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Peak Oil and The Energy Utilization Chain (EUC)

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This is a guest post, related to net energy, by Doug Reynolds. Dr. Reynolds is an associate professor of oil and energy economics at the University of Alaska Fairbanks, and author of "Scarcity and Growth Considering Oil and Energy", and "Alaska and North Slope Natural Gas".

I met Doug at the recent ASPO/USA conference in Boston. We both were intersted in Charlie Hall's working paper on "The Minimal EROI Required for Society" and struck up a conversation on net energy, and the peaking of Russian oil. I invited him to do some guest posts on his areas of expertise of economics/net energy and Peak Oil/Soviet Union. Below the fold is Doug's guest post on the "Energy Utilization Chain", followed by my comments.

The Maglev Train.

It has often been cited how economics does not incorporate or look at physics and biology when it comes to sustainability issues. However it can also be said that physicists and biologists have failed to recognize economics when it comes to studying Peak oil or how to adapt to Peak oil. One of the more interesting dimensions in the discussions of net energy analysis is the Energy Utilization Chain (EUC). Instead of looking only at the net energy from say the oil well to the car wheel (well to wheel), it is important to also look at the energy service itself. You can have a wheel on a car, but you can also take a train or develop other forms of transportation that can use high net energy sources. In economics, this is called substitution and the degree of that substitution is called the elasticity of substitution.

However, the problem from the economics side is that economists are quick to say that substitution is possible, which gives the appearance that the economists--the Julian Simon's Ultimate Resource crowd--have won the day. But they then fail to consider physics and the entropy law. For example if the net energy for an alcohol fueled car is low, then just use a coal fired steam locomotive train instead or use nuclear power to run electric trains. But if that is your substitute you need to ask, how many railroad tracks and electric corridors are you going to need to build, to replace all the automobiles you have? Such infrastructure would take a long time to build, but more than that it would also require a lot of energy. Thus the net energy of the EUC from in-situ energy source all the way to the energy service is important.

One reason oil is so valuable is because it is in the physical state of being a liquid as opposed to a gas or solid. Solar energy is in the form of an energy field, i.e. a field state, which is the lowest state. The state of the energy resource--the energy state grade--explains an additional value of each energy resource. Coal isn't as valuable as oil or natural gas because it has a lower solid state grade which is why you often pay a premium for oil or natural gas over coal. What is particularly great about a liquid energy resource is that you can take a single drop of that resource, burn it, and release the exhaust all within a split second. That has made the internal combustion engine possible which has made Large Independent Mobil Machinery (LIMMs) possible. The internal combustion engine--as opposed to a coal fired steam engine, which is an external combustion engine--has a great power to weight ratio making LIMMs possible. Coal or nuclear power cannot do that. This is why the oil EUC gives the economy such fantastic service.

Nevertheless, the switch to lower state grade energy resources implies more energy use in order to make heavier, clunkier coal steam engines, as well as electric transport systems, fit into the economy. Also electric transport systems will have a number of power losses along the way because power lines often lose a lot of energy due to heating the lines. So the net energy concept needs to expand to look at the entire EUC from original in-situ resource to the energy service that is being provided. Along the way there will be energy inputs needed to simply build new infrastructure.

Coal fired steam locomotive

Maglev train

For example what is the energy necessary to build two airports, one in Los Angeles and one San Francisco, compared to building, say, a high speed magnetic levitation (Maglev) rail all the way between the cities. Once the energy for building the rail is accounted for, and even some sort of energy rate of return on that initial energy use to compensate the investment, I suspect airports actually have a much lower net energy use. Even if plenty of nuclear power is available, and with out ancillary problems such as storage and nuclear weapons proliferation, you still need a liquid fuel to run all the LIMM construction machinery and LIMM construction vehicles that will build the Maglev line.

Alaksa pipeline pathway

Trans-alaska pipeline

The trans-Alaska pipeline cost $6 billion in 1975 dollars to construct, a cost overrun of six times, and undoubtedly all that construction used a lot of liquid energy. Luckily it was built to transport pure energy, upwards of 2 million barrels of oil a day. Building a similarly difficult maglev would only transport a few hundred people a day at most. Although without a maglev, and no planes being possible without liquid fuels, then steam trains and some higher cost electric trains would be left. That implies a major reduction in our standard of living, which will manifest itself as a GDP decline--a recession or a great depression. It would be similar to the Soviet Unions economic collapse. We would still need to construct a lot of new infrastructure just to accommodate steam locomotives or electric transport systems. Therefore replacing the oil EUC will create a lot of energy problems.

Other economic issues besides this must also be included into concepts of the Hubbert curve. Many such economic concepts can be read in my book, Scarcity and Growth Considering Oil and Energy: An alternative neo-classical view.

REFERENCES

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