Bioenergy with Carbon Capture and Sequestration: New Panacea or a Really Bad Idea?

Summary
Bioenergy with carbon capture and storage, (BECCS) has recently gained attention in national and international high level discussions on climate, as a supposedly viable means to reduce atmospheric carbon dioxide levels. The IPCC's recent Special Report on Renewable Energy Sources and Climate Change Mitigation, for example, claims "*Bioenergy technologies coupled with CCS...could substantially increase the role of biomass-based GHG mitigation if the geological technologies of CCS can be developed, demonstrated and verified to maintain the stored CO2 over time.*" [i] A report from IEAGHG claims technical potential for storing up to 10 Gtons of CO2eq annually.[ii] With the backing of fossil fuel companies, as well as groups like Biorecro and Bellona, a number of Swedish and Norwegian groups and WWF, BECCS is praised as an especially "promising" technology that will enable "negative emissions" (removal of greenhouse gases from the atmosphere).

Capturing carbon and pumping it underground itself requires considerable energy hence increasing energy demand and costs of construction and operation. For bioenergy with CCS, this means burning more biomass for less energy. CCS, for bioenergy or any other application is risky, unproven and prohibitively expensive.

Faulty carbon-accounting assumptions behind BECCS
Proponents of burning biomass for energy claim it is largely "carbon neutral", since following harvest, regrowth of harvested trees or plants will theoretically resequester an amount of carbon equivalent to that released during combustion. Proponents of BECCS build on this, claiming that if the carbon released from biomass combustion in power stations were captured and pumped into geological reservoirs rather than resequestered in new plant growth, then BECCS would be not just neutral but 'carbon negative' because re-growing crops and trees would sequester **additional** (not "replacement") carbon.

But the "carbon neutral" claim is a myth that has been soundly and scientifically refuted.

- When ***forests are logged*** for bioenergy, massive quantities of carbon are emitted from equipment, transportation of bulky materials and soil disturbance (which causes oxidation of soil organic material) as well as from the combustion of harvested wood. There is no guarantee that new trees will grow back. Even if they do grow back and resequester all the carbon released from harvest and burning of the previous generation of trees, it will take decades or even centuries to do so. This time lag is referred to as a "carbon debt". According to a study by scientists from the Joanneum Research Institute, the carbon debt from burning trees logged from 'well-managed European forests' can be 200 years.[iii] Since wood has a very low "energy density", using wood for energy releases more carbon per unit of energy production than coal, so the carbon debt will be very large, as well as long. Climate scientists warn that greenhouse gas emissions must be reduced immediately. Yet policies continue to entirely ignore emissions from biomass combustion, as if they are nonexistent, with dire consequences. In an article entitled "Fixing A Critical Climate Accounting Error", Searchinger et al state: "*The accounting now used for assessing compliance with carbon limits in the Kyoto Protocol and in climate legislation contains a far-reaching but fixable flaw [failing to count emissions from bioenergy] that will severely undermine greenhouse gas reduction goals.*[iv] According to a study published in Science, putting a price on fossil fuel carbon emissions while ignoring emissions from bioenergy will result in wholesale destruction of virtually all remaining natural forests, grasslands and most other ecosystems by 2065. [v]

- The European Environment Agency's Scientific Committee recently stated: "*It is widely assumed that biomass combustion would be inherently 'carbon neutral' because it only releases carbon taken from the atmosphere during plant growth. However, this assumption is not correct and results in a form of double-counting, as it ignores the fact that using land to produce plants for energy typically means that this land is not producing plants for other purposes, including carbon otherwise sequestered. If bioenergy*

production replaces forests, reduces forest stocks or reduces forest growth, which would otherwise sequester more carbon, it can increase the atmospheric carbon concentration." This statement was followed by a letter from nearly 200 scientists warning about the role of indirect land use change.

- Some advocate using shorter rotation trees and crops will shorten the carbon debt. However***, industrial tree plantations* are not forests** but rather "green deserts' that store far less carbon than real forests or other natural ecosystems, require synthetic fertilizers and other agro-chemicals, and deplete freshwater and soils. Bioenergy is fast becoming a major driver for the expansion of industrial tree plantations, and development of trees genetically engineered for fast growth, at the expense of forests, grasslands and people's farmlands and livelihoods.

- Many in the industry claim they will not harvest from forests, but only use "***wastes and residues***" from forest harvests that "would happen anyway". But, realistically, there is nowhere near enough waste and residue to supply even current demand. A facility burning wood chips for electricity requires around 13,000 dry tons of wood per megawatt per year – that is 650,000 tons per year for a medium-size 50 MW facility, year after year. Supplying that quantity of wood from nearby forests (to avoid long distance transportation) is not possible from wastes and residues alone. Forests are already being cut specifically for biomass. In fact, wood chips and pellets for burning are in ever greater demand, and an expanding international trade (especially to Europe to "meet" emissions reductions targets) has emerged, threatening forests worldwide. Removing more materials from harvest sites - branches, limbs and "non merchantable" timber from forest harvest sites means removing nutrients, leaving soils exposed to erosion and drying, and diminishing future regeneration potential. Nobody openly advocates the destruction of natural forests for BECCS, but there are no credible ways of preventing it from happening, as experience with biofuels has shown.

If the claim that bioenergy is largely 'carbon neutral' is invalid, then bioenergy with CCS cannot possibly be 'carbon negative'.

BECCS will accelerate land-grabbing

According to a report by the International Lands Coalition, at least around 42% of land grabs are for purposes of bioenergy crops.[vi] Advocates of BECCS and other forms of bioenergy assume that hundreds of millions of hectares of 'marginal' or 'abandoned' lands are 'available', mostly in the global South, a claim which entirely ignores the livelihoods of hundreds of millions of people who live on those lands and depend on them for their livelihoods, whether they rely on farming, pastoralism or other activities.

CCS itself, for bioenergy or any other application, is riddled with problems and risks.

- CCS **increases demand for energy** by 10-40% because capture, transport, pressurization and pumping of the CO2 takes considerable energy.[vii] Most biomass combustion facilities already operate at only about 30% efficiency. Adding CCS will make them even more inefficient, and result in even more deforestation, land use change and air pollution.

- CCS is **expensive**, estimated to increase the cost of energy production from 21-91% (IPCC). Pike Research states: "… the addition of CCS systems to both existing and future power plants will likely add between 50% and 70% to the cost of producing electricity. This cost will be underwritten by governments in the next decade and then passed on to ratepayers over the longer term." Large amounts of public funds have already been directed to research and development of CCS. In the U.S., Department of Energy investment in the FutureGen project was withdrawn after cost overruns for the 275 MW coal with CCS facility escalated to over $2 billion. The Decatur Project to capture CO2 from fermentation at a large ethanol refinery belonging to Archer Daniels Midland in the state of Illinois to be transported via pipeline and injected into the Mount Simone Sandstone saline aquifer, has been supported by grants from the U.S. Department of Energy for 4.4 million followed by a further $99 million in more recent federal aid. Currently there are about 74 large scale integrated CCS projects (not just bioenergy) in various stages of development, mostly in the US and Europe. In spite of hype and subsidies, very few of these – only 8, are actually operational. Many have been withdrawn due to cost overruns and other problems. The economic viability of BECCS seems highly questionable. The International Energy Agency states: "current CO2 prices are highly unlikely to result in an economic potential for BECCS."

- CCS is largely a means to **perpetuate dirty energy**: it is the assumption behind the oxymoron "clean coal" even though no operational CCS projects involve coal combustion. Current CCS projects largely involve capturing C from coal gasification (IGCC), natural gas, ethanol and fertilizer facilities, and pulp mills.[viii] To offset the expense, industry largely relies on the profitability of using captured CO2 for "Enhanced Oil Recovery", (EOR) forcing more oil out of existing depleted wells with pressurized CO2. Profits from sale of oil are expected to partially offset the expense of CCS. The Midwest Governors Association, among others, support EOR from CO2 captured from ethanol refineries as one of the more "economically viable" strategies for CCS in the near term. Cofiring of coal and biomass with CCS is considered to have more potential in the longer run. Using CCS to extract more fossil fuels or perpetuate coal burning, undermines any climate benefit.

- CCS is **risky and unproven**. Capture, transport and storage components all carry risks and serious concerns about liability remain. The long term reliability of underground storage cannot be guaranteed. Both slow and long term leakage, including from pipelines and any sudden large release could be extremely dangerous - Exposure to elevated concentrations of CO2 is lethal, and on large scale could have serious abrupt consequences on climate. So far, there is little basis for confidence: the first commercial scale test of CCS, in Weyburn, Saskatchewan, is known to be leaking, noted by a farmer who heard occasional booming noises and discovered numerous dead small animals nearby a pond where the water had become fizzy, discolored and algae filled. Testing confirmed very high CO2 concentrations.[ix] Monitoring of the BP and Statoil collaboration Sleipner CCS project off Norway revealed a large discrepancy between the amount of CO2 injected and what was subsequently detected in seismic surveys. Researchers concluded that the discrepancy was inexplicable, possibly due to miscalculations in their modeling, or, potentially, leakage.[x] A recent study by researchers at Duke University revealed that leakage of CO2 from storage formations into overlying freshwater aquifers can occur and in some circumstances results in up to tenfold increase in dangerous contaminants (arsenic, uranium, barium and other).[xi]

- A letter from scientists and Environmental Justice advocates to the US Environmental Protection Agency called for precaution, citing not only the energy demand and costs, but also the acidification of aquifers which can result in arsenic and lead contamination of ground water as well as leading to fractures and hence dangerous releases of CO2. Further they cite the risk of destablization of underground faults and potential earthquakes, as well as impacts of associated gases on microbial communities.

- Estimates of available underground storage space, a critical consideration, vary wildly.

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i http://srren.ipcc-wg3.de/, Chapter 2

ii Potential for Biomass and Carbon Dioxide Capture and Storage. IEAGHG. July 2011.

iii The upfront carbon debt of bioenergy, Joanneum Research, May 2010 www.birdlife.org/eu/pdfs/Bioenergy_Joanneum_Research.pdf This study looks at the greenhouse gas balance of bioenergy from wood sourced from "sustainably managed" European Forests.

iv Fixing a critical climate accounting error" Searchinger et al, Science, Vol. 326, October 23, 2009, www.princeton.edu/~tsearchi/writings/Fixing%20a%20Critical%20Climate%20Accounting%20ErrorEDITED-tim.pdf)

v Marshall Wise et al, Implications of Limiting CO2 Concentrations for Land Use and Energy. *Science* 324, 1183, May 2009

vi Anseeuw et al. (2012) Land Rights and the Rush for Land: Findings of the Global Commercial Pressures on Land Project. International Land Coalition

vii *IPCC special report on Carbon Dioxide Capture and Storage*. Prepared by working group III of the Intergovernmental Panel on Climate Change. Metz, B., O.Davidson, H. C. de Coninck, M. Loos, and L.A. Meyer (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 442 pp.

viii See list of projects: http://www.globalccsinstitute.com/projects/map?page=8

ix http://www.ecojustice.ca/media-centre/media-release-files/kerr-site-history/at_download/file

x Looking for CO2 Buried at Sleipner: http://www.precaution.org/lib/looking_for_sleipner_co2.100727.pdf

xi Little, M. G. and Jackson, R. B. Potential Impacts of Leakage from Deep CO2 Geosequestration on Overlying Freshwater Aquifers. Environmental Science and Technology 2010