Disclaimer: these comments have been overtaken by subsequent model updates.

Workshop on Greenhouse Gas Removals

Global Calculator Project

Imperial College London, 10th February 2014

Attendees

David Addison (Virgin)
Rob Bellamy (Oxford)
Thomas Counsell (DECC)
Richard Darton (Oxford)
Sophie Hartfield (DECC)
Nicole Kalas (Imperial)
Tim Kruger (Oxford)
Jason Lowe (Met Office)
Niall Mac Dowell (Imperial)
Chris Mack (DECC)
John Shepherd (Southampton Univ.)
Alexandre Strapasson (Imperial)
Erica Thompson (LSE)
Naomi Vaughan (UEA)
Jeremy Woods (Imperial)
Mark Workman (Imperial)

Summary

The purpose of the workshop was to bring together a group of experts in the area of greenhouse gas removal (GGR) technologies to provide input to this respective lever in the global calculator. Sophie Hartfield provided a general overview of the global calculator project, Alexandre Strapasson discussed the GGR lever within the Land/Bioenergy/Food/GGR module of the calculator, and Tim Kruger provided an overview of various GGR technologies, deployment status and elaborated on associated economic, social, environmental and ethical issues. The subsequent group discussion centred on the communication of uncertainty and GGR, BECCS, the technological feasibility vs. public acceptance of GGR and key messages of the global calculator.

Introduction to the Global Calculator Project

(Sophie Hartfield)

In her introduction to the global calculator project, Sophie Hartfield first discussed the UK 2050 Pathway calculator and other national calculators DECC assisted in developing subsequently. The national calculators present complex information in an intuitive manner and support decision-makers in exploring alternative greenhouse gas (GHG) mitigation pathways, where Level 1 represents 'doing nothing' and Level 4 an ambitious, credible maximum mitigation effort.

The global calculator considers mitigation pathways for different sectors at a global scale in a simpler and more accessible way than existing integrated assessment or energy system models. Whereas the target users for the national calculators are primarily policymakers, the target users for the global calculators are also businesses. The overarching ambition of the global calculator is to influence the 2015 UNFCCC negotiations. One of the barriers appears to be a lack of consensus among key stakeholders, especially businesses. The calculator therefore targets businesses to build

support for GHG mitigation actions and allows them to explore what a 2050 world may look like under different scenarios, e.g., markets for cars, travel options, types of cars, level of electrification in the transport sector, modal shifts, etc.

Discussion

General issues

With regard to agricultural production it was noted that the global calculator lacks a spatial representation of where land use change will occur, e.g., where energy crops would be grown. However, changes in land use locations are mostly determined by market forces and, therefore, it would not be accurate and consistent to present this spatial representation in the calculator. Also, the fact that the calculator does not feature climate change feedback loops, e.g., climate impacts on crop yields, there may be some limitations in the model that should be addressed or clarified.

Uncertainties

Also discussed was how uncertainties associated with different levers and level choices could be represented best. A colour coding scheme was suggested, where green would be 'high certainty' and red 'we really don't know', respectively, with degrees of shading for levels of certainty in between. It was noted that the large-scale deployment of specific technologies also varied in certainty, e.g., offshore wind farms vs. direct air capture (DAC) appear equally feasible, which is not the case and should be highlighted in the calculator. Furthermore, political and public acceptance comprise additional types of uncertainties, which may need to be considered. One-pagers addressing these uncertainties will be developed for each lever, but could also be communicated graphically, or with error bars. In addition, a labelling system will be developed that will flag inconsistencies in user choices. The notion of complexity on demand quite important, the tool has to be simple, but should not oversimplify the issues and represent uncertainties clearly.

The GHG removal approach in the global calculator

(Alexandre Strapasson & Tim Kruger)

Alexandre Strapasson discussed the representation of GGR technologies in the global calculator and Tim Kruger provided a high-level overview of various GGR technologies, including key constraints and state of development.

GGR in the global calculator

(Alexandre Strapasson)

The GGR lever in the global calculator is limited to the following technologies: biochar, direct air capture (DAC), enhanced weathering (terrestrial and oceanic) and ocean fertilisation. These are represented in aggregate to date, i.e., the user does not have an explicit choice in the level of deployment of individual technology options. Table 1 below shows the preliminary levels of ambition (1-4) and associated GHG emission reduction potentials in 2050.

Table 1: Preliminary lever on GGR technologies – Levels 1-4

Level	Description	2050
1	means no GGR technologies	0 Gt CO_2/yr
2	represents a low effort on GGR technologies (25% of Level 4 potential)	7.0 Gt CO_2/yr
3	means a substantial contribution of GGR technologies (50% of Level 4 potential)	14.0 Gt CO_2/yr
4	Based on the implementation of 100% potential of the following technologies: Biochar - 3.3GtCO2/yr; Direct Air Capture - 10.0GtCO2/yr; Enhanced Weathering - Oceanic - 10.0GtCO2/yr; Enhanced Weathering - Terrestrial - 3.7GtCO2/yr; Ocean Fertilisation - 1.0GtCO2/yr	28.0 Gt CO_2/yr

GGR includes Biochar, Direct Air Capture, Enhanced Weathering - Terrestrial, Enhanced Weathering – Oceanic, and Ocean Fertilisation. However, it does NOT include Forestry, BECCS or Land Use Management /Soil Carbon, given that these issues are already covered by other sectors in the calculator.

These figures assume no interdependencies between techniques.

Note for reference scenario : Based on WP2 team discussions

In the online version of the global calculator, the GGR lever is shown separately from the other Land/Bioenergy/Food levers because it is deemed highly speculative and does not interlink with the remaining levers. Furthermore, Carbon Capture and Storage (CCS), Bioenergy with carbon capture and storage (BECCS) and terrestrial carbon sequestration through land use / soil carbon management are not included in this lever as they are captured elsewhere in the calculator.

Questions raised for discussion included:

- Should GGR be included in the global calculator? If so, should we use a quantitative approach (estimating GHG removal potentials) and/or qualitative approach (e.g., basic information on a separate page with ad-hoc reports)?
- Which GGR technologies may be technically feasible by 2050?
- Can we estimate ranges of potential increase per type of technology?
- Would it be possible to propose four levels of GGR efforts by 2050?
- Are there any physical limits? Can we quantify them?

Discussion

BECCS and land use

It was pointed out that some GGR approaches do use land and that there may be interactions with land use which should be captured. Therefore, it was suggested that the calculator should introduce two categories of GGR technologies, those that have a land use impact and those that do not. It was also argued that given the already high uncertainties associated with GGRs, an overlay with land use would be difficult, but could be explored for some technologies, e.g., BECCS. It was also noted that because BECCS already sits in many global emission reduction scenarios (e.g., IEA), it should be represented explicitly in the calculator. In the current version of the global calculator BECCS is

separate from other GGRs because of the model structure and appear to be buried within bioenergy and CCS. Given its potentially significant role in GHG mitigation, it needs to become more explicit in the calculations and graphically and also be included in the *Resources* page of the online tool. Some experts expressed concern that if BECCS were to be rolled out at a large scale, it would adversely impact food security and biodiversity. Also, some thought that the food levels in the tool may be too high, and if so, there would not be enough biomass and/or land available for BECCS. Another potential constraint could be storage capacity for geosequestration, but several experts noted that there would not be any technical limit to storage capacity in the 2050 timescale. As this may be a general concern, it should be considered to include a graph showing available storage capacity in the *Resources* tab. However, storage capacity is not only a technical issue, but hinges largely on public acceptance, i.e., the physical capacity may be there, but public acceptance may be missing.

Technological feasibility of GGR technologies

Some experts were particularly concerned about the representation of DAC and BECCS, which may have the highest GHG emission reduction potential in the lever set-up. BECCS for example is considered elsewhere in the calculator prototype, but it should be included, in some manner, in the GGR visuals too. Furthermore, it was noted that simply because an approach was technologically feasible, it was not necessarily socially acceptable and that societal impacts needed to be taken into consideration in the decision-making process.

Levels

The key concern among the participants was the potential anchoring effect the publication of GGR potentials may have, and a resulting impact on reduced mitigation action because of a perceived 'get-out-of-jail-free card'. Some experts considered Levels 2 & 3 too high, but were generally okay with Level 4, as an speculative upper limit by 2050, which was derived from Parliamentary Office of Science and Technology POST note (Oct 2013). Very concerned about anchoring effect of these numbers.

GGR technologies

(Tim Kruger)

In his overview of GGR technologies, Tim Kruger summarised his *Briefing Paper on Proposed Greenhouse Gas Removal Techniques for the Global Carbon Calculator Project* and considered key constraints and the level of development of different GGR technologies. Several reports and scenarios, e.g., the UNEP Emissions Gap Report and IPCC's RCP2.6 scenario, include the tacit / explicit assumption of GGR as ER measure. He also noted that as the AVOID and similar studies show that the later emission mitigation will occur, the higher emission cuts will need to be, and GGRs may have to play an important role. However, the assessment of the feasibility of implementation of GGRs at scale is hampered by continued ignorance, uncertainty, narrowness of the assessments, inconsistent assessment bases, proponent bias, hype, pessimism, necessity (inventing numbers, because we need them, not actual technologies), as well as a moral and morale hazard.

Key questions he raised included:

- To what extent, if at all, should GGR be included in the global calculator?

- If we do include GGR, how should we express the uncertainties & avoid the statements about uncertainties being ignored?

Discussion

GGR

The global calculator was considered by some to be inconsistent in its inclusion of speculative technologies, i.e., DAC is considered, whereas thorium and fusion reactors are not. Some argued that thorium should be included, but not fusion reactors. In terms of the calculations of emission reductions, some argued that GGR should be included in the bottom-up modelling. One expert noted that another issue not mentioned in the calculator was geoengineering, as a broader concept, and argued for its inclusion. However, e.g., solar radiation management is not and should not be included because it is not a carbon management measure. Several participants also pointed out that the capacity of the calculator to frame issues should not be underestimated. There is a danger that technologies proposed in models get all the attention and lock us into these options. Given the speculative nature of GGR, all options should be kept open, as new technologies will come in and should not be excluded.

Messages

Most of the participants recommended keeping GGR in the calculator, because this issue has becoming part of the global climate agenda. The main issue was how to present the GGR approach properly in the web-tool in order to avoid misinterpretations and potential misuse of the calculator, which could compromise its credibility. In terms of communication and messages, there was a consensus that the emission gaps needed to be exposed. Some thought that GGR should not be a lever, but instead only come into play as a narrative if a user's scenario missed the 2C emission reduction target. It was also suggested to use more flags, including, for GGR, 'you're relying on technologies that don't exist (yet)' and to rename 'GGR' to 'GGR and Technological Imaginaries' or 'Surprise' (Shell scenarios). However, a technological imaginaries lever would be too broad and not traceable in the calculator, as is currently the case (although highly uncertain). It was also suggested that the tool should be like Amazon shopping including list of Gt CO2 emission reductions, which then shows measures that should be taken into account (e.g., public acceptance, storage options, markets). It was also suggested to present the GGR approach on a separate page in the calculator, instead of as an ordinary lever.

General issues

A significant limitation of the global calculator is that it does not address behavioural change consistently, and therefore its first prototype should be upgraded in this regard. Behavioural choices are implicit in some levers, e.g., type of diet, transport, temperature in homes, use of appliances, etc. It was also suggested to include 1 min video clips with key messages of the calculator and walk-through points.

Notes prepared by Nicole Kalas and Alexandre Strapasson, Imperial College London.

APPENDIX

WORKSHOP AGENDA

Workshop on Greenhouse Gas Removals

Global Calculator Project

Date: 10th February 2014, 2.00-5.00pm

Venue: Boardroom, Grantham Institute for Climate Change, Imperial College London, South Kensington Campus, Exhibition Road, London SW7 2AZ.

Organisation: *Imperial College London in collaboration with the UK DECC.*

Programme:

14.00 - 17.00	**Introduction to the Global Calculator Project** Sophie Hartfield (DECC)
	The GHG Removal approach in the calculator Alexandre Strapasson (Imperial College) Tim Kruger (University of Oxford)
	Discussions
	Next Steps

For more information about the Global Calculator Project please access:

www.globalcalculator.org