CHAPTER 10
CONCLUSIONS

David Campbell*,
Scottish Power, Longannet Power Station,
Kincardine-on-Forth, by Alloa,
Clackmannanshire FK10 4AA

Stuart Haszeldine,
Debbie Polson,
School of Geosciences, Grant Institute,
University of Edinburgh, West Mains Road,
Edinburgh EH9 2JT

Eric Mackay
Heriot-Watt University, Edinburgh EH14 4AS

Martin Smith,
British Geological Survey, Murchison House,
West Mains Road, Edinburgh EH9 3LA

**Corresponding Author*

By 2020 over half of the UK's electricity generation will continue to be fuelled by coal and gas. CCS technology has the potential to significantly reduce CO_2 emissions from fossil-fuel power stations and is therefore now a crucial element of the UK government's energy and climate change agenda.

The methodological approach adopted by industry and the regulators to CCS storage is strongly influenced by the level of knowledge of the subsurface. Whereas existing oil and gas operators and hydrocarbon service companies have extensive knowledge of the subsurface, new entrants to CCS, such as power companies and transport operators, do not. One of the defining differences is the acceptance of uncertainty.

A power company which operates surface assets will have well-established project development processes that feed into investment decisions based on their acceptance of uncertainty. For example, they will have very high levels of confidence that a new-build power plant will deliver the power output required. This view of uncertainty is fundamentally different from existing subsurface operators where their project development cycle accommodates for high levels of uncertainty. Hydrocarbon operators will typically accept that boreholes are drilled, with costs in excess of tens of millions (£, $ or €), which will not result in producing hydrocarbons. Given that a power company will operate at one end of the CCS chain and a subsurface operator at the other, this highlights the need for entry paths and understanding along the whole CCS chain.

The CASSEM project was therefore funded to develop a pathway to inform and de-risk investment decisions for new entrants to CCS in the subsurface and in the identification of suitable formations to store CO_2.

The value of interaction within a workflow and, ultimately, the uncertainty of subsurface operations is well illustrated, for example, by the work that was carried out on the Firth of Forth. The initial geological interpretation indicated that there was a small but usable storage structure and the CO_2 flow modelling that had been carried out in Phases 1 and 2 of the flow simulations supported this view. However, doubt remained with regard to faulting from the seismic interpretation. The original seismic data was reprocessed using current processing tools and then reinterpreted. The improved seismic data changed the interpretation of what had been assumed to be faults to be more confidently identified as tightly folded layering. This reinterpretation increased confidence in the site and follow-up testing of the relative permeability of the aquifer rocks was carried out. This testing, however, revealed very low relative permeability values, impacting on the injectivity and making it an unrealistic storage proposition. This information would have been invaluable to a new-entrant store developer in halting further investment in an unsuitable formation

The CASSEM project combines a 'conventional' geosciences approach to CCS, sets this in context and recognises external influences (e.g. costs, transport, etc.) on CCS deployment. The approach can be summarised in the following three questions:

- Will there be sufficient public support for the CCS deployment?
- How can the risk and uncertainty be framed?
- How should this deployment be costed?

To address the issue of public support, the CASSEM project included work on public perception; unsurprisingly, this work identified that the public understanding of CCS, and of climate change, was very low. Significantly, it demonstrated that by providing the public with unbiased information on climate change and how it could be mitigated, and providing access to credible experts that they could discuss the issues with, people could understand where CCS fitted and through that understanding were supportive of the potential of having a CCS scheme relatively close to where they lived.

Many projects contain an element of risk management; the CASSEM project went beyond that, using a risk and uncertainty work package to manage our own project risk. Within the project there was a budget allocated to obtain data for the other work streams, and it would have been simple and uncontentious to allocate those funds to each of the work packages on a pro rata basis to carry out the additional experimental work. Instead, the risk and uncertainty FEPs approach was used within the project, for each of the exemplar sites, and, using this approach, the areas of greatest uncertainty were identified and a data acquisition activity undertaken to reduce that uncertainty.

There are several cost models produced for a CCS deployment. The CASSEM project has produced a financial framework to allow that costing of a CCS deployment. The CASSEM financial model is not just intended to produce a cost per tonne of CO_2 emitted, but rather proposes a transparent method for calculating that cost. This model has been published with the expectation that it will be challenged, and through that, develop into a web resource available to the wider CCS community. We hope that this will allow CCS to be judged on an equal footing with other climate change mitigation strategies.

Through the development of the CASSEM project, new insights and scientific knowledge have been gained. The real benefit, rather than the sum of the constituent parts, lies in the linkages between the work streams and the application of an 'asset team' approach to subsurface development.

The individual insights and new knowledge that has been created as a result of the CASSEM project are summarised below as a series of value headlines.