From the Concorde to Sci-Fi Climate Solutions

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The interior of the Concorde aircraft at the Scotland Museum of Flight. (Photo: Magnus Hagdorn)

Touting "sci-fi climate solutions" – untested technologies not really scalable to the dimensions of our climate change crisis – dangerously delays the day when we actually reduce greenhouse gas emissions.

Last week, I took my son to Scotland's Museum of Flight. Its proudest exhibit: a Concorde. To me, it looked stunningly futuristic. "How old," remarked my son, looking at the confusing array of pre-digital controls in the cockpit. Watching the accompanying video – "Past Dreams of the Future" – it occurred to me that the story of the Concorde stands as a symbol for two of the biggest obstacles to addressing climate change.

The Concorde must rank among the most wasteful ways of guzzling fossil fuels ever invented. No other form of transport is as destructive to the climate as aviation – yet the Concorde burned almost five times as much fuel per person per mile as a standard aircraft. Moreover, by emitting pollutants straight into the lower stratosphere, the Concorde contributed to ozone depletion. At the time of the Concorde's first test flight in 1969, little was known about climate change and the ozone hole had not yet been discovered. Yet by the time the Concorde was grounded – for purely economic reasons – in 2003, concerns about its impact on the ozone layer had been voiced for 32 years and the Intergovernmental Panel on Climate Change's (IPCC) first report had been published for 13 years.

The Concorde's history illustrates how the elites will stop at nothing when pursuing their interests or desires. No damage to the atmosphere and no level of noise-induced misery to those living under Concorde flight paths were

treated as bad enough to warrant depriving the richest of a glamorous toy.

If this first "climate change lesson" from the Concorde seems depressing, the second will be even less comfortable for many.

Back in 1969, the UK's technology minister marveled at Concorde's promises: "It'll change the shape of the world; it'll shrink the globe by half . . . It replaces in one step the entire progress made in aviation since the Wright Brothers in 1903."

Few would have believed at that time that, from 2003, no commercial flight would reach even half the speed that had been achieved back in the 1970s.

The Concorde remained as fast – yet as inefficient and uneconomical – as it had been from its commercial inauguration in 1976 – despite vast amounts of public and industry investment. The term "Concorde fallacy" entered British dictionaries: "The idea that you should continue to spend money on a project, product, etc. in order not to waste the money or effort you have already put into it, which may lead to bad decisions."

The lessons for those who believe in overcoming climate change through technological progress are sobering: It's not written in the stars that every technology dreamed up can be realized, nor that, with enough time and money, every technical problem will be overcome and that, over time, every new technology will become better, more efficient and more affordable.

Yet precisely such faith in technological progress informs mainstream responses to climate change, including the response by the IPCC. At a conference last autumn, I listened to a lead author of the IPCC's latest assessment report. His presentation began with a depressing summary of the escalating climate crisis and the massive rise in energy use and carbon emissions, clearly correlated with economic growth. His conclusion was highly optimistic: Provided we make the right choices, technological progress offers a future with zero-carbon energy for all, with ever greater prosperity and no need for economic growth to end. This, he illustrated with some drawings of what we might expect by 2050: super-grids connecting abundant nuclear and renewable energy sources across continents, new forms of mass transport (perhaps modeled on Japan's magnetic levitation trains), new forms of aircraft (curiously reminiscent of the Concorde) and completely sustainable cars (which looked like robots on wheels). The last and most obscure drawing in his presentation was unfinished, to remind us that future technological progress is beyond our capacity to imagine; the speaker suggested it might be a printer printing itself in a new era of self-replicating machines.

These may represent the fantasies of just one of many lead authors of the IPCC's recent report. But the IPCC's 2014 mitigation report itself relies on a large range of techno-fixes, many of which are a long way from being technically, let alone commercially, viable. Climate justice campaigners have condemned the IPCC's support for "false solutions" to climate change. But the term "false solutions" does not distinguish between techno-fixes that are real and scalable, albeit harmful and counterproductive on the one hand, and those that remain in the realm of science fiction, or threaten to turn into another "Concorde fallacy," i.e. to keep guzzling public funds with no credible prospect of ever becoming truly viable. Let's call the latter "sci-fi solutions."

The most prominent, though by no means only, sci-fi solution espoused by the IPCC is BECCS – bioenergy with carbon capture and storage. According to their recent report, the vast majority of "pathways" or models for keeping temperature rise below 2 degrees Celsius rely on "negative emissions." Although the report included words of caution, pointing out that such technologies are "uncertain" and "associated with challenges and risks," the conclusion is quite clear: Either carbon capture and storage, including BECCS, is introduced on a very large scale, or the chances of keeping global warming within 2 degrees Celsius are minimal. In the meantime, the IPCC's chair, Rajendra Pachauri, and the co-chair of the panel's Working Group on Climate Change Mitigation, Ottmar Edenhofer, publicly advocate BECCS without any notes of caution about uncertainties – referring to it as a proven way of reducing carbon dioxide levels and thus global warming. Not surprisingly therefore, BECCS has even entered the UN climate change negotiations. The recent text, agreed at the Lima climate conference in December 2014 ("Lima Call for Action"), introduces the terms "net zero emissions" and "negative emissions," i.e. the idea that we can reliably suck large amounts of carbon (those already emitted from burning fossil fuels) out of the atmosphere. Although BECCS is not explicitly mentioned in the Lima Call for Action, the wording implies support for it because it is treated as *the* key "negative emissions" technology by the IPCC.

If BECCS were to be applied at a large scale in the future, then we would have every reason to be alarmed.

According to a scientific review, attempting to capture 1 billion tons of carbon through BECCS (far less than many of the "pathways" considered by the IPCC presume) would require 218 to 990 million hectares of switchgrass plantations (or similar scale plantations of other feedstocks, including trees), 1.6 to 7.4 trillion cubic meters of water a year, and 75 percent more than all the nitrogen fertilizers used worldwide (which currently stands at 1 billion tons according to the "conservative" estimates in many studies). By comparison, just 30 million hectares of land worldwide have been converted to grow feedstock for liquid biofuels so far. Yet biofuels have already become the main cause of accelerated growth in demand for vegetable oils and cereals, triggering huge volatility and rises in the price of wood worldwide. And by pushing up palm oil prices, biofuels have driven faster deforestation across Southeast Asia and increasingly in Africa. As a result of the ethanol boom, more than 6 million hectares of US land has been planted with corn, causing prairies and wetlands to be plowed up. This destruction of ecosystems, coupled with the greenhouse gas intensive use of fertilizers, means that biofuels overall are almost certainly worse for the climate than the fossil fuels they are meant to replace. There are no reasons to believe that the impacts of BECCS would be any more benign. And they would be on a much larger scale.

Capturing carbon takes a lot of energy, hence CCS requires around one-third more fuel to be burned to generate the same amount of energy. And sequestering captured carbon is a highly uncertain business. So far, there have been three large-scale carbon sequestration experiments. The longest-standing of these, the Sleipner field carbon sequestration trial in the North Sea, has been cited as proof that carbon dioxide can be sequestered reliably under the seabed. Yet in 2013, unexpected scars and fractures were found in the reservoir and a lead researcher concluded: "We are saying it is very likely something will come out in the end." Another one of the supposedly "successful," if much shorter, trials also raised "interesting questions," according to the researchers: Carbon dioxide migrated further upward in the reservoir than predicted, most likely because injecting the carbon dioxide caused fractures in the cap rock.

There are thus good reasons to be alarmed about the prospect of large-scale bioenergy with CCS. Yet BECCS isn't for real.

While the IPCC and world leaders conclude that we really need to use carbon capture and storage, including biomass, here's what is actually happening: The Norwegian government, once proud of being a global pioneer of CCS, has pulled the plug on the country's first full-scale CCS project after a scathing report from a public auditor. The Swedish state-owned energy company Vattenfall has shut down its CCS demonstration plant in Germany, the only plant worldwide testing a particular and supposedly promising carbon capture technology. The government of Alberta has dropped its previously enthusiastic support for CCS because it no longer sees it as economically viable.

True, 2014 has seen the opening of the world's largest CCS power station, after SaskPower retrofitted one unit of their Boundary Dam coal power station in Saskatchewan to capture carbon dioxide. But Boundary Dam hardly confirms the techno-optimist's hopes. The 100-megawatt unit costs approximately $1.4 billion to build – more than twice the cost of a much larger (non-CCS) 400-megawatt gas power station built by SaskPower in 2009. It became viable thanks only to public subsidies and to a contract with the oil company Cenovus, which agreed to buy the carbon dioxide for the next decade in order to inject it into an oil well to facilitate extraction of more hard to reach oil – a process called enhanced oil recovery (EOR). The supposed "carbon dioxide savings" predictably ignore all of the carbon dioxide emissions from burning that oil. But even with such a nearby oil field suitable for EOR, SaskPower had to make the plant far smaller than originally planned so as to avoid capturing more carbon dioxide than they could sell.

If CCS with fossil fuels is reminiscent of the Concorde fallacy, large-scale BECCS is entirely in the realm of science fiction. The supposedly most "promising technology"has never been tested in a biomass power plant and that has so far provenuneconomical with coal. Add to that the fact that biomass power plants need more feedstock and are less efficient and more expensive to run than coal power plants, and a massive-scale BECCS program becomes even more implausible. And then add to that the question of scale: Sequestering 1 billion tons of carbon a year would produce a volume of highly pressurized liquid carbon dioxide larger than the global volume of oil extracted annually. It would require governments and/or companies stumping up the money to build an infrastructure larger than that of the entire global oil industry – without any proven benefit.

This doesn't mean that we won't see any little BECCS projects in niche circumstances. One of these already exists: ADM is capturing carbon dioxide from ethanol fermentation in one of its refineries for use in CCS research. Capturing carbon dioxide from ethanol fermentation is relatively simple and cheap. If there happens to be some half-depleted nearby oil field suitable for enhanced oil recovery, some ethanol "CCS" projects could pop up here

and there. But this has little to do with a “billion ton negative emissions” vision.

BECCS thus appears as one, albeit a particularly prominent, example of baseless techno-optimism leading to dangerous policy choices. Dangerous, that is, because hype about sci-fi solutions becomes a cover for the failure to curb fossil fuel burning and ecosystem destruction today.