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Coal rank and thoughts on EROEI

Posted by Heading Out on January 11, 2008 - 11:30am
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Tags: coal, eroei, rank, surface energy, tech talk [list all tags]

PG here; this is a post from HO's Tech Talk series. This one was originally posted 5 FEB 2006. We encourage you, if you're interested, to look back at the entire extensive series under the tech talk tab up top under the banner.

Often when we talk about different fuels, the fuel itself is considered to be something that can easily be defined. However this is really not always the case, and today I would like to talk a little about types of coal, its content and the product size, and why this can make it a bit difficult to assess EROEI.

For those who wonder what is going on, this is a weekend tech talk, where some underlying aspect of fossil fuel energy is discussed. References to earlier posts are given at the end of this one, and the subjects are usually simplified to get across the basic ideas, within a reasonable amount of space.

Back when my grandfather was mining coal, with a pick and a shovel, he would very carefully separate rock from the coal as he picked lumps out from the solid. The reason for this relates to how he was paid. Before he began to fill a tub with coal, he would place a holder and a token with his mark on it at the bottom of the tub. Thus when it got to the surface, the teller would check that the tub only contained coal, and then would give him credit for the tub. But if the tub contained much stone, from the roof, or from layers of rock within the coal, then the tub would not be counted and my grandfather got no credit for it.

Thus the coal that was mined was carefully mined, and sorted before it was moved from the working face, ensuring a fairly high degree of quality control (a man filled perhaps 20 tubs in a shift so losing one or two because of rock content was a big pay cut). When the move was made to machine mining, that degree of quality control was lost. While, at first glance, a coal seam may appear flat it is not, and both the roof and floor contacts roll up and down as a machine mines forward. While a man can adjust to this, a machine that is being steered from behind can only be partially controlled. As a result the picks will often remove small segments of the roof or floor rock, as the machine moves forward. In the same way it is not uncommon to find layers of rock within the coal, and while a man could separate and leave these, the machine will grind these up with the coal and load them out. (This is where there is often a risk of gas ignition in a mine, since the impact of a pick on sandstone, for example, can generate a hot spot that can ignite any methane that is leaking from the coal near that point).

Because it is now much more difficult to separate the rock and coal (which is usually crushed to less than half-an-inch in size) both rock and coal are carried to the surface, and fed into a coal preparation plant. Here, using a combination of methods including gravity separation in a liquid that has a density between that of coal and the rock, the coal is separated from the rock. The

waste rock, historically was stored in the large coal tips that dotted the landscape of the Eastern United States, and Europe, while the coal was screened into different sizes and sold.

As coal is used more and more in power stations it is usually further crushed in additional mills to a much smaller size so that it will burn more efficiently in these plants. This is more costly in the energy that it takes to prepare the coal. To understand why consider that there is a physical property called surface energy. Simply it is the strength of the bond that holds two surfaces together. Let us, to work an example, say that it takes 10 units of energy to break the bonds over 1 sq-inch of surface, So that when I split a four-inch block of coal into two pieces then I am creating an additional 16 sq-inches of surface, and to do that I have to put in 16 x 10 = 160 units of energy to make that change. Now if I want to break the piece of coal into quarter-inch pieces, then it will take 15 x 15 x 15 cuts, and take therefore a total of 540,000 units of energy. Breaking the original four-inch piece from the solid would have taken 5 x 16 x 10 = 800 units of energy. In this way you can see that the finer the coal is ground, the more energy that is used in the process. Unfortunately grinding systems are not highly efficient so that there are additional energy costs over and above those needed for the simple surface separation.

The energy balance is then even more complicated when we add the fact that there are a variety of different types of coal. These are generally given a rank based on their carbon content. Thus, for example the lowest ranking coal is brown coal or lignite, and this may only have a carbon content of around 60% and contain a high percentage of water. Thus it has to be dried before it can be effectively used. (Peat, it's historical ancestor is even lower in energy and higher in water content). Moving up the scale, sub-bituminous coal has a carbon content of perhaps 75% and 10% moisture; bituminous coal can go up to 90% carbon and perhaps 5% moisture. The highest rank coal is known as anthracite and this has a carbon content above 90%.

As a result of the difference in carbon content, the heating value of the coal also changes. While numbers and definitions vary somewhat as one moves around the world as a rough guide a ton of Lignite is around 7 million Btu; sub-bituminous 17 - 18 million Btu; Bituminous 21 to 30 million Btu; and Anthracite around 16 million Btu. These values are if the coal has been cleaned of other rocks. The quality of the coal also affects the price. (It should be noted that current spot prices of coal may now be quite different.

There are other issues, however, that also control the price of the coal. These include the sulphur content, since this, in turn, has controlled the amount of scrubbing of the flue gases from power station that has been required to remove the resulting compounds. Since this is an expensive process, in the past it has driven some coal production areas to close, while purchases of lower sulphur coal have increased.

This is a part of a series of talks that has, most recently, dealt with coal mining. Earlier talks in that series dealt with three forms of mining;
Surface Mining
Longwall Mining
Room and Pillar Mining
As usual any concerns, corrections, or questions, should be addressed in comments.

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