

THE EFFICIENCY TRAP AND OTHER CARBON CAPTURE QUANDARIES

Much is said about the promise of increasingly efficient fossil fuel power, and indeed, designs for supercritical, ultra-supercritical, and even advanced ultra-supercritical coal plants are now being implemented. Despite the whiz-bang nomenclature, such plants all rely on the general principle of increasing the operating temperature relative to the thermal reservoir, i.e., the surroundings, in order to increase thermodynamic efficiency. Another method for increasing efficiency, in which the waste heat from a thermal cycle is used to drive downstream cycles, can be employed both in gas power generation (combined cycle gas turbines, or CCGT) and with coal (integrated gasification combined cycle, or IGCC).

Despite these advances, however, it is very difficult to increase thermal efficiency in such plants above approximately 50-55%. Based on this, the most advanced coal power stations, burning standard grade bituminous thermal coal, can reduce carbon emissions to about 670 GCO_{2e}/kWh without carbon capture.

While this is an improvement over average figures for typical coal plants of more than 800 g/kWh, current CCGT plants emit as low as 360 g/kWh without capture, and at much lower capital costs.

These numbers are significant in light of the UK's Emissions Performance Standard, which places a ceiling of 450 g/kWh for new build fossil fuel powered generation. On the face of it, this standard eliminates all new unabated coal power while allowing for coal with carbon capture as well as for CCGT. In practice, in the absence of a carbon price signal or tax, CCS coal is taken off the table as well, because why wouldn't a power producer build a CCGT plant given the choice – given that a CCS coal plant would currently cost more than 100 GBP/MWh to build and operate? The resulting lock-out of coal by capture-less CCGT may seem an improvement from an emissions mitigation point of view – 360 is just more than half of 670 g/kWh, after all – but does the policy guarantee the best possible outcome? If one were to fiat carbon capture coal (or gas), which emits less than 100 g/kWh, in place of all the new CCGT build implemented and planned in recent years, hundreds of millions of additional tonnes of CO₂ emissions could be avoided in the UK alone.

This does not come as a revelation – CCS has been repeatedly tasked as a necessary component of any energy strategy for limiting climate change to reasonable levels, given the seemingly inevitable growth in coal use in surging economies in Asia and elsewhere.¹

In the absence of a perhaps unrealistic surge of renewable power infrastructure within a very short time-frame – and we're talking years, not decades – carbon capture and storage will have to be implemented on a large scale. And although many new highly efficient power stations are being built, especially in the still-growing BRIC economies, net emissions will have to be reduced far below 300 g/kWh across the board if we are to avoid catastrophic warming. Although some progress is being made in these emerging economies – for example, with the Chinese coal giant Shenhua's demonstration CCS project in the Ordos Basin of Inner Mongolia – in the absence of a carbon price, developers there still seem to be casting about for compelling commercial reasons to go further.

So while the major implementation must occur elsewhere, Europe remains by and large the place where carbon policy is being pioneered. With the exception of several signature efforts, such as the Drax and Peterhead projects in the UK, however, CCS remains a hazy prospect here. Largely owing to Drax and Peterhead, the UK is the place where concrete prospects for CCS coal seem most advanced. For instance, Germany's sole major

¹ For instance, in the IEA's current *450 Scenario* for limiting warming to about 2 degrees above the historic baseline, CCS is a "wedge" representing 14% of the overall emissions reduction through 2050.

project to date, at Schwarze Pumpe, ended this year owing to cost and energy use overrun and public opposition to underground storage of CO₂. Despite its impressive progress in integrating renewables into its energy economy, the planned shutdown of the German nuclear fleet and its renewed commitment to mining and burning lignite – tonne per tonne the most carbon intensive fuel – makes Germany’s climate mitigation strategy out to be somewhat disjointed. Similarly, Poland has the most coal-intensive energy fleet in the EU, with an extensive lignite and deep mine/power plant complex that will remain in operation for the foreseeable future, and no large scale CCS projects in sight.

The Global CCS Institute’s database lists six projects related to power generation in Europe as of September 2014; of these, two are coded as being in the “evaluation stage,” while the remaining four are “defined,” a designation that the projects are ready for imminent financing, although there remain considerable planning and implementation hurdles before the turbines turn. Outside of a few enhanced oil recovery projects, the “active” category is empty on the continent of Europe and the first power producing projects are not expected to go online before 2018 at the earliest. In Canada, meanwhile, SaskPower’s Boundary Dam 110 MW CCS project is already in operation and was formally launched in October 2014, demonstrating that, technically at least, CCS is no longer a pipedream.

I started writing this brief with the goal of answering questions, but the problem of decarbonizing fossil fuel power - in the European Union at least – remains something of a quandary. We are now in a place where we can push the technology to its maximum potential; at the same time, we seem collectively unable to take the remaining mundane steps needed to hit the true target of emissions minimization.

The Energy Edge team has experts covering all aspects of energy and power station markets and regulation; we help you to ask and answer questions that guide strategic solutions for actors in the sector. Please contact [Linus Adler](#) for a preliminary chat or to set up a consultation discussion.