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Thermodynamics govern future trends in energy production economics

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First law thermodynamics is used to measure the energy cost of producing shale oil. For surface processing, energy is required to mine, process the ore, retort, clean and store the products and upgrade the oil. Likewise, for *in-situ* processes energy is required to prepare the site, drill into the formation, heat the formation, clean and store the products and upgrade the oil. Energy is required in the form of heat, fuel for mechanical energy, and electric power. Energy efficiency is a measure of the fraction of output needed for input. Efficiency is defined as e = output/ (output + lost energy). For surface retorting of mined oil shale, the efficiency is on the order of 82% for a 25 gallon per ton oil shale with an overburden to pay ratio of 1:1. By comparison, petroleum recovery is about 92% today, but falling rapidly. Projections suggest that oil shale will exhibit thermodynamic parity with crude oil in less than 10 years. One issue that was highlighted in the 1970s, but which has yet to enter the discussion this time around, is the degree to which oil shale processes will be energy 'self-sufficient'. Oil shale is uniquely suited for energy self-sufficiency, at least in the US, because the high hydrogen content results in large quantities of gas production, and because the kerogen is naturally low in sulfur, making it cost effective to sequester sulfur products from combustion of coke or gas. This paper will cover the relationship of first-law efficiency to variables such as grade, over-burden to pay ratio, surface vs. *in situ* and whether or not coke is burned for energy. The paper will put oil shale in the context of alternative energy sources such as oil sands, as well as conventional petroleum.