2016-IP34: Technical lessons learned from the UK CCS Commercialisation Programme (2012-2015)

Following its launch in April 2012, the 2nd competition to demonstrate full-chain CCS in the UK was cancelled in November 2015 – the first competition having been launched in 2007 and cancelled in 2011. In the 2nd competition, formally the "**UK CCS Commercialisation Programme**", two projects had been shortlisted for government support – Shell's **Peterhead** project and Capture Power's **White Rose** project.

Prior to cancellation, an agreement was reached between each project and the UK Government to determine what information could be released to the public that would enable both to share the knowledge and learning acquired from undertaking the front-end engineering design (FEED) study for their respective CCS projects. While some information would remain proprietary, publicly available information was published in a series of 86 reports known as Key Knowledge Deliverables (KKDs). The KKDs may be accessed at www.gov.uk/government/collections/carbon-capture-and-storage-knowledge-sharing.

Following cancellation, the UK's Carbon Capture and Storage Association (CCSA) commissioned a study based on interviews with project representatives and other expert parties, which was published on 29 June 2016 in a report entitled "Lessons Learned – Lessons and Evidence Derived from UK CCS Programmes, 2008 – 2015", available at www.ccsassociation.org/press-centre/reports-and-publications/lessons-learned. Subsequently, on 8 September, the CCSA held the "CCS Commercialisation Programme: Knowledge Transfer Workshop" at the offices of the Department for Business, Energy & Industrial Strategy (DBEIS), London, where the lessons learned were debated and discussed. There were around 80 attendees to the workshop, with delegates from the two projects, together with representatives from government, industry and academia.

Some important points were made upfront to frame the discussions:

1. There was high confidence on the part of all those associated with the projects that both would have delivered according to the competition rules. If both projects were selected, storage would have totalled around 3 million tonnes of CO_2 per annum;
2. The barriers to moving forward were fundamentally commercial and rooted essentially in the Competition's business model;
3. The two storage sites had been very well characterised and were ready for development. They had large capacities that would be eminently suitable for expansion should other projects pursue the same storage site in the future;
4. The value of CCS is often understated. For example, a power plant with CCS provides clean, flexible generation and the infrastructure developed would provide economy-wide benefits; and
5. Investment in CCS is highly unlikely in the absence of a clear government energy policy – policy that is now eagerly awaited in the UK.

Following a plenary introduction, the workshop split into two parallel streams, one focusing more on commercial aspects of the Competition and the other on technology. Only a flavour of the excellent, wide-ranging discussions is outlined below. For further insight, the reader is recommended to visit the KKDs and the CCSA's "lessons-learned" document that sets out 36 key lessons for industry and policy makers.

Cost was cited as the main reason for cancellation of the Competition. However, there were extenuating circumstances that led to high costs. For example, at up to 448 MW, the White Rose project's custom-designed oxyfuel coal-fired boiler was around half "commercial" size with economies of scale leading to clear cost and efficiency penalties for the sub-scale unit. And design constraints at Peterhead, due to the need to separate unambiguously generation from the non-CCS part of the plant for accounting purposes, led to the requirement for a bespoke steam turbine – smaller and less efficient than it would have been but for the need to comply with Competition requirements.

On the other hand, the transport and storage systems for both projects were deliberately oversized so that, in the future, other projects within the respective regions could be "clustered" to take advantage of the facilities. For the White Rose project, it was estimated that oversizing the transport and storage led to a direct cost increase of £110 million. Oversizing these elements of the projects would have resulted in reducing significantly the cost of successive plants.

While confidence was high following the FEED studies, project representatives gave several examples where they felt there was room for **technical improvements**. In a number of cases, the Competition schedule forced acceptance of an "effective" solution rather than the "optimum" solution that could have been achieved given more time. A number of examples were cited where improvements might have been accomplished in the White Rose project. For example, around 2% of the CO_2 was emitted from the flue gas desulphurisation plant; a solution to reduce this emission was not reached in the time available. It was felt that more could have been done to optimise heat integration across the plant. And, as initial exploration suggested an effective wastewater treatment process had both a large footprint and high cost, it was abandoned in favour of disposal; more time would have permitted a more exhaustive investigation.

Due to the specific location of the White Rose project, arduous conditions were placed on flood protection; addressing this issue added one year to the design time. The planned commissioning period was particularly long, with various components of the plant having to be commissioned sequentially; further study might reduce the period prior to the plant entering commercial operation. Greater application of modular construction could improve quality and reduce cost; delivery by barge was possible with Drax sited on the River Ouse with a purpose-built dock.

Representatives of the Peterhead project – a project that would involve capturing around 90% of the carbon dioxide from part of the existing gas fired power station – reported that, given time, they would have worked much closer with the engineering, procurement and construction (EPC) contractors. Around half-a-kilometre of 6m x 6m ducting connected the CCGT to downstream components; optimising design to shave increments of length from this ducting would be an extremely cost-effective exercise. Similarly, several different techniques for construction of the absorber tower were possible; a more optimal solution would also lead to cost savings and potential performance improvements.

Importantly, both projects made the point that to really learn lessons, for the most effective cost savings to be identified, the plants needed to be constructed, commissioned and operated. Demonstration projects are by definition less economic than n^{th} of kind commercial units. The project partners can already identify areas for major cost savings and performance improvement, and point to the negative cost impacts resulting from the Competition constraints. If they had gone further, they were quite confident that they would also have been in the position, as Boundary Dam did before them, of announcing quite confidently and unequivocally the potential for cost savings on the 2^{nd} of a kind.

Finally, a couple of interesting observations. First, it was suggested that the language used in the KKDs was judiciously selected. While proprietary information was necessarily excluded, some additional insights may be apparent to the careful reader by virtue of the wording used or omissions made. Secondly, while the KKDs remain on the website for future reference, technology advances continue and risks identified at the time of writing may well not hold the same concerns in the future. It is therefore incumbent on future readers to be well informed and not to take decisions based on information that may possibly not be current.

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