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Oil shale is not a viable fuel source, study says

Scientists' best estimates of the Energy Return on Investment (EROI) of oil shale suggest it is very inefficient compared to conventional fuel and emits up to 75% more greenhouse gases (GHGs. However, differences in the way energy efficiency is calculated can cause confusion over its potential use, according to the US study.

Shale is a sedimentary rock containing kerogen, which is heated to produce synthetic crude oil (oil shale). Liquid fuel derived from oil shale has been suggested as an alternative to conventional oil and gas. However, the energy inputs or 'costs' associated with oil shale are not always fully accounted for, leading to overestimates of its value relative to other fuel sources.

The study evaluated estimates of the energy efficiency of oil shale, using a method known as 'Energy Return on Investment' (EROI). In its most complete form, this is the ratio of the energy content of the fuel produced to the energy used over the full 'well to wheels' life-cycle of the product, including exploration, mining, processing, refining, transportation and combustion.

The most comprehensive study indicates an EROI of 2 to produce oil shale, meaning that 2 units of energy are produced for every unit consumed. This is very low compared to the EROI for conventional crude oil of around 20. Including the refining step, the EROI of producing gasoline from crude oil is around 4.7 compared to 1.4 for producing liquid fuel from oil shale.

Other studies have calculated an oil shale EROI of up to 8. However, this is largely because they only represent *direct* energy costs, such as energy to heat the shale, and under-represent *indirect* energy costs, such as energy used to produce drilling rigs and transportation. Studies that do include indirect energy inputs also vary in the methods used.

Shale can either be heated to produce oil shale while it is still underground (in-situ) or after transportation to the surface (surface retorting). In the in-situ method, hydrocarbon gases released during the reaction can be burned to generate electricity to 'self fuel' the extraction process.

In surface retorting, the same effect is produced by combusting coke or 'char' deposited on the shale during extraction. Some EROI estimates include this internal energy source as a cost since it is a direct expenditure of energy. Others do not, since the extra energy is not purchased externally from the grid and has no other economic use. If the internal energy is not included, the estimated EROI for oil shale can be as high as 16. However, there are currently very few operational facilities, which limits the reliability of these estimates.

Fully accounting for all energy used is also vital in assessing GHG emissions. Emissions from oil shale, which result from the direct energy input and as a product of the extraction reaction, are estimated to be 1.25 -1.75 times higher than for conventional crude oil. Oil shale production also requires large amounts of land and up to three barrels of water per barrel of oil produced. These environmental costs together with the low EROI lead the researchers to conclude that, although the energy accounting process needs rigourous review, there is little economic or environmental incentive to use oil shale as a fuel source.

Source: Cleveland, C.J. & O'Connor, P. A. (2011). Energy Return on Investment (EROI) of oil shale. *Sustainability*. 3; 2307-2322.

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