The Oil Drum
DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

Some history on Coal EROI and UK coal numbers

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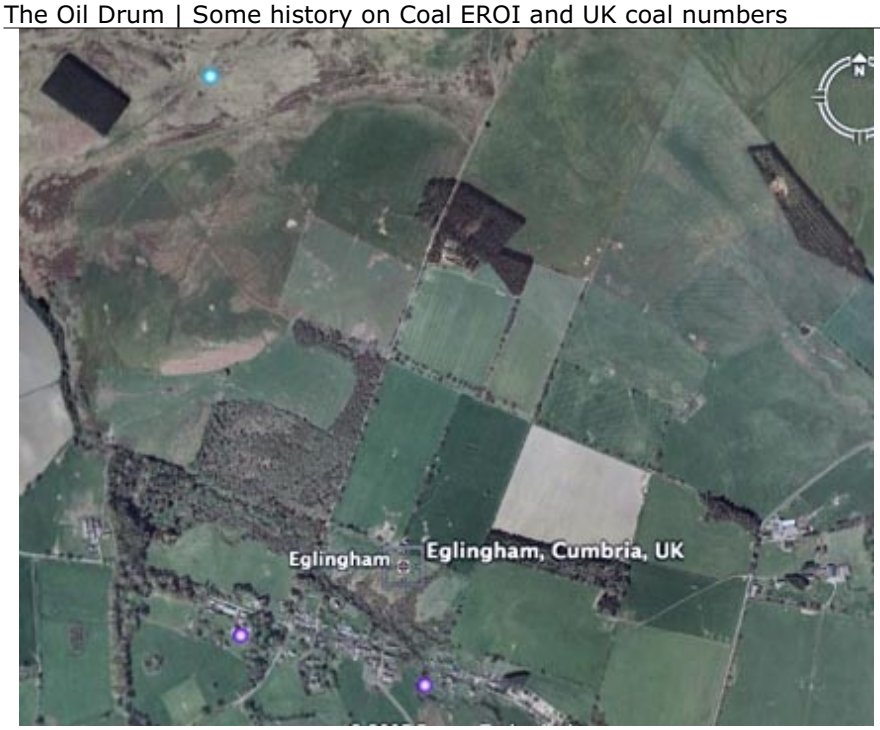
If you use Google Earth to look down on the village of Eglingham in Northumberland (thought they put it in Cumbria), (location 55deg28'13 N 1deg 49'38.43W at a height of 2.23 km - picture below the fold) you would rightly think that you are looking at a one of the more beautiful parts of the UK. And it was here that is as far back as my family history takes me, since back around 1700 my family lived in the street the ruins of which are now covered with gorse and moorland at the top of the lane that runs up from the bottom of the picture to the top. There are, as it happens, at least two mines whose remnants lie within the picture, and the family worked in one of them.

Back then the mines were small, the United Kingdom had 5 million inhabitants, and the coal was probably sold locally, although the village is not that far from the sea, and by 1770 the FOB price was 5s 4d per ton in Newcastle. In those times the coal was won by a hewer, who undercut the coal with a slot, using a pick, while lying on his side. He would then break the main body of the seam down into the free space in larger lumps. The coal was placed in baskets, or corves, which were dragged to the shaft by women and children, and then hoisted to the surface. (Hair's Bottom of the Shaft, Wallbottle Colliery) Those moving the coal were known as putters. To make it easier to move the corves they were first dragged along wooden rails, later small carts with wheels were added onto which the corves could be placed, And then, as the mines got larger, the rails were made with initially iron plate covers, and then entirely of metal, and the women and children were replaced by horses, or pit ponies as they became known.

Archeological evidence is sparse, but it looked as though the mines were relatively shallow drift mines, with the mine going into the side of the hill with a tunnel driven in the coal from the outcrop at Eglingham, rather than using a shaft. In 1865 Jevons noted that seven horses could do the work of 34 men, which allows the assumption that a man works at about 0.2 horsepower. Within a shift a hewer might mine perhaps 20 tons of coal (a ton occupies around a cubic yard), Jevons notes that in a larger colliery (South Hetton) the mine employed 140 hewers, 227 putters screeners etc, 123 employed in management and maintenance, and 39 boys. In a shallow mine the hewer would have only needed one helper, but in the deeper mines the distances would be greater, so loads would be consolidated, and there would also be need for boys to work the ventilation doors, and to bring in the support timber.

Can you spot the mines and the old house rows?



Mechanized cutting in the mines began to appear about the time that Jevons wrote his book, and a machine had been developed that would do the undercutting of the face, to take over the hardest part of the cut. The first machine was apparently introduced into West Ardsley mine and reported to reduce the efforts required to mine to coal by only 10%, which was, in that mine, some 27 men. The first attempt to mechanize had been made in 1761, but this was the first successful machine, and it was introduced in 1861. By 1881 this swinging pick machine, had been replaced by an electric rotating chain type of cutting machine which was found particularly advantageous as the mines had been switching from Room and Pillar Mining to Longwall Mining , which I have described in more detail in those posts. The undercutting of the face was carried out by a team of three men in the shift before the hewers came onto the face, and each hewer would then load the coal initially into his own tubs, but later onto a conveyor belt that ran the length of the face (and which I described in more detail in the Longwall post).

In the United States 2,739,700 tons were mined using a cutting machine in 1891, but by 1896 this had risen to 12,533,500 tons, with some 1,200 machines in operation. The machine had the advantage of cutting a 3.5 to 5.5 inch slot, as opposed to the wider slot cut by hand. Further, while a good hewer could undercut a face 5 yards long to a depth of 3 ft in a 10-hour shift, the machine could do twenty or thirty times this amount, according to Scott . The motor size used in these early machines was around 20 hp in size, so that, although the absolute production went up, the relative EROI for the face went down. Consider that while the machine cut twenty times faster than a man, it required 100 times the power.

These EROI numbers then proceeded to get worse, as the technology advanced (but also bear in mind that at least this part of the process is reversible to some degree). Why did that happen? Well if we accept Pimental's concept that we have to consider the energy that goes into the machines and supports as part of the process, one of the changes has been the change from using wooden props and bars to hold up the roof, to the use of steel machines, which require not only power to run, but also considerable energy to make. But I really don't want to complicate this bit of the argument, and so, for simplicity let me merely note this change, and also the transition to high-speed conveyor belts to carry the coal from the face to the main entries, where it was loaded into mine cars and then hauled around by small locomotives. In many places these tubs and locomotives have now been replaced by larger conveyor belts. (Much more energy intensive than

a horse, which, depending on conditions, required more energy support than women and children). I mention the latter point not because I favor that practice in any way, but rather remind folk that there are other considerations than just EROI when considering alternative approaches.

But let me get back to the face, where the hewer, given the free undercut, can now break the coal down with a pick more effectively. And because he breaks it out in larger pieces it requires less energy than if it is ground out, the way a modern shearer will mine it. I have written about this, and its impact on EROI in an earlier post In that post I showed that if the old miner had used a pick to wedge out a 4-inch square piece of coal he would have used 800 units of energy to break free the coal. If, on the other hand a machine had ground the coal from the face in quarter-inch pieces, then it would need 540,000 similar energy units. Thus switching from manual mining to mechanical mining, requires considerably more energy input than manual means, but it does get the coal out a lot faster. But then, adding a small amount of black powder (an explosive close to gunpowder) in holes spaced 6 ft apart along the face, and firing these off at the end of the undercutting shift meant that all the hewer had to do was to load out the broken coal (and break up the odd lump that was too big), so that his "stint" became something like 15 yards of coal, undercut 6 ft deep and at a good working height of 4 ft 6 inches, to give a production of 45 tons per 7.25 hour shift (which included walking time and 20 minutes for lunch). Not bad for 0.2 hp, though I remain confused as to how you determine the EROI of using explosives.

Oops! My explanation to Gail as to why you have to be careful in deciding what the EROI of underground mining is has gone on bit longer than I had intended. As a result I haven't given myself any room to explain why this EROI, while of some relevance, isn't the whole picture when we get around to talking about what we consider as a reserve, and what we don't. But I would suggest that might be possible to develop mining methods that are more efficient than some of those in use today, and perhaps get closer to that of the smart miner who was my ancestor.

So I will get to that next time, but before I go, let me give you the table I put together from Trueman on the reserves of coal in the UK as they were considered to be shortly after Nationalization.

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	

I will chat more about how these should now be considered next time. Have a good Fourth!

And some small additional bits of information - for initial estimation purposes you might assume that a seam of coal that covers an area of a square mile to the depth of a foot represents a million tons. (after Jevons)

And with all the comment about what fraction of a horsepower a person can produce, it earlier times the draught animal of choice was the ox. Not only did it do more work for less feed, when it

had reached the end of useful life it could be put into the stockpot.

And the original definition of an acre was the area that an ox could plough in a day. Twenty oxen could have been used to drag the individual blocks of the Stonehenge megalith to the site, rather than the more popular concept of 500 men.