# The Coming End of Cheap Oil

## *To Hubbert's Peak and beyond*

by John Attarian

Recently several petroleum geologists have predicted that within this decade, the world's annual output of conventional ( easily accessed and extracted crude) oil will peak, then irreversibly decline. In Hubbert's Peak (reviewed in *The Social Contract*, vol. XII, no.2), an excellent, lucid text, Kenneth Deffeyes, a Princeton professor emeritus and former Shell Oil research geologist, makes a persuasive case that output will peak around 2005, give or take a few years.[1]

Confirming that resources are finite, this debunks the cornucopianism of the late Julian Simon. More importantly, the coming end of cheap oil has disastrous implications. It makes radical reforms, including an immigration moratorium, imperative.

### Hubbert and His Followers

Deffeyes's analysis and title are inspired by Shell geophysicist and petroleum geologist M. King Hubbert (1903-1989), who over half a century ago first pointed out that fossil fuels (fuels derived from prehistoric organic matter-- coal, petroleum, natural gas, oil shale, etc.) exist in fixed, finite, and exhaustible quantity, and stated the necessary implications. In "Energy from Fossil Fuels" (1949), Hubbert noted that fossil fuels had accumulated over 500 million years, meaning that any quantity increase in the next 10,000 years would be nil. Beginning with the Industrial Revolution, man has consumed huge quantities of fossil fuels. Once burned, their energy is gone. "Hence, we are dealing with an essentially fixed storehouse of energy which we are drawing upon at a phenomenal rate." Hubbert wondered somberly how long this is sustainable. The supply at any given time equals initial endowment minus previous consumption; consumption is proportional to the area under the plot of annual extraction against time. Hubbert therefore announced "with certainty' that a plot of annual production of any fossil fuel against time "will rise, pass through one or several maxima, and then decline asymtotically to zero." While such a curve could have "an infinity of different shapes," in all cases the area under the curve – the amount produced – could at most equal the original quantity.[2]

This is the idea underlying the famous Hubbert curve. Clearly, it is what resource finiteness *necessarily* implies. Initial and final extraction of such a resource must be zero. In between, output must rise at first, then fall.

Hubbert estimated the world petroleum supply at roughly 320 billion cubic meters. At 100 billion barrels (hereafter Gb, for gigabarrels) per 16 billion cubic meters, this comes to 2,000 Gb of oil. Warning of fossil fuels' eventual exhaustion, Hubbert speculated that water power could replace them as an energy source. Release of energy from fossil fuels, he pointed out, is "unidirectional and irreversible," and "can only happen once." Hubbert concluded – correctly – that humanity's situation in the mid-twentieth century, with soaring total and per capita fossil energy consumption, and soaring population, was "precarious" and "among the most abnormal and anomalous" in world history. Neither reverting to a simpler way of life nor remaining in place was possible. Fossil fuel exhaustion was inevitable; even so, we might be able to stabilize world population at some "reasonable" level and sustain industrial civilization. Or we might simply continue until crises – overpopulation, resource exhaustion and decline – supervene.[3]

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Hubbert's famous "Nuclear Energy and Fossil Fuels" (1956) pointed out that while initial rates of American and world production of coal and crude oil grew at exponential rates, because the resource supply is finite, "physical limits prevent their continuing to do so." This, of course, is just common sense. Recapitulating his earlier analysis, Hubbert presented a stylized graphical depiction of the mathematical relations of the production cycle of a finite resource: a bell-shaped curve of extraction plotted against time, with the maximum possible area under the curve equal to the initial quantity. Time series plots of crude oil production in Ohio and Illinois, he observed, already manifested rise, peak(s) and decline. Based on current recovery methods, Hubbert estimated the ultimate world crude oil reserves (oil which can be removed from known fields with existing technology) at 1,250 Gb. Employing known rates of world production of crude oil and assuming that the maximum production rate would be 2.5 times as high, Hubbert drew a hypothetical bell curve for world production subject to the constraint that the area under it could not exceed 1,250 Gb. This yielded a peak date of about 2000, with the qualification that "variations of this assumed maximum rate would advance or retard" the peak date. He then applied this method to the 48 continental United States, using two estimates of oil reserves, of 150 and 200 Gb, and drew two bell-shaped "Hubbert curves." The first estimate generated a prediction that U.S. production would peak in 1965; the second famously – and correctly – predicted a 1970 peak.[4]

Hubbert qualified this by noting that reserves were based on existing production techniques, which permitted removal of only a third of the oil. Secondary-recovery techniques were improving though, so in future more oil could be extracted, this increasing reserves. Hubbert thought that this improvement would be too slow to affect the peak date much; more likely, better recovery would slow the production decline beyond the peak. Moreover, the peak and decline of oil output "does not necessarily imply" that industrialized countries will have no liquid or gaseous fuels, "because these can be produced from other fossil fuels which occur in much greater abundance."[5]

Subsequently Hubbert presented new estimates of oil supplies and peak dates. In 1962, using figures for past extraction and oil reserves, he estimated American oil supply at 175 Gb with production peaking in the late 1960s, or 225 Gb and output peaking in 2000. His 1981 estimates put ultimate world oil supply at 2,000 Gb with output peaking in 1995, or alternatively fixed at 1975 levels, due to Middle Eastern disturbances, until about 2050.[6]

Other geologists have recently applied Hubbert's method to world oil. In 1996, L. F. Ivanhoe pointed out that world oil discovery peaked in 1962, that world production tends to parallel discovery with a roughly 32-year lag, and that most of the world's large oil fields have probably already been found. Using United States Geological Survey (USGS) world data, and allowing for diminished consumption after the 1970s oil price shocks, Ivanhoe put the peak year at 2010, perhaps slightly postponed by discoveries since 1992.[7] Two years later, Colin Campbell and Jean Laherrère, then associated with the Geneva-based Petroconsultants, asserted that "within the next decade, the supply of conventional oil will be unable to keep up with the demand." With forty years' experience apiece in the oil industry, they debunked the industry's optimistic assessment of "proved" reserves exceeding a trillion barrels. Reserve figures are

**Some Estimates of World Oil Supply (Gb) and Predicted Dates of Peak World Oil Production**

| | | |
|---|---|---|
| | Deffeyes | 1,800 |
| Source | (2001) | 1,950 |
| Hubbert (1949) | World Oil | 2,120 |
| Hubbert (1956) | Supply | |
| Hubbert (1962) | 2,000 | |
| Hubbert (1981) | 1,250 | |
| Ivanhoe (1996) | 1,250 | |
| Campbell-Laherrè | 2,000 | |
| Campbell (2000) | | |
| Campbell (2001) | 1,800 | |

problematic, especially for countries outside America, which can and do inflate reserves for political purposes; shortly after OPEC modified production quotas in the 1980s to take reserves into account, several members increased their reserves by some 300 Gb total. Campbell and Laherrère put total world reserves at 850 Gb, with another 150 Gb still undiscovered. "There is only so much crude oil in the world, and the industry has found about 90 percent of it." Total supply (800 Gb consumed as of end-1997 plus probable reserves plus still undiscovered oil), they concluded was some 1,800 Gb, and output would peak before 2010.[8] Campbell's updated projections obtained similar results; even broadening conventional oil, to include natural gas liquids in oil wells, generated an estimate of 1,950 Gb and a peak in 2010.[9]

> *"A collision is coming, then, between rising demand and falling annual supply."*

Moreover, many specific examples exist of depletion following Hubbert's pattern. A table published by the Association for the Study of Peak Oil & Oil Depletion Analysis Centre (ASPO-ODAC) shows that several oil producers have already peaked, e.g., continental U.S. (1971), Russia (1967), Iran (1973), Venezuela (1970), Nigeria (1979), Libya (1970), Norway (2000), and Britain (1999).[10]

Very usefully, Deffeyes explains basic petroleum geology. Oil exists in layers of "source rock" full of prehistoric organic matter. The source rocks must be, or have been, in the "oil window" – depths between 7,500 and 15,000 feet – because 7,500 feet down, temperatures are sufficiently high, given geologic time, to "crack" sediments containing prehistoric organic matter into oil molecules, but below 15,000 feet, the rocks are so hot that all the oil's carbon-carbon bonds break and oil becomes natural gas. Moreover, the oil must be trapped in porous "reservoir rocks," which must be beneath less permeable "cap rocks," lest the oil seep to the earth's surface and disappear.[11]

Ignorant of petroleum geology, I checked this against some petroleum geology textbooks. Not only is Deffeyes right, geologists have known this for decades – an important point it turns out. John M. Hunt's textbook, *Petroleum Geochemistry and Geology* (1979) discusses the "oil window" in detail, pointing out that "There are limits to the time and temperature (depth) at which petroleum is formed in economic quantities." Moreover, "There is no point in drilling a hole to 20,000 feet … if the kerogen [prehistoric organic matter] is too immature to generate hydrocarbons or if it so depleted in hydrogen that the generating capability is gone."The oil window is a natural phenomenon caused by kerogen's "thermodynamic instability." Few reservoirs contain oil below 14,000 feet; very few below 20,000 feet. "Deep drilling will not change this picture very much," because the scarcity of oil deeper down is caused by greater temperature, not to too few deep tests.[12]

Only one conclusion is possible: *Hubbert was right.* The supply of conventional oil – and of all hydrocarbons – is fixed and finite. It *can't* increase.

Ominously, demand for this fixed resource has steadily increased. World oil consumption has grown at about 2 percent annually for 30 years. In 1990-2000, world crude oil output rose from 60 million barrels a day (mbd), or 21.9 Gb/yr, to almost 70 mbd (25.6 Gb/yr), and is now 75-76 mbd, which comes to about 27 Gb/yr. American consumption rose from 17 mbd (6.2 Gb/yr) to 19.5 mbd (7.1 Gb/yr). America extracts about 6 mbd and imports the rest. Campbell estimates total historical consumption of 873 Gb of conventional oil by end-2001.[13] As immigration bloats Western countries' populations and the Third World industrializes and acquires millions of vehicles, demand will rise.

But as University of Colorado physicist Albert Bartlett's excellent "Forgotten Fundamental of the Energy Crisis" explains, exponential (steady-rate) growth in a finite environment is unsustainable. Steady annual consumption growth of 2 percent implies, taking today's 27 Gb as the base figure, that 267 more Gb of oil will be gone by 2011 – for cumulative consumption of 1,140 Gb, over half the total supply even by optimistic estimates – and that in 35 years annual consumption will double to 54 Gb.

A collision is coming, then, between rising demand and falling annual supply. Conventional oil is *not* running out – roughly half the initial quantity will remain after output peaks – but it *will* be increasingly expensive.

Permanently.

Moreover, there are no easy escapes. Exploration and enhanced recovery technologies have already improved greatly, Deffeyes notes, and "there is little expectation" of a dramatic breakthrough. The South China Sea is the only potential province still unexplored. Whereas annual world oil discovery averaged 43.8 Gb in the 1960s, it is down to perhaps 10 Gb now. As of 2000, Campbell observed, we were consuming oil four times as fast as we were finding it. Even if, which is unlikely, more large oil fields are found, Bartlett noted – and his math is irrefutable – that given exponential consumption growth, "a doubling of the remaining resource results in only a small increase" in its life expectancy. Bartlett's recent mathematical analysis of oil production calculated that if the estimated ultimate oil supply were doubled from 2,000 Gb to 4,000, it would only delay the peak 26 years, from 2004 to 2030![14]

## Debunking the Cornucopians

All this is devastating for the cornucopian school. Julian Simon argued that natural resources are "not finite in any economic sense," and are infinitely substitutable. Our ultimate resource is human ingenuity. An infinite number of points can fit on a one-inch line segment, "because they have no defined size." Therefore their number is not finite. "Similarly, the quantity of copper that will ever be available to us is not finite, because there is no method (even in principle) of making an appropriate count of it," due to, for example, the possibility of making copper out of other materials. "Hence resources are not 'finite' in any meaningful sense."[15]

This is a farrago of absurdities. Points have no size, but copper and oil molecules do; drawing quantitative parallels between them is nonsense. And just because we cannot definitively measure something, that it is non-finite is a *non sequitur*. I cannot feasiblely count how often the letter "e" appears in the books on my desktop shelves, but the number of books, and their contents, are fixed; therefore "e" necessarily appears in finite quantity. Analogously, since only a finite quantity of source rock is or has been in the oil window, conventional oil must be finite. Making meaningful amounts of one element into another with atom smashers would be fantastically costly.

Simon breezily asserted that "our energy supply is non-finite, and oil is an important example." A given well's productive potential may be measured and limited, but the number of wells that can produce oil, and how much, "is not known or measurable at present and probably never will be."[16] Simon again confuses the indefinite and the infinite. Moreover, by now geologists *do* pretty much know where oil is – and isn't – and how much there is.

Even if we could know this global quantity, Simon continued, we would still have to measure the possible oil yield from shale oil and tar sands – and, beyond that, from coal and organic crops (e.g., soybean oils) – and, beyond that, energy from nuclear power, our sun, and possibly still other suns.[17] The supply of oranges is "non finite," then, because we can conceivably convert lemons, apples, watermelons, coconuts and other water balloons into oranges. As if science is magic. Moreover, Simon egregiously telescoped into the present all possible substitutions for conventional oil, from the currently feasible to the remotely possible to the wildly fanciful (apparently with no awareness of the difference), some of which cannot be achieved in relevant quantities for decades or centuries, if at all. *At any given time*, feasible substitution is limited, so is the quantity of substitutes, so is their yield of oil.

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Tellingly, Simon's famous books – *The Ultimate Resource* (1981), *The Resourceful Earth* (1985), *The State of Humanity* (1995) – ignored Hubbert. Much of what cornucopians did say about oil is embarrassingly counterfactual. Interviewed by William F. Buckley, Simon asserted that "we in fact grow oil in Illinois," and "copper and oil come out of our minds. That's really where they are."[18] No, Mr. Simon, they're in the ground, and oil doesn't come out of our minds, it comes out of source rocks, and therefore can't be "grown" like wheat.

William Brown's "The Outlook for Future Petroleum Supplies," in *The Resourceful Earth,* asserted that new technologies were "opening up vast new regions with great potential," such as jungles, polar regions, and offshore areas.[19] In fact, worldwide discovery has collapsed.

"Another promising region," Brown added, is deeper depths of existing petroleum areas. "That is, for economic reasons over 95 percent of the existing basins have not been explored below 15,000 feet." Higher prices give incentives to drill deeper, and while it is too soon to say what the potential of deeper deposits is, "[t]here is little doubt that they will be significant. There is a reasonable chance that they will prove to be astonishingly productive" due to new technology. By 2100, Brown believed, almost all petroleum resources up to 40,000 feet down, perhaps deeper, would be explored. Similarly, in 1991 Simon trumpeted that we will "dig deeper and pump faster" and get more oil.[20]

But going deeper would overshoot the "oil window." Drilling stopped at 15,000 feet for geological reasons, not economic ones: going deeper didn't make sense, because deeper down there generally wasn't any oil. Petroleum geologists already knew this. Hunt's textbook, to repeat, appeared in 1979. That Brown, and Simon himself, were so crassly ignorant of well-established facts readily available even in a previously published college textbook is damning. The cornucopians did not know what they were talking about.

Geologists would not have made these howlers, but Brown was Director of Energy and Technological Studies at the Hudson Institute; Simon was an economics professor and Heritage Foundation adjunct scholar. Cornucopians tend to be dwellers in a realm of words, theories, and abstractions – not people in contact with the realities of a limited world. The latter, such as Campbell, Deffeyes, and Ivanhoe, do not parrot Simonesque platitudes. They know better. That the closer one gets to reality and hard science the fewer cornucopians one finds is telling.

In *The Economics of Petroleum Supply*, economist Morris Adelman flatly asserted that "Minerals are essentially inexhaustible. Oil, gas, coal, and copper … will never be depleted. Investment in exploration and development creates an in-ground inventory of proved reserves, constantly used up and replaced." Adelman's *The Genie Out of the Bottle* proclaimed, "Reserves are renewable and constantly renewed, if – and only if – there is enough inducement to invest in creating them. The inducement depends on price and cost." And: "Oil is a renewable resource."[21] Constantly replaced out of what? Renewable how? A higher price gives incentives to find more already-existing oil, but cannot "create" fresh reserves by giving source rocks "inducement" to enter the oil window.

***"Drilling stopped at 15,000 feet for geological reasons, not economic ones: going deeper didn't make sense, because deeper down there generally wasn't any oil."***

Similarly, USGS geologist Peter McCabe analogized oil reserves to a grocery warehouse "constantly being replenished with baked beans from canned food manufacturers."[22] Food canneries exist; oil factories do not. Where do the new reserves ("baked beans") keep coming from, if, as McCabe admitted (see below), fossil fuels are finite? An Easter Egg hunt is a better analogy; as the kids search longer, harder, and smarter, they find more eggs – but they can't find more than Mom's basket held to start with.

Adelman and Michael Lynch argued that seeing resources as fixed is unduly pessimistic. Estimates of falling reserves and production "are incurably wrong because they treat as a quantity what is really a dynamic process driven by growing knowledge." Knowing the limit to oil reserves and output requires knowing future science and technology, which is impossible.[23] Simonesque confusion of indefinite and infinite. And the facts of oil formation necessarily mean a ceiling on discovery.

Other cornucopians, such as Robert Bradley, president of the Institute for Energy Research (and Enron's Director of Public Policy Analysis) regurgitate earlier optimism, assert abundance, and ignore contrary evidence. Bradley's "The Increasing Sustainability of Conventional Energy," written for the Cato Institute, a leading libertarian think tank, cites Adelman and Lynch, invokes "human ingenuity," and asserts that the 1992-1996 period's 40 percent drop in costs for finding oil in America "is perhaps the best indicator that oil is growing more abundant, not scarcer."[24] This *non sequitur* (cost may be dropping because exploratory technology is getting more powerful) cannot be squared with the well-known collapse of American oil discovery, which Bradley ignores.

A hint that cornucopians inhabit an alternative wish-based reality is their citation of physicist Thomas Golds' theory of a "deep, hot biosphere" in which oil is produced, from which it rises, implying abundant undiscovered oil.[25] If this is so, why has world oil discovery collapsed since the 1960s? More to the point, will new oil from the "deep, hot biosphere" arrive quickly and abundantly enough to avert a painful crisis? Oil which won't be accessible for another thousand years *does not exist* for all practical purposes.

## Flawed Cornucopian Attacks on Hubbert

When cornucopians do engage Hubbert, they often misrepresent him or raise false issues. Witness the following examples.

Trying to make Hubbert look gloomy, Adelman and Lynch cite him selectively. They present his 1974 estimate of the U.S. oil supply of 170Gb – then note that as of 1997 production was already 170 Gb, with proved reserves of another 20 million barrels, with 2 Gb added annually, and that the USGS's current estimate was 250 Gb. But his prediction of the 1970 peak assumed a 200 Gb supply, which they ignore. Likewise, they present only his 1,250 Gb estimate of world supply and cite the USGS estimate of 2,400 Gb – ignoring Hubbert's other estimates of 2,000 Gb.[26] This is too dishonest to take seriously.

McCabe characterizes Hubbert as believing that "resources are finite," as if this is a defect – but admitted that "in the long run the supply of fossil fuel is finite," and "The amount of fossil fuel … of course, is finite." He misrepresents Hubbert as "regard[ing] Ohio's oil resources as virtually exhausted," when his 1956 paper said no such thing.[27]

Cornucopians belabor the bell-shaped curve. "There is no inherent reason" why a given fossil fuel's production plot "should have a symmetrical bell-shaped curve," McCabe intones. The University of Oklahoma's David Deming adds that "there is no unique Hubbert curve," but that Hubbert himself apparently exclusively used symmetrical curves.[28] Much ado about nothing, since, as these writers admit, Hubbert said production plots could have more than one maximum and an infinity of possible shapes. Worse, this is a red herring, conveying an impression that Hubbert stands or falls on production plots following a bell-shaped curve. Hubbert's essential points were that a fossil fuel's supply is fixed and finite, therefore exponential growth in extraction is unsustainable, extraction must eventually decline and cease, and total extraction cannot exceed initial quantity. The curve's shape is unimportant.

Deming claims that Hubbert's 1956 paper "made what he considered to be a 'best' estimate" of total U.S. crude oil supply – 150 Gb. As for predicted peak dates, "The actual peak occurred in 1970. Hubbert's best estimate (1956) of peak production in 1965 was in error by five years, with the actual production peak occurring at the outer limit of his uncertainty range." The claim of Hubbert's adherents that he was right "is only true if Hubbert's (1956) upper curve … is used, and Hubbert's actual prediction of 1965 is ignored."[29] This is flat dishonesty. I have read Hubbert's paper, and nowhere did he describe the 150 Gb estimate as his "best," or call 1965 his "actual" prediction or "best estimate," or give it more weight than 1970.

Deming notes that Hubbert "was intimately involved with technocracy," which envisioned a "highly authoritarian" ideal society, and that authoritarian governments – Nazi Germany, the Soviet Union, Communist China – were mass murderers. Hubbert's politics "appear to have been dangerously wrong." Deming wonders if they "may have influenced his scientific conclusions" regarding oil.[30] A shameful smear by association.

## The Chimera of Alternatives

But the cornucopian trump card is that we can substitute unconventional hydrocarbons (shale oil, heavy oil, tar sands, etc.) for conventional oil if oil price increases make it economically viable. We could even extract carbon and hydrogen from the air and fabricate hydrocarbons. "The only realistic limitation … is price," argues Maurice Dessault of the University of Waterloo in Ontario.[31]

Uncannily, like the shipwrecked economist assuming a can opener in order to open the can of food, cornucopians assume that technology will make this feasible. This is just Micawber-like profession of faith: something will turn up. What if it doesn't?

More importantly, the price argument overlooks the physics. Processing unconventionals is energy-costly. If processing consumes more energy than it yields, it is a loser; price is relevant.

Shale oil could yield trillions of barrels. But extraction is forbiddingly tough. Oil shale is kerogen-containing rock – source rock which has not been in the oil window. It requires not only mining, but processing: replicating, in telescoped time, what happens in the oil window, by crushing the rock and heating it to 900 degrees Fahrenheit, liquefying the kerogen – which must be processed into oil by adding hydrogen, then refined. Resultant waste requires disposal. Net energy yield is at best slightly positive. "It is doubtful that shale oil can ever play a significant role in replacing world oil supplies, if it can replace them at all," geologist Walter Youngquist concludes. "Shale oil cannot possibly make the United States energy self-sufficient in terms of liquid fuel."[32]

Extracting heavy oil requires heat (often steam or hot water) and solvents. On average, one oil barrel's worth of energy must be expended to get two barrels of heavy oil. Extracting oil from tar sands is underway in Canada, but requires much heat, currently supplied by natural gas, an average of one thousand cubic feet of gas required per barrel of tar sand oil.[33] With present extraction technologies, these alternatives are not promising.

Heavy oil deposits along Venezuela's Orinoco river have been processed into an oil-water emulsion ("orimulsion") for powering electric generating plants. New methods are in use to extract the heavy oil and refine it into crude, and from crude into fuels. Canadian tar sands now yield 250,000 barrels as day, expected to double by 2007. Over 200,000 barrels flow daily from the Orinoco; this is expected to triple by 2006. "Gas-to-liquids" conversion of natural gas to liquid fuels may yield a million barrels by 2020. Campbell estimates that combined Canadian and Venezuelan output of tar sands and heavy oil will be 2.8 mbd in 2005, 3.6 mbd in 20120, and 4.6 mbd in 2020 – or 1.0, 1.3, and 1.7 Gb/yr, respectively.[34] These are drops in the bucket, given today's consumption of 75 mbd, and higher demands in the future. Absent crash programs to boost output, and technological breakthroughs, these sources will not help much.

As for making ethanol from corn, after examining the process and factoring in all its energy costs, including those entailed by growing corn, Cornell University agricultural science professor David Pimentel concluded that a gallon of corn-based ethanol costs about 71 percent more energy than it contains, making ethanol a loser.[35] Ethanol partisans, including the National Corn Growers Association, retort that Pimentel recycles old data and ignores recent technical progress.[36] But even if he is too pessimistic, significantly replacing oil with ethanol would require colossal expansion of corn cultivation, massively depleting water and topsoil, and competing with other land use, such as housing our immigration-swollen population.

Natural gas is abundant, and can partly substitute for oil. But natural gas too is finite, and its output too will eventually peak and decline; Campbell and Laherrère project world output peaking in 2020.[37]

Wind, nuclear, and solar power cannot replace oil as input for petrochemicals – plastics, pharmaceuticals, tires, asphalt, fertilizers, etc. They are only limited energy substitutes: aircraft, trains, tractor-trailer rigs, farm machinery, and construction equipment cannot use wind, nukes, solar panels, or batteries. Many vehicles and other machines integral to our way of life simply must have liquid fuel.

The claim that a price will solve any problem or remove any shortage if it simply gets high enough reflects two related, fundamental impieties in modern man: that human ingenuity can escape the limits of the human condition and of reality, and that demand creates supply. In short, *you can get your way if you want it badly enough*. Clap your hands, and your servant Reality will come running. This is what makes Julian Simon's glib, fatuous blather so dangerous. One of the most pernicious manifestations of man's perennial rebellion against creaturehood, the cornucopian school tells impious modern man what he most wants to hear: limits do not exist, you can get something for nothing, desires trump reality, don't worry, be happy.

But man is not God and reality cannot, will not, infinitely accommodate him, never mind price or blustering about human ingenuity. If rocks contain no oil, *they will yield no oil;* if an aquifer is drained, *it will yield no water;* if processing an alternative source takes more energy than it yields, *it is senseless* – no matter how high prices get. Prices convey information. They do not work magic. In anything grounded in physical reality, science, not economics, has the last word.

Clearly, the cornucopian school is an intellectual opium den. There are limits on human possibilities, and we are about to collide with them.

## Connecting the Dots: The Grim Consequences

This collision will be painful. All economic activity requires energy, and roughly 40 percent of the world's primary energy demand is met by oil.[38] Petroleum underlies just about everything we do. No other energy source can match conventional oil for versatility, portability, ease of storage, net energy yield, and so on. Cheap conventional oil is one of the primary factors making our affluent, comfortable modern way of life possible. It follows that when oil is no longer cheap, our way of life will be disrupted to the point of unsustainability.

The drying-up of cheap conventional oil will do for the modern economy what a long drought does for agriculture. One obvious consequence will be a persistent replication of the "stagflation" – simultaneous inflation and recession – which followed the 1973-1974 oil embargo. Real wages and labor productivity will stagnate or even decline. Since producing and transporting all production inputs takes energy, much of it fossil fuel, costlier oil will make them costlier too, meaning that an investment dollar will not buy as much productivity growth as it could before.

Meanwhile, by a gruesome coincidence, right around the time oil peaks, the Baby Boomers will start flooding Social Security and Medicare beneficiary rolls. So just as the largest generation in American history begins retiring (the oldest Boomers will be 65 in 2010), the cheap oil bottom will start dropping out of the economy which will have to support them. The inflationary recession largely caused by the 1973-1974 oil crisis precipitated the first financial crisis in Social Security's history, as higher-than-anticipated inflation drove inflation-adjusted benefit outlays up and unemployment shrank Social Security's tax base. This time the oil shock will be permanent.

The Congressional Budget Office projects that spending for Social Security, Medicare, and Medicaid, which provide old-age and elderly health care benefits, will rise from 7.8 percent of GDP in 2001 to 14.7 percent by 2030. Assuming federal revenues remain roughly 20 percent of GDP, and entitlement programs are unchanged, the General Accounting Office forecasts that by 2030 federal outlays will be roughly 28 percent of GDP and Social Security, Medicare, Medicaid and interest on the debt will take 75 percent of revenues. By 2050, outlays will be almost 40 percent of GDP, and revenues will cover only half of them, making the budget deficit some 20 percent of GDP.[39]

These frightening calculations reflect only an aging population, and ignore cheap oil's demise. Moreover, *all* forecasts by Social Security's and Medicare's actuaries, *including* the pessimistic ones, assume steady long-term growth in real wages, productivity, and GDP. Obviously, an economy crippled by higher inflation, soaring energy costs, rising unemployment, and stagnant productivity cannot carry these burdens. The oil crunch, then, will disastrously worsen the coming fiscal crisis of entitlements. It therefore greatly strengthens the case for rigorous means testing to cut entitlement costs. It also kills Social Security privatization, a severe, prolonged bear market in stocks being a likely consequence of a persistent and worsening energy squeeze.

The effects will be grimmest in agriculture. As cornucopians always brag, modern agriculture is fantastically more productive than traditional farming. What they overlook is that it gives hostages to hydrocarbons. As Bartlett aptly put it, "Modern agriculture is the use of land to convert petroleum into food." In 1999, according to the U.S. Department of Agriculture's Economic Research Service, energy costs accounted for 24-31 percent of the total variable cost for field crops (e.g., corn, wheat). Not only does modern agriculture use fossil fuels for machinery, transportation, groundwater pumping and irrigation, it depends heavily on fertilizers, which are made by reacting natural gas with nitrogen. Since natural gas accounts for 75-90 percent of the cost of nitrogen fertilizers, rising natural gas prices will devastate the fertilizer industry; fertilizer producers could not cover costs by the end of 2000 due to high gas prices.[40]

With natural gas substituting for oil, demand will be increasing for a supply which will be falling after about 2020. This means steadily rising gas, fertilizer, and food prices, and dwindling crop yields in nations which must import natural gas, fuels and fertilizers, and which cannot afford the squeeze. North Korea's recent famine is a warning of modern petroleum-based agriculture's vulnerability to breakdown if hydrocarbon inputs disappear; when fuel and fertilizer supplies collapsed, so did agriculture; three million North Koreans starved to death.[41]

Moreover, costlier energy will exacerbate our already-worsening water problems by making it costlier to purify and recycle contaminated water and to drill for, pump, and transport ground water.

The coming oil crunch makes curtailment of mass immigration an urgent imperative. Mass migration from Third World countries with low per-capita energy use to affluent nations with high per-capita energy use must necessarily increase total energy demand. Surging immigration, the main contributor to America's population growth, will greatly increase demand for costlier energy. In 1973-1995, American energy consumption rose some 22 percent, some roughly 90 percent of it due to population growth.[42] It is well known that immigration accounts for some 70 percent of population growth since the Seventies. This means immigration accounts for the lion's share of the increase in energy use – roughly 63 percent (.9 x .7 = .63). It necessarily follows that we cannot tackle energy without tackling immigration. This is not nativism, this is arithmetic.

California's energy crisis is grimly instructive as to what continued mass immigration means. As Ric Oberlink observed, California's total energy consumption more than doubled in 1969-1999, even though per-capita use grew only 22.9 percent (from 5,655 kilowatt-hours to 6,952). The reason? California's population rose from 19.7 million to 33.1 million (up 68 percent), some 95 percent of it due to immigration.[43]

Not only will mass immigration worsen the oil problem, most immigrants have no human capital to offer to help cope with it. In fact, immigration will make coping disastrously harder. Floods of immigrant labor will exacerbate productivity and wage stagnation, thereby worsening economic stagnation, making it harder to afford costlier energy, goods, services, and entitlements – and harder to finance the urgently needed huge investments in alternative energy sources, meaning our energy plight will worsen. Should hydrocarbon inputs for agriculture decline, yields on already-heavily worked croplands, depleted of natural nutrients, will fall, forcing us to bring more land under cultivation – which will collide with the urban sprawl due to immigration-driven population growth. Mass immigration and the decline of conventional oil, then, will create a vicious circle, each one worsening the problems spawned by the other.

Colin Campbell warns that America "has to somehow find a way to cut its demand [for oil] by at least five percent a year."[44] This will be impossible without a complete moratorium on immigration, for at least two decades, to see us through the transition from cheap oil to a sustainable mix of substitutes. We cannot simultaneously cut demand for oil while allowing the main force driving it higher to keep operating. The longer mass immigration continues, the more per capita energy use must fall to compensate – meaning the more austere and impoverished our lives must become. Put another way, continued mass immigration in a context of declining conventional oil output will rapidly turn America into an impoverished nation with Third World living standards.

Obviously, we must promptly develop alternatives to conventional oil and natural gas. But equally obviously, we must take measures promptly to conserve energy. And an immigration moratorium is at the top of the list. •

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### RECOMMENDED WEB SITES ON THE OIL CRISIS

**www.oilcrisis.com**
(www.energycrisis.com, www.hubbertpeak.com)

Best English language site. Arguing from a Hubbert perspective, it includes news, editorials, information on natural gas and alternative sources, information on Hubbert and his theory, some key works by Hubbert, and articles, reviews, and analyses by experts such as Professor Albert A. Bartlett, Colin J. Campbell, L. F. "Buss" Ivanhoe, Deffeyes, Jean Laherrère, and Walter Youngquist. Clicking "Ivanhoe" accesses the M. King Hubbert Center for Petroleum Studies, a unit of the Colorado School of Mines, which Ivanhoe coordinates. This gives access to the complete set of issues of the concise but highly informative Hubbert Center Newsletter, published quarterly since 1996.

**hubbert.mines.edu**

This is the internet address for the Hubbert Center, in case you want to go there directly rather than through oilcrisis.com.

**www.isv.uu.se**

Detailed coverage of May 2002 International Workshop on Oil Depletion, Uppsala University, Uppsala Sweden, and beginning with the January 2002 issue, the excellent newsletter of the Association for the Study of Peak Oil & the Oil Depletion Analysis Centre, edited by Colin J. Campbell (co-author of "The End of Cheap Oil").

**www.energiekrise.de**

A German site which makes its materials available in both German and English. (To convert German language materials to English, click "English" on the bar at the top of the home page).

**www.runningonempty.org**

This is a useful survey of the situation with basic facts, figures.