IASS WORKSHOP SUMMARY

Institute for Advanced Sustainability Studies (IASS)

Societal Contributions and Policy Needs of CCU Technologies

Summary of the 4th Round Table CO_2 Utilization "Contextualizing Carbon Dioxide Utilization - International Policy Perspectives on CCU"
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Summary

On 27 January 2019, the research group CO_2 Utilisation Strategies and Society at the Institute for Advanced Sustainability Studies (IASS) hosted the International Round Table “Contextualising Carbon Dioxide Utilisation – International Policy Perspectives on CCU Technologies”. The Round Table on CO_2 Utilisation is a series of events, initiated, organised by and held at the IASS in Potsdam. First started in 2014, it is now an established series that provides an occasion for the professional community involved with the development of CCU technologies to debate and engage with a broad range of societal stakeholders.

Framed by two presentations about the United Nations’ Sustainable Development Goals (SDG) and CCU technologies' possible contribution to their delivery, the one-day event consisted of three sessions. The sessions were structured according to global regions and focused first on selected countries in Europe (Finland, France, Germany), then on overarching European perspectives and eventually took on a non-European perspective with presentations from China and the United States.

Actors in the field of CCU technologies as well as funding agencies and other organisations ascribe the potential to contribute to ecologic, environmental and societal objectives to CCU technologies. Such objectives may be part of the SDGs and other policy targets. Except for further technical development, the extent of this contribution largely depends on political support with regard to ecologic aspects as well as economic incentives. In order to unfold their full sustainability potential, CCU technologies need a supportive regulatory and policy framework on a European and international level today, and require more tailored support in the future. On either level, specific risks need to be monitored and considered in policy decisions.

Contents

1. Introduction

For almost 50 years, researchers in the field of chemistry have been exploring the idea of using the greenhouse gas CO_2 as a feedstock (Aresta 2010): “Carbon Capture and Utilisation (CCU) refers to technologies and processes which use carbon dioxide as a component of a carbon dioxide compound in materials or as an energy carrier, thus rendering the carbon dioxide useful. CCU processes involve the capture and compaction of CO_2, its transport (if necessary) and its functional utilisation.” (von der Assen, Jung et al. 2013) In a circular approach, also the end of life phase needs to be taken into account. CCU processes can be used in the production of a broad range of carbon based materials, both intermediate and end products - for example as base chemicals for the production of plastics and foams, in the production of aggregates for the building sector and in liquid or gaseous fuels (Olfe-Kräutlein, Naims et al. 2014).

Since the oil crises of the 1970s, and especially since climate change has become a focus of public discussion, such technologies have been under development. Particularly in recent years, the idea of utilising CO_2 has gained momentum. In many regions funding schemes have been introduced to support the development of such technologies (Olfe-Kräutlein, Naims et al. 2016). The current IPCC report has again stressed the importance of considering all options that possibly offer a contribution to reach the climate goals and as such, has explicitly included technologies that utilise carbon dioxide (IPCC 2018). For those reasons, several technological breakthroughs can be observed in recent times, and first products are now entering the markets (Fröndhoff 2015, Materialscience 2015).

To date, most CCU technologies are still in an early development state, and predictably, in many application options the production costs may rise in comparison to a conventional product, while the product itself might not be significantly altered or improved: Therefore finding a business case is not always easy (Naims 2016). Hence, in many cases, the further development and implementation of carbon dioxide utilisation technologies will depend on continued public funding in the research and development phase, and on accompanying policy support during a market implementation (Olfe-Kräutlein, Naims et al. 2016)

In this context, it is necessary to carefully consider the aims and objectives of different actors in the field attributed to CCU technologies as well as the policy needs that they express. They feed in the political discourse and are likely to shape and influence the relevant decision making processes in the policy environment. In this regard, the 4th Round Table CO_2 Utilisation at the IASS in Janaury 2019, as described in the next section, made societal contributions and policy needs of CO_2 utilization technologies a subject of discussion.

The purpose of this document is to first provide a framing for the discussions of the Round Table event by giving a brief overview of self-declared aims and possible societal contributions that are connected to the implementation of CCU technologies, based on own declarations and statements of industry actors, funding agencies and others (3.1). Then, the following sections (3.2 and 3.3) compile and discuss policy needs as a result of the presentations given and the outcomes of the discourses during the Round Table event at the IASS; thus, they deliver a conclusive summary of framework perspectives and specific viewpoints from different countries and global regions that were raised during the event. The document concludes with remarks on possible societal risks (3.4) that might be connected with the implementation of CCU technologies.

2. The 4th Round Table on CO_2 Utilisation

On 27 January 2019, the research group CO_2 Utilisation Strategies and Society at the Institute for Advanced Sustainability Studies (IASS) hosted the international Round Table “Contextualising Carbon Dioxide Utilisation – International Policy Perspectives on CCU Technologies”. The Round Table on CO_2 Utilisation is a series of events, initiated and organized by and held at the IASS in Potsdam. First started in 2014, it is now an established series that provides an occasion for the professional community involved with the development of CCU technologies to debate and engage with a broad range of societal stakeholders.

In January 2019, almost 50 experts came together to gain new insights and discuss potential policy needs that arise during the further development and a possible market implementation of carbon dioxide utilisation technologies. The attendees came from different professional and functional backgrounds, including industry actors, policy makers, scientists, consultants and representatives of different societal interest groups.

The day started with an introductory presentation about the United Nations’ Sustainable Development Goals (SDG), discussing the possible contributions of CCU technologies to their implementation. The three following sessions were structured according to global regions and focused first on selected countries in Europe (Finland, France, Germany), then on overarching European perspectives and eventually took on a non-European perspective with presentations from China and the United States.

3. Societal contributions and policy needs of CCU technologies

The purpose of this document is to first frame the discussions of the Round Table event by providing a brief overview of self-declared aims and possible societal contributions that are connected to the implementation of CCU technologies based on own declarations and statements of industry actors, funding agencies and others (3.1). Then, the following sections (3.2 to 3.4) compile and discuss policy needs as a result of the presentations given and the outcomes of the discourses during the Round Table event; thus, they deliver a conclusive summary of framework perspectives and specific viewpoints from different countries and global regions, as raised during the event. The document concludes with remarks on possible societal risks (3.5) that might be connected with the implementation of CCU technologies.

3.1 Actors in the field of CO_2 utilisation: Aims and possible contributions to societal objectives

The great variety of possible CCU applications from base chemicals to fuels and their varying state of development (European Commission 2019) involves an equal variety of relevant actors in several industries and different organisations in government and society. With the aim to provide an introductory framing for the discussion of political needs and societal contributions at the Round Table, this section gives a brief overview of self-declared aims of such actors and possible societal contributions that they are connecting with the implementation of CCU technologies. This overview is based on a non-representative online research into the own declarations and statements of selected industry actors and associations[1], European funding agencies and national or supra-regional organisations[2] and others who express aims associated with CO_2 utilisation.

[1] Covestro: https://www.covestro.com/en/company/strategy/attitude/co2-dreams,
HeidelbergCement: https://www.heidelbergcement.com/en/pr-29-06-2017,
ThyssenKrupp: https://www.thyssenkrupp.com/de/carbon2chem/#420630,
Evonik: https://corporate.evonik.de/de/Pages/article.aspx?articleId=105490,
Saudiaramco: https://www.saudiaramco.com/en/creating-value/products/converge,
Sunfire: https://www.sunfire.de/de/anwendungen/synthesegas,
CO2value Europe: http://www.co2value.eu/about-us/, all accessed 13 August 2019

[2] Phoenix: http://www.phoenix-co2-valorisation.eu/phoenix
BMBF: https://www.bmbf.de/foerderungen/bekanntmachung-1875.html
DoE:https://www.energy.gov/fe/science-innovation/office-clean-coal-and-carbon-management/carbon-capture-utilization-and-storage
JRC: http://s3platform.jrc.ec.europa.eu/carbon-capture-and-utilization
CO2Chem: http://co2chem.co.uk/
Club CO2: http://www.captage-stockage-valorisation-co2.fr/en/home, IPCC https://www.ipcc.ch/, all accessed 13 August 2019

Relevant actors are allocated in both the societal meso-level[3], encompassing organisations like companies[4] or industry associations[5], and in the macro-level, encompassing state governments or their agents accounting for respective programmes or networks for CCU (e.g. the Federal Ministry of Education and Research (BMBF) in Germany[6], the Department of Energy[7] in the USA, the European Commission[8], CO2Chem[9] in Great Britain or the Club CO_2 in France[10]) and global organisations such as WWF[11] or the IPCC[12].

While not aiming for being representative, the evaluation of a selection of self-declared aims and objectives is insightful insofar as they depict the context that the respective actors define when presenting their project or product to their stakeholders, and when asking for public and/or political support for their particular undertaking. Here, different actors define what role they intend to ascribe to CO_2 utilisation technologies within a broader framework and thus they deliver their specific political and societal framing.

This framing is particularly important, since, as is discussed in the following sections, all actors are convinced that the future fate of CCU technologies is determined by some sort of support, be it financial, political or public acceptance. Thus, they express their aims seeking to convince their specific audience to support the further development and implementation of CCU technologies. The specific audience may be funding bodies or policy makers for industry actors, or may be the public or specific stakeholders for policy makers or funders.

As the overview shows (see p. 9), the expressed aims associated with CO_2 utilisation technologies are composed of ecologic, economic and societal objectives, hence suggesting that CO_2 utilisation technologies have the potential to contribute to all three pillars of a sustainable social development. While the overall distribution along the three fields is rather even, actors on both the societal meso and macro level place the most emphasis on ecological aspects, in particular on emission reduction. Industry actors on the meso level articulate their economic aims more often that actors on the macro level. National or international actors rather put emphasis on societal objectives and point for example to the possible contribution to superordinate strategies or policies.

Thus, aims of different CCU actors involve CCU technologies' potential to contribute to a variety of economic, ecologic and societal objectives, if they reach a large scale implementation. In order to do so, further technical advancement is still the key for the future deployment of many applications (European Commission 2019), but the progress and market entry of such technologies also needs to overcome other hurdles and barriers. While many important preconditions for a successful market entry are specific to products or industry branches, some overarching needs in policy making can be determined and are discussed in the following section.

[3] The distinction between societal micro, meso and macro level refers to the levels as defined by e.g. Jarren and Donges (2011) as analytical levels of social interaction, whereas ators on the micro level are defined as individuals, on the meso level as (corporate) organizations and on the macro level as societies and their subsystems.

[4] https://www.sunfire.de/de/anwendungen/synthesegas, accessed 13 August 2019

[5] http://www.co2value.eu/about-us, http://www.phoenix-co2-valorisation.eu/phoenix, accessed 13 August 2019

[6] https://www.bmbf.de/foerderungen/bekanntmachung-1875.html, accessed 13 August 2019

[7] https://www.energy.gov/fe/science-innovation/office-clean-coal-and-carbon-management/carbon-capture-utilization-and-storage, accessed 13 August 2019

[8] http://s3platform.jrc.ec.europa.eu/carbon-capture-and-utilization, accessed 13 August 2019

[9] http://co2chem.co.uk/, accessed 13 August 2019

[10] http://www.captage-stockage-valorisation-co2.fr/en/home, accessed 13 August 2019

[11] https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/WWF-CCU-Final.pdf, accessed 13 August 2019

[12] https://www.ipcc.ch/, accessed 13 August 2019

		Meso-level actors	Macro-level actors
	Objective	**Industry and industry organisations**	**Nations/regions, federal funding bodies, global society**
Economic objectives	Enhance revenue	**5**	**1**
	Secure competitiveness	**0**	**2**
	Growth	**1**	**1**
	Knowledge/innovation	**6**	**3**
	Industrial symbiosis	**1**	**0**
Ecologic objectives	Reduction of CO_2 emissions/ carbon footprint	**5**	**6**
	Low carbon economy	**1**	**1**
	Supporting energy transition processes/energy storage	**4**	**1**
	Reducing the depletion of fossil resources	**3**	**2**
	Advancing a circular economy by closing the carbon cycle	**1**	**2**
	Generally more environmentally friendly	**3**	**0**
Societal objectives	Broadening the raw material base	**2**	**2**
	Lowering dependencies on imports of fossil fuels/ security of supply	**1**	**3**
	Technological leadership	**0**	**2**
	Contribution to superordinate strategies or policies	**2**	**3**
Other	Secure existing fossil infrastructures	**0**	**1**
	Combine with CCS	**1**	**4**

Legend:

The colour scale indicates the frequency of the respective objective being mentioned in the literature which is also given in numbers (white colour means the objective was not mentioned; the darker the colour, the more frequently the objective was mentioned)

3.2 Policy needs of CCU technologies

This section gathers and discusses policy needs for the further development and implementation of CO_2 utilisation technologies as a result of the presentations given and the outcomes of the discourses of the Round Table event at the IASS. In this respect, it is not a meta-analysis of the current body of policy reports on the issue, but rather a conclusive summary of specific viewpoints from different countries and global regions raised during this event.[13]

3.2.1 CCU technologies' needs from environmental and energy policies

- Support the provision of energy from renewable sources at competitive prices

In order to deliver an ecologic advantage, many CCU processes rely on the availability of energy from renewable sources at competitive prices (European Commission 2019). Hence, the realisation potential of CCU technologies is closely related to energy transition objectives, as laid out, for example, for Germany in the Climate Action Plan 2050 (Bundesministerium für Umwelt 2016) or for the European Union in A Clean Planet for All (European Commission 2018). Therefore, a fundamental policy need for CCU technologies is the continued pursuit and achievement of ambitious renewable energy targets.

- Create stronger incentives for the reduction of industrial emissions

The industry needs incentives to circulate already extracted carbon and to keep fossil carbon underground. But until today, the capture of carbon dioxide for utilisation from industrial sources is not recognised as a reduction in the European Emission Trading System (ETS) (European Commission 2019). Since the recognition of CCU processes in the ETS and other comparable systems could foster their advancement, such mechanisms should be considered under the condition that an overall saving in CO_2 emissions can be proven in a transparent assessment (for example with an LCA, e.g. von der Assen, Voll et al. 2014). A common and uniform CO_2 emission regulation in form of harmonised trading schemes could create a level playing-field between EU markets and the rest of the world.

Especially if the recognition of CCU processes within emission trading schemes cannot be realised, other incentives for greater efforts in the reduction of industrial CO_2 emissions may be beneficial, like for example efficiency measures. They can indirectly foster growing industrial activities in carbon capture and thus enable the provision of CO_2 for utilisation purposes.

- Facilitate the development and recognition of specific tools for the assessment of environmental effects of CCU technologies

Each CCU application must prove its environmental benefits. This is a fundamental precondition with regard to policy makers in order to enable them to reasonably allocate public funding; and with regard to stakeholders and the public in order to ensure that the necessary societal support is based on a proven contribution to environmental objectives. To enable a transparent assessment of the potential ecologic advantages of CCU applications, it is necessary to facilitate the development of appropriate and consistent tools for assessment and declaration and then to recognise and integrate them, if possible in the context of already existing labelling schemes, such as the German "Blauer

[13] When necessary for consistency, additional input from literature has been added, as made visible by the respective references.

Engel"[14]. This process needs the support of different actors, for example in the realm of technical standardisation or the development of engineering or product standards. Even before CCU products have reached a sufficient degree of technical readiness, preparing participatory processes that are concerned with the development of assessment procedures, their harmonisation and applicability should be supported by relevant funding bodies and should result in a technology neutral recognition of measurable contributions to environmental goals.

- Support and enable synergy effects between industry sectors that may create ecologic and economic advantages

Especially on the larger scale, CCU processes will cut across industry sectors or at least are most promising if they do so. Thus, CO_2 can function as a link for sector coupling: The advantages may achieve their full potential only when industrial sectors cooperate, which have not been co-working before (Acatech 2018). This is due to the different actors that may contribute to a new low carbon CCU value chain (Pieri 2018), such as providers of captured carbon dioxide, actors who can utilise this carbon, industrial facilities that produce waste heat, etc. Policy makers can support such synergies by acknowledging the importance of these cooperations in the outlines of their respective funding schemes and support options.

- International alignment of political support and recognition

A supportive regulatory and political framework is needed, preferably on a global, but at least on a European level. Here and in specific countries, a common governmental opinion on the potential contributions of CCU technologies, rooted in a broad acceptance among policy makers, could support all efforts to further develop and implement CCU technologies and help to provide a coordination of funding activities on different levels, such as in EU member states and on the European Commission level. Furthermore, a structural facilitation of knowledge transfer could enhance the possible impacts of CCU technologies.

- CO_2-based fuels: Development of hydrogen production from renewable sources

Just as the need for fossil-free electricity, the delivery of ecologic objectives of many CCU applications is likewise depending on the availability of hydrogen from renewable sources (European Commission 2019). Therefore, the success of some CCU technologies is bound to policies that enable the provision of renewable hydrogen.

3.2.2 CCU technologies' needs in terms of economic incentives

- Improve the regulatory conditions to improve investment security

Technology research and development as well as the period until deployment require long-term thinking and acting from science and industry alike. Especially for industry actors, the uncertain regulatory situation poses a hindrance when decisions about the further investment in CCU technologies need to be taken (European Commission 2019). Often these plants require very long running times of several decades. In policy making, this need should be considered and reflected in order to provide a reliable regulatory environment and allow for long-time planning for industry investment decisions.

- Introduce incentives for a successful market entry of CO_2-based products

[14] https://www.blauer-engel.de/de, accessed 13 August 2019

Under current conditions, many products made with CO_2 are expected to be more expensive than the comparable conventional products (Naims 2016). Therefore, a successful market entry can depend on supporting policy measures (Olfe-Kräutlein 2016). Possible measures could be tax advantages, either via a higher taxation of fossil carbon or a tax advantage for utilising CO_2 from industrial emissions or air capture; moreover, product blending quotas in the production of synthetic fuels, base chemicals as well as building materials or the consideration of public procurement (European Commission 2019).

- Continue and coordinate R&D funding and support on different levels

For the time being, CCU based products might not instantly be economically viable for the industry (Naims 2016). Also, fundamental research and a scientific assessment of possible implications and consequences are needed today and will still be necessary in the future. Therefore, a continued funding of research activities is required. This funding should be technology neutral and provide a long-term perspective for research and development, also for projects with a Technology Readiness Level higher than 6.

- Introduce targeted support in tackling infrastructure challenges

The implementation of CCU technologies might encounter infrastructure challenges, for example the construction or retro-fitting of industrial facilities or the erection and use of transport-related infrastructure such as pipelines. Here, tailored policy support might be needed in order to help the industrial actors tackle such larger infrastructure challenges.

3.3 Regional differences in the presented perspectives

The needs in technical research and development of CCU technologies do not differ significantly among the countries that were represented at the Round Table event. But while European representatives rather seem to follow a transnational path and demand policy solutions that address comparability issues and alignment of the conditions, under which CCU technologies can be developed and implemented in different countries, the perspectives from the USA and China seem to focus more on national measures as the most influential.

However, more considerable among the Round Table's contributions was the difference in what is to be called a CCU technology. The critical difference in defining a CCU technology mainly lies in either the in- or exclusion of Carbon Capture and Storage (CCS) technologies and Enhanced Oil and Gas Recovery (EOR/EGR). While in Germany, the political debate on CCU and CCS is mostly separated and led by different actors, other nations have a different approch (e.g. USA and China). This reflects the observation laid out in section 3.1. which shows that actors on the societal macro-level include CCS-related aims in their future vision of CCU as well, whereas on the meso-level, industry actors usually do not connect both.

The ex- or inclusion of CCS in CCU is an important aspect, since the idea of what to consider a CCU technology has a major effect on the assessment of a current “state of the art” and of estimates of future potentials, on acceptance issues and on the political context and hence on the policy needs for research, development and implementation.

3.4 Societal risks involved in the implementation of CCU technologies

As summed up in section 3.1, aims and objectives of different actors involved with CCU technologies claim to deliver ecologic, economic and societal advantages for society. Nevertheless, when discussing the possible effects of an innovation, a look at possible societal risks and downsides needs to be taken here as well in order to provide a more complete and consistent picture. This is despite the fact that during the Round Table event, the discussion did hardly extend to overarching societal effects but remained within the limits of discussing policy needs.

For example, path dependencies may occur, such as a lock-in effects with fossil-based energy production or other unwanted industrial plants, and might go along with the retro-fitting of, for instance, coal fired plants with capture facilities. Also, the advancement of applications that utilise CO_2 in order to extract more fossil carbon, such as EOR and EGR, may not serve the societal benefit and be in line with long-term environmental strategies. Moreover, the development of other technologies might not be advanced further, due to CCU "solutions" and thus hinder technological progress in other fields.

Rebound effects can be caused by increased production and consumption as a result of improved product or production attributes. It is also possible that through utilisation processes, carbon emissions are delayed and thus shifted into the future and then will burden future generations.

From a global perspective, the implementation of CCU technologies in developed countries may contribute to the consolidation of an unjust global status quo, since without technology transfers, CCU supports and enhances the advantage of the developed countries as opposed to the less developed countries who are unlikely to deploy and benefit from such innovations because they do not have the resources to conduct the research and development or buy the required intellectual property licenses.

These risks need to be monitored carefully and taken into account when considering and developing policy measures in favour of CCU technologies.

4. Conclusions

CCU technologies have the potential to contribute to several policy targets. Important contributions can be anticipated in the context of energy transition processes and societal advancements as defined by the scope of the SDGs that are linked to technological progress. The size of this contribution depends on continued technology developments and on several other factors like the supply of energy from renewable sources.

The 4th Round Table CO_2 Utlisation at the IASS brought together experts in policy implications of CCU technologies from different regional and national contexts and other interested stakeholders in a public dialogue event. Thus, the event enabled an inventory of perspectives and fostered an active dialogue on possible societal contributions and policy needs of CCU technologies.

In order to unfold their full sustainability potential, CCU technologies need a supportive regulatory and policy framework on a European and international level today, and require more tailored support in the future.

Some of the required support, as for example a continously growing supply of energy from renewable sources and hydrogen, is enclosed in national or international policy goals and not specific to CCU. Other necessary support, like the recognition in carbon accounting mechanisms or product labeling schemes, needs to be addressed in particular with regard to CCU technologies. In this context, it is beneficial to join forces in organisations such as CO_2 Value Europe or the PHOENIX Initative or in common projects like "CO_2nsistent" of the Global CO_2 Initative and EIT Climate-KIC, which aim at aligning assessment procedures and thus also potentially advance the visibility of CCU technologies' potential contributions.

On either level, specific risks need to be monitored and considered in policy decisions.

5. Literature

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Institute for Advanced Sustainability Studies e.V. (IASS)

Funded by the ministries of research of the Federal Republic of Germany and the State of Brandenburg, the Institute for Advanced Sustainability Studies (IASS) aims to identify and promote development pathways for a global transformation towards a sustainable society. The IASS employs a transdisciplinary approach that encourages dialogue to understand sustainability issues and generate potential solutions in cooperation with partners from academia, civil society, policymaking, and the business sector. A strong network of national and international partners supports the work of the institute. Its central research topics include the energy transition, emerging technologies, climate change, air quality, systemic risks, governance and participation, and cultures of transformation.

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