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DISCUSSIONS ABOUT ENERGY AND OUR FUTURE

The Future of Capitalism - Profits and Growth

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This is a guest post by George Mobus, who is an Associate Professor of Computing and Software Systems at the University of Washington Tacoma. His blog is Question Everything. He recently wrote another guest post published on The Oil Drum, Energy Flow, Emergent Complexity, and Collapse.

Growth Feasibility

Growth is only possible when energy flow is increasing.

It is pretty simple really. When energy flow is increasing in each subsequent time period it is possible to increase the amount of work devoted to increasing the asset base of society. Alternatively, if the energy flow is decreasing...

Short of a miracle (let's *pray* for it!) energy flows are about to decline in a serious way. And as a result growth is an utterly fatuous notion. Unfortunately, the majority of the population, and especially the economists and politicians, don't get it. The economists still firmly believe that if energy costs (oil, coal, etc.) rise as a result of constraints on production then we will simply substitute other sources (wind, solar PV, etc.) and keep going as we have been for the last two hundred years. This is both stupid and foolish. It is a complete failure of intelligence and wisdom.

Over the next several decades we (humans) will have to change our understanding of what is feasible and what we need to be doing to have a future. The future does not include growth of the GDP or profits. Capitalism as it has been practiced in the 20th century and now hanging on in the early 21st century is dead. Or rather, at this juncture in history, it is moribund. It served its purpose to raise mankind's understanding of what is possible in this world. It was a necessary step in the evolution of knowledge but its time has come and gone.

Real Profits

As growth depends on the continual increase in energy flows, more energy available to do useful work, so profits depend on more net energy available per unit of time, the energy that is left over after accounting for the energy needed to acquire energy.

We need to look more closely at the uses of energy in the economy. My energy mentor, Charlie Hall et al, produced a simple but complete model of energy flows in the world economy that does a good job of summarizing the situation [1, 2]. It starts with an investment of energy to obtain more energy. This is the energy used to build and operate energy extraction, capture, conversion, and distribution infrastructure. When all is well, the amount of usable energy returned from this

investment is many times larger than the energy invested. Or, there is a net energy profit. That profit is then what is available to the rest of the economy to drive the activities of several major sectors. The first major use of energy profit is to maintain the existing asset base. Assets tend to wear out with use and time. The Second Law of Thermodynamics applies to the structures of material goods that we use. So a substantial fraction of the energy flow is directed at work processes that repair or replace these assets. Many kinds of intangible assets, e.g. intellectual properties, also need on-going maintenance work.

The maintenance of assets is the minimal level of work and requisite energy flow in the economy. So these two uses of energy profit, reinvestment in energy capture to keep the energy flowing, and maintenance of the rest of the asset base or capital, constitute the minimum economic activities needed to maintain a steady-state condition in which energy flows at a constant rate and assets are maintained at a constant level.

Historically, humans have discovered and exploited methods of energy capture that have far exceeded the minimum profit needed to just maintain the social economy. Agriculture, exploitation of wind and hydro power, and later fossil fuels, have all allowed humans to generate huge energy profits from nominal investments. Under these circumstances there has always been considerably more available energy for human purposes than could actually be used. This led to the development of two additional uses of energy profits. The first is growth of the economy itself. This first, and foremost, means growth of the population (human bodies are a material asset in the strict sense of the term). But it also means growth and development of all other kinds of assets, both those needed to directly support the culture and those that extend the culture (new kinds of products, services, and arts). The measure of an economy's size is the population plus the asset base, measured in embodied energy units. Once money was invented as a convenient way to represent work, both potential future and past accomplished, assets, at least, could be monetized and the size of the monetary pool could be used to measure the economy size, or at least be a reasonable surrogate measure.

One way of slicing the excess energy available (above that needed for just maintenance) is between necessary and discretionary asset production. Necessary assets are those deemed needed to maintain a given quality of culture. For example building more homes of comparable size to meet the needs of an increasing population would be in this category. Discretionary energy expenditures would include things like building much larger houses than strictly needed to maintain the cultural milieu. Discretionary spending of energy might satisfy egos and desires, but is not, strictly speaking, needed to maintain a given level of affluence. What it is needed for is the evolution of culture. And arguably, a major part of the human condition is involved in the co-evolution of the species and the culture. So from that standpoint it is pointless to denigrate what might now seem to us as excesses of the past. In a real sense these were necessary to promote the evolution of knowledge and understanding. But, all stories of expansion and development do come to an end eventually.

The Energy Budget

Energy flows through the economy (all sectors) have to be budgeted in order to assure the proper balance of energy inputs to the various subsystems. Figure 1 shows this budget roughly. Of especial importance is the feedback of usable energy to the energy capture and conversion capital for maintenance (top white arrow). This is what keeps the usable energy flow into the whole economy up to demand.

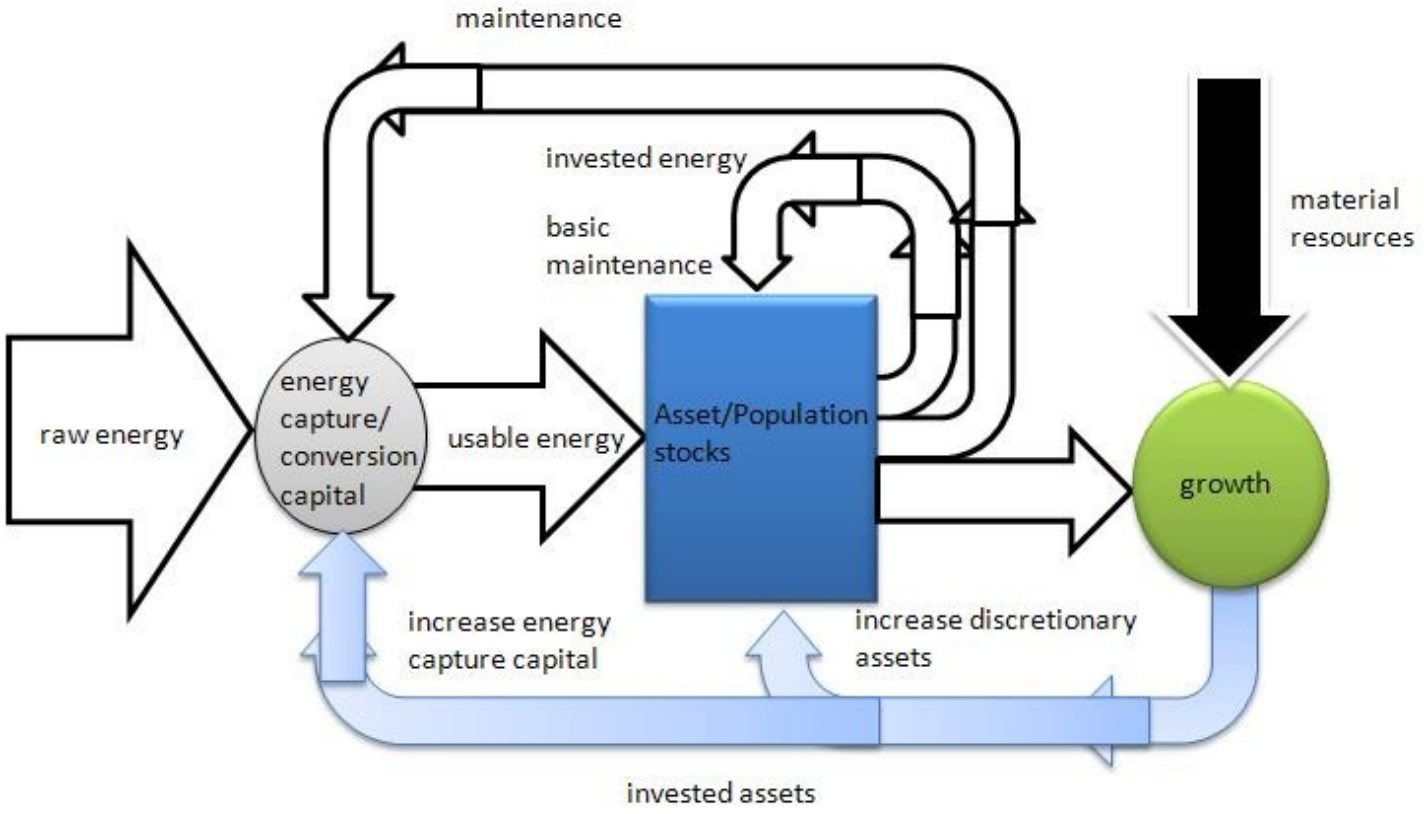

Figure 1. *The energy budget for the economy consists of various flows of usable energy into investments in maintenance and growth. Not shown is the waste heat output from each energy conversion process. After Hall, et al, the "Cheese slicer" model in reference [1].*

The figure shows energy feedback to maintain the current asset base and the flow of energy directed toward work processes involved with producing new assets, labeled 'growth'. This process takes new material resources from the Ecos and converts them into human usable form. Both non-energy related and energy capture assets (capital) are created and fed into the two subsystems. This represents adding assets to the economy at a higher than ordinary maintenance rate; in other words, growth.

Growth applies to all asset classes and human biomass (population and girth) and, importantly, to the energy capture and conversion capital assets. The latter need to grow in order to increase the usable energy flows into the economy assuming that there is more raw energy than is currently being converted available. The amount of growth of all other non-energy assets is now greatly determined by open markets just as the neoclassical economists claim. There is no value judgments placed on what happens in terms of choices about what gets produced. The market is value-free or amoral in this regard. Whatever the buyers want will get produced and sold. Energy will be directed in the appropriate directions to satisfy these desires without anyone actually controlling the process.

But suppose the supply of raw (gross) energy is not only fixed, but actually starting to decline. Instead of excess raw energy that could be exploited by simply putting more energy capture/conversion capital into play, suppose that the raw energy arrow started to contract in size. In that case it would not be profitable (in terms of usable energy return on the investments in energy capture/conversion) to grow that capital equipment. This is exactly the case for fossil

fuels today. We have passed the peak of gross energy production (oil) and are now starting down the decline side of Hubbert's peak. The input energy arrow is starting to shrink. As it does, the usable energy produced and available to the economy for budgeting is getting smaller as well. Note that all of the investments made in the energy capture/conversion process are now starting to provide a smaller return per unit. This is exactly what is meant by a declining energy return on energy invested (EROEI (ERoEI, EROI, and EROeI are all the same concept but different authors insist on slightly different versions of the acronym to maintain their personal sense of internal consistency!)). As the marginal returns start to diminish (the logistic goes through its third inflection point), the investments in both growth of capital and maintenance will start to diminish. After all, profits are starting to decline so who, under our current capitalistic system, would invest in lower profit margins? Of course this can exacerbate the situation with respect to production of usable energy.

Rational Realignment of the Energy Budget, Post-Peak Oil

Figure 2 shows the results of a rational response to a decline in gross and net useable energy flows. Investments in energy capture/conversion capital should diminish as the EROEI declines past a point where an acceptable profit is being made. But at the same time the energy put into growth should be diminished (growth curtailed) so that an adequate flow to maintain current assets can be continued.

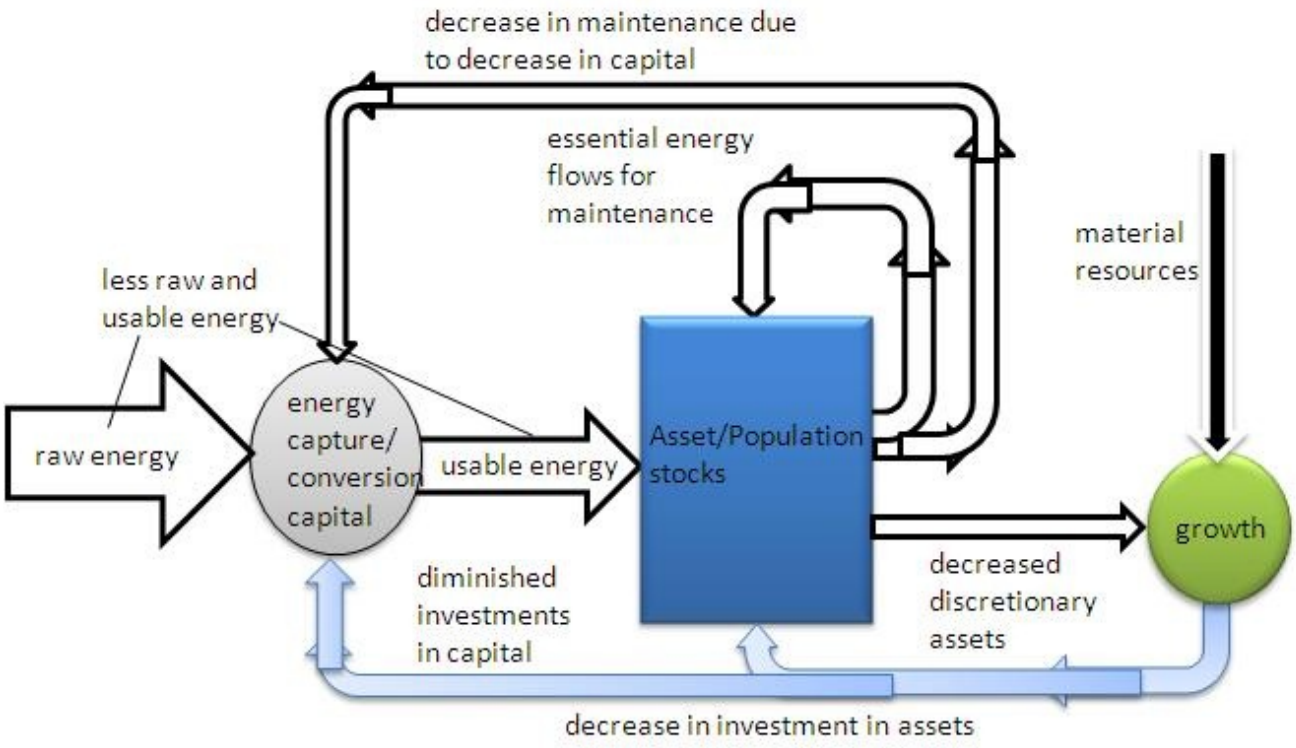

Figure 2. *The energy budget starts to diminish as the raw energy supply shrinks or declines. Investments in the energy capture/conversion capital shrinks in response to poor EROEI. As well the energy flow to growth is diminished as overall useable energy flow is restricted. This model assumes that a rational choice will be made to continue servicing maintenance to current assets, so the reduced energy flow results in a lower growth rate.*

Unfortunately, who, besides economists, said the economy and the markets are rational? Or, more to the point, the individual participants in the market decisions are not rational. Nor do they anticipate changes that will have a time lag between the restriction in energy flows and the 'pain' they will eventually experience. The market mechanism for conveying information is price denominated in dollars (or money value). This is problematic for at least two reasons. First monetary values have been effectively decoupled from the underlying real physical value (in work units - energy) by many distortions, mostly due to the invention of debt (in the form of borrowing by speculation on future earnings) and bizarre financial instruments that pose as money. Second the time lag for effective changes in monetary measures of real economic importance are much longer than the actual time scales for changes in energy flows. Thus, at no particular time is there a direct and causal relation between the money supply and the energy supply. But in our modern capitalistic marketplace, decisions are based on monetary valuations. This leads to all kinds of anomalies, like market bubbles that further distort whatever weak relation still exists.

We have been witnessing the results of these distortions in the current financial meltdown. There has been a massive correction with respect to bringing the relation between money and energy back into focus. But the decision makers continue to fail to recognize the actual cause of the problems. They are still believing that the key to economic success (defined as growth of the gross domestic product - GDP - year over year) is to continue to channel energy flow to the growth process. This is based on the fact that our economy is seen now as a consumer-oriented one. It is healthy if we are producing more goods and services and aggregating the monetary transactions (sales) to show that our GDP is growing.

There are many motivations for believing this way. One is that that is the way it worked in the past. When the raw energy was expanding (we were on the up side of Hubbert's curve) this expansionary logic actually worked fine, except, of course, that we were damaging the environment in doing so. Another is a more subtle interaction between economics and politics. There is a huge political pressure to provide the workers with jobs and cheap goods so that they are "happy". In the democratic nations politicians get and hold their jobs by promising the people that they will do everything in their powers to assure the continuance of business as usual (BAU).

And so, in our less than rational market system, we continue to direct energy flows into the growth production function even though it has meant diminishing our investments into new energy capital (e.g. into renewable energy sources because they have much lower EROEI, at least by historical precedents). Or at least we have not rerouted a significant energy investment that way. Instead we continue to try to expand the fossil fuel raw energy inputs, even as the evidence mounts that this is an impossible route to take. We also continue to budget energy flows to the growth processes in the vain hopes that money will prove to be more powerful than energy. This is, of course, the epitome of foolishness, the antithesis of wisdom.

The proper response to the reality of diminishing energy flows from fossil fuels would be to greatly reduce the flow budgeted to growth and redirect it toward investment in alternative energy capture/conversion capital. It would also be rational to start lowering our energy investment in maintaining large parts of the asset base that are non-productive or discretionary. For example, what would be wise is to start converting much of the standing housing stock into multi-family living quarters instead of trying to revive the new house building industry. The maintenance energy feedback into the standing stock would be to make that stock more efficient in using energy. We need to cut the wasteful parts of the asset base like luxuries and unnecessary entertainments. As per my previous post (on Question Everything), I feel strongly that some of that energy has to be dedicated to preserving the valuable artistic treasures of the past as well as support current humanities. No easy decisions there. But if we don't do something along those

lines, we have lost our humanity.

That brings us, finally, to the crux of the matter, the decision processes needed to respond rationally to the realities of energy contraction. Capitalism is now based on a single pursuit, profit in monetary measures. And that profit applies equally to the growth processes as it does to the energy capital. Yet under the constraints of the real world, the one dictated by the laws of physics, not only is growth no longer rational, neither is the use of profit potential as a guideline of where to put investments. In other words, the market as the main mechanism for decisions regarding energy budgets is now counterproductive. Indeed profits not involved with either the capture of new usable energy or the increase in efficiency for our machines that use that energy have to go the way of the Dodo bird!

Capitalism driven by the profit motive worked pretty well in a growing energy flow economy. We should not be anxious to demonize it outright just because it also led to problems with cost externalities that damaged the Ecos. After all, we humans were actually starting to become aware of that problem and were starting to seek ways to amend it. The problem with capitalism and profit motive today is quite different however. It only works when energy supplies are growing and technologies are making strides to improve overall efficiencies. Today we now know that the former condition is no longer true. Energy supplies are starting to contract and there is nothing on the horizon in the way of alternative energy sources that can come close to the power production from fossil fuels. We may be able to eek out a stable (steady-state) flow of some exosomatic energies from these sources to provide future society with a basis for living a comfortable life, but they will never be able to support BAU. Not even close.

As far as new technologies improving efficiencies, there will, of course be some of that developing, especially if we direct some energy investment toward that end. But reality must intercede again to point out that efficiency gains in real machines suffers from the same Law of Diminishing Returns as in all other physical systems. Efficiencies have upper bounds, both theoretical and practical for all machine types. It is hard for techno-cornucopians to accept but the fact is that our engineering work for the last hundred years has helped us achieve close to the practical limits for many of our modern machine types already. In other words, we can't look for huge gains in efficiencies in our prime movers (though there might be big gains to be made in our heat trap systems, e.g. buildings, through improved insulation and other such measures). We can and will have to stop wasting energy resources on trivial, non-productive or previously discretionary uses. And there may be substantial savings to be realized there (but note that stopping waste is not the same as improving efficiency since, by definition, wasting a resource is something you don’t have to do and can just stop without any technological advances).

An Uncomfortable Conclusion

The conclusion is not comfortable but is imperative. Capitalism, as it has been practiced in a market and democratic governance system, is going to die. It will die in one of two ways. Either people will start to exercise some rationality and some wisdom and realize that as the energy supplies diminish the capacity to do useful work also diminishes. They will then seek to reorganize our governance structures/institutions in such a way as to rationally respond to the reality. Somehow I have a hard time seeing this kind of response. From outright denial, to outright insistence on exceptionalism and blind faith in market mechanisms, I suspect that most people will be blind-sided by reality.

This leads to the alternate more likely response. People will demand, and politicians will give them, continued support for direction of the energy budget into growth and discretionary asset

production as long as they possibly can. For all practical purposes this is exactly what we already see. Think about the state of critical infrastructure in the US. Some of it is falling apart from neglect. Some of it is decaying due to inattention and restriction of energy flows into work to manage it properly. What are the outward signs of this neglect? Aversion to taxes and regulations is an obvious example. The attitudes of libertarians (regardless of political party) is a prime example of psychological resistance to grasping the true nature of what is happening to human economies. Additional examples of the political aversion can be seen in Obama's reliance for economic advice from the very architects of the destruction of financial regulations designed to prevent some of the kinds of bubbles that have arisen in the banking and stock market sectors. I must be frank. I am not hopeful for rationality and wisdom to prevail in the near future.

We (*Homo sapiens*) may be lucky enough that after the SHTF due to mismanagement of the economic energy budget, there may be a spark of rationality and wisdom available and recognized that we can turn to in our despair. Unfortunately even this possibility is highly problematic. More likely mankind will be subjected to a mean and uncaring dictatorial hand, a person or persons not eusapient, but harsh and vindictive. After all, the stock from which to choose potential candidates for leadership is composed largely of minimally sapient beings to begin with. Evolution help us.

For readers interested in an alternative view to the prevailing beliefs you may want to read my series on Sapient Governance here.

Many thanks to Charlie Hall and his associates for so many good insights into the nature of our predicament. I treasure the time I spent with him at SUNY-ESF.

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[1] Hall, Powers, & Schoenberg (2008). "Peak Oil, EROI, Investments and the Economy in an Uncertain Future", in *Biofuels, Solar and Wind as Renewable Energy Systems*, David Pimentel (ed). Springer, New York.

[2] Hall, Balogh, and Murphy (2009). "What is the Minimum EROI that a Sustainable Society Must Have?", *Energies, 2, 25-47; doi:10.3390/en20100025*
