Can CCS be an economic lifeline for coal power?

Coal may no longer be leading carbon capture and storage progress but there is a chance the technology could still provide a lifeline for some coal fired power plants, especially in Asia. **Toby Lockwood** explains.

Despite everything, 2020 turned out to be a good year for carbon capture and storage (CCS), with both the UK and Norway committing to spend big on new infrastructure to store CO_2 emissions deep beneath the North Sea. In the US, the climate change mitigation technology received early backing from the President-elect. CCS has previously struggled under half-hearted support, cast by critics as a desperate bid by fossil fuel companies to maintain the status quo. Following an initial wave of political interest in the 2000s, relatively few large projects were realised, and many high-profile initiatives fell through due to rising costs or insufficient backing.

The recent rise of corporate and national net zero carbon targets has been instrumental in putting CCS back in the frame – now a fundamental means of making the numbers add up. Several governments have concluded that carbon capture must finally be cracked, while oil and gas companies – who crucially have the engineering expertise to store the greenhouse gas

vision – and sometimes the economics – has shifted in favour of gas or biomass-fuelled plant. The association with coal is seen by some as an embarrassing relic of the technology's less successful past.

Where does this leave coal power? CCS was once regarded as the salvation of the sector, capable of ushering in a more sustainable future and averting plant closures. The technical feasibility of fitting CO_2 capture to a coal plant has been demonstrated over the last decade by pioneering projects at Boundary Dam 3 in Canada, and Petra Nova in Texas, which both achieved their performance targets after some initial teething problems. Based on this experience and other advances, capture technology manufacturers claim cost reductions of around a third are possible for a next wave of coal plants. But any kind of CCS is still a costly business, which makes little commercial sense unless it can be used to generate some kind of revenue.

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first movers. The US Department of Energy (DOE) has therefore helped fund detailed engineering studies for CCS on nine existing power plants – five coal fired and four gas fired. Located across the country, the projects tend to feature cheap coal and communities with an interest in retaining a vital local industry. Several are also backed by capture technology providers keen to prove their worth on a full-scale plant. Most claim they will achieve a capture cost of around $45 per ton of CO_2 – coming in conveniently below the 45Q level.

Aside from oil recovery projects, a major initial barrier to CCS expansion has been the costly, time-consuming process for characterising and permitting geological storage sites. The DOE's 'CarbonSAFE' initiative, which is performing this work for several suitable formations around the country, is therefore a huge benefit for coal power plans including Prairie State in Illinois, Project Tundra in North Dakota, and Dry Fork in Wyoming. An initiative at San Juan Generating Station in New Mexico,

duce over 100 Gt of CO_2 if allowed to see out their normal economic life.

Although China has been active in CCS research since the 2000s, even setting up some fairly large-scale facilities, real political support seems to have balked at the idea of burning more coal for less power. However, following President Xi Jinping's September announcement of a target to reach 'net zero' in 2060, many expect this stance to change. With its huge fleet of mostly 'cookie-cutter', efficient plants built in the last 15 years, good domestic capture technologies, and favourable geology for CO_2 storage, the stage seems set for mass CCS roll-out.

Prior to the net zero announcement, interest in CCS for the power sector was already growing, partly as a result of an average CO_2 emissions intensity target placed on the country's major power companies. Given China's highly regulated power market and current excess of coal capacity, awarding CCS-equipped plants with guaranteed operating hours is often proposed as an initial driver. Although

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The recent rise of corporate and national net zero carbon targets has been instrumental in putting CCS back in the frame – now a fundamental means of making the numbers add up. Several governments have concluded that carbon capture must finally be cracked, while oil and gas companies – who crucially have the engineering expertise to store the greenhouse gas – have scented a business opportunity, which could also secure their long-term future. CCS advocates now hope that the technology will feature heavily in post-Covid stimulus packages.

But CCS today looks quite different to CCS ten years ago. Where once the technology was practically synonymous with 'clean coal', coal power now appears low on the agenda. This is perhaps unsurprising, given that in Europe and North America, where interest in CO_2 capture is greatest, coal is in sharp decline. The political focus is increasingly on emissions from process industries such as steel and cement, as well as the idea of decarbonising the production of hydrogen from natural gas. While some countries still envisage a role for CCS-equipped power plants in balancing renewable generation, the other advances, capture technology manufacturers claim cost reductions of around a third are possible for a next wave of coal plants. But any kind of CCS is still a costly business, which makes little commercial sense unless it can be used to generate some kind of revenue.

In 2018, the US took a major step towards creating just such a business case with the expansion of the existing 45Q tax credit to directly reward CCS – raising it to $35 per ton of captured CO_2 used in enhanced oil recovery projects, and up to $50 per ton for storage in saline aquifer formations. A thriving market for CO_2 to boost flagging oil well production has long put the US at the forefront of CCS developments, but these revenues are too low to fund capture of the greenhouse gas from relatively dilute, large-scale emitters like power plants. The new credit therefore represents an effective income stream, which could put many more projects in the black.

Even with 45Q, and the slightly perverse 'advantage' of producing large amounts of CO_2, fitting CO_2 capture to coal plants is still on the brink of profitability, particularly for permitting geological storage sites. The DOE's 'CarbonSAFE' initiative, which is performing this work for several suitable formations around the country, is therefore a huge benefit for coal power plans including Prairie State in Illinois, Project Tundra in North Dakota, and Dry Fork in Wyoming. An initiative at San Juan Generating Station in New Mexico, meanwhile, plans to simply link up to the existing nearby network of CO_2 pipelines for the oil industry.

With coal power in the US already struggling to compete with cheap gas, CCS seems unlikely to forge a future for new coal capacity, but it may well extend the lifetime of some well-located generators with healthy demand and limited gas. The justification for the current wave of projects often rests on a comparison between the cost of fitting CO_2 capture to the unit with the cost of its replacement by a new gas-fired plant, while recognising that no matter how cheap wind or solar gets, some backup will be needed.

Following the mothballing of the Petra Nova capture project in May 2020, the new initiatives have also been quick to point out the unusual business model of the Texas facility, which encompassed ownership of an oil field and was therefore intimately linked to falling oil prices. Some of the projects will directly claim the tax credit, and others will look to secure stable offtake agreements for CO_2. Proposed legislation aims to further strengthen 45Q by converting it to a direct cash payment and extending the deadline to begin construction – currently set at the end of 2023.

Completing at least some of these 45Q-driven coal projects in the US will be vital in further establishing the technology and reducing costs, but the real market for CCS with coal power will always be in Asia. The massive global scale of coal emissions was a key reason for the initial focus of CCS on coal, and it is not a problem which has gone away. Well over half the world's coal capacity has been built in the last 20 years, with 90 per cent of that growth taking place in Asia and two thirds in China alone. Existing coal plants will provide interest in CCS for the power sector was already growing, partly as a result of an average CO_2 emissions intensity target placed on the country's major power companies. Given China's highly regulated power market and current excess of coal capacity, awarding CCS-equipped plants with guaranteed operating hours is often proposed as an initial driver. Although next steps in China also seem centred in the oil and gas sector, such as an initiative in the far west of the country led by the Oil and Gas Climate Initiative and China National Petroleum Corporation, a few coal power projects are on the drawing table.

Coal may no longer be leading CCS progress, but there is a chance it can follow. Much of the current shift in direction is linked to a widespread realisation that the major hurdle to overcome is the development of shared infrastructure for CO_2 storage and transport – an activity naturally dominated by the oil and gas sector. If a viable CO_2 storage service industry can be created, then emitters of all types will be free to concentrate on capturing CO_2 and selling it at the plant fence. Why shouldn't a coal plant tap into such infrastructure if the price is right? Might even Germany consider equipping its many new, efficient coal plants with CCS, perhaps for the CO_2 to be shipped to vast North Sea stores? On the other hand, the 'pay to take away' model proposed in Europe will not favour the high CO_2 intensity of coal in the same way as 45Q currently does.

While not even CCS is likely to alter the anti-coal mood in Europe, the technology must surely play a role in decarbonising China and the many other Asian countries where coal remains king. In these regions, a protracted shift from coal to gas would merely delay the eventual need for CO_2 capture on all fossil plants. So far, lower-income economies have understandably hesitated to properly back CCS while the West still dithered – now, the world will be watching their next move.

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Levelised cost of CO_2 capture for large scale post-combustion facilities at coal fired power plants, including previously studied facilities