IEAGHG Information Paper: 2017-IP10; What's in a name (CCS, CCUS, or CCU) and the debate about CCU being a climate mitigation option?

I was drawn to a blog recently by David Hone Chief Climate Change Advisor for Shell, entitled Carbon storage or use? The blog can be found at:
https://twitter.com/davidshellblog/status/832269797320691712

The topic of the blog relates to communication and the point that CCS, CCUS and CCU are often used incorrectly and can lead to confusion even amongst the community to which presenters are actually referring to. If that leads to confusion amongst the CCS community think how it will look to the outside world who we are trying hard to convince that CCS is a viable mitigation option.

In David's blog he refers to a meeting he attended of major industrial emitters and the discussion moved on to the subject of carbon capture. As he indicates "*This shouldn't have come as a surprise, but one aspect of it did; the context was entirely carbon capture and use (CCU) rather than carbon capture and storage (CCS). One participant did mention CCS, but corrected himself to CCU.*"

David then goes on to make the point that CCS and CCU are two very different approaches to managing atmospheric carbon dioxide and don't behave in the same way or necessarily give the same outcome. The differences he highlights are set out in the box below for reference.

Carbon Capture and Storage (CCS) for industrial processes involves geological storage of the carbon dioxide, typically 2-3 km below the surface. The Shell Quest facility in Canada operates in this way. This removes carbon from the biosphere and returns it to the geosphere such that it has no impact on atmospheric carbon dioxide concentration or ocean acidity. It is the basis of a permanent solution to elevated carbon levels in the atmosphere and effectively replicates in a very short space of time what nature would otherwise do over hundreds or thousands of years. Most climate models show that even when a rapid reduction in fossil fuel use is assumed, society will likely still require large scale storage of carbon to limit warming to 1.5°C and probably for the 2°C case as well.

Carbon capture and Use (CCU) operates in a very different way. There are examples in practice today or in the pipeline, including the use of carbon dioxide for enhanced oil recovery (EOR), the conversion of carbon dioxide to certain chemicals (e.g. urea) and the production of materials such as polycarbonates. These processes all require carbon dioxide to operate, but are not necessarily designed to store the carbon dioxide permanently (although in most cases this is what happens with EOR). If the carbon is returned to the atmosphere, such as through the degradation of the compound that is made, then the overall impact of the process may be zero in terms of atmospheric carbon dioxide levels. However, the impact may be delayed for quite some time, possibly stretching into hundreds of years. CCU may therefore solve a local carbon dioxide emission issue, but does not necessarily address the bigger question of climate change.

The last point David makes regarding CCU is that it "*does not necessarily address the bigger question of climate change"* then opens another issue that was highly emotive at GHGT-13.

David considers the option in which CCU could become as a mitigation option;

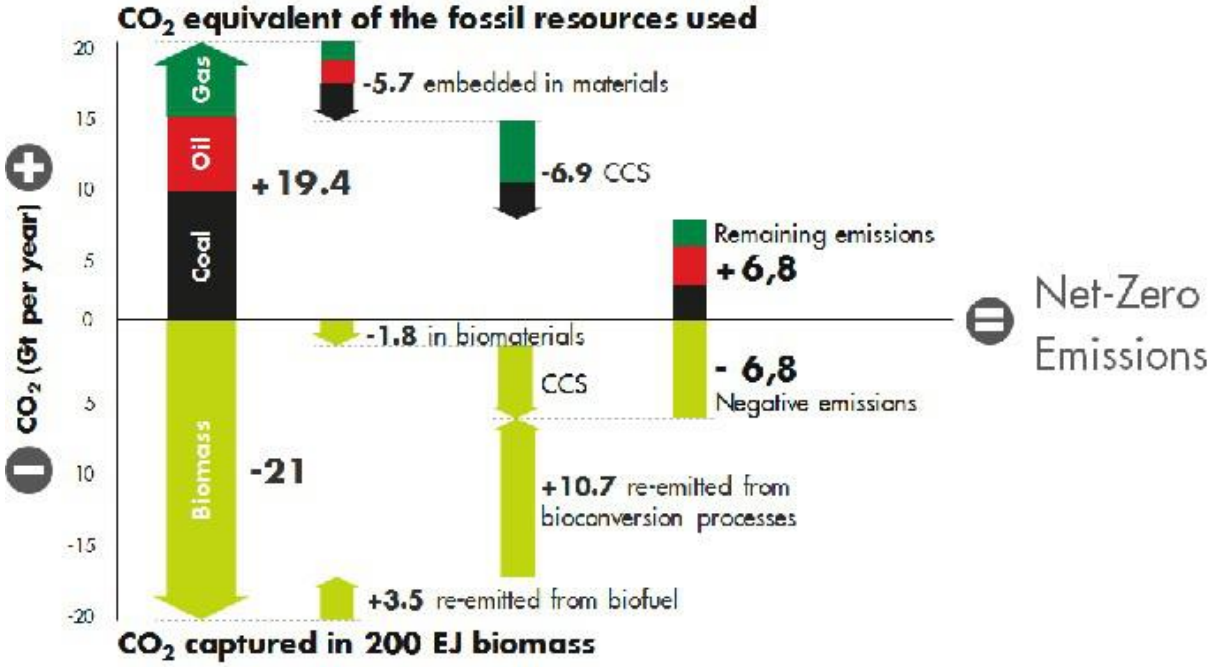
1. CCU might be used to manufacture synthetic hydrocarbon fuels, which could displace the need to extract fossil hydrocarbons. However, the synthetic fuels industry would have to scale very significantly before it could be claimed that this was indeed a reduction. Further, as is always the issue with mitigation analysis, it is even more difficult to claim that the total fossil resource extracted over time diminishes. There is always the possibility that the same amount is eventually extracted, but over a longer period.

2. CCU could be applied to the manufacture of certain goods, for example building materials. But to act as a mitigation mechanism akin to CCS, CCU has to lead to storage. This would be accomplished by increasing the total stock of the material in use at any one time. Say, for example, that homes are built with the new material. The starting point would be zero, but in a decade or so there might be 50 million homes constructed. Even if the homes are eventually torn down (and the carbon released), so long as the total number of such homes in use continues to increase, then more and more carbon is stored. The issue here is that the total stock has to be maintained for a very long time (at least a century or more) for CCU to approach CCS equivalence.

   As populations grow and development proceeds, the stock of all goods in circulation has generally increased, even as old items are removed and new ones added. We have more buildings than ever before, more stuff in the buildings and more machines such as cars, ships and planes. All of these could be potential carbon stocks for century long storage. But we will need to be aware of the corollary, i.e. winding down the global stock of a certain item will result in the stored carbon being returned to the atmosphere.

Finally, David refers to the recent Shell publication, **A Better Life with a Healthy Planet, Pathways to Net Zero Emissions**[1], which builds on Shell's New Lens Scenarios published in 2013[2], which showed that economic growth coupled with near net-zero emissions is a challenging but achievable vision. In the latest publication they have taken the most optimistic features of our 2013 scenarios and combined them with individually plausible further shifts in policy, technology deployment, circumstances, and events that might move the world onto a new, even lower-emission trajectory, resulting in net-zero emissions on a timescale consistent with global aspirations.

In the new analysis the net zero outcome made use of both CCU and CCS, as shown in the chart below.



It is pointed out that this a scenario for later in the century so it is important to recognise that not all the technologies are sufficiently developed to fully deliver this. For example, air capture of carbon dioxide is still at pilot-plant stage. Nevertheless, in the scenario the on-going use of some fossil fuels

[1] http://www.shell.com/energy-and-innovation/the-energy-future/scenarios/a-better-life-with-a-healthy-planet.html

[2] http://www.shell.com/energy-and-innovation/the-energy-future/scenarios/new-lenses-on-the-future.html

in certain applications is balanced by geological storage of carbon dioxide and embedding carbon in materials, with the assumption that the stock of that material in circulation globally increases over time.

David summarises by saying that this means that accounting plays a critical role. Assigning a mitigation value to CCS is a relatively simple task; where each tonne stored can be counted as permanent mitigation and will contribute to the overall task of reaching net zero emissions. The same cannot be said for CCU yet. While it is clear that carbon can be embedded in urea or polycarbonates, there is no established protocol to define this as permanent mitigation. Work remains to be done in this field.

Summary

There are two important points made here, the first is on communication. As a community we should NOT use CCS, CCU, CCUS randomly but show discipline in the use of these terminologies and be clear which technologies we are referring to when we communicate to the outside world. For reference I use:

- CCS when I talk about greenhouse gas mitigation i.e. the permeant removal of CO_2 from the atmosphere
- CCUS, when I refer to CO2-EOR because this involves both the industrial use of CO_2 and some permeant storage
- CCU for operations that produce CO_2 related products like urea, methanol etc. but that do not involve permeant storage of CO_2 and as a result are not mitigation options.

The second point David makes is regarding accounting. IEAGHG have studies accounting issues around BIOCCS and CO2-EOR; both have proved to be difficult subjects to tackle, accounting for CO2-EOR also proved to be quite a contentious issue within the membership. We are now embarking on a new study that will look at the issue of CCU accounting, this work is being funded outside of the members' common research fund by the Ministry of Environment of Japan. We hope to report this work in the autumn of 2017, no doubt that study will also provoke a lot of debate amongst members and the broader CCS/CCU community.

John Gale
27/02/17