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The case against CCS

By Peter Droege and Matthew Ulterino

Governments all over the world are spending billions to build a massive carbon capture and storage (CCS) infrastructure. This money would be much better spent on helping to develop renewable energy, argue Peter Droege, Professor of Sustainable Spatial Development at the University of Liechtenstein and and urban planning consultant Matthew Ulterino. A plea for governments and research groups to rethink their CCS pledges.

Pipes carrying liquid CO2 at the Black Pump power station near Berlin, where greenhouse gases are captured (Photo: AFP/Getty Images)

Capture and injection of CO2 has been a common practice since the 1970s for enhanced coalbed methane recovery and enhanced oil recovery. This might give the impression that CCS is more or less ready to go and that all that is missing is the will (or a price on carbon) to make it happen. This perception is misleading. CO2 injected for these purposes was not meant to be permanently sequestered; it cannot simply be adapted to CCS. Bringing CCS to scale at large power generating facilities the world over, and safely managing the staggering volume of carbon dioxide from the point of emission to a guaranteed indefinite repository, faces formidable financial, technical, regulatory and safety obstacles.

To begin with, the economics of CCS certainly don't stack up. In its 2009 Carbon Capture and Storage Technology Roadmap, the International Energy Agency (IEA) lays bare the problem. "In the current regulatory and fiscal environment", it says, "commercial power plants and industrial facilities will not invest in CCS because it reduces efficiency, adds cost and lowers energy output."

CCS requires more fuel to create an equal amount of energy than a plant operating without it – estimates range from a 15 to 40 percent fuel penalty. The IEA-roadmap's hoped-for outcome is that by 2030, CCS plants use no more energy than non-CCS plants today, though they will still cost more to build than conventional plants.

Parsing the cost data for CCS is difficult. There are various uncertainties at play at this moment:
-there are very few replicable examples to draw from
-there are various methods to separate carbon from the fuel and they are all still in a state of trial and refinement
-plants have high capital costs and long lead times
-there are various transport and storage options (pipelines versus tankers, onshore versus offshore repositories) and differences in distances

These factors all contribute to widely ranging estimates that are grasping for certainty decades out. A European-based CCS research and advocacy group, the Zero Emissions Platform (ZEP), confirms as much in their 2011 report The Costs of CO2 Capture, Transport and Storage. This is as close to comprehensive on the cost equation as any publicly available report, and it is, not surprisingly, optimistic too – perhaps in spite of itself. It contends that post 2020, "CCS will be cost-competitive with other low-carbon energy technologies".

'Such a technical feat coould not be accomplished within a single generation'

Technical feat

One scenario given in the report for the levelised cost of electricity (or LCOE, which captures build, operating and fuel, maintenance costs, and return margins over the life a plant) shows a non-CCS base case delivering electricity at the high €40s per MWh, versus costs in the middle €60s for an optimal (post-demonstration) cost

CCS plant. ZEP's assumptions tend toward conservative so there's a chance that costs will work out lower than projected.

But a read of some of their headline figures raises warning flags. To take a few examples:
-storage cost estimates vary by a factor of 10
-the most voluminous storage options are the costliest to access
-large-scale CCS deployment will need a transport infrastructure similar in scale to that of the current hydrocarbon infrastructure
-CO_2 avoidance costs vary from €34 per tonne for lignite, €37 for hard coal and €90 for gas, far higher than carbon trades at in the various mandatory and voluntary carbon markets of today.

ZEP's carbon abatement figure is nearly the same as that found in a 2009 global GHG abatement cost report from McKinsey. But rather than demonstrating its 'cost-competitiveness', the Mckinsey study shows CCS to be the most costly option available – nearly double the abatement costs of solar electric (PV) and several times higher than what can be realised through land use practices, e.g. grassland management, organic soils restoration and reforestation.

There are various pre- and post-combustion capture methods possible, most of which are being demoed at dozens of pilots around the globe. These projects aim to discern the best approach that balances capital cost, complexity and efficiency, but there's more to the puzzle. Identifying appropriate deep onshore and offshore underground repositories and sorting the ownership and indemnification rights needs attention, as does monitoring the stored carbon.

Adding the pipeline network to move the compressed CO_2 will also be a massive undertaking. As Professor Vaclav Smil of the University of Manitoba said at a conference in May 2006: 'In 2005 worldwide CO_2 emissions amounted to nearly 28 Gt [gigatons]... Sequestering a mere 1/10 of today's global CO_2 emissions (< 3 Gt CO_2) would thus call for putting in place an industry that would have to force underground every year a volume of compressed gas larger than or (with higher compression) equal to the volume of crude oil extracted globally by petroleum industry whose infrastructures and capacities have been put in place over a century of development. Needless to say, such a technical feat could not be accomplished within a single generation.' In other words, if CCS is to make a significant impact, a huge infrastructure roll-out is required which is certain to arouse public opposition from land-take and risk of pipeline leaks.

The economies of many countries are heavily dependent on their fossil fuel industries

Government budgets

In spite of all these obstacles, governments around the world support CCS wholeheartedly. Tens of billions of public subsidy dollars are in play globally to map potential reservoirs, test separation technologies, inject gas and monitor for leaks, and plan distribution networks. The membership list of the Global CCS Institute, an advocacy and information exchange platform launched by the Australian government, includes 27 countries (including 7 of the 9 largest coal reserve countries), plus supranational organisations like the EU and World Bank as well as dozens of government-backed think tanks and research institutions. A scan of the locations of the CCS demo plants show they're all across North America, Europe, Asia and Australia, with a handful dropped in South America and Africa. Given that these are all subsidised, it says something about the universality of government support.

This is perhaps not so surprising, because there are huge interests at stake. Globally, coal is the most widely used energy source for electricity generation and it is of course the most carbon-intensive. But the gas industry is also becoming increasingly interested in CCS. Gas is the fastest growing fuel in power production so the contribution of gas-fired power plants to total CO_2 emissions will only grow.

And there is a more subtle reason at work as well. The economies of many countries (Australia, Canada, the US, the UK, Norway, the Netherlands, to name just a few) are heavily dependent on their fossil fuel industries. Many government budgets would be blown full of holes without fossil fuel-based taxes. That's why so many countries are prepared to invest heavily in CCS: to keep the fossil fuel sector going.

The Global CCS Institute reports that as of mid-2010, there were more than 320 trial CCS projects at various stages of development. Most won't be operational, however, until mid-decade. It lists just eight large-scale projects (circa a million tonnes of CO_2 captured per year, or about a quarter of what an average US coal-fired power station emits) currently operating that separate and inject carbon underground. Five of the eight, though, are used for enhanced oil recovery (EOR), which means injecting the gas into declining oil wells to increase pressure and improve yields. This carbon Ponzi scheme is hardly new and certainly a minimal contributor to slowing greenhouse emissions.

CCS pilot plant at lignite power station Schwarze Pumpe in Brandenburg (Photo: Vattenfall)

The ZEP website also offers details on a hundred plus international projects at various stages of implementation. But there appear to be no aggregated estimates of CO2 volumes sequestered by these projects, or from any other source. A scan of the projects shows CO2 capture and storage volumes ranging from the hundreds to tens of thousands of tonnes per year, a drop in the ocean. For argument's sake: if the three non-EOR projects referenced above withdraw a million tonnes per annum, and another 120 operating projects do 50,000 tonnes each, the total would be 9 million tonnes, which would be about 0.15% of carbon emissions coming from the United States.

The IEA roadmap envisions that by 2050 3,000 CCS projects will capture and store 10 billion tonnes of CO2 annually, about a third of current global carbon emissions. A tall order, in view of the fact that not a single utility-scale CCS plant is currently operating on the planet. Assuming that the first project will be ready in 2020that means one project will have to start up every 3 or 4 days for 30 years.

To see what practical obstacles this undertaking would encounter, consider that this past summer, one of America's largest operators of coal energy plants, American Electric Power, cancelled plans to deploy CCS at one of its big facilities – even though the U.S. government offered to pick up half the tab. They cited economic reasons as the justification: the regulator could not approve rate-based cost recovery in the absence of federal regulations over carbon emissions.

Another major U.S. government-backed CCS project, FutureGen, hopes to have a project up and running by 2015 – twelve years after the initiative was first announced. Mind-boggingly slow considering the U.S. is chipping in about a billion dollars, or 75 percent of the capital cost.

Similarly, there has been a lot of fanfare around industry-government partnerships in the UK for utility-scale CCS but concrete results have been few and far between. A pledged £1 billion of government support could yield an operating demonstration project by 2015, eight years after a partnership program was announced.

South Africa, a fast-growing economy that is hugely reliant on coal for stationary energy and even for a portion of its liquid fuels too, is planning for test injections in 2016, a demonstration CCS plant operating by 2020, and commercial plants online by 2025.

Gas-fired power

In itself, there's nothing wrong with government subsidies to push important public-good infrastructure to market. But where funds are limited – and they will be for most governments for the foreseeable future – money should be spent on where the best promises lie. There is precious little evidence that CCS is such an option. In the decade or more that government and industry have found common cause in CCS, the most obvious breakthrough has been in the volume of unsubstantiated estimates of "cost-competitiveness" in industry roadmaps. All this time renewables have surged through actual year-on-year efficiency gains and upscaling production.

Most observers peg 2020 or 2025 as the earliest date by which enough large-scale CCS plants are on-line and returning evidence to prove technical viability. Renewables are set to achieve 'grid-parity' over the same period. This means that there will be risk that CCS becomes economically obsolete just as the returns come in. In some markets, wind has already hit the grid-parity mark.

What's more, the crossing point of the fossil and renewable energy costs curves should only widen in future. The US Energy Information Agency sees yearly average fuel price increases of roughly 2 percent through 2035, even as extraction volumes grow.

It's a poor innovation strategy that relies on higher costs to prolong sunsetting industries, but that is the best that CCS can offer: energy costs must rise for carbon capture and storage to become viable. But if the costs of generating electricity from other sources drop below that of coal-fired powers, these plants face the prospect of becoming stranded assets. Suggesting that coal plants currently designed and built should be retrofitted to add CCS when it's ready and "cost-effective", as many national government policies do, only makes the economics of CCS worse. This wishful thinking may be soothing balm for policymakers pledged to a distant carbon reduction target, but does little to actually deliver it. It only slows down the process of renewables integration.

It's a poor innovation strategy that relies on higher costs to promote sunsetting industries

Incidentally, as to the idea that CCS could find a new future application in gas-fired and biomass power plants, which the gas industry no doubt finds appealing, note that while the ZEP study puts the avoided cost for CO2 from coal fired power plants at the mid-30 euros a tonne, natural gas plants come in at €90. In all likelihood large centralised energy coal plants will be the only path to offer sufficient economies of scale to make CCS close to affordable. Costs will be too high at other facilities, given, somewhat paradoxically, that these don't emit enough carbon to make investment in capture and storage worthwhile.

Safe haven

Government and industry have banged on for so long about the progress of CCS and the inevitability of using coal far into the future they can seemingly no longer make sense of the evidence or discern the basic economics. A recent report by Ernst and Young posits 2017 as the year that solar energy reaches grid parity in the UK. In other countries, installed renewable capacity routinely overshoots the estimates laid out for the industry only a few years previously. Italy has more than doubled its installed photovoltaic capacity in the past year, making its previous 2020 target of 8 GW from solar startlingly obsolete. It's instead targeting 23 GW installed by 2016. A 2007 report from Greenpeace, the European Renewable Energy Council and the German Space Agency DRL, entitled The Energy Revolution, predicted 2010 installed capacity from renewables globally at 156 GW, a figure that was surpassed by wind energy alone in 2009.

While funds for CCS often sit on the table for years before any use can be found for them, many national governments in Europe have been forced to scale back their funding commitments to solar generation because they've been too popular. And currently, the International Energy Agency, long a safe haven for fossil-fuel adherents, is in the process of revising its global energy supply estimates. Where previous reports issued by the IEA projected solar power providing 21 percent of the world's electricity needs in 2050, news agency Bloomberg reported recently that the IEA will come with new estimates later this year that suggest that 'most of the world's demand for electricity and half of all energy needs' may be met by photovoltaic and solar-thermal power plants, 'with wind, hydropower and biomass plants supplying much of the remaining generation'.

Waiting for cost drops and efficiency gains that eventually will arrive if CCS is brought to maturity and scale might be an admirable strategy if there were no other options. But renewable energy, with both distributed and concentrated sources, in combination with an advanced grid and storage system, can make the fossil fuel economy obsolete. Renewable energy price trends and its immediate availability are far more promising than anything demonstrated by CCS to date or likely to be seen in the next half decade. As for the ability for mass deployment, the scale for a global roll-out of renewables infrastructure is arguably no more a barrier than it is to fit existing and new coal plants with CCS, build the pipelines to carry the captured gas, and monitor that the lids stay sealed.

The IEA will come with new estimates that suggest that most of the world's demand for electricity can be met by solar power plants

It's time for governments and research groups to rethink their CCS pledges. Funds can be far better spent on stimulating demand reduction and energy efficiency, improving renewable energy storage and two-way energy grids to balance intermittent generation, and - last, not least - to bank on 'carbon storage' that works: namely the active biosequestration of greenhouse gases in wetlands, moors, humus rich agricultural soil and in growing new forests.

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These are some of the major articles we published on CCS at European Energy Review:

A further regulatory boost is vital for CCS by Ioannis Michaletos
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EU making headway on getting carbon capture ready by Hughes Belin
'Policy not technology' the big barrier to carbon storage by Alex Forbes
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