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Note

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Measures to Encourage CCSU in cities

Contents

This *Measures to Encourage CCSU in cities* note is a part of a project on Carbon Capture Storage and Utilisation (CCSU) from a city perspective. The project is funded by the Carbon Neutral City Alliance (CNCA) and is carried out in collaboration between five leading climate action cities, all members of the network; Amsterdam, Copenhagen, Helsinki, Oslo and Stockholm.

CNCA is a collaboration of leading global cities working to cut greenhouse gas emissions by 80-100% by 2050 or sooner — the most aggressive GHG reduction targets undertaken anywhere by any city. The network enhances knowledge sharing and encourage member cities to test and implement radical, transformative changes to core systems.

NIRAS has contributed to the project with the development of this note and additional another note and a report. In total 10 notes, a technical report and a fact sheet have been produced throughout 2019.

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1 Carbon capture, storage or utilisation in cities

1.1 Why carbon capture, storage or utilisation?

Many cities are realizing that emissions reductions are not enough to reach carbon neutrality within their sphere of influence. For the foreseeable future, it will be necessary to offset some unavoidable emissions, either locally or internationally. Here, carbon capture from local sources can play an important role as a readily accountable measure, as long as the captured carbon is sequestered or processed to replace fossil carbon.

On a longer horizon, the achievement of the targets of the Paris Agreement require negative emissions, which make carbon capture and storage (CCS) inevitable as a tool to extract GHG from the atmosphere. Carbon capture and utilisation (CCU) for the production of hydrocarbons may also be an important part of carbon husbandry cycles in this future. The role of cities in this context is that they will be the centres of economic activities that can finance CCSU (the common term for CCS and CCU together), and also the primary sources of emissions, either directly or through their consumption of goods and agricultural produce.

Cities are a major part of the problem and the primary source of the solution. It is a reasonable assumption that a modern city can only achieve carbon neutrality by employing CCSU in a manner that allows the city to include the achieved reductions in their climate accounting

Cities who opt for CCSU must engage with relevant stakeholders, firstly their citizens and emitters, and secondly capture and storage or utilisation entities. Given that cities are not naturally operators of CCSU, they can facilitate and motivate CCSU in a number of ways that can justify the inclusion of the ensuing GHG reductions in their climate accounting.

1.2 CCSU in Cities

Cities are hosts to carbon emitting facilities (combustion and industrial process plants), which represent fairly concentrated sources of CO_2 for capture. It is technically feasible to (retro)fit such sources with carbon capture (CC)[1], and cities can contribute by including provisions for carbon capture in spatial planning and permitting discussions. Not only capture facilities, but also logistical infrastructure must be made available.

A city will usually be able to identify and prioritize installations for carbon capture based on permits, zoning, etc. so that the maximum benefit from investments in CC can be obtained. For example, criteria could be:

- CO_2 concentration (Biogas 30%, Cement factory 20%, combustion plants 10%)
- Available land for CC plants and intermediate storage
- Transportation routes, either by pipeline, vehicles or vessels
- Environmental considerations (noise, residual emissions, traffic)
- Zoning considerations (height, access, etc.)

Once the CO_2 is captured, it must be transported to storage or utilisation facilities, which would rarely be possible or desirable to locate close to the emitters. Hence

[1] Amin absorption seems most applicable as a mature and commercially available technology.

transportation routes must be made possible and available. Cities can again contribute by providing right of way, and locations for transfer of CO_2 for shipping or for utilisation facilities.

Since:

- Most sequestration pathways will require access to geological structures that are not within the city boundaries, and
- Most utilisation pathways will require large amounts of hydrogen, which again require large amounts of electricity,

it is a likely scenario that captured CO_2 must be exported from the cities of origin. The exporting city must ensure that the end destination of the exported CO_2 constitutes a verifiable CO_2 reduction in order to justify its engagement in CCSU.

1.3 Indirect CCSU (scope 3 emissions)

Cities are importers of products, all of which carry a carbon footprint with them. Cities can account for the indirect emissions from imported products and influence them. By requiring carbon neutrality or even negative emissions from products entering their territory, cities can drive the implementation of CCSU at the sources of their imported products.

The cities authorities themselves can include carbon footprint requirements in their procurement strategies, and also raise awareness among their citizens. Such initiatives, especially if concerted among several cities, can trigger a demand for CCSU at the sources of products, which again can lead to global impacts of local actions.

The first step in indirect CCSU is for cities to expand their carbon accounting to include scope 3 emissions, as the initiatives will otherwise not be accountable.

2 Measures to encourage CCSU

2.1 Direct Measures for CCSU

Cities can incentivize and facilitate CCSU (or most likely CC) within their boundaries by imposing requirements on emitters, for example by requiring that a waste incineration facility is carbon neutral or even negative[2], or that a thermal power/CHP plant is[3]. Cities can to some extent also incentives such as subsidies or privileges – for example free and reserved parking for electrical vehicles.

There are also challenges for some of the more potent measures such as CO_2 emission requirements to installations that are included in the European Emissions Trading Scheme (ETS). Emissions reductions by CCS for those installations would free EU Allowances that could be traded, so CCS could only have an effect if accompanied by a requirement to cancel emission allowance units (EAUs).

[2] If the CO_2 from the fossil portion of waste (typically 30-40% of total CO_2 in flue gas, mainly due to plastic and chemical) is captured, the facility will be carbon neutral. If more is captured, it will

[3] A fossil fueled facility become almost carbon neutral by applying CC (capture rate 85-90%), and a biomass fueled facility can become carbon negative.

In most cases, requirements to installations in cities should be accompanied by compensation mechanisms until they become national and/or international, as they would otherwise reduce competitiveness for the afflicted installations. It is not desirable that such installations decide to relocate due to emission requirements, even though it would reduce emissions locally, as there is no global effect.

For example a waste incineration plant will be forced to increase gate fees if it must apply CC[4], which may divert waste streams to competing incineration facilities without CC. If 1 ton of waste emits roughly 1 ton of CO_2 when incinerated, and 1/3 is fossil CO_2 that costs 150 e/ton to capture and store, the gate fee must be increased by 50 €/ton to ensure CO_2 neutrality. For a typical Danish facility, this would constitute an increase by more than 50% of the gate fee, which would lead non-regulated waste (in Denmark commercial waste) to move elsewhere.

Similarly, if a thermal power/CHP plant located in a city was required to employ CCS and/or cancel EAUs in order to be CO_2 neutral, it would will lose ground in the day ahead auctions to competing installations without CC and/or requirements to cancel EAUs.

Cities cannot curb market forces, but in case of captive customers like household waste or district heating customers, they may be able to sanction[5] tariff increases to finance CCSU. For a citizen who produces about 700 kg of waste per year, the application of CCS for the fossil part of the waste would mean an increase of the waste management fee of about 40 €/year (0,25 tons of CO_2 at 150 €/ton).

Cities can also influence certain direct emissions, such as those from individual boilers and stoves, construction machinery and vehicles in service of the city. This would require carbon neutral fuels or offsetting of the emissions, which a city may choose to demand to be by CCS or other technologies with the same impact (none of which are currently available).

2.2 Indirect measures for CCSU

Cities can influence the requirements for carbon footprint of products and materials, and in the case of strict enough requirements, indirectly force CC implementation at the production sites. A number of avenues are available:

- Carbon footprint requirements in procurement (e.g. carbon neutral production and logistics). This would require reliable accounting and verification systems all through the value chain.

  It would also require evaluation models that reward low carbon products to the extent that increased prices due to e.g. CCS become competitive.

- Producer responsibility for life cycle emissions (e.g. zero carbon footprint and zero carbon after disposal). This could also include Carbon footprint / life cycle carbon requirements for building materials. An example could be cement that is certifiably produced at a facility with CCS.

[4] Assuming that the requirement is to prove carbon neutral end use, i.e. sequestration or fossil substitution like electrofuels

[5] Given that national legislation is not violated, as the captive customers will be the subjects of (regulated) natural monopolies.

- Acceptance of voluntary markets for low carbon solutions, involving certificates proving carbon reductions from production and waste treatment facilities, that can be sold through reliable registries. Such certificates can be allowed to count in fulfilment of some carbon footprint requirements in procurement.

- CO_2 reduction requirements for transportation fuels, ultimately including compensation by BECCS for CO_2 from hydrocarbon fuels used within the city. This could start with CO_2 reduction requirements for e.g. construction machinery as part of building permits, whereby e.g. electrofuels from CCU can be promoted.

All of these options presume that the emissions that are affected are included in the GHG accounting of the city. It must also be ensured that emissions reductions are not double counted. i.e. accounted both at the source and in the city. And there must be considerations to avoid leakage, i.e. that CO_2 emitting activities do not simply relocate.

Cities can establish carbon footprint/impact requirements for procurement and for activities within their jurisdiction, but it is questionable whether they can impose certain technologies without being discriminatory. Hence carbon requirements are not certain to achieve CCSU, but for e.g. cement production, no other options are currently available.

Several of the measures above require action at national or international level to be effective. Cities do not have direct influence at these levels, but they can facilitate and motivate with great impact. Without concerted actions, there is severe risk of leakage, i.e. that activities move out of certain cities without reducing global emissions. So an important part of city measures is co-ordination amongst cities and common initiatives at national and international level.