UK coal emissions performance standard: a sign of things to come?

Modern Power Systems: Comment.

UK coal emissions performance standard: a sign of things to come?

Authors: J. Gibbins, H. Chalmers and R.S. Haszeldine

Despite the new UK government's proposal for an emissions performance standard (EPS) appearing to be somewhat circular in its definition at least part of its intention is clear enough. The forthcoming Energy Bill announced in the Queen's speech on 25 May is expected to include EPS regulations for new coal-fired power plants. What is not clear, however, are the details of the EPS that will emerge and when analogous regulations may also be introduced for new natural gas plants and existing plants of all types.

An EPS that applies only to new coal is very unlikely to be sufficient to meet overall UK electricity sector emissions targets of less than 100 kgCO2/MWh by 2030 (and even lower thereafter) – see graph, right. In 2008 the UK generated 46% of its electricity from natural gas vs 31% from coal1 and much larger numbers of new gas plants are expected to be built in the UK over the next few years than coal plants. Reducing long term fossil fleet emissions in the UK is therefore likely to involve also reducing emissions from gas generation.

As an interim measure, however, while CCS is being developed, a 'new-coal-only' EPS might be helpful if it established sound principles for industry-wide EPS regulations and did not hamper the development of CCS for gas and biomass as well as coal. It would definitely not be helpful, however, if the main result was an even stronger incentive to just build gas plants and forget about CCS.

Key EPS principles to establish

One key principle for any EPS is that CO2 emissions are averaged over an extended period, of at least a year. This will make it much easier and cheaper to design and operate the equipment and has absolutely no detrimental environmental consequences, with cumulative CCS emissions over decades or longer being the relevant factor2.

Another important EPS principle is that it is consistent with a CCS deployment strategy that involves converting progressively larger numbers of fossil plants to full CCS rather than attempting to cut emissions to progressively lower levels in parallel at every plant in the fleet. The latter would be technologically almost impossible and prohibitively expensive, for absolutely no environmental benefit. In the former case CCS retrofits could start at the sites with the newest capture-ready plants and the most convenient access to transport and storage, significantly reducing the costs that must be met for fossil sector emission reductions.

Consideration will also have to be given to how biomass with CCS will be treated in an EPS and other applicable incentive schemes in order to ensure that the significant additional environmental benefits of combining sustainably-sourced biomass energy with CCS (BECCS) compared with biomass only, no CCS (BONCCS3) are adequately encouraged. Current proposals to build dedicated biomass plants with an output of 295 MW, just below the 300 MW limit at which capture readiness is required for new plants permitted in the UK, are obviously not helpful in this respect.

Risks for CCS development that need to be avoided

One obvious problem would be if exemption from the EPS was taken as a clear signal that carbon capture development for natural gas was unnecessary. Even if a programme of first generation commercial-scale demonstration projects and second generation reference plants for CCS from gas was started immediately in the UK it could not be completed much before 2020. Delays now would therefore directly affect the options available for achieving electricity sector decarbonisation in the 2020s to meet the challenging targets in 2030 and beyond.

CCS development for coal could also be hampered if an EPS was applied to first generation post-combustion (and oxyfuel) demonstration projects without any initial period for learning on what will be novel systems. Policy-makers should, therefore, consider having a limited initial period (eg, the first three operating years) when the EPS does not have to be achieved. This will allow problems to be identified and solved while keeping the power station running.

Without the ability for such learning utilities may be forced to adopt coal CCS systems based on gasification and combined cycle gas turbines (CCGT) irrespective of their underlying merits relative to other capture options. This is because the reliability of the

gasification and pre-combustion CO2 capture components is largely immaterial, provided that natural gas is available to power the CCGT (as has been seen in the initial years of non-capture IGCC demonstration plants). But pre- and post-combustion systems need to be allowed to compete on the relative merits of reasonably well-developed systems, not on a balance of first-of-kind risks that are arbitrarily skewed by the choice of a natural gas standard for allowable emissions.

The level of allowable CO2 emissions in the EPS could also cause problems if it is taken as too rigid a guide for CCS demonstration projects. It seems likely that, at least initially, it would be set at a value comparable to new gas plants. In theory a 'gas standard' based on the latest H and J class CCGT plants at a newly-installed, full output efficiency of 60% LHV4 would be around 330 kgCO2/MWh. In practice, because peak efficiency is not always the highest priority and with changes in ambient conditions, performance degradation in service and part load operation, values of 350-450 kgCO2/MWh would probably be more representative.

Not surprisingly, none of the 'gas standard' values above match 'reasonable' coal demonstration project cases very well. For post-combustion capture, the objective is to be allowed to test single full-size first-of-a-kind units thoroughly before moving on to build multiple copies. Setting a upper number of 450 kgCO2/MWh might just accommodate a 1 x 50% post-combustion capture unit on a single5 new supercritical coal generation unit (especially given the scope for biomass co-combustion). The value chosen in California6, 500 kgCO2/MWh, would, however, be easier to work with for the operator and the regulator7. Once this first capture system has been successfully 'demonstrated' (and the inevitable bugs sorted out!) a second similar system treating the other 50% of the flue gas from the same boiler would be fitted, to achieve around 100 kgCO2/MWh.

Conversely for an optimised pre-combustion demonstration running on coal it should be possible to recover costs for exceeding the likely EPS from the outset. The most reasonable configuration for a gasification demonstration unit would probably involve a two-stage shift (from CO to CO2) for all the syngas in the pre-combustion capture train from the outset. This would be expected to give at least 85% capture and emissions of 150 kgCO2/MWh, so much less than the 350-450 kgCO2/MWh range for a 'gas standard' EPS. The CCGT would be designed to burn the hydrogen-rich fuel gas produced by the two-stage shift (and also natural gas as a back-up for periods when the pre-combustion components are not operating, as discussed above).

A ‘glass half full’ view of the prospects

Interestingly, Conservatives and Liberal Democrats voted for an EPS that would apparently have applied to all new plant, and not just coal, when in opposition (see box). But it appears that both previous and present governments are cautious about immediately applying an EPS either to new gas or to existing plants of all types – ie, the plants that have to keep the lights on, and so are also likely to be emitting the bulk of fossil CO2. Nonetheless, provided the problems identified are avoided, a trial of a limited EPS on new coal is likely to be very valuable for ‘learning by doing’, in the same way as the UK’s planned CCS demonstration projects. Progress in all of these areas could see a vote on a more comprehensive EPS later in this parliament getting the sort of cross-party agreement that the CCS incentives included in the Energy Act 2010, with the scope for application to coal and gas projects, received at the end of the last parliament. And 2015 is a good deadline for finalising regulations for a managed transition to decarbonisation of all fossil electricity that launches across the whole fossil generation sector in 2020!