The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Another thought on coal supply

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The National Research Council, as Leanan reported earlier, has just issued a report Coal: Research and Development to Support National Energy Policy dealing with both current reserves and needed research. While I haven't had a chance to read it in detail yet, there was one paragraph I thought worth mentioning before I write a longer review, and it is this one.

> Despite significant uncertainties in existing reserve estimates, it is clear that there is sufficient coal at current levels of production to meet anticipated needs through 2030. Looking further into the future, there is probably sufficient coal to meet the nation's needs for more than 100 years at current rates of consumption. However it is not possible to confirm the often-quoted assertion that there is a sufficient supply of coal for the next 250 years.

I had written in the non-too-distant past about why coal reserves can be smaller than those anticipated. There is, however, a current part of the in-situ deposits that are not considered, and to illustrate what I mean, I thought I would use the example of the Prairie State Energy Campus that is being developed in Southern Illinois. This is a 1,600 megawatt power plant that will serve customers in Illinois, Missouri, Indiana and Kentucky. It will be served by a dedicated adjacent underground coal mine. It is one aspect of this mine that I thought I would address here.

The mine is planned to produce 5.9 Mt/year (pdf) of coal for the power station, and given that it will be in operation with a planned life of 30 years, this will mean that the mine will need a current reserve of some 180 Mt. However, the coal is to be extracted by Room and Pillar Mining with five continuous miners working Super Sections, and leaving pillars of coal to hold up the roof, with the pillars measuring either 18.3 or 21.3 m on a side (60 to 70 ft). The 2.1 m (7 ft) seam is between 60 and 90 m (2-300 ft) below the surface at this point.

As currently planned there will be no secondary recovery, which means that the company will not go back, after the area has been mined to the boundary, to try and recover any of the coal left in these pillars. I have explained how Room and Pillar Mining works in an earlier post, but let me just revisit one illustration from that to get to my point. The view looks down on the working area in the coal seam, with the overlying rock layers removed.

As you can see, and this is just one of the working sections of the mine (not including the additional equipment for the Super Section), the pillars are larger than the entries and cross-cuts. While I don't have these dimensions for the mine, a reasonable size would be 6 m (20 ft). Now if

you are defining a 60 ft pillar with a passage 20 ft wide around it, then the relative amount of coal you are removing is ((80x80) – (60x60))/(80x80) or 43% of the coal. In fact there will be larger pillars left in strategic places around the mine, and I have used the smaller, rather than the larger pillar sizes to give the greatest percentage extracted.

In other words, of the coal that is in place, less than 50% will be mined, while the rest will be left in place. Typically, after an area has been mined in this way, the coal that is left is considered lost, since the area that is abandoned may fill with water, or noxious gases, or the roof may, with time, collapse. However there are mines that have been entered many years later where the conditions have remained good.

So the countable reserve for that seam of coal, being won this way, is for less than half the coal in place. Now that does not mean that there are not other ways to mine the coal. However, given how shallow it is, and the need to ensure that the surface remains undisturbed, this, at present is how the mine is planned to be operated.

Now it could be argued that leaving more than half the coal in place is depriving our children of a resource that they might need. However I didn't want to get into that discussion today, rather I wanted to point out that there are resources not currently considered as reserves, which perhaps might be as the need becomes more apparent.

I am going to try and get hold of a copy of the NRC report this week, and will try and tie this into a greater discussion of what is and is not the state-of-the-world in regard to reserves. But in part that discussion revolves around methods used to extract the coal, and the innovations and creative new techniques that can be developed to do this safely, and with a higher extraction ratio. Unfortunately that is not likely to happen soon. As the report notes:

> Over $538 million was spent by federal government agencies for coal-related research and technology development in 2005. Of this, more than 90% (~$492 million) was directed towards "downstream" aspects of coal use, mostly coal utilization technology development and transmission research funded through the Department of Energy (DOE). Federal support for R&D activities related to all "upstream" aspects of the coal fuel cycle – i.e. mine worker safety and health, resource and reserve assessments, coal mining and processing and environmental protection and reclamation- accounted for less than 10% of the total federal investment in coal-related R&D. Federal funding in 2005 for individual components of upstream activities ranged from $24.4 million (4.5%) for mine worker safety and health R&D to $1.3 million (0.2%) for coal mining and processing R&D.

UPDATE
I wrote the above part of the post on Sunday after coming back from some time off (and for those curious, having the wonderful Fathers' Day gift of seeing the Engineer be hooded). Thinking to catch up I had read posts up through the Drumbeat that I had cited, and hadn't seen Dr. Rutledge's post when I prepared it. It gave me some several hundred additional pages to read, of which Jevon's book on British Coal is proving to be one of the more fascinating. (Yes it is that Jevons, and he does write about the paradox in the book).

Jevons points out, for example, that the British population was seeing a growth rate of between 18 and 11% for the ten year intervals from 1800 (thereby going from 9 million to 20 million

people) but that the rate was decreasing, while the rate of marriage was increasing. At the time that he wrote the mines were producing some 84 million tons of coal a year, which was largely mined by hand. The treatise has many parts that relate to the NRC report, and it may therefore be interesting to see how things have changed over the past hundred and forty years. However I will keep that comparison to another time, because I would like to correct an impression that I picked up from the piece by Dr. Rutledge who writes as follows:

> Jevons wrote that even though the reserves-to-production (R/P) ratio was around 1,000 years, exponential growth would exhaust British coal in the 20th century. Jevons was right. In his time, there were more than 3,000 coal mines. Now the British are down to six major underground mines, with the last Welsh mine, the Tower Colliery, due to finish off its last seam next year. Figure 3 shows a Hubbert linearization for British coal. There is a good trend line, and the very first point in 1854 is near the line. We will see that the quality of the trend is in contrast to the reserves, which badly over-estimate remaining production throughout.
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> This, unfortunately, leaves the clear impression that there is no coal left in the United Kingdom. So I went to The Coalfields of Great Britain by Sir Arthur Trueman. Because the British Geological Survey has access to the core sections recovered from coal exploration across the country and that there was a fairly comprehensive evaluation done at the time that the industry was nationalized in 1947 the estimates of coal reserves in the various fields of the UK have some measure of validity. The book divides the country into 11 coalfields, and generally assumes that coal will only be mined at thicknesses above 2 ft, and at depths above 4,000 ft. (In which regard there was a comment a couple of weeks ago about mining a 12-inch seam in West Virginia, and in Ukraine they have gone down to 4,500ft).
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> Let me cite information from just a few of these fields. I quote, first for South Wales:
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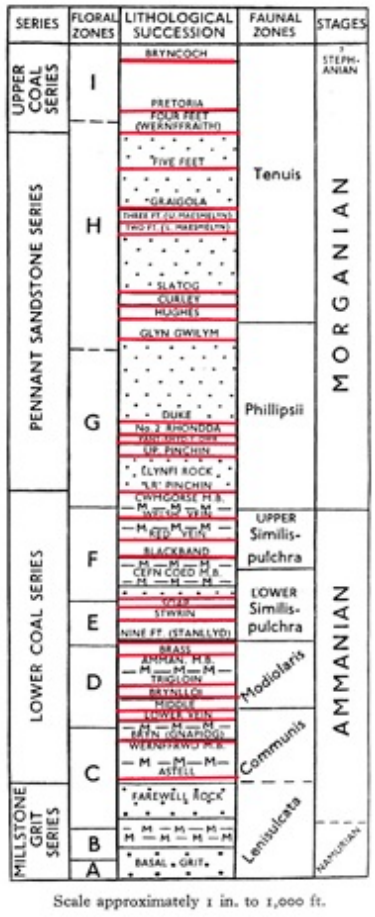
> > Reserves (a) In seams 24 inches and upwards, in existing colliery leases, and in those colliery leases projected by the Regional Valuation Board: 6,475 million tons, of which 3,300 million tons will be worked in the next 100 years.
>
> Reserves (b) In seams 24 inches thick and upwards in areas not at present leased and which occur at a depth not exceeding 4,000 ft from surface: 3,000 million tons.
>
> Total reserves 9,500 million tons approximately. The output of raised and weighed coal was 46 million tons in 1930, and declined to 25 million tons in 1944. The output of anthracite 5.5 million tons in 1930 declined to 3 million tons in 1944. For the sake of discussion I am assuming that the production in 1930 represented the peak (this was just before the Depression) and you may note that at that rate of production South Wales had 206 years worth of coal left – under the conditions defined.
>
> The depth limitation of 4,000 ft is artificial and its influence can be seen, for example in considering the Somerset and Gloucestershire coalfields, where there is roughly 3 billion tons of coal at depths below 3,000 ft in the fields, which lie within an area of some 270 sq miles.
> There is also relatively little account taken of coal seams that run out to sea. In the Kent coalfield, for example, the 2,200 million tons of reserves did not count the possibility, considered good, that the coal continued under the English Channel. (Kent at the time

mined about 2 million tons a year).

In even the oldest of coal fields, Northumberland and Durham (commercially developed since 1239, though likely also used by the Romans). The reserves in 1945 were estimated at 2,100 million tons for Northumberland and 3,000 million tons for Durham.

It may not be widely recognized but the Coal Measures can extend up to more than 4,000 ft thick, and contain, in N&D, for example, 21 named seams of varying thicknesses. Many of these seams, for varying reasons, have not yet been worked. This illustration, for example, shows the named seams in South Wales. I have colored them red, so as to provide contrast, and the original image is some 6.5 inches tall in regards to the scale.



Scale approximately 1 in. to 1,000 ft.

(Source Trueman - Coalfields of Great Britain)

There are a significant number of reasons why the coal industry of the United Kingdom has sensibly disappeared, but, as the above figures illustrate, it is not because the UK ran out of coal. It is more that there were alternative, cheaper, and cleaner fuels coming in from the North Sea in large part. The coal is still there, it has just been too expensive to mine, and the question perhaps becomes when will that change?

And I suddenly realize that there will have to be at least a couple more posts in this series – the first of which will likely compare Jevons and the NRC's views on coal – with some 140 years between them, and then I'll try and give some numbers for the rest of the world. Better dig out my colliery brass band CD's.