IPCC 5th CLIMATE ASSESSMENT REPORT: AN UNEQUIVOCAL CALL FOR ACTION ON (BIO-)CCS

The latest report of the Intergovernmental Panel on Climate Change (IPCC 5AR, 2014) issued a stark warning: to stand a reasonable chance of avoiding disastrous climate change, we have to remain within a 'safe' level of CO_2 emissions so that average global temperature rise is limited to 2°C.

Because more than half of the CO_2 'budget' that allows us to remain within this threshold has already been used and current rates will exhaust the remainder within 25 years, the **IPCC's scenarios now rely on negative emissions to keep temperature rise below 2°C.**

Negative emissions are achieved when excess CO_2 is removed from the atmosphere. This is attainable through the combination of Carbon Capture and Storage (CCS) and sustainable biomass used for energy or products, so-called Bio-CCS or BECCS. **The message from the IPCC cannot be misunderstood: Bio-CCS is going to be a critical safeguard against disastrous climate change.**

Rejecting any role for Bio-CCS will: Drastically increase decarbonisation costs; preclude reaching the 2°C / 450 ppm target this century; likely result in missing our only chance to deal with runaway climate change; alienate potential allies from industrial sectors needed for deep decarbonisation; and increase the political barriers to transformational change.

This brief summarises the case for action on CCS and Bio-CCS as laid out in the IPCC 5AR.

2°C scenario lost without (Bio-)CCS

"**Many models cannot reach about 450 ppm CO_2eq concentration by 2100 in the absence of CCS** *[CO_2 Capture & Storage]*, resulting in a low number of scenarios for the right panel" (IPCC, 2014).

"Many models could not achieve atmospheric concentration levels of about 450 ppm CO_2eq by 2100 if additional mitigation is considerably delayed or under limited availability of key technologies, **such as bioenergy, CCS, and their combination (BECCS)**" (IPCC, 2014).

"If other technologies, such as CCS, are constrained the role of nuclear power expands" (IPCC, 2014).

"Scenarios that are likely to maintain warming at 2°C include more rapid improvements in energy efficiency and a tripling to nearly a quadrupling of the share of zero- and low-carbon energy supply from renewable energy, nuclear energy and fossil energy with **CCS, or bioenergy with CCS (Bio-CCS) by the year 2050**" (IPCC, 2014).

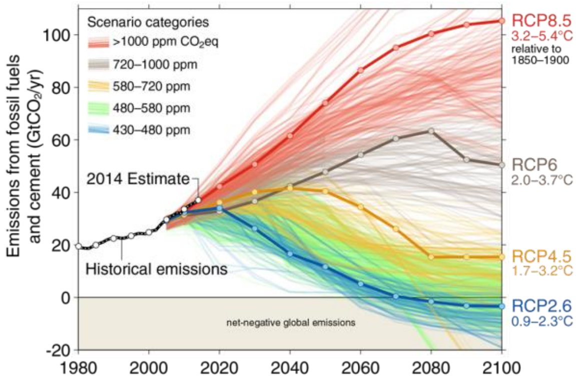

Figure 1: Over 1000 scenarios from the IPCC Fifth Assessment Report, where carbon negative solutions are shown to be necessary for 2 degree global warming limit (Fuss et al 2014; CDIAC; Global Carbon Budget, 2014)

Primary Carbon Removal tool

"**CDR technologies such as BECCS are fundamental to many scenarios that achieve low-CO2eq concentrations**, particularly those based on substantial overshoot as might occur if near-term mitigation is delayed. In contrast to the electricity sector, decarbonization of the non-electric energy-supply sector (e. g., liquid fuels supply) is progressing typically at much lower pace and could therefore constitute a bottleneck in the transformation process" (IPCC, 2014).

"In mitigation scenarios from integrated models, decarbonization of the electricity sector takes place at a pace more rapid than reduction of direct emissions in the energy end-use sectors **More so than any other energy supply technology, the availability of BECCS and its role as a primary CDR technology has a substantial effect on this dynamic, allowing for energy supply sectors to serve as a net negative emissions source by mid-century** and allowing for more gradual emissions reductions in other sectors" (IPCC, 2014).

"BECCS features prominently in long-run mitigation scenarios for two reasons: (1) **The potential for negative emissions may allow shifting emissions in time**; and (2) **in scenarios, negative emissions from BECCS compensate for residual emissions in other sectors** (most importantly transport) in the second half of the 21st century" (IPCC, 2014).

"Delayed mitigation further increases the dependence on the full availability of mitigation options, **especially on CDR technologies such as BECCS"** (IPCC, 2014).

"Instances where the combination of delay and limited options for CDR has been explored and has resulted in model infeasibilities which supports the notion that this combination presents important challenges. For example, in the AMPERE study, **seven out of nine models could not produce a scenario with global delay through 2030 and a restriction on CCS technology that reached 450 CO2eq by 2100**" (IPCC, 2014).

"BECCS is markedly different than fossil CCS because it not only reduces CO2 emissions by storing C in long-term geological sinks, but it **continually sequesters CO2 from the air through regeneration of the biomass resource feedstock**" (IPCC, 2014).

"The overall technical potential is estimated to be around **10 $GtCO_2$** *(negative)* storage per year for both Integrated Gasification Combined Cycle (IGCC)-CCS co-firing (IGCC with co-gasification of biomass), and Biomass Integrated Gasification Combined Cycle (BIGCC)-CCS dedicated, and around **6 $GtCO_2$** storage for biodiesel based on gasification and Fischer-Tropsch synthesis (FT diesel), and **2.7 $GtCO_2$** for biomethane Production (IPCC, 2014)."

"Integrated model outputs tend to show energy demand reduction over the coming decades, followed by a more significant role for decarbonization of energy supply (with, in some cases, **heavy reliance on bioenergy with carbon dioxide capture and storage (CCS) to offset remaining direct emissions** from buildings and the other end-use sectors)" (IPCC, 2014).

"**BECCS features prominently in many mitigation scenarios. BECCS is deployed in greater quantities and earlier in time the more stringent the climate policy.** Whether BECCS is essential for mitigation, or even sufficient, is unclear" (IPCC, 2014).

"The **availability of CCS, and therefore BECCS, has important implications for bioenergy deployment.** In scenarios that do include BECCS technologies, BECCS is deployed in greater quantities and earlier in time the more stringent the goal, potentially representing 100 % of bioenergy in 2050" (IPCC, 2014).

Cost of avoiding climate change

"**The lack of availability of CCS is most frequently associated with the most significant cost increase, particularly for concentration goals approaching 450 ppm CO2eq,** which are characterized by often substantial overshoot. One fundamental reason for this is that the **combination of biomass with CCS can serve as a CDR *[Carbon Dioxide Removal]* technology in the form of BECCS**. In addition to the ability to produce negative emissions when coupled with bioenergy, **CCS is a versatile technology that can be combined with electricity, synthetic fuel, and hydrogen production from several feedstock's and in energy-intensive industries such as cement steel.** The CCS can also act as bridge technology that is compatible with existing fossil-fuel dominated supply structures" (IPCC, 2014).

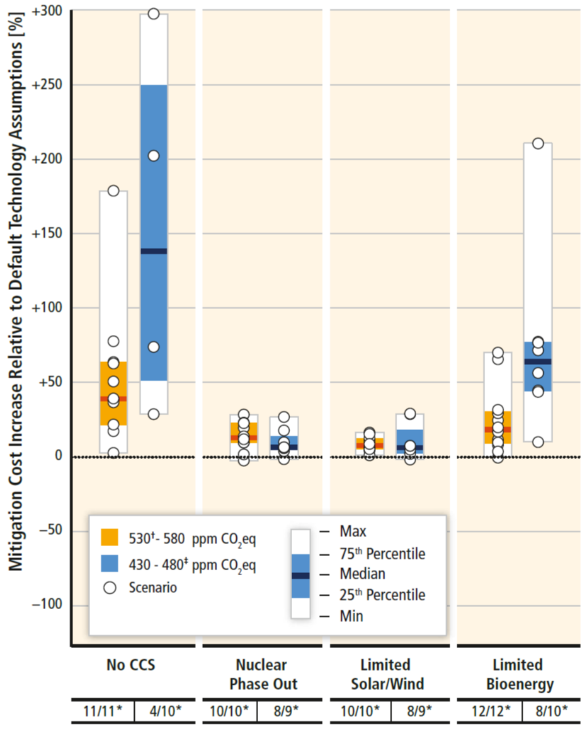

Figure 2: The relative increase in net present value mitigation costs (2015 – 2100, discounted at 5 % per year) from technology portfolio variations relative to a scenario with default technology assumptions (IPCC, 2014)

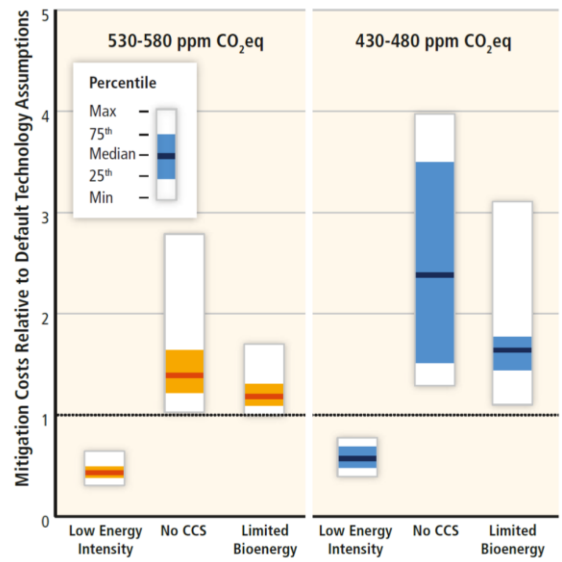

Figure 3: The effects of real world assumptions on mitigation costs. Relative mitigation cost increase in case of technology portfolio variations compared to a scenario with default technology assumptions for stabilizing atmospheric GHG concentrations cantered on 450 ppm (430 – 480 ppm, right) and 550 ppm (530 – 580 ppm, left) CO2eq in the year 2100 (IPCC, 2014)

	Consumption losses in cost-effective scenarios[1]				Increase in total discounted mitigation costs in scenarios with limited availability of technologies				Increase in medium- and long-term mitigation costs due to delayed additional mitigation until 2030			
	[% reduction in consumption relative to baseline]			[percentage point reduction in annualized consumption growth rate]	[% increase in total discounted mitigation costs (2015–2100) relative to default technology assumptions]				[% increase in mitigation costs relative to immediate mitigation]			
									≤55 $GtCO_2eq$		>55 $GtCO_2eq$	
2100 Concentration [ppm CO_2eq]	2030	2050	2100	2010–2100	No CCS	Nuclear phase out	Limited Solar/Wind	Limited Bioenergy	2030–2050	2050–2100	2030–2050	2050–2100
450 (430–480)	1.7 (1.0–3.7) [N: 14]	3.4 (2.1–6.2)	4.8 (2.9–11.4)	0.06 (0.04–0.14)	138 (29–297) [N: 4]	7 (4–18) [N: 8]	6 (2–29) [N: 8]	64 (44–78) [N: 8]	28 (14–50) [N: 34]	15 (5–59)	44 (2–78) [N: 29]	37 (16–82)
500 (480–530)	1.7 (0.6–2.1) [N: 32]	2.7 (1.5–4.2)	4.7 (2.4–10.6)	0.06 (0.03–0.13)	N/A	N/A	N/A	N/A				
550 (530–580)	0.6 (0.2–1.3) [N: 46]	1.7 (1.2–3.3)	3.8 (1.2–7.3)	0.04 (0.01–0.09)	39 (18–78) [N: 11]	13 (2–23) [N: 10]	8 (5–15) [N: 10]	18 (4–66) [N: 12]	3 (−5–16) [N: 14]	4 (−4–11)	15 (3–32) [N: 10]	16 (5–24)
580–650	0.3 (0–0.9) [N: 16]	1.3 (0.5–2.0)	2.3 (1.2–4.4)	0.03 (0.01–0.05)	N/A	N/A	N/A	N/A				

Figure 4: Global mitigation costs in cost-effective scenarios1 and estimated cost increases due to assumed limited availability of specific technologies and delayed additional mitigation (IPCC, 2014)

Decarbonising industry with CCS

"Improvements in emissions efficiency in the mitigation scenarios result from a shift from fossil fuels to electricity with low (or negative) CO2 emissions and use of **CCS for industry fossil fuel use and process emissions**" (IPCC, 2014).

"If existing barriers (see Section 10.9) can be overcome, industrial applications **of CCS deployed in the future could provide environmental cobenefits because CCS-enabled facilities have very low emissions rates for critical pollutants even without specific policies being in place for those emissions**" (IPCC, 2014).

"**The stringent mitigation scenarios discussed in Section 10.10.1 envisage emission intensity reductions, in particular due to deployment of CCS**" (IPCC, 2014).

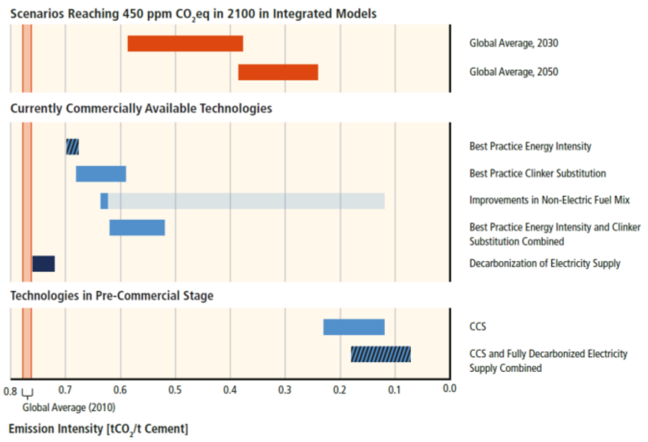

Figure 5: Indicative CO2 emission intensities for cement shown for various production practices / technologies and for 450 ppm CO2eq scenarios of a limited selection of integrated models (IPCC, 2014)

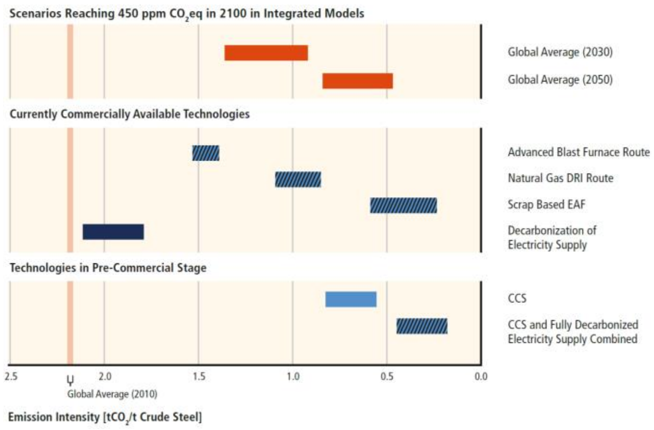

Figure 6: Indicative CO2 emission intensities for steel shown for various production practices / technologies and for 450 ppm CO2eq scenarios of a limited selection of integrated models (IPCC, 2014)

CO_2 storage

"The deployment of **CCS at a scale of 100s of $GtCO_2$** over the course of this century (which is consistent with the stabilization scenarios) would imply that **large, regional, deep-geologic basins would have to accommodate multiple large-scale CO2 injection projects**" (IPCC, 2014).

"Cost-effective pathways (without delay) show a remarkable near-term up-scaling (between 2008 and 2030) of CCS technologies by about three orders of magnitude from the current **CCS facilities that store a total of 5 GtCO2 per year**. The deployment of CCS in these scenarios is projected to accelerate even further reaching CO2 storage rates of about half to double current global CO2 emissions from fossil fuel and industry by 2100. **The majority of the models indicate that in absence of this CCS potential, the transformation to low-GHG concentrations (about 480 ppm CO2eq) might not be attainable if mitigation is delayed to 2030.** Delays in mitigation thus reduce technology choices, and as a result some of the currently optional technologies might become 'a must' in the future" (IPCC, 2014).

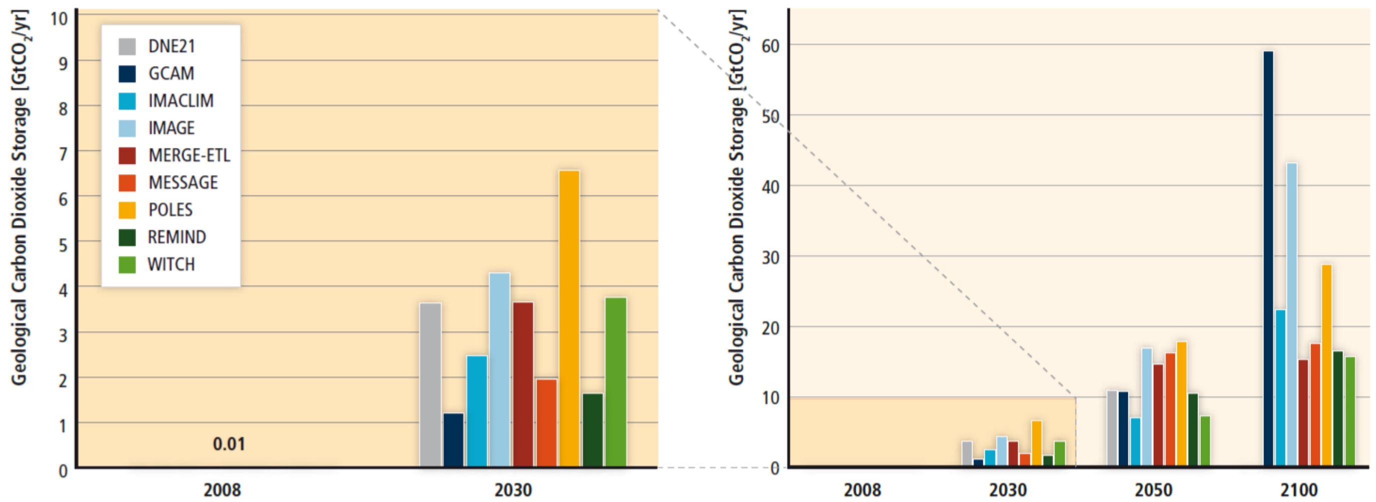

Figure 7: Annual Levels of Geological Carbon Dioxide Storage in cost-effective mitigation scenarios reaching 430 – 530 ppm CO2eq. (IPCC, 2014)

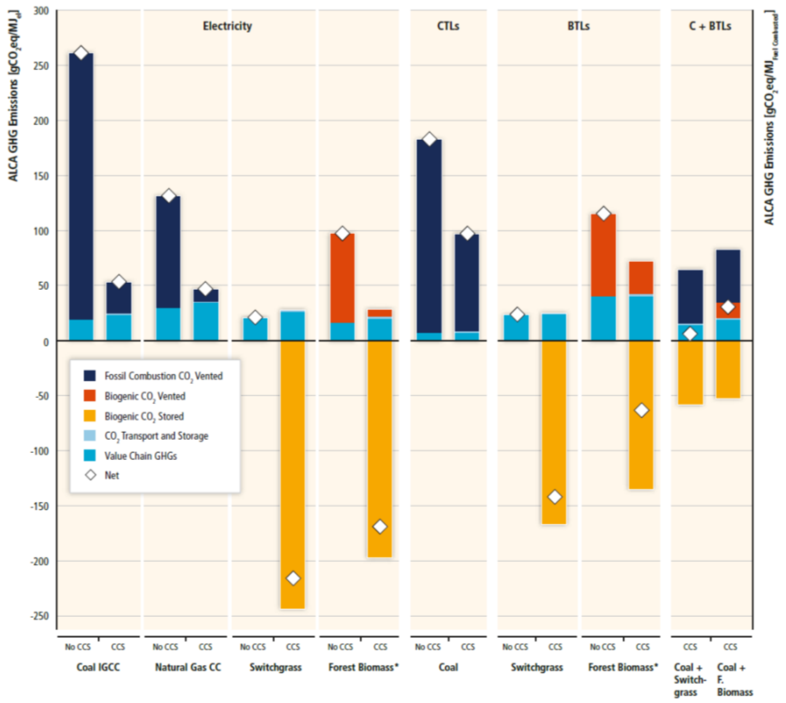

Figure 8: Illustration of the sum of CO2eq (GWP100)* emissions from the process chain of alternative transport and power generation technologies both with and without CCS. (IPCC, 2014)

Other relevant publications

- *The Carbon Negative Solution: Incentivising Bio-CCS in EU* (Bellona, 2015)

- *Scaling the CO_2 storage industry: A study and a tool* (Bellona, 2014) http://bellona.org/publication/scaling-co2-storage-industry-study-tool
- *Biomass with CO_2 Capture and Storage (Bio-CCS) – The way forward for Europe* (JTF Bio-CCS of ZEP and EBTP, 2012) http://www.biofuelstp.eu/bio-ccs-jtf.html

BELLONA
EUROPA