon hydrogen instead of natural gas. CO₂ is captured by the producer and stored by the producer or stored by EBN. A minimum of 60% of the emissions are captured and stored so that the hydrogen can be certified and sold as low-carbon hydrogen. See: <https://www.h2-international.com/2020/05/15/how-to-guarantee-a-renewable-product/>

Emission Reduction: the operator producing the hydrogen will reduce or avoid 60% of emissions normally associated with (grey) hydrogen production. If the installation is an ETS installation then EUAs will need to be purchased and/or surrendered for the 40% remaining emissions. The low-carbon hydrogen will have a premium value over standard grey hydrogen. It is recommended to register new blue hydrogen production locations as ETS installation (even if total emissions do not require it to do so) so that CO₂ transfer to pipelines & storage is made easier.

e) Carbon Storage (CSUs):

- a) If the producer does the CO₂ storage himself then he will have the right to the CSUs generated. He can use them to balance his own gas production or he can sell (part of) them to other producers/importers that need CSUs.
- b) If EBN is doing the storage then EBN will have the right to the CSUs. The producer will have to purchase CSUs for the gas he produces to make the hydrogen. Financial flows: It is important for this option that blue Hydrogen can be sold at a premium price. This could be realized by selling to first-mover customers who are keen on reducing their scope 2 emissions, or to energy companies in case of a mandate to mix in a certain percentage of low carbon hydrogen in the gas grid. Other money flows are comparable to the first two examples.

4. Natural gas is imported and sold on the Dutch market.

When a company imports natural gas for the Dutch market they also have to purchase and surrender CSUs unless the gas was bought from a country which also has a comparable CTBO

in place. If the CTBO was implemented at a North Sea regional level then gas imported from Norway (or the UK) could be sold on the NL market without having to purchase (additional) CSUs. On the other hand, if gas is bought from Russia (and assuming Russia has not adopted a CTBO policy yet) then CSUs would have to be purchased to be allowed to sell the gas on the Dutch market. This effectively makes natural gas produced under a (Paris-compliant) CTBO worth more than 'normal' natural gas. This premium value needs to be guaranteed by certification.

5. Gas producer builds a Direct Air Capture unit and stores the CO₂.

For example, the producer/operator builds a DAC plant next to the CO₂ compressors at the coast (to make use of the waste energy, and to have easy access to CO₂ transport and storage). In this case the gas producer would have the right to the carbon removal units, and also to the CSUs. If someone else captures the CO₂ and e.g. EBN would store it then EBN would be the owner of the CSUs and whoever captured the CO₂ should be able to receive the CRUs. Similarly, if CO₂ from biological sources is stored this should result in CRUs for whoever captures the CO₂. CRU's can (in the future) be traded and deducted from emissions. In a net-zero world all remaining emissions have to be offset with CRU's.

6. Mineralization, Olivine weathering, etc.

CO₂ sequestered permanently with enhanced weathering with olivine, when verified, is very similar to DAC + CCS. Therefore, it will create CRUs and CSUs. Often the CRUs will be claimed by the organisation paying for the project (as these can be used to reduce the carbon footprint of the organisation). The CSUs could be an additional source of revenue for whoever executes the project if they can be sold to oil/gas producers and importers. Depending of course on demonstration of permanence of storage (and no other unwanted side-effects).

From these examples a few early conclusions can be drawn:

- a) To avoid double counting it is extremely important to *not* confuse and mix Carbon Storage accounting with greenhouse gas emission accounting (emission reductions and/or carbon removal). CSUs and carbon production data keep track of how much carbon goes in and out of permanent storage (in our case mainly geological storage). Emissions and CRUs keep track of how much greenhouse

gas is going into and out of the atmosphere. Greenhouse gas stocks (and flows going in and out of the atmosphere) are measured in tons of CO₂ (or CO₂e). They are not interchangeable.

- b) The EU ETS may need to be amended, especially for emission reductions and/or carbon removal resulting from storage of CO₂ from non-ETS installations, from bio-energy/resources and from DAC.
- c) Typically, whoever captures the carbon (and pays for it) will be allowed to deduct those emissions from their total scope 1 emissions. For a retro-fit that means actual emission reductions, and for a completely new installation that means a lower emission installation. In both cases the owner of the installation will not have to buy (and surrender) EUA's for the emissions that are stored underground.
- d) Typically, whoever sequesters the CO₂ (storage permit holder) will be the owner of the CSUs. Operators/producers can choose to become a storage operator themselves and do direct deals with companies capturing CO₂, or a hybrid public/private set-up could also be possible where EBN is the formal operator of the entire CO₂ storage system (multiple platforms and fields) and

they work with individual operators to carry out the actual storage operations.

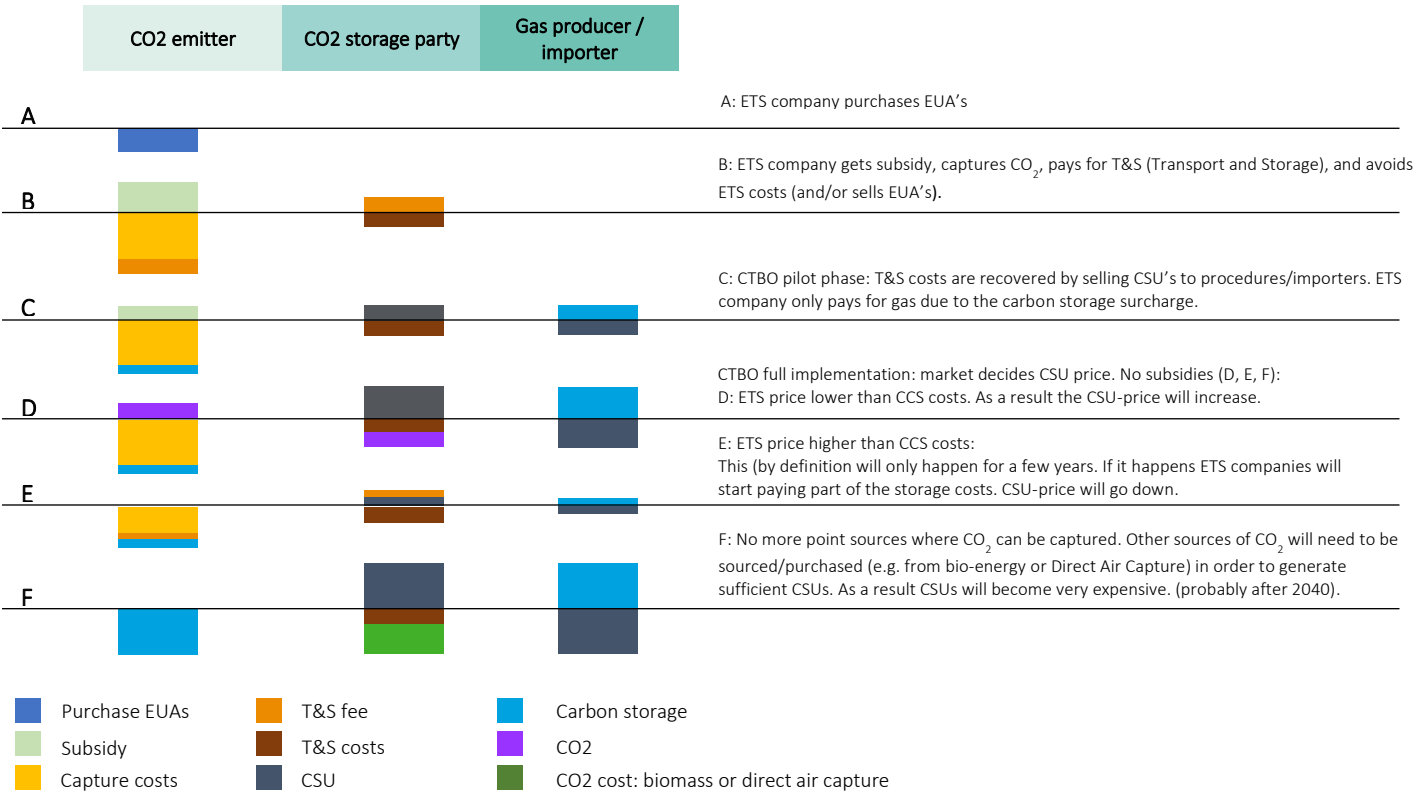
- e) Overall project emission reductions (e.g. eligible for subsidies) are usually smaller than the amount captured and the amount stored as some additional energy is needed to capture, transport and store the CO₂. The net emission reductions are usually the basis for subsidies. This issue does not affect Carbon Storage Credits. No Life Cycle or project level calculations are needed. All that needs to be monitored is 'carbon out' and 'carbon in'. This makes the accounting, administration and transparency of this policy (CTBO) much easier than for many emission policies and regulations.
- f) To fully function, certification will likely be needed for:
 - Carbon Storage Units
 - Carbon removal units for CO₂ removed from the atmosphere (DAC, BECCS, olivine, etc)
 - Natural gas produced under a (Paris-compliant) CTBO
 - Low-carbon hydrogen (is nearly there; see link above)

Appendix E . Who pays and how; interaction with ETS and non-ETS users

In the Summary and chapter 4.5 the differences between a situation with and without a CTBO is shown for the early implementation phase of the CTBO (when there is a SDE++ subsidy and when the price of CSU is determined by an allocation system instead of market forces. In the table/figure below we have added possible scenario's later on in which there is an open market for trading CSUs. It is assumed that the ETS price will rise further and that at some point there are no easy capture options left, at which point carbon will have to be sourced from other sources (atmosphere, biomass) to generate sufficient number of CSUs. This will obviously raise

the price of fossil carbon significantly which should help alternatives to outcompete fossil carbon use.

Business models will evolve to optimise value chains. For example, it is highly likely that Producers will also become storage providers when CSU costs start to rise. They may switch to selling (blue) hydrogen or low carbon electricity themselves, instead of selling gas. They may also try to integrate Direct Air Capture (using waste heat) in their operations so they can offer both Carbon Removal Units and Carbon Storage Units (virtually decarbonized gas).



Attachment F. Climate Policy Strategy; and how the CTBO fits in

The addition of a Carbon Takeback Obligation for natural gas in the Netherlands can be argued for in the context of a more comprehensive Climate Policy Strategy for fossil carbon emissions, which is based on the following elements:

Preference for policies that reduce fossil carbon use or replace it with more sustainable energy options.

The speed with which fossil energy use will be reduced is determined primarily by the success of these policies
Acknowledgement that besides policies to ‘reduce & replace’ the use of fossil carbon we also need policies to ‘clean-up’ fossil carbon use.

The speed with which the emissions (per unit of energy) of remaining fossil carbon use will be reduced are determined by these policies.

Stimulation of cooperation in the value chain (supply and demand side). By implementing both supply- and demand-side policies this cooperation can be encouraged.

	Supply (producers, importers)	Demand (users, emitters)
Reduce/replace fossil carbon	Renewable Energy Directive Subsidies Fuel Quality Directive Upstream tax Production bans	Performance standards for efficiency and emissions for buildings, equipment, etc Emission tax, ETS, etc. Fleet standards (EURO 7) Subsidies for EV’s, heat pumps Buy-outs (coal power)
Clean-up fossil carbon use (CCS, blue hydrogen, etc)	Fuel Quality Directive (if CCS allowed/integrated) CTBO	ETS, taxes Performance standards

The above overview is not complete. There are many more EU and NL policies and regulations in different sectors on the

demand/user side. Policies on the supply-side are more rare still, and mainly focussed on stimulating more supply of renewable energy.

The CTBO will focus on natural gas as there are no other policies in place yet on the supply-side to clean-up (lower the carbon footprint of) the use of natural gas.

For **oil** the situation is more complicated. The Fuel Quality Directive could be an effective supply-side instrument that could stimulate both replacement with renewable and also emission reductions through CCS. And of the allowable emissions for all fuels would become net-zero in 2050 then BECCS and DAC(+CCS) should also be included. And then there is the complicated issue of the more permanent products that are made from oil.

For now, the following is proposed for further evaluation in the next phase:

- a) Include all the CO2 emissions from oil in Dutch refineries under the CTBO. All emissions that can be captured in theory should be included as part of the CTBO to ensure its integrity.
- b) Exclude the emissions of oil products for now. Work on getting CCS-technologies included in updates of the FQD.
- c) Start to monitor the stored fraction of oil products use in the Netherlands (CO2 emissions from oil captured and stored, divided by total CO2 embedded in all oil use in NL); this fraction needs to go to 100% in 2050. Progress with the FQD and this Stored Fraction should inform the decision on whether to also add a CTBO for oil production and imports.

For **coal** the situation is fairly straightforward: all thermal coal use will be phased out by 2030 so there is no need for additional supply-side regulations.

Metallurgical coal use is different. For example, it is quite likely that quite a bit of the CO2 that Tata steel is planning to capture

will come from coal (not gas). Therefore these emissions should also be subject to a CTBO (as for oil, see a) above).

For **cement** the majority of emissions take place during production and not in the user phase. As there is no cement production in the Netherlands taking place anymore, it is proposed to exclude cement products from the CTBO. Once border correction factors would be allowed (see Section 4.8c) then it could be considered to also apply a CTBO for the upstream emissions from imported cement. Ideally, by then there should also be a certification system so that it is easy to know the emissions from cement from different sources. As there are no emissions in the Netherlands it will not be possible to generate CSUs from capturing and storing cement CO₂. CSUs would have to be purchased abroad or generated by BECCS or DAC+CCS. This could have a big impact on the price of cement. International cooperation will be required for this.