



EROI Post - A Response from Charlie Hall

Posted by [Nate Hagens](#) on April 7, 2008 - 9:59am

Topic: [Miscellaneous](#)

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On Tuesday we ran [Part 1](#) of a 6 part series of EROI posts by Professor Charles Hall and his energy students. Professor Hall (to my surprise) read through all theoil Drum comments and sent me an email with his responses and some summary comments, which I have posted below.

In addition to being interesting and insightful, Charlies comments, in a rough draft sort of way, reminded me how powerful the internet could be in academia if leveraged correctly. Real time 24 hour peer review. Of course, many of our posters are anonymous, and the standard deviation of commentary is very high. Still, the timing of Peak Oil, and the potential steepness of the post-peak decline rate, suggest that the normal 12-24 month turnaround time for the traditional academic review process will not keep pace with events, and would best be supplemented by something faster...something viral. I guess thats one of the things we are attempting here at TOD.

Charlies response below the fold. (Next Tuesday will be his draft paper on oil and gas EROI.)

To: TOD responders to Charles Hall's EROI post

From: Charles Hall (With assistance from Graduate Student David Murphy and thanks to Nate)

RE: Your posts

I am rather blown away by the response to my post, both the many attacks and the equally many folks who have come out of the woodwork to my defense, or rather the defense of the validity of the EROI approach. I thank you all, for I think we need more discussion of this issue. I regret only that since I am a very fully employed professor, teaching four courses this semester (2 more than "required" in order to try to get energy/environmental/economic analysis properly placed in our curriculum), my responses will be more limited than would otherwise be the case. In addition this is advising week, we hope to get a new energy major approved by the faculty next week, and I have many graduate students to work with. A telling comment on this whole process came from my equally busy faculty wife who asked, upon hearing me read aloud many comments "How come these people have so much time to do this stuff" to which I answered "Because we still have surplus energy".

The main thing I get out of all of this is that Nate is right, there just are different camps, just as there are differing favorite political candidates (including none of above). OK. Please just sit happily in your camp. Carp if you must. I will ignore those who confuse

conversion efficiency or material extraction with EROI (See Science June 23 2006) or who think that markets solve all problems. If you wish, however, I might introduce the latter to the Easter bunny.

I am an ecologist (but not of the tree hugging variety). All this EROI stuff comes out of my spending most of my life measuring and attempting to understand energy flows in natural ecosystems. There is no money in these systems, but there are perfectly good economies. If e.g. a trout does not maintain appositive EROI he does not survive, and if he or she does not make a substantial energy profit that trout or system does not go into the future. Likewise societies (Tainter).

For those like Mr. Barton who question my energy bona fides my graduate training under Howard Odum, certainly one of our great energy thinkers, was about energy every day, and included courses in energy and engineering as well as chemistry and biology. I did a post doctorate under George Woodwell at Brookhaven and Oak Ridge National Laboratories (basically energy laboratories) and partook in many energy-related activities with physicists, economists and so on there and later at Cornell University where I was professor for 13 years. Most of my 200 plus publications and 7 books are explicitly or implicitly about energy. I do not know everything about energy but I think few have been more consistently trained or involved, and I do not especially appreciate comments that because I am an ecologist I do not know about energy.

In mid career I became turned off by theory in ecology so I went to study economics which I thought was much more rigorous. Instead I found most of economic theory even further removed from reality than ecological theory. All this is chronicled in my various publications and my present efforts to construct Biophysical Economics. In both ecology and economics I have found a vast confusion between mathematical rigor and scientific rigor, but energy is something I can sink my teeth into and can believe. If you cannot, then it will be difficult for you to understand what we are trying to do.

But let's get some basics down. The really sorry thing is that I believe that we asked and mostly answered most of these questions 30 years ago when a substantial portion of academia and government were really engaged in doing this kind of analysis and when we had some fine programs within which to do it at Cornell (where I was with Cleveland and Kaufmann as my students), at Florida (where my advisor H.T. Odum was still very active), at Illinois (where very comprehensive energy analyses were undertaken and published), at Berkeley and a few other places. There were national meetings, a lot of personal energy, and all the same questions as we see here. It is frustrating that in a sense we have made no progress in the last 30 years during which energy was off most people's radar screens. (I have summarized this history in a paper with John Day just submitted). My students now look very hard to find any real energy programs to apply to that excite them beyond engineering and the development of silver bullet non solutions. Additionally, and except for ASPO and the private sources listed in my acknowledgements (thank you!), there is essentially no place at NSF or DOE to even apply for funds. As those who have attended my presentations know the top ten energy analysts I know have not been funded AT ALL, and tell me they do their work "on the weekends", "pro bono", "after retirement " and so on. The point of all this is that these issues are old, have been pretty thoroughly hashed over long ago, and we should have made much more progress in deriving and promulgating and undertaking sensitivity analysis of EROI than we have. But there has been neither financial support nor, except amongst the faithful out in the wilderness, activity. And, as Nate says, rather than

arrogantly publishing formally the work I have done I am somewhat humbly approaching all of you to get your input. An interesting point to add to this was made by one of my graduate students about our TOD discussions so far: "Lots and lots of discussion but no new hard numbers." Well we hope that will change.

OK Let me respond in a very general way to the most frequent issues:

1) Are there problems with EROI analysis? Yes, of course. But in my opinion far less of a problem than with e.g. conventional economics (See Hall et al. 2001 Bioscience. All my important papers downloadable from my web site, See also Cleveland's Boston University site). I have never advocated making decisions just from EROI but, as is clear in my post, think it a damn useful tool in our toolbags. Thank you Nate and others for clarifying the essential issue. I think in time EROI will largely drive the economics, and we have, I believe, saved some investors a lot of money on e.g. corn-based ethanol even when market signals had been the opposite. Some says that EROI analysis is useful only at very low EROI values. I think instead that the qualitative and quantitative analysis synthesized in the balloon graph shows, even with the considerable uncertainties, some important histories, some good and some bad ideas about future possibilities and a pretty good road map of what we have to do if we are to replace gas and oil.

2) "EROI has not considered the different qualities of energy". Get real. Energy quality always has been central to most EROI analysis since its beginning (Odum as given in yesterday's postings, Hall and Cleveland 1981, Cleveland et al. 1984; Hall, Cleveland and Kaufmann 1986, Hall et al. 2003). These papers are published in our "best" Journals (Science, Nature, BioScience) and are available in any good library. Now of course determining exactly what "quality" means can be difficult. Our method has been normally to simply weigh primary electricity as 3 times fossil fuels (i.e. that is the conversion efficiency and roughly the economic cost differential) and do the analysis with and without this quality correction. Cleveland prefers the price-based divisia index, and we are exploring that more.

3) EROI does emphasize and include many issues missed in conventional economic analysis but its cost boundaries are as subject to discussion and opinion as are those in economics. I for one like to do the analysis with various inclusion of e.g. indirect, environmental, labor and so on and let the reader take his or her choice. We have done that in the past. But without much financing that is pretty tough to do these days.

4) Howard Odum and Mark Brown have considered all of the "Earth energies" in their emergy (with an m) analysis, which attempts to include e.g. the sunshine used to lift and purify the water used, the Earth energy to make the oil and so on. I have avoided this issue because of the considerable uncertainty in estimating the "transformities" required but like the approach conceptually and believe it is a more or less upper energy cost approach. Mark Brown, Mathis Wackernagel and I have used comprehensive economic, emergy and ecological footprint analysis to examine the issue of sustainability in Costa Rica (in Hall 2000). Fortuitously or not our answers were similar.

5) My own assessments have always been based on the actual, the here and now, the energy flows now occurring (which are about 40 percent oil and 25 percent natural gas in the US), time series that have examined trends, and, sometimes, extrapolations into the relatively near future. I accept things as they are: oil rigs normally use oil or gas because this is what is available and cheap to them, coal extraction uses mostly diesel or

electricity either from the grid or occasionally from dedicated coal plants because that is what they do. Manufacturing uses the general mix of energy in society unless we have more specific information, which is rare. I do not find the idea of dedicating the output of a given source to constructing more of that source except as an exercise in what that might mean because that is not what we do.

6) Yes we need more explicit protocols. I gave a paper on that at ASPO Boston, which suggested what some of those protocols might be, and wrote it up, but its completion has been delayed for reasons beyond my control

7) Oil prices do not respond just to EROI but also overall availability relative to demand, which was high in e.g. the 1990s.

8) Ok the full oil and sub prime issue. Oil was cheap, \$3.50 a barrel, at the start of 1973. The US was the world's largest producer. Peak oil had just occurred but no one noticed. Demand kept growing, US supply fell, foreign suppliers gained leverage. Political events and bulldozer accidents intervened. The price increased by a factor of ten, to \$35 a barrel. The proportion of GDP that went to buying oil increased from about 4 percent to 13 percent, restricting discretionary spending for all. All around the world oil that had been found but not developed (as it had not been worth much) suddenly became profitable to develop, and it was. By the 1990s the world was awash in oil, and the real price fell to nearly what it was in 1973. The proportion of GDP that was energy fell to about 5 percent, essentially giving everyone a sudden free extra 8-10 percent of their incomes to play with. Many invested in the stock market, but the burst bubble of 2000 cured many. Real estate was a "safe" bet, so many invested into what was really a huge surplus square footage of McMansions etc. Just as my mother recounted to me about 1929, speculation became rampant. Then as energy prices have increased over the past 6 years an extra 5 to 10 percent "tax" has been added to our economy, and that much of the surplus wealth disappeared. Speculation was no longer desirable or possible as everyone was tightening their belt because of increased energy costs. This may or may not be accurate and it certainly is not a sufficient explanation by itself sufficient (we would have to add in the failure of Allen Greenspan etc to do their regulatory job) but two of my energy-savvy financial friends say "that just about captures it". In systems theory language: the endogenous aspects of the economy, that the economists focus on (Fed rates, money supply etc.) became beholden to exogenous forcing functions that are not part of their training.

9) As shown in our paper in press on investments, markets DO NOT resolve the oil and gas issue. Historically, when scarcity occurs (1970s, now) drilling rates increase BUT THERE IS NO INCREASE IN FINDING/PRODUCTION RATES. We just waste more money/energy drilling foolishly. EROI gives better information on this than does markets. There are many other examples.

Short notes:

a) My eyeball tells me that Gail's prices are more or less ranked inversely in order of EROI.

b) It would be good to do: "food chain" analyses for energy from the mine mouth to the use, "efficiency balloons" etc Good ideas. As noted I have said since 1975 that efficiency (i.e. insulation) is the best investment, but that is not what I am doing here. Hope someone wants to do that. Or find me the money and I shall get students to sweat it out. Not my thing. Anyone who thinks I am a tool of industry certainly does not know me.

c) Efficiency has been improving, but so has energy use per household. Efficiency is in a constant race with depletion, and the empirical result is that it seems that depletion (and increased consumption and Jevon's paradox) is winning. Efficiency increases have not resulted in energy saved overall. Mario Giampietro et al. have a new book on Jevon's paradox.

d) As I said in my original post I am not in a position to judge the nuclear claims one way or another. Maybe someone more knowledgeable than I can pull this together. Sorry to offend with my misinterpretation of the French nuclear cycle (given with appropriate wiggle words I would say) but I think that the final rendition, such as I can interpret from the postings, indicate that maybe I was not too far off. (I think, arguments are hard to follow). I have promoted for many years the Carlos Rubia's possibility of a cyclotron-triggered thorium reactor, but no one has stepped forward to build it. Why? To the pro nuckies: if you are so smart why aren't you rich? And have you looked into the plumbing costs at Chalk River or the investment balance sheets of Clinch River or Super Phoenix lately? Nice ideas, but let's analyze them when/if they are operational. I appreciate the web sites and I will see what I can get from them. Maybe nuclear energy surplus is much higher, maybe not. We need a good analysis by someone good with no preconceived position. As for fusion, Karl Ekdahl showed me fusion, or something like it, at Cornell in 1970 when commercial fusion was 30 years away. Now it is 40 years away. Do the math...?

Renoir said of his paintings "If you don't like them, don't look at them". Until the EROI police come and make our national energy decisions based on EROI then I think that those who wish to try to undertake and refine these methods, get better data, and undertake sensitivity analysis on the results should not be so bothersome to those who seem so exercised by their attempts. But that is just my opinion. I end with the last posting I saw (at 198) by cliffman. Hey, that's the basic issue!



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