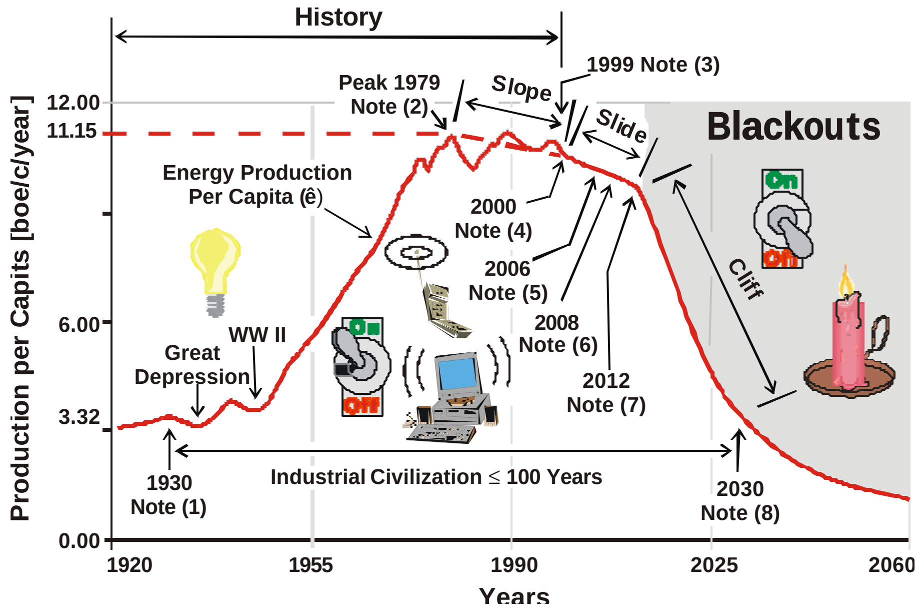
Abstract: Petroleum geologists have known for 50 years that global oil production would "peak" and begin its inevitable decline within a decade of the year 2000. Moreover, no renewable energy systems have the potential to generate more than a tiny fraction of the power now being generated by fossil fuels.
In short, the end of oil signals the end of civilization, as we know it.



For an explanation of the above graphic, see http://dieoff.com/page224.htm

SYNOPSIS

by Jay Hanson, Mar, 8, 2001 -- http://www.dieoff.org

"What becomes of the surplus of human life? It is either, 1st. destroyed by infanticide, as among the Chinese and Lacedemonians; or 2d. it is stifled or starved, as among other nations whose population is commensurate to its food; or 3d. it is consumed by wars and endemic diseases; or 4th. it overflows, by emigration, to places where a surplus of food is attainable."
-- James Madison, 1791

- **ENERGY IS** the capacity to do work (no energy = no work). Thus, the global economy is 100 percent dependent on energy -- it always has been, and it always will be.

- **THE FIRST LAW OF THERMODYNAMICS** tells us that neither capital nor labor nor technology can "create" energy. Instead, available energy must be spent to transform existing matter (e.g., oil), or to divert an existing energy flow (e.g., wind) into more available energy. *There are no exceptions to the thermodynamic laws!*

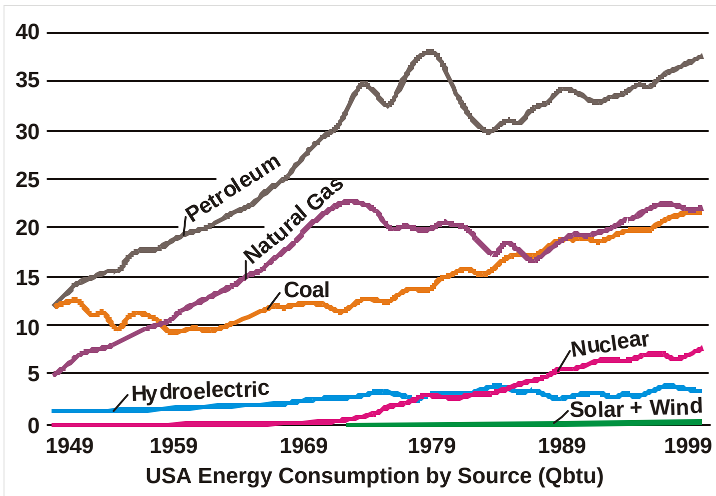
- **THE SECOND LAW OF THERMODYNAMICS** tells us that energy is wasted at every step in the economic process. The engines that actually do the work in our economy (so-called "heat engines"; e.g., diesel engines) waste more than 50 percent of the energy contained in their fuel.

- **ENERGY "RESOURCES" MUST** produce more energy than they consume, otherwise they are called "sinks" (this is known as the "net energy" principle). About 735 joules of energy is required to lift 15 kg of oil 5 meters out of the ground just to overcome gravity -- and the higher the lift, the greater the energy requirements. The most concentrated and most accessible oil is produced first; thereafter, more and more energy is required to find and produce oil. At some point, more energy is spent finding and producing oil than the energy recovered -- and the "resource" has become a "sink".

  There is an enormous difference between the net energy of the "highly-concentrated" fossil fuel that power modern industrial society, and the "dilute" alternative energy we will be forced to depend upon as fossil fuel resources become sinks.

  No so-called "renewable" energy system has the potential to generate more than a tiny fraction of the power now being generated by fossil fuels!

ENERGY QUALITY: *The* Critical Economic Variable



Different kinds of energy resources have *fundamentally different* "qualities". For example, a BTU of oil (oil before it is burnt) is *fundamentally different* than a BTU of coal. Oil has a higher energy content per unit weight and burns at a higher temperature than coal; it is easier to transport, and can be used in internal combustion engines. A diesel locomotive wastes only one-fifth the energy of a coal-powered steam engine to pull the same train. Oil's many advantages provide 1.3 to 2.45 times more economic value per kilocalorie than coal.

Oil is the most important form of energy we use, making up about 40 percent, or 152 quadrillion Btu, of the world energy supply (DOE, 1998). No other energy source equals oil's intrinsic qualities of extractability, transportability, versatility and cost. These are the qualities that enabled oil to take over from coal as the front-line energy source in the industrialized world in the middle of this century, and these qualities are as relevant today as they were then:

> "If one considers the last one hundred years of the U.S. experience, fuel use and economic output are highly correlated. An important measure of fuel efficiency is the ratio of energy use to the gross national product, E/GNP. The E/GNP ratio has fallen by about 42% since 1929. We find that the improvement in energy efficiency is due principally to three factors: (1) shifts to higher quality fuels such as petroleum and primary electricity; (2) shifts in energy use between households and other sectors; and (3) higher fuel prices. Energy quality is by far the dominant

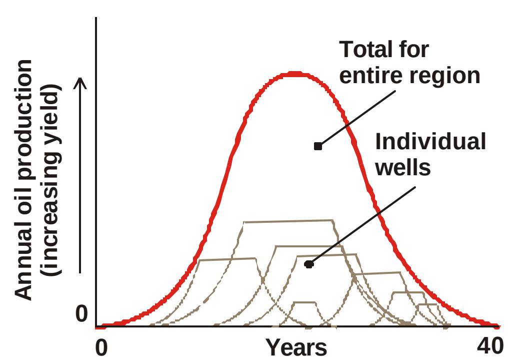
factor." http://dieoff.com/page17.htm#energy .

A BTU of sweet oil is *fundamentally different* than a BTU of sour oil. Sour oil is contaminated with sulfur and requires special refineries with higher energy costs. Some giant oil fields (e.g., Manifa in Saudi Arabia) are "virtually unusable" because they are contaminated with hydrogen sulfide *and* vanadium (a heavy metal). http://www.prospect-magazine.co.uk/highlights/essay_fleming/ .

About a third of the natural gas produced in the lower-48 states is known as "subquality". That is to say, it contains nitrogen (N2), carbon dioxide (CO2) or hydrogen sulfide (H2S) in amounts that preclude its use without being processed to remove these contaminants or blended with volumes of less contaminated gas. Between one- third and one-half of the discovered gas reserves in the lower-48 states also falls into this subquality category. Since the processing adds to the [*energy*] cost of production, subquality gas is not typically a producer's first choice. Once high quality reserves are depleted, however, producers will need to implement cost-effective methods for bringing greater volumes of subquality gas to the marketplace. http://www.gri.org/pub/content/feb/20000224/110827/gtwnt00b-toc.html .

A BTU of coal is *fundamentally different* than a BTU of wood. Coal contains more energy per pound than wood, which makes coal more efficient to store and transport than wood. Solar radiation is *fundamentally different* than natural gas. Natural gas is *fundamentally different* than oil shale, etc. Moreover, a new study shows that energy quality is still *the* critical economic variable! http://dieoff.com/cleveland.pdf .

NON-RENEWABLE ENERGY



After Colin J. Campbell & Jean H. Laherrère, THE END OF CHEAP OIL, Sci Am, March 1998

A "non-renewable" energy source is one that can only be used once. Moreover, physical constraints limit how *quickly* energy can be extracted from a non-renewable natural resource. One can only extract it at a certain rate, the rate peaks, and as the source empties, the rate falls off (the "peak" principle).

THE GLOBAL "EUR" OIL "PEAK"

For many years, geologists and petroleum engineers have published estimates of how much oil can be recovered from any given basin. This is known as "Estimated Ultimately Recoverable" (or "EUR") oil. *Remarkably, estimates of total worldwide EUR oil have varied little over the past half century!* http://www.wri.org/wri/climate/finitoil/eur-oil.html -- http://dieoff.com/eur.htm -- http://dieoff.com/eur.xls -- http://dieoff.com/eur.pdf .

Fifty years ago, geologist M. King Hubbert developed a method for projecting future oil production and predicted that oil production in the lower 48 states (the USA except Alaska) would peak about 1970. Hubbert's prediction proved to be remarkably accurate. Yields have risen slightly compared to Hubbert's original estimate, but the timing of the peak and the general downward trend of production were correct. Hubbert showed that oil production peaks and starts to decline when approximately half of the EUR oil has been recovered. http://dieoff.com/hubbert.htm -- http://www.hubbertpeak.com/hubbert/ .

The petroleum industry itself has announced that global oil production will "peak" in less than ten years!

IHS Energy Group (formerly Petroconsultants) is the world's leading provider of data and analysis for oil exploration and production. The company maintains its headquarters in Geneva. It also has offices in London, Houston, Calgary, Sydney, Perth, Singapore and Hong Kong and a global information network. The backbone of the company is a staff of 300, embracing numerous nationalities, cultures and professions, specializing in petroleum geology, geophysics, petroleum engineering, economics, political science, petroleum legislation, cartography, computer science and information technology. http://www.ihsenergy.com .

In 1995, Petroconsultants published a report for oil industry insiders titled WORLD OIL SUPPLY 1930-2050 ($32,000 per copy) which concluded that world oil production could peak as soon as the year 2000 and decline to half that level by 2025. Large and permanent increases in oil prices were predicted after the year 2000. http://www.forbes.com/forbes/98/0615/6112084a.htm -- http://dieoff.com/page116.htm .

In November 1997, the International Energy Agency (IEA) convened an Oil Conference in Paris. Jean Laherrere and Colin Campbell (empirical arguments) presented three papers on oil depletion against Morris Adelman (economic) and Michael Lynch (technology) from MIT. Here are two of them: http://dieoff.com/page182.htm -- http://dieoff.com/page183.htm .

As a result of this conference, IEA prepared a paper for the G8 Energy Ministers' Meeting in Moscow March 31, 1998. *IEA rejected Adelman and Lynch's arguments*, adopted Laherrere and Campbell's view, and forecast a peak in conventional oil for 2012 at 78.9 Mb/d and a decrease in 2020 at 72.2 Mb/d.

According to Richard Duncan, this represents a significant reversal of the IEA position: "This is a real stand-down for them because until recently they were in the Julian Simon no-limits camp." See the IEA site at http://www.iea.org/g8/world/oilsup.htm . Figure 9 shows oil production peaks: 2000 for world excluding OPEC Middle East, 2015 for OPEC Middle East, 2012 for world oil supply.

See Colin Campbell and Jean H. Laherrere's Scientific American article at http://dieoff.com/page140.htm . See Campbell's presentation to The House of Commons http://www.hubbertpeak.com/campbell/commons.htm . See one of Richard Duncan's papers at http://dieoff.com/page133.htm .

2005 - GLOBAL OIL PRODUCTION "PEAK"

Petroleum experts Colin Campbell, Jean Laherrere, Brian Fleay, Roger Blanchard, Richard Duncan, Walter Youngquist, and Albert Bartlett (using various methodologies) have all estimated a "peak" in "conventional oil" around 2005. Moreover, the CEOs of Agip, ENI SpA, (Italian oil companies) and Arco have all published estimates of peak in 2005. So it seems like a reliable estimate.

Canadian Imperial Bank of Commerce (CIBC) is the second largest bank in Canada and one of the 10 largest in North America with assets of USA $182 billion and a market capitalization of USA $10.5 billion. CIBC relies on Petroconsultants' analysis for its energy research. http://www.cibcwm.com/About/ -- http://research.cibcwm.com/economic_public/download/Or28.pdf .

On Sep. 19, 2000, CIBC released a new report that concluded "After rising for 140 years, world oil production is about to peak." http://www.ottawacitizen.com/business/001006/4643011.html -- http://research.cibcwm.com/economic_public/download/Fcsep00.pdf .

Campbell and Blanchard say that Norwegian production (the second largest exporter after Saudi Arabia) is at "peak" now and set to enter long-term decline.

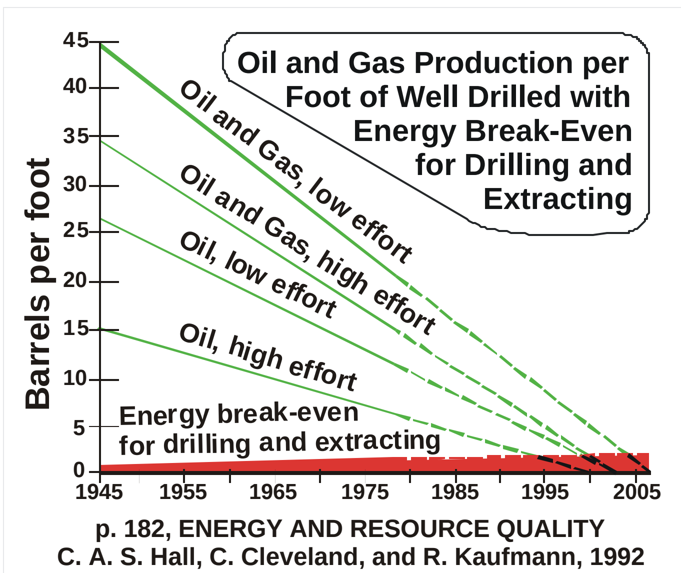
Colombian oil production appears to have peaked in 1999, but one can't be certain for a few years. Colombia obtains most of its oil from a few giant fields, which are now in rapid decline.

Venezuela's oil production has been by influenced world demand, OPEC quotas, and political events. Peak production occurred in 1970 but based upon data from Colin Campbell, the midpoint of EUR was 1998. The mature oil fields in Venezuela have gross decline rates of 20-25%/year. Conventional oil production in Venezuela can be expected to decline in coming years.

Mexico's oil production will probably peak this year or next at the midpoint of depletion.

The latest estimates by country can be found at http://dieoff.com/campbell.htm -- http://dieoff.com/campbell.pdf -- http://dieoff.com/campbell.xls -- http://www.halcyon.com/duncanrc/ .

2005 - THE END OF OIL EXPLORATION IN THE USA



In the 1950s, oil producers discovered about fifty barrels of oil for every barrel invested in drilling and pumping. Today, the figure is only about five for one. Sometime around 2005, that figure will become *one for one*. *Under that latter scenario, even if the price of oil reaches $500 a barrel, it wouldn't make "energy sense" to look for new oil in the USA because it would consume more energy than it would recover!*

THE NORTH AMERICAN NATURAL GAS "CLIFF"

More than 275 North American gas-fired electrical generation plants are planned to begin operations through 2006, up from 158 a year ago, which would increase gas consumption by more than 8.5 tcf!

Unlike oil, natural gas cannot easily be shipped by sea. It must be liquefied prior to shipment, and then shipped in specially designed refrigerated ships destined for specially equipped ports, and then re-gasified for distribution -- at an estimated 15 to 30 percent energy loss. Moreover, natural gas cannot be easily stored like oil or coal.

Campbell says that gas production is better described as a "plateau" followed by a "cliff" due to the high mobility and recovery of gas. Under declining pressure, oil declines slowly as it moves through the porespace of the rocks, but the decline of gas is a cliff -- not a slope. The gas market gives no warning of the cliff because it is no more expensive to produce the last cubic foot than the first. North American production is at or near (< 10 years) its "cliff" now:

> "North American natural gas has no excess capacity. It disappeared several years ago. What we do have is extremely aggressive decline rates in almost every key production basin making it harder each season to keep current production flat.
>
> "The electricity business has also run out of almost all existing generating capacity, whether this capacity is a coal-fired plant, a nuclear plant or a dam. The electricity business has already responded to this shortage. Orders for a massive number of natural gas-fired plants have already been placed. But these new gas plants require an unbelievable amount of natural gas. [The] supply is simply not there." [ENERGY IN THE NEW ECONOMY: The Limits to Growth, Matt Simmons; http://www.simmonsco-intl.com/research/default.asp?viewnews=true&newstype=1]

When Canada signed NAFTA, it ceded total control of its oil and gas reserves. Canada currently makes up about 13% of the USA gas supply. Canada is running out of gas too:

> "Outwardly the production projections of the NEB, EUB and GESI are confusing and even contradictory. But they really carry the same message: the limits of the Western Canada Sedimentary Basin (WCSB) are being recognized. We could gradually increase consumption of the basin's reserves over the next decade and accept sharply falling supply thereafter (the NEB result). We can rapidly increase consumption through drilling quick, short lived deliverability wells and live with an early rapid supply decline (the EUB result). Or, we could redirect more activity to larger reserve plays that require greater lead times and thereby accept an earlier, but gradual supply decline (the GESI result)." http://tabla.geo.ucalgary.ca/NatGasCan/opipaper.pdf

Mexican gas production reached a plateau in 1998 and has had a downward slope of around 2% ever since. http://dieoff.com/mexgas.gif .

> "Energy Information Administration figures showed that volumes coming to the US from Mexico fell from a total of more than 54 bcf in 1999 to just 4.71 bcf for the first 4 months of 2000 and then to nothing. Mexican domestic demand for gas no longer allowed for exports" http://cnniw.yellowbrix.com/pages/cnniw/Story.nsp?story_id=17910217&ID=cnniw&scategory=Energy

Campbell says it is not practical to make up the North American shortfall in gas by shipping it in from the Middle East (shortage of LNG facilities, tankers, and energy loss). However, the construction of a new gas line to Alaska and the Canadian arctic where there probably are large untapped deposits could temporarily mitigate the North American gas cliff.

Energy analyst Stephen B Andrews recently wrote:

> "According to the Oil & Gas Journal (8/21/00), there were 114 existing LNG tankers on January 2000. Only 8 vessels were available for spot-market trade...that is, weren't locked in to long-term trading agreements.
>
> "The 28 LNG tankers now on order and being built will increase the LNG fleet's capacity by close to 1/3. An additional 52 vessels would be required between 2005 and 2010. Combined, the total increase

would be an 87% rise in LNG shipping capacity. Most of those on order today are locked into long-term trading contracts.

"Today, the world trade in LNG is apparently about 125 billion cubic meters -- which would make it around 5% of world natural gas consumption (using BP's Statistical Review of World Energy for the total sum). LNG trade is forecast to increase by 35% by 2005. If all of that increase were directed to North America, it wouldn't come close to covering our projected increased consumption.

"As luck would have it, Asia has already spoken for that upcoming increase in new LNG. 'The potential for LNG imports in India and China is enormous,' wrote O&GJ.

"In the face of projected rapidly growing demand for natural gas in the electricity generation sector, plus relatively flat production in recent times and on the near-term horizon, I wouldn't count on LNG saving North America's bacon."

On October 17, 2000 (Reuters), a top BP Amoco official admitted that there was a "dire need" for gas from both Alaska and northern Canada. Forecasts show gas demand could outstrip supplies from traditional sources by as much as 4 billion cubic feet a day within a decade! -- http://dieoff.com/nagas.htm -- http://dieoff.com/pp.htm .

CANADIAN OIL SANDS (BITUMEN)

Canada's conventional oil production peaked in 1973. By 1999, Canada's oil total production was about 2.6Mb/day of which 0.5Mb (20%) was from oil sands. The Alberta Energy and Utilities Board estimates that production from Canada's oil sands will be extremely slow (100 to 200 years for all of it).

It has been estimated that Alberta oil sands contain about 300 billion barrels of recoverable oil. Syncrude is producing over 200,000 barrels of oil a day right now: http://www.syncrude.com/0_00.htm

Oily waste water is a byproduct of the process used to recover oil from the tarry sands. For every barrel of oil recovered, two and a half barrels of liquid waste are pumped into the huge ponds. The massive Syncrude pond, which measures 22 kilometers (14 miles) in circumference (25 sq. km.), has six meters (20 feet) of murky water on top of a 40-meter-thick (133 feet) pudding of sand, silt, clay and unrecovered oil.
[http://dieoff.com/page143.htm]

To replace conventional crude -- 70 million barrels a day -- would require about 350 such plants. If each of the 350 plants were the size of the present plant, they would require a waste pond of 8,750 sq. km. Or about the half the size of Lake Ontario.

But oil sands are less than half as "energy efficient" as conventional oil, so perhaps one would need 700 plants and a pond 17,500 sq. km -- almost as big as Lake Ontario -- to replace conventional oil.

The above numbers assume that all economic "growth" stops at present levels. Moreover, that does not allow for the increasing energy cost feedback as existing nuclear plants are decommissioned and another 80% of our existing energy sources -- oil, gas, and coal -- become sinks.

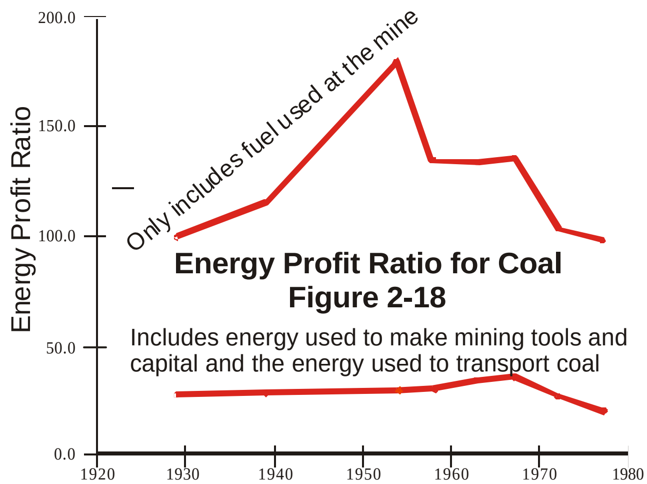
If global energy use continued to double every 30 years or so, five more doublings would put Alberta entirely under oily waste water. But even at 100% efficiency, 300 billion barrels of oil sands would only last 12 years at 70 million barrels a day.

At, say, an average of 25% efficiency over all 300 billion barrels, Alberta could supply about 3 years of oil for today's economy. However, because of the decreasing energy efficiency of existing energy sources, and because the mining of oil sands is so environmentally destructive, it seems unlikely that all 300 billion barrels will ever be recovered:

> "Since opening its operation in 1978 one company, Syncrude, has excavated 1.5 billion tons of so-called overburden, the 20 meters deep layer of muskeg, gravel and shale that sit atop the actual oil sands. More soil has been excavated by Syncrude than from the construction of the Great Pyramid of Cheops, the Great Wall of China, the Suez Canal and the 10 biggest dams in the world combined. Syncrude has possibly created the largest surface mine in the world."
> http://sll.fi/TRN/TaigaNews/News17/Oilsand.html
>
> "Much of the oilsand is too deep to be reached by strip mining. Other methods are being tried to recover this deeper oil, but the economics are marginal. With the strip mining and refining process now in use, it takes the energy equivalent of two barrels of oil to produce one barrel. To expand the strip mining operation to the extent which could, for example, produce the 18 million barrels of oft used each day in the United States would involve the world's biggest mining operation, on a scale which is simply not possible in the foreseeable future, if ever. Canada will probably gradually increase the oil production from these deposits, but until the conventional oil of the world is largely depleted these Canadian deposits are likely to represent only a very small fraction of world production. The production will always be insignificant relative to potential demand. Oilsands are now and will be important to Canada as a long-term source of energy and income. But they will not be a source of oil as are the world's oil wells today." [GeoDestinies, by Walter Youngquist; National Book Company, 1997. http://www.amazon.com/exec/obidos/ASIN/0894202995 . See http://dieoff.com/page132.htm]

USA COAL

> [pp. 65-68, BEYOND OIL, by John Gever et al., Univ. Pr. Colorado, 1991. http://www.amazon.com/exec/obidos/ASIN/0870812424 http://whipper.abebooks.com/abep/il.dll] The United States is in a somewhat better position with regard to coal supply. Because the United States has used only a small fraction of its total coal supply, a Hubbert analysis is only speculative: so little of the left side of the Hubbert curve is known that the rest of it cannot yet be projected confidently. Nevertheless, it appears that coal production will not peak until the twenty-second or twenty-third century. Could coal be the answer to "the energy problem"? Certainly the aggressive ad campaign sponsored by the coal industry would have us think so.
>
> We disagree. Besides glossing over the environmental damage resulting from heavy coal use (acid rain, particulate pollution, carbon dioxide buildup in the atmosphere), optimistic projections have been based on total coal resources and have ignored the fact that substantially less net energy may ultimately be obtained from these supplies. The quality of mined coal is falling, from an energy profit ratio of 177 in 1954 to 98 in 1977



(Figure 2-18 http://dieoff.com/f.gif).

These estimates include only fuel used at the mine, however, and do not include the considerable amounts of energy used to build the machines used in the mines, to move the coal away from the mines, and to process it. When these costs are included, the shape of the energy profit ratio curve changes and starts to drop in 1967. More important, with this formulation the energy profit ratio for coal slips to 20 in 1977, comparable to that of domestic petroleum. While an energy profit ratio of 20 means that only 5 percent of coal's gross energy is needed to obtain it, the sharp decline since 1967 is alarming. If it continues to drop at this rate, the energy profit ratio of coal will slide to 0.5 by 2040.

There are several good reasons to expect coal's energy profit ratio to continue its decline, albeit at a slower rate. Strip mining is becoming increasingly popular, accounting for over 60 percent of total production in 1977, compared to 38 percent in 1969. Because it involves building and operating complex machinery to physically strip away vast amounts of overlying dirt and rock (and to put it back), it is more energy intensive than underground mining. Increased strip mining will therefore lower the energy profit ratio. The average thickness of veins uncovered can be expected to continue its downward trend, and the depths at which they're found will increase. Most important, the average heat content of a pound of coal has dropped, about 14 percent between 1955 and 1982, and will probably continue to fall.

Thus, just as the total content of manganese in the crust lying under the United States does not give a true measure of U.S. manganese reserves, simple inventories of total fossil fuel deposits are deceptive. It will be profitable in terms of net energy to tap only a fraction of them -- perhaps only a small fraction.

HYDROGEN

The automobile industry is planning to put fuel-cell-powered automobiles on the road by 2004. But the new cars won't be on the road for long because these fuel cells use hydrogen via methanol that is made from fossil fuel.

Hydrogen is not a "source" of energy -- it's an energy "carrier" (like electricity). A chemical process known as "steam methane reforming" produces about 95 percent of the hydrogen used in the USA. A carbon-based feedstock (usually natural gas or coal) is combined with steam under high pressure and temperature to produce hydrogen at about a 35 percent energy loss. Methanol is usually produced from natural gas or coal at a 32 to 44 percent net energy loss. http://dieoff.com/page175.htm .

But how about hydrogen from water? The Schatz Energy Research Center recently built a hydrogen generation station for use with their fuel cell vehicles. According to Michael Winkler, hydrogen generation is about 80% efficient using electricity to extract hydrogen from water. The Center's fuel cells are about 50% efficient. This leads to a total cycle efficiency of approximately 40%. http://www.humboldt.edu/~serc/index.shtml .

None of this includes the energy costs of either producing the original electricity or manufacturing the equipment. *Moreover, no renewable energy systems have the potential to generate more than a tiny fraction of the electricity now being generated by fossil fuels.*

OCEANIC HYDRATES

Laherrere has provided two papers that show there is no evidence from all the worldwide research and extensive coring for any massive hydrate deposits. http://dieoff.com/page192.htm -- http://dieoff.com/page225.htm . According to Fleay:

> Gas hydrates resources on the ocean floor are formed at depth where the pressure is high enough and the temperature low enough which means the hydrates are DISPERSED and not amenable to processes to concentrate them in large reservoirs as happens with natural gas and oil. For this reason the cost of extracting them would be formidable and would certainly end up being an energy SINK not a source. Jean Laherrere is well informed on this having been involved in exploring for ocean floor gas hydrates.

NUCLEAR

Nuclear power generation is limited by a shortage of fuel:

> "Overall, uranium is relatively scarce in the earth's crust, at about 4 parts per million on average. Therefore, a significant expansion of nuclear power -- even the five-fold expansion widely canvassed before the incidents at Three Mile Island and (much more disturbing) at Chernobyl -- would out-run readily accessible supplies. These supplies include both deposits previously exploited but mothballed due to lack of current demand, and known high concentration pockets that could be opened up quite quickly. Therefore, the expansion of nuclear would highlight the need to bring rapidly back on course the development of fast-breeder reactors and pursue fusion technology." [p. 90, ENERGY FOR TOMORROW'S WORLD; World Energy Council, 1993]
>
> "Further, nuclear energy, if exploited only in its present form, does not represent an exceedingly long-term source of energy. The basic fuel stock, uranium, is in finite supply. Although there is some debate regarding the quantities of available uranium ore, there is general consensus that the available feedstock will fuel the current generation fission reactors only for decades, not centuries However, it has long been recognized that it is possible to design fission reactors in a manner to convert 'fertile' material into a 'fissile' material, thereby greatly extending the useable fuel supply. [Fast Breeders]" [p. 56, AMERICA THE POWERLESS: Facing Our Nuclear Energy Dilemma, By Alan E. Walter, Ph.D, Forward by Dr. Glenn T. Seaborg, Nobel Laureate and former Chair of the AEC; Cogito, 1995; http://www.amazon.com/exec/obidos/ASIN/0944838588/brainfood.a]

The USA, UK, and France have all dropped their "fast-breeders" because they are "too costly and of doubtful value"! http://dieoff.com/page155.htm

POSITIVE FEEDBACKS -- WITH NEGATIVE CONSEQUENCES

The rising energy costs (increasing extraction effort) and rising economic costs of oil set up a positive feedback loop: since oil is used directly or indirectly in everything, as the costs of oil increase, the costs of everything else increase too -- including other forms of energy. For example, oil provides about 50% of the fuel used in coal extraction. Production from Canada's oil sands will be severely impacted by the depletion of natural gas in less than ten years, etc.

RENEWABLE ENERGY SYSTEMS

ENVIRONMENTAL ACCOUNTING: Energy and Environmental Decision Making **by Howard T. Odum; Wiley, 1996 ;** http://www.amazon.com/exec/obidos/ASIN/0471114421
From page 314, we find that in 1993 total USA fuel use was 4.78 x 10e24 sej (increasing about 2% per year ever since). From page 187 we find that total net solar radiation absorption for Alaska and the lower 48 was 4.48 x 10e22 sej. *In other words, the USA is presently using fossil fuels more than 100 times greater than the total absorption of solar radiation across the entire USA!*

So-called "renewable" energy systems are evaluated differently than "non-renewable" energy systems. In order to be "renewable", an energy system must produce enough net energy to reproduce itself.

A BTU of sunlight is *fundamentally different* than a BTU of fossil fuel. Directly and indirectly it takes about 1,000 kilocal of sunlight to make a kilocalorie of organic matter, about 40,000 to make a kilocalorie of coal, about 170,000 kilocal to make a kilocalorie of electrical power, and 10 million or more to support a typical kilocalorie of human service. So when renewable energy systems are evaluated, both inputs and outputs must be converted to solar eMjoules (or "sej") and compared. *(There are ten different sets of equations to convert energy to sej:* http://dieoff.com/emergy.pdf *)* The difference between the sej input and sej output is known as the "net sej".

Calculations show that solar cells consume *twice as much* sej as they produce. http://dieoff.com/pv.htm So even if all the energy produced were put back into production, then one could build only half as many cells each generation -- they are not sustainable. Even if the sej efficiency of solar cells doubled, ALL of the energy produced would have to be used to manufacture new cells, which still leaves a zero net benefit to society!

Traditional measures of "net energy" for solar cells may be improving but "net sej" may be getting worse because there are ten different sets of equations to convert energy to sej. The only way to know is to DO THE MATH. http://dieoff.com/emergy.pdf

H.T. Odum's solar "eMergy" (eMbodied energy) measures all of the energy (adjusted for quality) that went into the production of a product. Odum's calculations show that the only forms of alternative energy that can survive the exhaustion of fossil fuel are muscle, burning biomass (wood, animal dung, or peat), hydroelectric, geothermal in volcanic areas, and some wind electrical generation. Nuclear power could be viable if one could overcome the shortage of fuel. No other alternatives (e.g., solar voltaic) produce a large enough net sej to be sustainable. In short, there is no way out.

The fact that our society can not survive on alternative energy should come as no surprise, because only an idiot would believe that windmills and solar panels can run bulldozers, elevators, steel mills, glass factories, electric heat, air conditioning, aircraft, automobiles, etc., AND still have enough energy left over to support a corrupt political system, armies, etc.

[If you are interested in more specific details, read the messages at http://www.egroups.com/messages/energyresources or write to me at mailto:j@qmail.com]

A LETHAL EDUCATION

"There is a crime here that goes beyond denunciation.
There is a sorrow here that weeping cannot symbolize.
There is a failure here that topples all our success."
-- John Steinbeck

For want of a nail the shoe is lost,
for want of a shoe the horse is lost,
for want of a horse the rider is lost.

Economic students are taught that banks "create" money every time they make a loan, and that the economy is powered by money instead of energy. The juxtaposition of these two data (the first is true, the second is false) leads even Nobel Prize-winning economists to conclude they have discovered a perpetual-motion machine!

No person has had a greater influence on the thinking of experts who have become government regulators of the world's oil and gas industries than economist Morris Adelman: "There are plenty of fossil fuels and no limit to potential electrical capacity. It is all a matter of money."

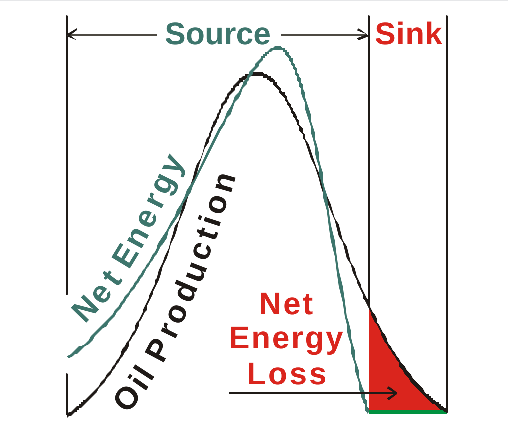
But Adelman -- and every government regulator he has ever influenced -- is wrong. It is a matter of energy! (The only source of energy in money is the medium itself, and a $100 bill contains no more energy than a $10 bill.)

ENERGY LAWS: PERPETUAL MOTION IS IMPOSSIBLE

Although economists treat energy just like any other resource, it is not like any other resource. Available energy is the prerequisite for all other resources. Moreover, universal energy laws tell us that the economist's perpetual-motion machine is impossible.

To lift 15 kg of oil 5 meters out of the ground requires 735 joules of energy just to overcome gravity -- and the higher the lift, the greater the energy requirements. The most concentrated and most accessible oil is produced first; thereafter, more and more energy is required to find and produce oil. At some point, more energy is spent finding and producing oil than the energy recovered. Thus, Adelman is wrong: it is not all a matter of money.

Empirical studies on Louisiana oil fields suggest that oil wells and fields are "energy losers" before they become "money losers" and are closed down. http://dieoff.com/page197.htm



After pp. 186-187, ENERGY AND RESOURCE QUALITY
C. A. S. Hall, C. Cleveland, and R. Kaufmann, 1992

It's important to note that the last 10% or 15% that is *PRESENTLY BEING RECOVERED* is losing energy. [Ref] Thus, if a typical field recovery is 33%, then only about 30% of a field probably provides net energy. If so, then no more energy can be produced from these fields no matter how high the price of oil!!

Neither capital nor labor nor technology can "create" energy (the first law of thermodynamics). Instead, available energy must be spent to transform existing matter (e.g., oil), or to divert an existing energy flow (e.g., wind) into more available energy. The engines that actually do the work in our economy (so-called "heat engines"; e.g., diesel engines) waste more than 50 percent of the energy contained in their fuel (the second law). Thus, Adelman is wrong again: there is a physical limit to potential electrical capacity.

Economists everywhere are wrong: perpetual economic motion is impossible! Imagine having an automobile with a ten-gallon tank, but the nearest gas station is eleven gallons away. You cannot fill your tank with a trip to the gas station because the trip burns more gas than you can carry -- it's impossible for you to cover your overhead (the size of your bankroll and the price of the gas are irrelevant). You might as well plant flowers in your auto because you are "out of gas" -- *forever*. It's the same with the American economy: if we must spend more-than-one unit of energy to produce enough goods and services to buy one unit of energy, it will be impossible for us to cover our overhead. At that point, America's economic machine is “out of gas” -- *forever*.

NEARLY EVERYONE IS WRONG!

Nearly everyone in the world (all governments, and all but a handful of scientists, etc.) has accepted the economists' perpetual-motion machine. Even the Energy Information Administration (EIA) of the USA Department of Energy has no idea how much energy is required to produce energy ("net energy"). Nor does the EIA have any idea how long energy can be produced ("peak")!

But even a child can understand that machines do not run on money -- they run on energy ("Daddy's car needs gas!") -- and available energy is a prerequisite for producing more energy.

Once the truth is told, no one will ever believe that the energy experts in the Clinton Administration were just too stupid to see it coming; too stupid understand these simple energy principles that can be taught to a child...

SURPRISE!

The sudden -- and surprising -- end of the fossil fuel age will stun everyone -- and kill billions. Once the truth is told about gas and oil (it's just a matter of time), your life will change forever.

Envision a world where freezing, starving people burn everything combustible -- everything from forests (releasing CO2; destroying topsoil and species); to garbage dumps (releasing dioxins, PCBs, and heavy metals); to people (by waging nuclear, biological, chemical, and conventional war); and you have seen the future.

Envision a world utterly destroyed by a lethal education:

> "Should we be taking steps to limit the use of these most precious stocks of society's capital so that they will still be available for our grandchildren? … Economists ask, Would future generations benefit more from larger stocks of natural capital such as oil, gas, and coal or from more produced capital such as additional scientists, better laboratories, and libraries linked together by information superhighways? … in the long run, oil and gas are not essential."
>
> -- Nobel Laureate Paul Samuelson and William Nordhaus

> "The problem is, of course, that not only is economics bankrupt but it has always been nothing more than politics in disguise ... economics is a form of brain damage."
>
> -- Hazel Henderson

[More on economics at http://dieoff.com/page185.htm]

[Ref] There are at least two ways an oil company can make money but lose energy: 1) financial subsidies (and thus, energy subsidies) upwards of $600 billion a year http://www.igc.org/wri/media/lash_paris.html (or $1.5 trillion, according to Norman Myers); 2) differences in energy "quality", and thus, price.

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