The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Coal reserves and resources - a gentle cough

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I have written recently about some of the reasons that coal reserves, as currently understood, might not be quite as large, at present, as they are assumed to be. However, while I could continue on that tack for some additional time, it is perhaps time to give a gentle cough and suggest that there is perhaps a little terminologically inexact thinking in some of the discussions on the actual size of reserves, relative to the overall resource and that there is another viewpoint that should be considered in this debate. Particularly this relates to how much is left and how long it will last.

Firstly it should be recognized that a number of studies of coal reserves have put caveats on their numbers along the lines of "under current operating and economic conditions." And so let me first put back up the table I posted in my last post , relating to the coal reserves of the UK back in 1952.

England's Reserves and Production 1952		
	reserve tons	max annual prod
South Wales	9,500,000,000	46,137,000
Forest of Dean	60,000,000	360,000
Somerset/Glouc	6,083,600,000	1,505,400
Kent	2,200,000,000	2,250,000
Yorkshire/Notts	13,369,000,000	
Lancashire	2,082,000,000	
North Staffs	600,000,000	6,000,000
North Wales	800,000,000	3,000,000
South Midlands	2,027,724,233	11,000,000
N'th'land/Durham	5,100,000,000	
Cumberland	583,500,000	
Scotland	3,337,000,000	
Total	45,742,824,233	

Note that this is coal that has largely been proved to be in place. However, in the time frame between 1952 and today it has not been mined or gone away, but it has become, at present, uneconomic to mine. And thus under current conditions it is no longer a reserve. And the one thing that those who write here should know better about assuming is the "current conditions." Jeepers! We have spent over two years here accumulating convincing evidence that current conditions are not sustainable, and yet that argument is accepted, with little discussion, when it is proposed.

The problem that I have with Dr Rutledge's argument , and those of similar inclination, is that they conflate physical and economic removal from the stockpile. But in reality is it to a large extent the economic conditions that currently prevail, not the physical ones. In large measure the

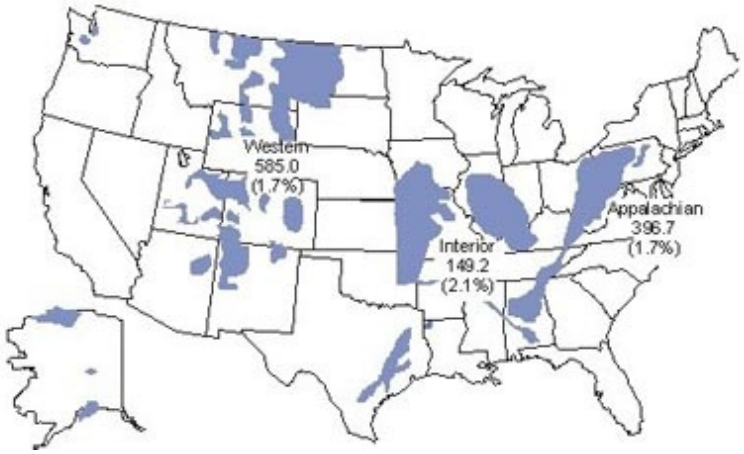
coal is still there – and yes that includes quantities of Pennsylvanian anthracite. As was noted in the comments, one of the major reasons for the collapse of the industry around Wilkes Barre was that a mine broke into the bottom of the river . This caused extensive flooding and it was not, at that time, economically viable to do the necessary geological repairs to recover the deposits. So let me give you some numbers from a couple of studies on coal volumes, from back when it was not competing as ferociously with oil as it has been for the past few decades. (Because that is the prevailing condition we are moving into).

I am therefore going to start with the 1974 Survey of Energy Resources.

	Total Resource millions of tons	Reserve base	Recoverable reserve	1971 production
USSR	5,713,600	273,200	136,600	641
China	1,000,000	300,000	80,000	410
Rest of Asia	108,056	40,495	17,557	176
USA	2,924,053	363,562	181,781	512
Canada	108,777	9,034	5,537	19
South America	32,997	9,220	2,809	17
Europe	607,521	319,807	126,777	1,086
Africa	58,844	30,291	15,628	60
Oceana	199,654	74,699	24,518	85
Total	10,753,502	1,420,308	591,207	3,006

Now in these tables the resource is what is there, with no consideration as to whether it can be mined. Obviously it has to be of some finite thickness and there is some assumed maximum depth in the selection, but that is all. The reserve base is the amount that can be potentially mined (at 100% recovery) with the existing methods of the time, and economically. However (as earlier noted) mines don't get all the coal, they only recover part of it, and thus the recoverable reserve is the amount that is likely to leave the property. And as you may note it is a small fraction of the grand total.

To refresh your memory this includes all the defined varieties of coal including lignite, (6,300 Btu per pound); sub-bituminous (around 10,000 Btu/lb); bituminous (14,000 Btu/lb) and anthracite. For the United States these can be found as shown in the following map (this information is from the EIA, and shows coal production in 2005, the table is from the late Bob Stefanko's book "Coal Mining Technology – Theory and Practice).



Coal Production in the United States by region in 2005 (from the EIA)

And the U.S. resource was considered to be when defined as -more than 1 ft thick for anthracite and bituminous, more than 2.5 ft thick for sub-bituminous, and at depths of less than 6,000 ft. Interestingly (as noted in the NRC report) the definition of inferred is for seams that are more than a quarter to three miles from an existing borehole (depending on the state for the definition).

United States	million tons
Demonstrated reserves	434,000
Identifed reserves	1,297,000
Hypothesised to 3000 ft	1,849,000
Hypothesised 3,000 to 6,000 ft	388,000
Total	3.968.000

Note that the numbers are slightly different from that in the global table, since it includes depths below that considered by the larger projection. In overall total it has not changed much by the 2007 NRC report , although the component parts have. In 1980 the World Coal Study modified these numbers, considering that the minimum thickness for hard coal would be 0.6 m and for soft coal (brown and lignite) it would be 2 meters. There numbers (with a different selection of countries) was as follows.

WOCOL Study		Resource	Reserve	BP 2005
		millions of tons of coal		
Australia		600,000	32,800	78,500
Canada		323,036	4,242	6,578
China		1,438,045	98,883	114,500
Germany		246,800	34,419	6,739
India		81,019	12,427	92,445
Poland		139,750	59,600	14,000
South Africa		72,000	43,000	48,750
United Kingdom		190,000	45,000	220
United States		2,570,398	166,950	246,643
Soviet Union		4,860,000	109,900	157,010
Others		229,164	55,711	143,679
	Total	10,750,212	662,932	909,064

Note again that they distinguish between what is there and what is, with the technology of the time, considered recoverable. The countries named accounted for 98% of world production at the time. For interest I have then added a column that gives the current estimate of reserves from the BP Statistical Review, 2006). The interesting number, perhaps, is the dramatic drop in the UK considered reserve. It does not indicate that there has been huge mining numbers over the past 25 years, but rather the constraint of what is currently economically viable. Re-sinking shafts is expensive, and the price is not yet high enough or the market large enough to justify the investment.

Now there are various definitions of what is viable and recoverable, and this is technology related, as much as anything else. You may remember that I pointed out (and Gail further noted) that as the mines have become mechanized the EROI has dropped. Our 0.2 hp miner can be quite effective, if rather slow. Further he can (as at Eglingham) work small mines that would not be economic for the larger machines and support structures of a modern mine. And that holds as true in China as it does in the rest of the world. It will also likely hold true in Africa. But to put it in perspective across the US mining industry productivity is 4 tons/manhour underground, and 10 tons/manhour surface.

Most modern mining equipment today is relatively inefficient – as an illustration rock is much stronger in compression that under tension, and yet machines work more to induce failure using compressive loading rather than tensile. Thus current EROI calculations, on the energy costs of mining underground, are similarly based on the use of existing mining machines and systems. There are alternatives, and given that a considerable part of the Energy cost is spent in keeping miners alive and safe, the gains from remote mining can be considerable.

As a result of this (and bearing in mind, as the NRC Report noted, that the Government of the moment is not funding mining research at any significant level) it is possible that future developments may lower costs for mining coal, making more of the resource a reserve (for illustrative example only, this might include burning some of the coal in place). A major weakness

of both the Rutledge and Energy Watch positions is that they do not recognize some of these issues. The reserves, such as those in Illinois, did not cease to exist when they were downgraded, they just became uneconomic – under the then prevailing conditions. (The coal was higher sulfur and more difficult to sell against the cheap cleaner coal from Wyoming- because of the need for the power station customer to install scrubbers). In both those cases there is an assumption that once the change has been made, it is not reversible.

To illustrate the fallacy of this position, let me convert it to another example. It is the equivalent of saying that when the Saudi Government cut off the flow of oil during and following the 1973 war that this was not reversible, and that, from that point on Saudi oil production could never rise again. (Hint – it did).

I've been watching Connections 1 again, and was reminded, watching the episode on "Thunder in the Skies", which starts by noting that, at the end of the last warming period we had to invent chimneys, and the impact that had on architecture – but then goes on to show the evolution through the Newcomen and Watt engines to Diesel's machine (with the aid of a scent bottle) and the modern aircraft. The germane part of this is that the Newcomen engine was developed to pump water from mines, and with its evolution what had been an untappable resource of unminable material, suddenly was accessible and a reserve. (And then Stephenson came along and developed the railway and his Blucher (after the Prussian general) which led to the Rocket to get the coal down to the coast).

I thus see two factors making an impact, first, without the investment in a viable alternative, within a few years coal will be the major fossil fuel left, and demand will rise dramatically over the current levels, thereby shortening the life of the existing reserve significantly. And then, secondly, the development of technologies that will allow a greater amount of the resource to be effectively recovered.

For the first to occur investors and companies must be assured that when they make an investment, that this will have a market that will allow them to recover that investment and profit from it. Given the current concerns on Greenhouse gases that is a debatable question, and will likely delay investment. And for the second, someone has to encourage folk to develop those new ideas, and at present they aren't. Both of which are a pity, since I am not looking forward to repeating the late '70's again but this time without an immediate answer.