The climate council is an advisory expert body aiming to guide the Swedish export finance system in its ambition to adapt their operations to align with the Paris Agreement's 1.5°C target. The climate council is a knowledge resource and a discussion partner for EKN and SEK concerning principled positions.
The climate council meetings are held under the Chatham House Rule. The purpose of the meeting notes is to reflect and summarize the council's key take-away messages to EKN and SEK.

Participants 17 February 2023 (physical meeting)

Climate Council: Anna Krook-Riekkola, Max Åhman, Måns Nilsson, Tomas Kåberger.
EKN: Anna-Karin Jatko, Peter Tuving, Karin Wessman
SEK: Magnus Montan, Maria Simonson, Teresa Hamilton Burman, Catherine Beijer, Martin Johansson

Topics for the climate council's fifth meeting

- ***The significance of Carbon Capture, Utilization, and Storage (CCUS) in achieving climate goals*** *– what opportunities and challenges exist?*
  - ***Key aspects for evaluating these types of projects*** *and what needs to be considered in the analysis of reduced climate impact - short and long term?*
  - ***Technological risks and political risks?***
- ***Reflections on COP27 on the way to COP28***

The Significance of Carbon Capture, Utilization, and Storage (CCUS) in Achieving Climate Goals

CCS/CCU - What it is and how it works

Some abbreviations and definitions in the field:

- Carbon Capture (CC): Capturing carbon dioxide
- Carbon Capture Utilization (CCU): Capturing carbon dioxide for further use
- Carbon Capture Storage (CCS): Separation and storage of carbon dioxide
- CCUS: An overarching term for both CCU and CCS. The term is often used when fossil carbon dioxide is captured or stored.
- BECCS: When the carbon dioxide originates from vegetation, the term BECCS (Bio Energy CCS) is often used.
- DAC: When the carbon dioxide is captured directly from the atmosphere, it is called DAC (Direct Air Capture).
- Carbon dioxide (CO_2): Carbon dioxide is a greenhouse gas formed during the combustion of carbon compounds and naturally by aerobic organisms. Carbon atoms look the same regardless of their source.

How CCS and CCU Work:

- In CC, CO_2 is captured from the exhaust gases of power plants, combustion facilities, or large process industries.
- In CCS, CO_2 is compressed and then transported to a deep underground storage site. The transport of captured CO_2 is mainly done by ships but also through pipelines.
- A prerequisite for CCS is stable storage over a foreseeable period. Currently, this means storage in a porous rock formation with stable and impermeable rock layers above.

- CCU involves converting captured CO_2 into substances or products, giving it a new purpose (e.g., plastics, concrete, or fuel).

Capturing CO_2 can be significant in addressing climate change, but it's essential to consider the entire value chain.

Carbon Capture has a role to play in addressing climate change but is not the entire solution

- To achieve the goals of the Paris Agreement of limiting global warming to 1.5 degrees Celsius, greenhouse gas emissions must be reduced.
- The IPCC[1] emphasizes the importance of working in parallel on climate adaptation, emission reduction, and carbon capture. The longer we wait to significantly reduce our emissions, the greater the need for so-called negative emissions. Negative emissions occur when carbon dioxide is removed from the atmosphere either through various methods in forestry and agriculture, BECCS, or through direct air capture (DAC).
- Carbon capture can prevent CO_2 emissions from, for example, industries and power plants from reaching the atmosphere. However, since it's impossible to capture 100%, the technology alone is not sufficient.
- The CCS/CCU process and management require a significant amount of energy. To be environmentally beneficial, energy supply and management throughout the entire value chain must also be climate-neutral.

CCS/CCU technology itself is not new, but it has had a slow start:

- The IEA[2] has compiled 35 projects worldwide that collectively capture 445 million tons of CO_2 per year (equivalent to Sweden's total emissions).
- The learning curve has been slow because investments are made in individual large projects, and often these methods have only been used for a short period. To achieve full learning and thus lower costs, it will be essential to both build and use the technology.

In CCU, the source of CO_2 and its use are significant:

- The source of CO_2 matters, whether it comes from fossil fuels, directly from the atmosphere, or through biofuels.
- From a climate perspective, CO_2 from fossil fuels should be avoided.
- The potential for BECCS is significant but not unlimited. Therefore, it's important to use captured CO_2 from BECCS where there are no other alternatives or where other alternatives are extremely costly, such as in the production of green electro-methanol for shipping or for the transition in the chemical industry and plastic production. The best use can vary between different countries.
- Captured CO_2 used in a new product only offsets CO_2 during the lifetime of that new product. For fuels, this time span is short, but if CO_2 is used for material production (e.g., plastics), it can be sequestered for a longer period.
- It's important to direct CCU to industries that have significant societal benefits and have difficulty reducing their emissions in other ways, such as the chemical industry and intercontinental shipping and aviation.
- There are examples of capture projects where captured CO_2 is used as an accelerator to extract more oil/gas, which becomes counterproductive as it leads to more efficient and increased oil extraction.

[1] United Nations Intergovernmental Panel on Climate Change, IPCC
[2] OECD International Energy Agency, IEA

For carbon capture technology to be used, there must be a functioning market for captured CO_2, and someone must be willing to pay for captured CO_2 and/or for CO_2 storage:

- Capturing CO_2 requires energy, which is associated with a cost. Therefore, there must be an economic incentive over a foreseeable period for the technology to be used.
- CCU: BECCS and captured CO_2 have a potential market in the form of synthetic fuels (i.e., using carbon atoms once again). However, it is still an expensive way to produce fuels. Actors willing to pay for synthetic fuels produced with captured CO_2 are mainly in the aviation and maritime transport industries and on a small scale in electricity production.
- CCS: Currently, there is no market for carbon dioxide storage, but there is an incentive in the form of persistently high costs of emitting fossil carbon dioxide, which could lay the foundation for creating such a market in Europe.

Because these are long-term investments, robust policies and guaranteed funding from governments are necessary - politicians play a crucial role here:

- There are many private actors globally, but they typically rely on government financing.
- The USA and Canada are currently leaders in CCS and have the most substantial support packages (US Inflation Reduction Act, US IRA). However, there are uncertainties regarding the US IRA and what will happen after the next presidential election.
- The EU traditionally has not used tax incentives but only project support. However, there are now relaxations of state aid rules in response to the US IRA. A significant part of the EU's climate policy involves investments in CC and CCS.
- In Scandinavia, various frameworks and regulations affect the area, such as permitting and emissions trading system, as well as the countries' different needs and conditions for CCS/CCU. It is essential to clarify the responsibility issue in cases where CCS does not work.
- Global harmonization of various emissions trading systems will contribute to development because multiple parallel systems could lead to double-counting, undermining interest.

Market willingness to pay is a counterforce to political risk. There is a force in the business sector to move toward net-zero emissions:

- Net-zero commitments drive investments in CCS and CCU-technology. According to McKinsey's[3] calculations, CCS and CCU-technology needs to increase by 120 times by 2050 for countries' net-zero commitments to be achievable.

It's essential to consider the entire value chain:

Capturing CO_2 has a cost - even after the technology has been installed. For the capture technology to remain in use, there must be a functioning market for the captured CO_2 and someone willing to pay for CCS or CCU.

- CCU: Biogenic and air-captured CO_2 have a potential market in the form of synthetic fuels.
- CCS: Since CCS is based on long-term investments, its future depends heavily on policies, support packages, or voluntary initiatives. For CCS to be implemented, the entire value chain must be in place, which is more challenging to achieve with many small storage points, making large-scale capture preferable.

[3] Scaling the CCUS industry to achieve net-zero | McKinsey

The prerequisites for and benefits of CCS/CCU vary by country and industry - some examples:

Different countries have different conditions for investments in storage (CCS) and utilization (CCU):

Bioenergy-rich countries without fossil extraction: In Sweden, construction is underway for "FlagshipONE" in Örnsköldsvik to produce electro-methanol as ship fuel using CO_2 from a biomass-fired combined heat and power plant. Companies like Vattenfall, UNIPER and others are planning similar systems to produce aviation fuel. Several reforms are being prepared to facilitate CCS, including tax exemptions for electricity used in such processes. There are also preparations for systems for transporting captured CO_2 with a final destination under the North Sea.

Fossil resource-rich states: Carbon capture and Enhanced Oil Recovery/EOR ("CO_2 push down") are applied in the fossil sector for oil/gas extraction. In these cases, the capture point for CO_2 is often just above where the CO_2 is to be injected, resulting in lower transport costs and more commercial viability. However, this is less favorable from a long-term climate perspective as it continues to support oil/gas extraction since the injection of CO2 often means that more oil/gas can be extracted. There is political will to work on this issue, and likely investment capital. These countries' most valuable natural resources are within the fossil sector, and their economies are built around these structures. For example, Saudi is building a Circular Carbon Economy, which is also spreading to several states with similar conditions. In the UK, political pressure on "low carbon"-regions has resulted in significant industrial clusters competing for CCS or CCU-facilities. Here, fossil CO_2 is used as a raw material in other chemical processes. Since there is clear support for CCU and CCS, the political risk is lower, but not the economic risk.

Developing countries: There are challenges in establishing CCS/CCU, as the investment cost is high, and capital is often lacking. In addition, there are challenges in the institutional frameworks, and the institutional regimes need to ensure that the entire chain (capture to storage) works - both in terms of physical infrastructure and payment models.

The benefits of CCS/CCU depend on the industry:

Biogas production: Biogas consists of methane and CO_2 (about 60/40). Biogas needs to be purified from CO_2 to be used in the gas network or in vehicles. In the current purification process, the highly concentrated CO_2 is separated from biomethane and typically vented into the atmosphere, but this could instead be easily captured CO_2. The EU's REPowerEU-plan includes both (i) building biogas production facilities and (ii) simultaneously utilizing the concentrated CO_2, which is beneficial for the biogas industry.

Reflections on COP27 on the way to COP28

SEK, EKN, and the Climate Council shared reflections from COP27 on the way to COP28:

- In comparison to COP26 in Glasgow, which was a force for change and a source of positive energy, COP27 was somewhat of an intermediate year. This was partly influenced by a changing geopolitical situation and increased prices of fossil fuels.
- Both EKN and SEK participated in COP27 and, despite the absence of concrete results from the negotiations, experienced that there was power in the business sector's focus on solutions, such as the solar energy industry.
- The Chairman of the next conference, COP28 in Dubai, is Sultan Al-Jaber – Managing Director and Group CEO of the Abu Dhabi National Oil Company. Al-Jaber is a proponent of renewable energy and a central figure in energy development. From his position, he may be able to make a difference as he has the ear of the fossil fuel market, but he also expresses forward-looking ambitions.
- The power lies in politics and the business sector focusing on and demonstrating solutions and opportunities. Here, SEK & EKN have an essential role in showing what is possible to finance. There is

great interest in Swedish solutions that can be exported and contribute to the transition to a low-carbon economy.
