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Carbon capture and storage

Trouble in store

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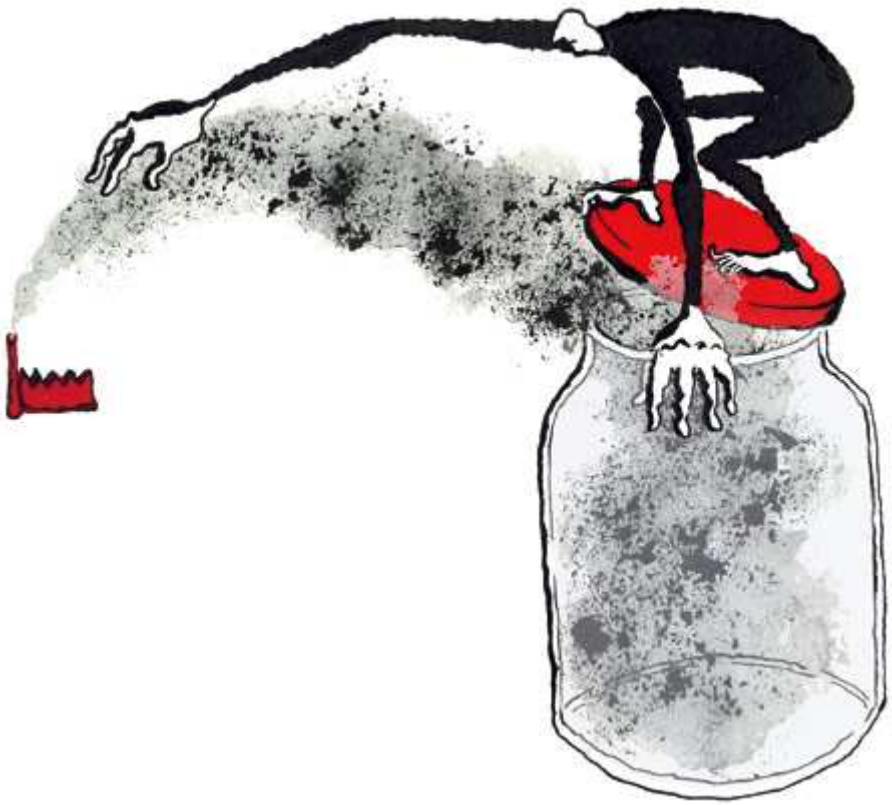
Politicians are pinning their hopes for delivery from global warming on a technology that is not quite airtight

Illustration by Belle Mellor



A RECENT American television advertisement features a series of trustworthy-looking individuals affirming their faith in the potential of "clean coal". One by one, a sensible old lady in a hat, a lab-coated scientist standing by a microscope, a fresh-faced young schoolteacher, a weather-beaten farmer and a can-do machinist face the camera square-on and declare, "I believe."

The idea that clean coal, or to be more specific, a technology known as carbon capture and storage (CCS), will save the world from global warming has become something of an article of faith among policymakers too. CCS features prominently in all the main blueprints for reducing greenhouse-gas emissions. The Stern Review, a celebrated report on the economics of climate change, considers it "essential". It provides one of the seven tranches of emissions cuts proposed by Robert Socolow of Princeton University. The International Energy Agency (IEA) reckons the world will need over 200 power plants equipped with CCS by 2030 to limit the rise in average global temperatures to about 3°C—a bigger increase than many scientists would like.

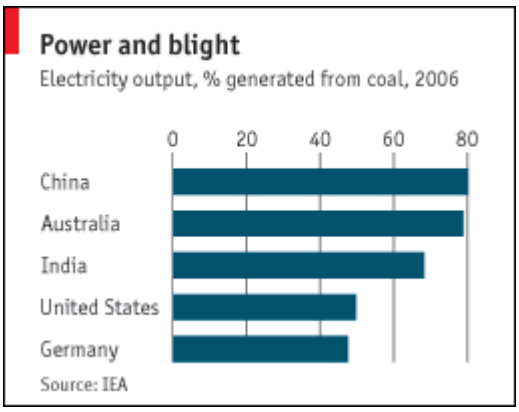
Politicians have duly lined up behind the idea. Barack Obama talked up CCS during last year's election. Gordon Brown, Britain's prime minister, has said the technology is necessary "if we are to have any chance of meeting our global climate goals". The leaders of the G8, a rich-country club, want it to be widespread by 2020.

Despite all this enthusiasm, however, there is not a single big power plant using CCS anywhere in the world. Utilities refuse to build any, since the technology is expensive and unproven. Advocates insist that the price will come down with time and experience, but it is hard to say by how much, or who should bear the extra cost in the meantime. Green pressure groups worry that captured carbon will eventually leak. In short, the world's leaders are counting on a fix for climate change that is at best uncertain and at worst unworkable.

CCS sounds beguilingly simple. It entails isolating carbon dioxide wherever it is produced in large quantities, such as the smokestacks of coal-fired power plants, compressing it and pumping it underground. The oil and chemical industries already use most of the processes that this involves, although not in combination. And oil, gas and salt water seem to stay put in certain rock formations indefinitely, suggesting that carbon dioxide should as well.

CCS particularly appeals to politicians reluctant to limit the use of coal. Coal is the dirtiest of fossil fuels, and burning it releases roughly twice as much carbon dioxide as burning natural gas. The world will struggle to cut greenhouse-gas emissions dramatically if it continues to burn coal as it does today. Yet burning coal is one of the cheapest ways to generate power. In America, Australia, China, Germany and India coal provides half or more of the power supply and lots of jobs (see chart). Rejecting cheap, indigenous fuel for job cuts and international energy markets is seen, naturally enough, as political suicide. CCS offers a way out of this impasse.

In a purely technical sense, CCS looks promising. There are several proven ways to isolate carbon dioxide from fossil fuels, using a variety of combustion techniques and an assortment of chemical "scrubbers" to react with the gas. Oil firms, meanwhile, have long experience of pumping carbon dioxide into reservoirs to increase their pressure and thus squeeze out more fuel. To that end, Exxon Mobil runs the world's biggest carbon-capture facility, at La Barge, Wyoming. America boasts a network of 5,800km (3,600 miles) of pipes to carry carbon dioxide from such facilities to the oil- and gasfields where it is needed.



For the most part, oil firms do not worry what happens to the carbon dioxide used in this way after they have got hold of their oil and gas. But in recent years a few of them have launched projects to test whether it stays underground. The oldest project, Sleipner, off the coast of Norway, has been up and running for 13 years without any sign of leaks.

Last year Vattenfall, a Swedish utility, opened the first power plant to incorporate CCS at Schwarze Pumpe, in Germany. It is only a pilot project, less than a twentieth of the size of most modern coal-fired plants. But so far, Vattenfall says, it is working fine. Several other firms hope to start pilot plants on a similar scale this year.

Money for nothing

The problem with CCS is the cost. The chemical steps in the capture consume energy, as do the compression and transport of the carbon dioxide. That will use up a quarter or more of the output of a power station fitted with CCS, according to most estimates. So plants with CCS will need to be at least a third bigger than normal ones to generate the same net amount of power, and will also consume at least a third more fuel. In addition, there is the extra expense of building the capture plant and the injection pipelines. If the storage site is far from the power plant, yet more energy will be needed to move the carbon dioxide.

Estimates of the total cost vary widely. America's government, which had vowed to build a prototype plant called FutureGen in partnership with several big resources firms, scrapped the project last year after the projected cost rose to $1.8 billion. Philippe Paelinck, of Alstom, an engineering firm that hopes to build CCS plants, thinks a full-scale one would cost about €1 billion ($1.3 billion).

In 2005 the Intergovernmental Panel on Climate Change, a group of scientists that advises the United Nations on global warming, came up with a range of $14-91 for each tonne of emissions avoided through CCS. Last year, the IEA suggested that the price for the first big plants would be $40-90. McKinsey, a consultancy, has arrived at an estimate of €60-90, or $75-115.

Either way, that is more than the price of emissions in the European Union: about €10 a tonne. America does not have a carbon price at all yet. A bill defeated last year in the Senate would have yielded a carbon price as low as $30 in 2020, according to an official analysis. So CCS might not be financially worthwhile for years to

come.

Analysts assume that the price of emissions will rise, as governments impose tighter restrictions, and that the price of CCS will fall, as engineers learn how to do it more cheaply. The IEA, for example, predicts CCS will cost just $35-60 per tonne of emissions reductions by 2030. McKinsey foresees a price of €30-45 when the technology is mature, some time after 2030.

Fingers crossed

But these estimates entail some generous assumptions. McKinsey, for example, imagines that CCS plants will break down no more often than normal coal plants, despite their more complicated machinery. It assumes that the average cost of capital for CCS plants will be no more than 8%. And it projects that costs will fall by 12% for every doubling in capacity. That is roughly the same rate as for wind power, even though most of the processes in CCS are already widely used in other industries, suggesting that the scope for improvement is slender.

Greenpeace, a pressure group, argues that it is impossible to be certain that carbon dioxide will not eventually leak out of the ground. Carbon dioxide forms an acid when it dissolves in water. This acid can react with minerals to form carbonates, locking away the carbon in a relatively inert state. But it can also eat through the man-made seals or geological strata intended to keep it in place. A leakage rate of just 1% a year, Greenpeace points out, would lead to 63% of the carbon dioxide stored in any given reservoir being released within 100 years, almost entirely undoing the supposed environmental benefit.

Illustration by Belle Mellor

Spills would also be a health risk, since carbon dioxide is heavier than air, and so can build up in low-lying or poorly ventilated spots. Earlier this year, Zurich Financial Services said it would offer insurance for CCS plants and storage sites while they were operating, and for a limited time thereafter. But CCS advocates all assume that governments will eventually take charge of reservoirs, along with all the monitoring costs and legal liabilities. America's lawmakers went a step further, and agreed to insure the proposed FutureGen plant and to indemnify the firms behind it from all lawsuits arising from leaks.

Last year the EU passed a law requiring its members to draw up rules for CCS. In theory these should be in place within two years, although such deadlines often pass unmet. At a minimum, governments are supposed to lay down criteria for selecting storage sites and to set standards for monitoring, financial guarantees, safety and so on. If the safety regulations require stored carbon dioxide to be pure, for example, they would add to the cost of CCS, points out Anthony Hobley, of Norton Rose, a law firm. Meanwhile, those considering CCS plants in poor countries cannot earn UN-backed carbon credits, since the Kyoto protocol, the UN's treaty on climate change, makes no provision for the technology.

All this uncertainty and expense has doubtless put off utilities. Omar Abbosh, of Accenture, a consultancy, says that carbon trading as practised in the EU and contemplated in America does not give enough certainty about future carbon prices to justify an investment in a CCS plant. Mr Paelinck of Alstom agrees: no board would risk spending €1 billion on one, he says, without generous subsidies.

Statoil Hydro, the Norwegian firm behind the Sleipner project, says that even with Norway's heavy carbon tax, which last summer reached over €40 a tonne, CCS does not make financial sense. Hydrogen Energy International, a joint venture between two big resource firms, Rio Tinto and BP, says that its proposed CCS plant in California will need extra subsidies, even though the state is imposing a carbon price and the project will earn revenues from enhanced oil recovery.

Many governments are offering lavish handouts. America's stimulus bill set aside $3.4 billion for CCS. Earlier this year the EU proposed spending €1.25 billion on a few demonstration plants. It has also said it will give some 300m emissions permits, now worth around €3 billion, to the operators of CCS plants. Australia, Britain and Norway, among others, also plan to help pay for CCS projects.

Yet CCS's expected advent keeps receding. FutureGen was scheduled for 2012, but has now been scrapped in

favour of several smaller projects that have yet to be selected. Britain's subsidised plant has suffered repeated delays. In 2007 the IEA called for 20 plants to be under way by 2010—a goal that seems certain to be missed. CCS's boosters now talk of the first full-scale plant being ready by 2015 or so.

Al Gore, America's green conscience, does not see CCS working commercially "in the near term or even the medium term". Sam Laidlaw, the boss of Centrica, a British utility, thinks it will take at least 15 years, and probably 20, to roll out CCS plants in large numbers. By contrast, Centrica is keen to invest in nuclear plants right away, without any subsidy. Greenpeace argues that CCS will never be competitive, since other low-carbon technologies, such as wind power, are already cheaper and becoming more so as time passes. It is hard to square these views with the G8's ambition for widespread CCS by 2020, or the IEA's call for 200 plants by 2030.

Some sceptics feel so strongly they have started airing advertisements of their own to lambast CCS. In one of them, an engineer with a hard hat and a clipboard promises a tour of a "state-of-the-art clean-coal facility". He pushes open a factory door to reveal a patch of barren scrubland; the factory, it turns out, is just a façade. "Amazing!" he shouts, gesturing at the empty space. It is a fairly accurate portrait. For the moment, at least, CCS is mostly hot air.