

Why EROI matters

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Making investment decisions

Society usually makes its economic decisions, at least those not predicated by personal greed at the expense of others or strictly political considerations, on economic analysis and most explicitly via either non government market decisions or governmentally-administered cost-benefit analysis. Probably most decisions are made by people in the financial markets who seek to gain the best economic return on their economic investment. Probably most of these people believe that their own best judgments, while of course subject to the vagaries of the market, are the best way that we can prepare for the future. There is an implicit assumption, probably believed by most market analysts, that if they (collectively) make good financial decisions, based on market information, market projections and good hunches then we collectively (i.e. society) will make the best investments possible. Although there are certainly good rationales that such analyses make considerable sense, in many cases it is not so clear to me that they are an effective guide to the future of energy supplies. This is because 1) few understand the degree to which most technologies today are principally a means of subsidizing whatever it is we do with still-cheap petroleum 2) today's price signals are unlikely to be especially influenced by future conditions when today's most abundant and cheapest fuels are likely to be much less available, for either geological (depletion) or political reasons 3) current prices of energy in the U.S. are greatly influenced by various subsidies 4) there is painfully little transfer of information from the (rather limited) scientific community that has examined the large picture of energy to the financial communities. We propose to improve the information flow on these issues from the scientific community to the general financial community as well as to the world more generally.

Why peak oil matters

Our society is overwhelmingly dependant upon oil, which supplied about 40 percent of US energy use in 2007, and natural gas, which supplied another 25 or so percent. Global values are similar. It has also been dependent upon their growth in supply to support additional economic growth, even with some efficiency improvements. As of this writing there is considerable concern about whether "peak oil" (meaning the point for a region, a nation or the world at which oil production no longer increases year by year but enters a plateau or decline) has occurred for the world or might soon. If this is true then the "end of cheap oil" might be, or might soon be, upon us. Natural gas might not be too far behind, especially in North America. Because of the critical importance of this petroleum for essentially everything we do economically there are major concerns as to what the financial implications might be. A thoughtful although possibly extreme view of the implications of peak oil on the American Economy has been presented by Gail Tverberg at: <http://www.theoildrum.com/node/3382#more> . An assumption of some who examine this issue is that since all that we do economically in the US is based on cheap oil and gas then the absence of that

cheap oil and gas will have enormous economic implications. Do conventional economics and conventional economic models and tools work only when it was possible to readily expand the petroleum supply? There is a strong view held by myself and others (see references at end) that because our main economic concepts were derived during a period of our expanding ability to do everything – i.e. that more or less regardless of policy we were able to pump more oil out of the ground readily to implement whatever we were trying to do, that conventional economic approaches may have much less relevance during times of contracting supplies. In other words, are finances beholden to the laws of physics? I think yes. Thus the question becomes: can we supplement or improve upon our ability to do economics and financial analysis by using procedures that focus more on the energy available (or not) to undertake the activity in question? I next attempt to make that case.

Predicting energy supplies and the importance of EROI

There are many, notably those associated with The Oil Drum and the Association for the Study of Peak Oil (ASPO), who believe that they can predict the amount of oil and gas that will be available in the future. This can be readily gleaned from their web sites. The news is not good, especially over the next few decades. Other, different views are available of course, both from the US Energy Information Agency and Cambridge Energy Research Associates, but even their probably inflated estimates would only extend the time until peak, not cause it to disappear. In addition their predictions seem to have lost a lot of credibility due to the recent analysis of Morton, who showed that all of their price predictions thus far had failed miserably.

Most economists are not too concerned about peak oil (if they think about it at all) because they believe that markets will generate substitutes from which markets will choose. But today's markets often give very misleading signals about the potential of various fuels. The boom and bust of ethanol is an obvious example. I have been working on this issue for 40 years and have no idea what might be an adequate qualitative and quantitative substitute for petroleum except possibly and with enormous difficulty something based on electricity.

One potentially useful alternative or supplement to conventional economic analysis is *net energy analysis*, which is the analysis of how much energy is required to make a unit of the energy in question. Net energy is sometimes called energy surplus, energy balance, or, as I prefer, energy return on investment (EROI) (Hall 1972, Hall and Cleveland 1981, Cleveland et al.1985, Hall, Cleveland and Kaufmann 1986). Its advocates, including me, believe that net energy analysis offers the possibility of a very useful approach for looking at the advantages and disadvantages of a given fuel and offers the possibility of looking into the future in a way that markets seem unable to do. Its advocates also believe that in time real market prices must approximately reflect comprehensive EROIs, at least if corrections for quality are made and subsidies removed. Thus can we make market decisions based on biophysical, rather than market, economic analysis? At a minimum I believe that biophysical analysis can add a great deal of insight to traditional market analysis.

The current literature on net energy analysis, such as it is, tends to be mostly about whether a given project is or is not a net surplus, that is whether there is a gain or a loss in energy from e.g. making ethanol from corn (see June 23, 2006 issue of Science Magazine for a fairly thorough discussion of this issue). The general criteria used by much of the current debate is focused on the

“energy break even” issue, that is whether the energy returned as fuel is greater than the energy invested in growing or otherwise obtaining it. If so then the general argument seems to be that the fuel or project “should be done”, and if not then it should not. Obviously this issue is clearest when one might be discussing whether the fuel requires more energy for its production than is delivered in the product, a claim held by several of the participants (most notably Pimentel and Patzek 2005 discussed in the above issue of Science) in the current debate about corn-derived ethanol. Others (summarized in e.g. Farrell et al., 2006) argue that ethanol from corn is a clear energy surplus, with from 1.2 to 1.6 units of energy delivered for each unit invested. Further aspects of this argument center around whether one should include co-products (such as residual animal feed), the quality of the fuels used and produced (liquid – presumably more valuable -- vs. solid and gaseous, for example) and whether or not to include the energy required to compensate for environmental impacts in the future e.g. for the significant soil erosion occasioned by corn production. Such arguments are likely to be much more important in the future as other relatively low quality fuels are increasingly considered or developed to replace oil and gas, both of which are likely to be more expensive and probably less available in the not so distant future. If, of course, the alternatives require much oil and or gas for their production, which is usually the case, then an increase in the price of petroleum will not necessarily make the alternatives cheap and more available as a fuel. And, as we have seen, the use of biomass fuels can have enormous and generally adverse ripple effects through the world’s food and environmental systems that were completely unpredicted by narrow market analysis.

Why EROI matters—what information can it give about the future

I believe that EROI can give the investor or the public a great deal of information that markets cannot which are summarized below:

1) Markets can give you information only about the cost of *exploiting* a fuel, which usually today has nothing to do with *making* or even necessarily *finding* it in the future. Case in point is petroleum: today globally we find only one barrel for each 4 or 5 that we extract, so that we are basically pumping out known reservoirs. Hence we are not paying, assuming that we could, the cost of finding the replacement or of making some substitute. We are just emptying our tanks. Time trends and predictions of EROI can give you a much better insight into what the costs relative to the gains are likely to be in the future.

3) Nevertheless energy investments on the whole probably cannot fail to give the investor a profit. If costs go up, so will prices. If depletion of high quality fuels occurs whatever energy is left is likely to be worth more. Society as it has existed for 100 years simply cannot operate without energy, probably more or less as much as it can get. But while the investor might be satisfied the general economy will suffer, and indeed that is beginning to happen. I believe that even the sub-prime mess is about increasing oil prices increasingly removing once-discretionary income that had allowed the speculation.

4) Essentially all information that we have indicates that the EROI for our major fuels (solar may be an exception) are declining over time, so that in the future society will be having to invest much more money and energy into getting the necessary fuel to run the economy than we do now (e.g. Hall et al. in press). Thus we can tell investors that this is not a good time to invest in additional Caribbean hotels, new restaurants and so on. Both society and individual people will be spending far more of

their income on just getting the energy to make the economy work, , resulting in a serious diminution of discretionary income and everything dependant upon it (e.g. Hall et al. in press, <http://www.theoildrum.com/node/3412>)

5) EROI can be used to help evaluate which alternative fuels are likely to be the most viable economically in the future (See the “balloon” graph in the above post)). Those investors who had used EROI information to guide investments in the last few years avoided being burned in the corn-based ethanol boom and bust. Similarly, science can tell you now that we have not yet broken down cellulose on a commercial scale, and that maintain the conditions where this has been done in the laboratory on a large scale is exceedingly difficult. So much for the present-day advocates of switchgrass and other cellulostic alcohol. Maybe we can do it, but don't bet the house on it.

6) EROI can be combined with estimates of the total magnitude of resources to indicate which fuels are likely to be able to make significant additions to US energy resources. For example, rapeseed is an attractive potential for biodiesel but the entire area in which rapeseed can be grown with a significant net energy gain probably is probably not enough to make a substantial input to the US liquid fuels budget.

7) Environmental issues can be included in EROI analyses, allowing a more comprehensive analysis of EROI. For example if growing a biofuel causes soil erosion the energy cost of making fertilizer to restore the fertilizer can be readily factored in.

Thus there are many reasons that good energy and EROI analysis can help guide the investor and the interested member of the public.

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