

WORKSHOP REPORT

Sustainable Negative Emissions:

A Climate Risk Management Option?

December 6th & 7th, 2013

Tokyo

GCP-TSUKUBA INTERNATIONAL OFFICE

December 12, 2013



December 12, 2013

Contents

Workshop Overview

Day 1 :

Presentations

Day 2:

Discussions

List of Participants

Co-organizers

Global Carbon Project (GCP)

International Institute for Applied Systems Analysis (IIASA),

Mercator Research Institute on Global Commons and Climate Change (MCC),

National Institute for Environmental Studies (NIES)

Organizing Committee

Nebojsa Nakicenovic (GCP-SSC, IIASA Dpt. Director, TU Vienna), Florian Kraxner (IIASA), Sabine Fuss (MCC), Yoshiki Yamagata (Head of GCP International Office, NIES), Ayyoob Sharifi (GCP, Executive Director, NIES) and Josep Canadell (GCP, Executive Director, CSIRO)



Workshop background and overview

In the first half of this year Earth's CO₂ level has surpassed 400ppm, which is the highest level in our history since the Pliocene. It thus appears that we are indeed steering towards an **overshoot** by which the new IPCC Report's climate change mitigation scenarios are characterized, before stabilizing at ppm levels allowing us to restrict global warming to 2 degree C above pre-industrial levels. How can this stabilization still be achieved? One core ingredient in the mitigation mix are negative emissions, mostly based on carbon-neutral bioenergy (due to the same amount being sequestered by feedstock growth as being emitted when combusting biomass for energy generation) combined with carbon capture and storage (**BECCS**), which in addition captures CO₂ during the energy production phase. Yet, while having long appeared to be an attractive option for **climate risk management**, many uncertainties remain – both socio-economically/technologically and on part of the climate science. In a series of workshops, both dimensions have been explored by experts with backgrounds as diverse as geology, climatology, economics, engineering, policy, physics, etc. (see below for references to these workshops and associated material). While those workshops partially targeted the **incentivization** of BECCS diffusion in specified countries, the GCP workshop at IIASA highlighted in a much more explicit way also the uncertainties on the **climate side**:

- What are the effects on and interaction with the albedo?
- Do negative emissions decrease the airborne fraction and is the functional relationship between emissions and climate symmetric?
- What happens to other GHGs and radiatively active substances, don't we need a radical decline of those, too, to make negative emissions work?

In this workshop, we came back to these questions, but also added **technology and economic perspectives**. One important aspect discussed was whether negative emissions technologies will create a situation of moral hazard, where costly transitions to carbon-free technologies are postponed in expectation of future cost reductions in abatement costs and containment of climate risks through BECCS. Whether further lock-in will lead to costly investments in carbon-intensive technologies, which will be a disincentive for later transitions, is one obvious question. The International Energy Agency's latest update of the CCS roadmap¹ also emphasizes that CCS is not on track and that substantially more efforts are needed in order to have CCS ready to generate the carbon savings needed to stabilize the climate. Concerning the latter, we also explored the question how negative emissions would be coordinated globally in the face of the **climate agreement impasse** we are currently experiencing. Which countries would agree to be providers of **public goods** enabling others to maintain industrialized patterns of production and what are their incentives? Can **co-benefits**² provide sufficient grounds for the development of BECCS? Is bioenergy the most promising entry point?

¹ Scott Vivian, Gilfillan Stuart, Markusson Nils, Chalmers Hannah, Haszeldine R Stuart (2012) [Last chance for Carbon Capture and Storage](#). Nature Climate Change 3, 105-111 doi:10.1038/nclimate1695.

² "For GHG mitigation policies, co-benefits can best be defined as effects that are additional to direct reductions of GHG and impacts of climate change" [www.oecd.org/fr/env/cc/benefitsofclimatechange/policies.htm]

Day 1 :

Presentations

Yoshiki Yamagata, Tokuta Yokohata

“Land, water and ecosystem nexus for climate risk management” (Synthesis report of latest ICA-RUS Theme 2 project research results)

Yoshiki presented on the land, water, and ecosystem nexus for climate risk management. Pointing to the importance of land, water nexus for human life and also climate change mitigation and adaptation he explained how geographically explicit integrated land use models can be used as decision support systems for climate risk management. He also explained how different scenarios affect different mitigation and adaptation approaches.

Tokuta reflected on water, ecosystems and future challenges. He showed how global hydrological models can be used to make future scenarios for global water management. Emphasizing that risk in water resources is closely related to ecosystem, he explained that modelling is needed to manage future risks in water resources. He showed how a dataset of historical changes in global crop yields has been developed to explore factors affecting the global yield. Finally, he mentioned uncertainties in terrestrial ecosystem models and emphasized that collecting results of various models is the best way to investigate uncertainties in future predictions.

Etsushi Kato

“Ecosystem sustainability of 2⁰C scenario using BECCS”

Etsushi talked about potentials of BECCS in Japan and explained that even with the RCP 2.6 scenario negative emissions are necessary at the end of this century. He continued by explaining that large uncertainties exist in deployment of BECCS and emphasized that possible contribution of BECCS depends on the potential and societal acceptance of large scale bioenergy production and CCS. He then focused on the potentials of sustainable BECCS in Japan. He sees limited land allocated to cropland and also the high cost of forestry management as main challenges that need to be faced. Despite these challenges, it is estimated that under current economy and technologies, BECCS is capable of contributing to about 10% of energy needed in Japan.

Atsushi Kurosawa

“BECCS in integrated assessment models - road to the negative emissions based on Japanese experiences”

Atsushi began his talk by describing the share of new and renewable energies (including bioenergy) in Japan is very limited. Throughout his presentation, he showed that Japanese industries have technological basis for bioenergy utilization and CCS. However, he mentioned that scale-up demonstrations are needed for both technologies. This scale-up is needed to make it comparable to commercial scale currently existing in the US. Pointing to the lack of integrated BECCS demonstration in Japan, he suggested that it is essential to bridge between the two technologies. At the end he emphasized the need for cost reduction and policy support and suggested that BECCS should be assessed in the context of broader conversion technology portfolio.

Kunio Yoshikawa

“Innovative Japanese Waste-to-Green Product Technologies: Economically Viable BECCS”

Kunio's presentation focused on new commercialized technologies available to realize economically feasible BECCS. He described that the current use of biomass is not economical. He proposed converting biomass and waste into green products and fertilizer as a viable alternative. By gasfiring biomass together with electricity we can obtain char which is a carbon material. This char can be utilized as a fertilizer. He then showed how this concept can be technically realized. He pointed out that the new waste to coal technology can save the society both time and money. He then continued by describing the process of converting waste to electricity as a gasification technology and mentioned the example of using chicken manure to obtain biochar and fertilizer. His talk was ended by reiterating that the combination of small scale power generation and fertilizer production is a good option contributing to the achievement of negative emission pathways.

Nebojsa Nakicenovic

“Carbon fluxes in scenarios with significant NE based on GEA, RCPs and CMIP5”

Naki began with showing the NASA earth city lights to argue what we need more energy and discussed that if that energy is fossil it will not work. Pointing to the adverse consequences of fossil energy providing all of the services and negative impacts of climate change and global warming, he argued that tackling these adverse impacts is the main motivation for looking at the 2 degree scenarios. He mentioned the low cost of coal and gas as a challenge to the huge investment made in renewable energies. This is one of path dependencies that might prevent us from reducing emissions fast enough and therefore we will overshoot and need negative emission and BECCS later in the future. He continued by briefly describing the latest global energy assessment report. He explained that the current emissions are well above the previously set trajectories and we are 2 to 3 decades behind and this has caused an overshoot. So the reductions need to be very large and if they are smaller, than we need negative emissions. He then compared the carbon flux in RCP 2.6 and 8.5 scenarios. Describing various scenarios and given the huge differences between them, he argued that much more research is needed to really understand the dynamics not only from the climate side, but also from the technological side. He concluded by describing several challenges that need to be addressed.

Thomas Gasser

Net vs. Gross Negative Emissions: How much NE needed in the RCP 2.6?

Thomas's presentation was focused on the negative emissions issue from the point of view of a climate scientist. He has utilized inverse modelling to find out how much negative emissions can be achieved under the RCP 2.6 scenario. He has defined emissions floors as being trajectories of fossil CO₂ emissions that cannot be avoided. These are a gross positive emission flux. Then the difference between the floor and the compatible emissions is the actual -- real -- negative emission flux, i.e. the gross negative emissions. The key point he emphasized is that, contrarily to what appears with the IPCC compatible emissions / official RCP emissions that show only a small (net) negative emission flux after 2070, the required amount of negative emissions to follow the RCP2.6 might be way higher than what we think. He concluded that we need to include negative emissions limitations in integrated assessment models and also need to take into account what happens to the climate system after 2100.

Florian Kraxner

“Multiple objectives and interaction with other (land-based) emission reduction options”

Florian presented on multiple objectives in the area of land use, and its modelling and change. Analysis of multiple objective shows that it is essential to deal with the target to maximize bioenergy together with looking at the ecosystem services and at the same time looking at the food production issues. He explained that considering all these simultaneously would be a hard task. He described lack of commercial availability, biomass availability, cost, uncertainty, lack of awareness and public acceptance as some of many challenges of BECCS with respect to these multiple objectives. Concerning global biomass availability, he showed that the greatest potential is in the tropics where under BAU assumptions the largest deforestation will take place. He showed that we need to produce a huge amount of bioenergy over the next hundred years but there are still ambiguities about the source of this needed biomass. We need to produce bioenergy in order to live up to our scenarios and at the same time we have to protect forest in the tropical areas and the way this should be done is a big question. Explaining situations in different regions, he also mentioned the issue of trade-offs. By protecting forests it would be possible to save emissions. However, protecting forests needs a lot of water to produce bioenergy and this needs to be taken into account. He concluded by discussing several related issues such as governance, planning, logistics, technologies, and the issue of conventional CCS together with BECCS.

Sabine Fuss

“BECCS as a climate risk management tool: opportunity, uncertainty and pitfalls”

Sabine's presentation focused on the potentials of BECCS for climate risk management. She further explained the risks of not achieving the 2 degree target. She mentioned that a lot of uncertainties exist about the tipping points, especially in relationship with other GHG such as methane. This can have really significant implications. She continued to say that due to these non-linearities it cannot be said with certainty that if emissions are taken out of the atmosphere what would be the impacts on the temperature. Behavioral aspect was another major issue discussed by her. The fact that NE would bring down the emissions very rapidly brings up the question as whether we are ready for this rapid abatement. Interactions and trade-offs with other options was also discussed by her. She emphasized that apart from negative emission options, other options should also be considered. She pointed to the issue of conflicts of the need for economic development in some countries with high potential for realization of negative emissions and emphasized that this needs to be considered in climate negotiations. Furthermore, she explained that capacity building in the area of governance is an issue that needs appropriate consideration. At the end, she reiterated that negative emissions are essential to reach 2 degrees but still large gaps exist that need to be filled to better understand both the potentials and dynamics of the issue.

Daniel Johansson

“The role of BECCS in meeting global temperature targets”

Daniel spoke about the BECCS and its interaction with various scenarios. He focused on the role of BECCS in meeting temperature targets. Bringing up the issue of cost-effectiveness, he argued that BECCS has little economic benefit for ceiling targets, but big benefit for overshoot targets. He estimated that BECCS has the potential of reducing the temperature by a measure of 0.6-0.7 degree in a century. One major issue discussed by Daniel was that BECCS can be regarded as a tool with potential to make climate

change reversible, although the degree to which BECCS can make climate change reversible depends on the CO₂ storage capacity available, bioenergy supply and climate-carbon cycle feedbacks. Additional major challenges mentioned by him are that controlling and changing climate with BECCS takes a long time and it cannot be used for controlling acute risks. He concluded by arguing that BECCS can reduce NPV abatement costs by delaying emission reduction, and cautioning against the use of BECCS as a reason to postpone other mitigation option.

Massimo Tavoni

“Negative emissions in the transitional pathways to climate stabilization: role and challenges”

Presenting over Skype, **Massimo** discussed various issues related to CDR (Carbon Dioxide Removal). He stated that the probability of reaching 2 degrees with the Kyoto budget is 50-55%. Picturing CDR as a love-hate relationship, he explained that CDR eases near term mitigation and therefore is capable of playing a big role. He continued to say that most models show that the 2 degrees target will not be achieved without CDR and CDR will lower the mitigation costs. One issue he raised was that a big difference in cost saving exists between EEX and Non-EEX countries. He then explained about CDR in the IAMs and bioenergy implications by providing an overview of several existing literature. With regard to ocean responses to CDR, he showed that due to outgassing concentration goes up again. To play a dominant role, he emphasized that CDR technologies would be needed in daunting quantities. He concluded by asserting that modeling of CDR in integrated assessments can be enriched by further iterative dialog with other disciplines.

Day 2 :

Discussions

In addition to conversations and discussions in the first day, the second day was fully devoted to deep discussions about the research questions based on which the workshop was organized and also questions raised throughout the first day. The session began with reflections from the first day and major issues discussed were reiterated. This was followed by discussions to answer the following questions:

Q: What assumptions does effective risk management on the basis of BECCS rely on? And can we do without BECCS?

Q: What are the costs of not having the BECCS option – both in terms of actual cost and risk?

Q: How does the availability of BECCS alter expectations and thus potentially near-term investment?

Q: Can we realistically assume that BECCS will be “ready“ on time, given the current status?

One of the main objectives of this workshop was to come up with a research agenda. Relatively broad scope of the presentations and deep discussion sessions yielded interesting insights and ideas for future research. These include various aspects such as scoping for technological innovation; planning issues and various scales for intervention; process-based issues such as boundaries, trade-offs, and implications for terrestrial systems; potential of biomass vs practical implications; institutional challenges and governance issues that cover various issues such as policy-making, vulnerabilities, context-specificities, and behavioral and lifestyle aspects; and climate management risk that should, among others, deal with issues related to multi-objective risk management, the entry point, better understanding of risk, uncertainties, storage space necessary, and policy relevance.

Before closing, all the attendees were given the chance to reiterate their main points to make sure that various viewpoints have been considered.

The next step is to finalize a research plan based on the key themes emerged from this workshop

LIST OF PARTICIPANTS

Name	Organization	Email
Dennis Best	International Energy Agency (IEA)	Dennis.BEST@iea.org
Sabine Fuss	Mercator Research Institute on Global Commons and Climate Change (MCC)	fuss@mcc-berlin.net
Thomas Gasser	LSCE/IPSL and CIRED	thomas.gasser.2006@polytechnique.org
Daniel Johansson	Chalmers University of Technology	daniel.johansson@chalmers.se
Etsushi Kato	National Institute for Environmental Studies (NIES)	kato.etsushi@nies.go.jp
Florian Kraxner	International Institute for Applied Systems Analysis (IIASA)	kraxner@iiasa.ac.at
Volker Krey	International Institute for Applied Systems Analysis (IIASA)	krey@iiasa.ac.at
Atsuhi Kurosawa	The Institute of Applied Energy (IAE)	kurosawa@iae.or.jp
Nebojsa Nakicenovic	International Institute for Applied Systems Analysis (IIASA)	naki@iiasa.ac.at
Ayyoob Sharifi	National Institute for Environmental Studies (NIES)	sharifi.ayyooob@nies.go.jp
Massimo Tavoni	Fondazione Eni Enrico Matte	massimo.tavoni@feem.it
Koji Tokimatsu	Tokyo Institute of Technology (TITECH)	tokimatsu.k.ac@m.titech.ac.jp
Yoshiki Yamagata	National Institute for Environmental Studies (NIES)	yamagata@nies.go.jp
Tokuta Yokohata	National Institute for Environmental Studies (NIES)	yokohata@nies.go.jp
Kunio Yoshikawa	Tokyo Institute of Technology (TITECH)	yoshikawa.k.aa@m.titech.ac.jp

Contact Us

GCP-Tsukuba International office
Centre for Global Environment Research
National Institute of Environmental Studies
16-2 Onogawa, Tsukuba, 305-8506 Japan
Tel: 81-29-850-2672
Fax: 81-29-850-2960
Email: sharifi.ayyooob@nies.go.jp