

## REVIEW OF COMMITTEE ON CLIMATE CHANGE REPORT OF CHAPTER 2 “PRODUCTION SCENARIOS”

*Prof. Fred Worrall, Dept. of Earth Sciences, University of Durham*

The remit of my review was limited to the content of chapter 2 and as such reviews only the development of production projections for a prospective shale gas industry in the UK. In performing this review I was particularly interested in the use of the source materials which the chapter relies upon and so I also read those source materials to ensure that The Committee on Climate Change (CCC) use of them was justified in the context of the objectives of this chapter.

### *Minor issues*

It is important when developing scenarios in such a controversial subject as shale gas production that sources are documented and that it is clear whether inputs to the chapter are from elsewhere or they are the work of the authors. Figure 2.1 is not very informative as it lacks any units or scales.

### *Major issues*

The substantive issues with the chapter are its relationship and use of its source materials. The source material used comes from 3 major sources and other potential major sources are not considered. The study could have used the following reports: Broderick et al. (2011); and Bond et al. (2014). It is not possible to use the Mackay and Stone report (Mackay and Stone, 2013) for this chapter as Mackay and Stone produced their figures relative to energy production, and they do not therefore need to estimate production for their purposes. Opinions regarding shale gas remain very polarised and the sources used in the CCC report could be seen as coming from the “pro-fracking” position. Given that perception is reality it might be advisable to consider the production scenarios from Broderick et al. (2011) and as seen below this particular report provides a contrasting viewpoint to some of the reports used by the CCC.

All the reports used, and indeed those projected by Broderick et al. (2011), are really a Lancashire-centric scenarios and when the Bowland shale is referred to it is still referring to Lancashire and not to other areas where Carboniferous shales may be exploited. Only Bond et al. (2014) refer to conditions that might occur outside of Lancashire.

To discuss the specific sources<sup>1</sup>:

- *National Grid report* – their scenarios arbitrarily take half their preferred projection as their low projection there is no reason given as to why half is a reasonable estimate of low production figures is given. If it was an arbitrary choice then that should have been made clear. The report relies heavily on the Institute of Directors report (IoD).
- *Navigant report* – it was very difficult to understand the estimation process within the Navigant report as its sources are rarely specified and comments are not attributed. Although it is not easy to work out how Navigant arrived at their estimate it does represent, by some margin, the lowest estimate of shale gas production.

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<sup>1</sup> I have not given references for reports already included in the chapter.

- *Institute of Directors report (IoD)* – this report is also used within the National Grid report. This report has a number of issues:
  - This report fails to consistently cite its sources (it would never be accepted into a scientific journal) and this is important as it is not clear where estimates are guesses, preferred values or based upon reviewed studies.
  - It is noticeable that choices made are often on the high side of the available range. For example, The EUR per lateral is stated as 3.2 bcf over a 30 year period, however, this is an unweighted average of the data cited while the weighted average is 2.83. The range then used is 2.4 to 4, i.e. the choice would favour higher values of EUR per lateral.
  - Throughout they do not use ranges but use a three scenario strategy. It would be possible for both IoD and this chapter to use a stochastic approach and then results could be reported as ranges rather than as scenarios.
  - In the IoD report no sources are given for the initial production values and their decline. These values are important as they govern the shape of the curves in Figures 4.3 and 4.4 of the CCC report.
  - The percentage flowback water is at the low end of values normal in the literature, Broderick et al. (2011) give higher values.
  - The range of well pad designs is at the upper end of those considered in the literature with a range from 10/10 (i.e. 10 wells per pad with 10 laterals) and 10/40 well pads, but other sources never go this high. Current average in the US is 4.67 wells per pad (Jantz et al., 2014); Broderick et al (2011) and Bond et al. (2014) use a 10/10 well pad scenario and this can be traced to projections for Cuadrilla by Regeneris consulting (Regeneris, 2011).
  - The most serious issue is the development scenario outlined in the IoD report. The IoD report proposes a “hypothetical development” of 100 pads of 10 wells with 40 laterals with no more than 10 new well pads per year. This is based upon their own upper estimate (not their other estimates) of the well pad design but the choice and the proposal is not given any justification.
  - The logic of the production scenario used by the IoD can be readily questioned from two approaches. Firstly, the current estimates of recoverable reserves suggest between 130 and 200 tcf available (e.g. DECC, 2011), but even using a 10/40 well pad is thought to have a lifetime production of 126.2 bcf and given a production scenario of 100 of these well pads means that only 12.6 tcf would actually be realised, i.e. even at the upper end of well pad productivity there would need to be many times more well pads to realise the current recoverable resource estimates. Secondly, and alternatively, the government in the 14<sup>th</sup> licensing round has given 159 licenses for onshore exploration (over 90% of which are for shale gas). The licensed blocks are typically up to 10 x 10 km grids and most of the reports used in this study agree that a 10/10 well pad can access an area of shale formation of up to 2.5 km<sup>2</sup>, i.e. there is a lot of capacity within current licenses to have many more well pads than the 100 projected by the IoD report. This production scenario is partly a problem with the number of well pads predicted but also the rate of well pad development appears as a

number without justification. This speculative production scenario governs the height and timing of the peak production in Figures 4.3 and 4.4 of the CCC report. I do note that the CCC report does not attempt to project beyond 2030 and the decline of any shale gas production and so the IoD production scenario has no further effect on the CCC report.

Several of the sources used by CCC are now out of date and the reports used were made before the recent estimates of recoverable reserve (e.g. Andrews, 2013, Monaghan, 2014).

### *Conclusions*

Given the reports and ranges used it is probable that CCC report does cover the range of production scenarios because the problems with any report are offset by another decision within the same report, for example, the IoD report chooses to project based upon well pad productivity far above any other reports proposals but also proposes very few well pads. Similarly, the Navigant report, for all its opaqueness, is consistently lower than any other report. The timing and magnitude of peak production as expressed in Figure 2.3 and 2.4 could be sensitivity tested.

### **References**

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**CCC notes on the peer review:**

We provided a draft of the chapter on production scenarios to Prof. Worrall both for feedback on suggested amended and for peer review. We are publishing the full set of comments, regardless of whether the suggestions led to changes in the final report.

In particular we note:

- As a result of these comments, we included a Broderick et al. (2011) scenario in our survey of scenarios from the available literature.
- The Navigant report cited turned out to use scenarios by Pöyry, now referenced as such in our final report.
- While some of the productions scenarios in the literature do pre-date the British Geological Surveys studies on the Bowland Shale and Midland Valley (Andrews, 2013 and Monaghan, 2014), we refer to these studies elsewhere in the report in the context of the gas-in-place resource.