2022-IP09

2nd International Conference on Negative CO_2 Emissions

This second 4-day conference on negative emissions technologies (NETs) took place from 14th – 17th June, with more than 275 in-person and 40 online attendees. It was hosted by Chalmers University of Technology in the Swedish city of Gothenburg. The varied content and key speakers with expertise in NETs highlight the growing importance that NETs have in reaching net zero target goals by 2050 but only if national and international policies invigorate its application. This IP summarises the 12 keynotes that were given by experts on various negative emission topics throughout the week. In addition, there were about 140 presentations organised into 10 sessions in four parallel streams and 30 posters.

In his opening keynote, Christian Holzleitner (European Commission's (EC) Director-General for Climate Action) highlighted the necessity for more sustainable production of carbon from non-fossil sources combined with more sustainable use, and storage, of non-fossil sourced carbon. Land-use has an important contribution to these aims however the contribution from carbon capture and storage (CCS) was acknowledged specially for the abatement from industrial sources. One way to achieve climate neutrality is the enhanced use of land use especially biomass in the form of forestry. By 2050 improved carbon practices could have the potential to reduced 200 $MtCO_2$. One of the advantages of enhanced land-use practices are the added benefits. These include: increased carbon dioxide removal (CDR); additional income for land owners; greater biodiversity; and increased climate resilience of agricultural and forestry resources. Examples include afforestation, less intensive crop production, and, significantly, reverting or rewetting peatlands to their natural state. One of the biggest challenges facing carbon management, and land-use, is carbon accounting and the associated accreditation scheme that would be needed to ensure accurate implementation. To this end the EC is setting up an Action Plan to establish such a system, an expert group and a legislative proposal. The presentation concluded with a summary of the EU's Innovation Fund which is supporting seven first-of-a-kind (FOAK) projects with a total of €1145 million to simulate sustainable NETs and carbon capture, utilisation and storage (CCUS). The seven projects include a bioenergy with CCS (BECCS) CHP plant linked to CO_2 storage in the North Sea and an electrolytically derived hydrogen direct reduction for steelmaking project. With the clear expansion of NETs, and greater international trade either in carbon credits or materials from sustainable sources, there is a clear message from this keynote address that a robust accreditation scheme with transparent rules for high quality carbon credits, as well as open-access cross-border CO_2 infrastructure, will be essential.

Anders Lyngfelt (Professor at Chalmers University of Technology) debunked the biggest misconceptions with regards to biomass with CCS (Bio-CCS). These include the following: not needed; not enough (referring to the land needed, this is where multi-use biomass systems come into play to reduce pressures on land by managing land-based systems more efficiently); not existing at scale; not safe; not a priority (it is needed now considering the carbon budget will be used up by ca 2029); and too expensive. Anders Lyngfelt also highlighted the importance of CO_2 emitter liability.

Forestry specialist Peter Holmgren (Founder and Senior Advisor at FutureVistas Inc.) showed, using the example of Swedish forests which store on average ca. 70 tC/ha, that active forestry can lead to more carbon stored and highlighted the role of a circular forest bioeconomy in this regard. Over the last 30 years, Swedish forests have been a net sink of 1.16 $GtCO_2$. Well managed forests with sustainable harvesting can provide large and stable negative emissions, of course depending on the financial viability.

Jean-Francois Soussana (French National Research Institute for Agriculture, Food and Environment) provided insights from the IPCC Special Report on Climate Change and Land (SRCCL). Emissions from the global food system are estimated to be about 21-37% of total net anthropogenic greenhouse gas emissions (GHG) emissions. The total technical mitigation potential from crop and livestock activities and agroforestry is estimated to be about 2.3 – 9.6 $GtCO_2$/a by 2050. Some agricultural response options are able to deliver co-benefits across land-based challenges. In addition, negative emissions from agricultural soils can complement urgent mitigation efforts in the global food system and maintaining and increasing soil organic carbon (SOC) stocks has multiple co-benefits. However, SOC stocks are finite and fragile and the carbon storage is reversible. There is a need to accelerate transitions through R&I and to address knowledge, financial and policy barriers limiting carbon farming.

Claudia Kammann (Professor at Geisenheim University) gave an overview on biochar (BC) developments. At the end of 2021, BC production in the EU was 35 kt and is estimated to rise to 65 kt in 2022. Long-term experiments have confirmed that SOC increases significantly when adding BC, such as shown in coffee agroforestry in Ethiopia, where SOC increased by 0.84 – 3.33% per year. The use of BC-based fertilisers has a lot of other benefits, such as nitrate capture and NH_3 adsorption.

Detlef van Vuuren (Professor at Utrecht University and Netherlands Environmental Assessment Agency) provided a summary on modelling, in particular integrated assessment models (IAMs). IAMs show that current policies can slow down emissions growth but won't lead to fundamental transitions. They also explore the future, especially trade-offs, but are not meant to predict it. There is a large gap between current policies and < 2°C targets. It is important to clearly differentiate between net zero CO_2 and net zero GHG. Emissions reductions of about 3,500 $GtCO_2$ and negative emissions of about 500 $GtCO_2$ (total range 20 – 660) are currently estimated to be needed. The three most critical CDR themes are role of timing, role of negative emissions, and the role of different methods. Also, on a higher level, the role of CDR for compensating hard-to-abate emissions, fast trajectories and overshoot are important.

Mijndert van der Spek (Assistant Professor at Heriot Watt University) opened his keynote by emphasising the reality of direct air CCS (DACCS). Companies like Climeworks and Carbon Engineering are gearing up the technology, the latter for use in CO_2 enhanced oil recovery (EOR). Although the principle of the system is straight forward, there are 10 variations mostly in the capture system. These vary considerably in terms of technological advancement, energy use, energy costs and the levelized cost of net CO_2 removal. The Heriot-Watt research team have independently projected the cost of four DACCS technologies: alkaline solvent with lime looping; alkaline solvent with electrochemical regeneration; solid sorbent; and magnesia looping/ambient weathering. The technological analysis shows that there are large ranges and uncertainties with these parameters. FOAK costs are high for modular technologies but when compared to the development of wind power there is a discernible downward trend towards comparable cost levels. Although costs are high now there is confidence that cost reduction to 100's USD/tonne for net CO_2 removal is possible. This achievement needs strong policy intervention/support but different financing systems may be necessary for different technologies.

Stefano Caserini (Adjunct Professor at Politecnico di Milano) gave an overview on ocean alkalisation. Ocean pH has decreased by 0.1 pH units since the pre-industrial period, which is an unprecedented shift in the last 65 – 300 Ma. Increasing ocean alkalinity is a means by which CO_2 might be sequestered from the atmosphere, limited only by the availability of energy. However, the potential side effects of such geoengineering approaches are yet unknown. Costs for ocean alkalisation enhancement are estimated to be about USD 150/tCO_2 removed. The task of even partially reversing the acidification of the oceans by adding limestone powder to upwelling regions is enormous and would need to continue for several 100 years.

Oliver Geden (Lead Author IPCC AR6 WGIII Chapter 12 & Synthesis Report and German Institute for International and Security Affairs) provided a summary of the recent IPCC AR6 WGIII report on the mitigation of climate change. The deployment of CDR to counterbalance hard-to-abate residual emissions is unavoidable if net zero CO_2 or GHG emissions are to be achieved. Upscaling the deployment of CDR depends on developing effective approaches to address feasibility and sustainability constraints especially at large scales. The taxonomy and terminology in the report avoids a 'nature based vs hybrid vs technological' classification of CDR methods, based on AR6 WGI, highlighting the type of removal process and timescale of the carbon storage instead. Modelled residual emissions are mainly non-CO_2 GHGs from agriculture but also CO_2 from industry, aviation and land use. Net zero GHG is a more ambitious target, occurs later and needs more CDR than a net zero CO_2 target. Every ambitious illustrative mitigation pathway (IMP) involves CDR, the volumes and sectoral composition of residual emissions and CDR differ across them though. CCS and CCU methods can be part of CDR if the storage is durable. There might be a SR on CDR in the future or CDR could heavily feature in another themed SR. New items on the research agenda are the definition of durability, treatment of non-permanence, monitoring, reporting and verification (MRV) issues, residual/hard-to-abate emissions vs CDR, real world CDR governance and policy making.

Mai Bui (Imperial College London) talked about the status of BECCS in her keynote. CCS/BECCS is technically feasible, with capture, transport and storage technologies currently commercially available. The deployment of mature (i.e. high technology readiness level (TRL)) CCS options tends to be hindered mainly due to insufficient funding and policy support. For sustainable BECCS, the amount of CO_2 sequestered geologically must exceed the amount emitted over the supply chain in order to achieve a net removal of CO_2 from the atmosphere. Thus, good quality, transparent life cycle assessments (LCAs) are important and needed. The IPCC scenarios show that some amount of BECCS will be required, although we don't know exactly how much, when and where. BECCS pathways are quite complex due to the multitude of different feedstocks, conversion processes and end uses that can be combined, so the negative emissions delivered by each pathway will be different. Only a few of those BECCS pathways have been demonstrated at scale so far. Key factors that drive the cost of CDR are the availability of secondary biomass (i.e. waste, residues), land availability and yields. To maximise net CO_2 removal for power BECCS, biomass with a low carbon footprint and high carbon capture rates needs to be used. Power BECCS pathways have a higher carbon efficiency than biofuel BECCS pathways: 50% vs 25%, with some power BECCS chains reaching up to 85%. BECCS can have negative side effects but also positive ones, e.g. socio-economic (job creation, gross value added (GVA) increase).

Stuart Haszeldine (Professor at University of Edinburgh) provided an overview on CO_2 geological storage. Although the IEA is distancing itself from fossil fuels, oil and gas companies show no real sign that exploration and production will stop or decrease any time soon. Since 1996, the Sleipner project in Norway has injected and stored 1 MtCO_2/a safely, with a high detection precision in the seismic reflection surveys. Potential leakage of the reservoir would need years or decades to break through to the surface, so it is better to monitor the legal complex rather than just the surface. In case of breakthrough leakage, CO_2 disperses into the air relatively quickly. The timeline for storage reservoir appraisals/evaluations is 6 – 10 years, so this needs to be considered projects development and timelines for climate targets. The cost range for CO_2 transport and storage (T&S) is currently 4 – 20 €/tCO_2, based on actual site data. However, the pace of CCS is 10x – 100x too slow, so there is an urgent need to get projects off the ground.

In the last keynote, Wilfried Rickels (Kiel Institute for the World Economy) summarised the situation around emissions trading markets, highlighting that pledges are not binding by international law/treaties, and even if, you can always leave the treaty. From economic point of view, there are practically no (physical) residual emissions, as a lot of them originate from activities that can be considered luxurious (eating meat, flying, driving, etc.) but which we might want to undertake and are willing to pay for (economists call it a "high willingness to pay" and accept it). CDR should be thought of as part of climate policy, not something extra for residual emissions, and the share of CDR will likely be determined in a non-cooperative cost-benefit framework. Various design options are available for inclusion into emissions trading, each with different implications for efficiency. The procurement of carbon removal credits (CRC) could realise several option values: realising the technology development, management of transition periods from positive over net zero to net negative, realising larger amounts of negative emissions, and using CRCs as a bargaining chip in international negotiations. Developments are regionally very different: e.g. Europe with a rule based compliance market, and the US with a voluntary market, which is perceived by some as Wild-West but regulations might emerge as a response to market demand

The 3rd International Conference on Negative CO_2 emissions is planned to be held in the UK in 2024 and organised by the University of Oxford.

Conclusions and IEAGHG actions

IEAGHG has been on the Scientific Committee of the conference since the first edition. We will continue to support the conference format and the organisers for the 3rd edition.

Reference list:

Conference website:

https://negativeCO2emissions2020.com/

Jasmin Kemper

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