The Jig Is Up

Supplies of oil and gas are running out

Book Reviews by John Attarian

For several years, veteran geologists have warned persuasively that the peak and decline of oil and gas extraction are imminent. Two recent books are invaluable for understanding this epochal development and its consequences.

A Masterful Look at Depletion Up Close

Perhaps the foremost depletion expert, geologist Colin J. Campbell spent decades exploring for oil worldwide for Texaco and Amoco, then worked with Geneva-based Petroconsultants. In *The Coming Oil Crisis* (1997) and other publications, Dr. Campbell warned repeatedly that world oil extraction will peak early in this century. In 2000, he founded the Association for the Study of Peak Oil and Gas (ASPO), an international body of scientists devoted to examining peak and depletion and educating the world about them. Drawing heavily on his work for ASPO, *The Essence of Oil & Gas Depletion* is an authoritative treatment of depletion, compre-hensive, rigorous, yet lucid.

Since oil and gas were formed in the geological past, they are necessarily finite and depletable. The important issue, Campbell argues, is not when they will disappear, but when production will peak and then decline due to supply constraints. "This threatens to be a discontinuity of historic proportions, given that oil provides 40% of traded energy and 90% of transport fuel." For convenience, efficiency and cost, oil and gas far surpass all existing substitutes. Thus, "by any reasonable reckoning, *Hydrocarbon Man* will have become extinct by the end of the Century." Yet awareness of this catastrophe is blocked by unreliable data on oil reserves; business and government interests having an incentive to deny it; our lack of precedent in exhaustion of an essential resource; our faith in deliverance through technology; and mainstream economics, which deems man the master of his world. Campbell hopes that knowledge of depletion will enable people to understand the limits Nature imposes and devise a better way of life.

The Essence of Oil & Gas Depletion

by C. J. Campbell
Brentwood, Essex, England: Multi-Science Publishing Co., Ltd.
348 pages, $48.00, £33.00, paperback
[Can be ordered through R.B. Swenson, P.O. Box 7080, Santa Cruz, CA, 95061. Prepaid by check only. CA residents add 8% for $51.48 total.]

The Party's Over: Oil, War and the Fate of Industrial Societies

by Richard Heinberg
Gabriola Island, Canada: New Society Publishers
288 pages, $17.95, paperback
[Heinberg"s biography and some issues of his monthly newsletter are available at www.museletter.com.]

Part I is perhaps the best available summary of the situation. Because oil must be found before it can be extracted, Campbell points out, production must reflect the earlier discovery trend. Since worldwide discovery peaked in 1964, "the global peak of production is now close." Getting an accurate picture of oil supply is vital, but published data on "proved reserves" are unreliable. Greater realism, he rightly argues, requires both backdating revisions in reserve data to the date of discovery, and good definitions of the different kinds of oil: conventional (cheaply, easily-accessed oil) and nonconventional (more difficult and expensive types such as heavy oil and deepwater oil, i.e., found below 500 meters or more of water). Economists argue that as oil prices rise we will turn to nonconventional oils, but Campbell warns bleakly that "most of them can come on only slowly" because "they are expensive and difficult to extract." They may alleviate the

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decline, but not the peak.

Demand for oil, Campbell points out, affects the depletion rate. Rising oil prices will induce recession, reducing demand. Thus the "peak" will probably be a plateau, with bumps corresponding to cyclical fluctuations in demand.

Campbell's treatment of natural gas is likewise illuminating. Being a gas, it depletes differently from oil. Since uncontrolled extraction would quickly exhaust gas deposits, "production is generally capped at far below capacity to provide a long plateau, set by pipeline infrastructure," with seasonal fluctuations. Capping production creates built-in excess capacity – but when excess capacity is exhausted, output collapses, without warning signals from prices.

"Changes in the oil industry – mergers, fewer drilling rigs, oblique admissions of depletion – offer further evidence, [Campbell] notes, that depletion is real."

Campbell predicts oil extraction peaking around 2010, with oil plus gas peaking about 2015. The supply constraint driving the subsequent decline must then curb demand. "It implies that the economic growth of the past, which was largely driven by an abundant supply of cheap oil-based energy, cannot continue on the same trajectory."

Therefore, Campbell argues compellingly, humanity must learn to use substantially less oil – difficult, but possible given current "monumental" waste. We should tap alternative energy sources to cover as much of the oil shortfall as possible. The stakes are enormous, but if we act now we can conceivably weather the decline; we have "a little breathing space…since the production of all liquid hydrocarbons… need not fall below present levels for some twenty years."

Most of Campbell's book consists of edited excerpts from the first 24 issues (December 2000-November 2002) of the monthly *ASPO Newsletter:* a rich mixture of discussions of the role of energy and oil in economic life; reports on educational activities by ASPO members about peak and depletion; rebuttals to the "cornucopian" (non-finite resources) camp; detailed examinations of individual oil-producing countries; notification of changes in published oil reserve data; reporting on exploration and discovery; commentary on America's economy and foreign policy; mentions of important new depletion literature; and illuminating treatments of technical points such as oil reserve reporting and the decline in oil discovery. Numerous charts of oil discovery, extraction in various nations and individual oil fields, world oil supply, estimates of total ultimate oil recovery, the gap between oil discovery and consumption, and so on, complement the text.

Some topics merit special mention. Depletion debunkers invariably cite data supposedly showing that oil reserves are growing. Campbell persuasively demolishes the "reserve growth" myth. The U.S. Securities and Exchange Commission, he explains, mandated a conservative standard for reporting "proved reserves," i.e., "the best estimate of what current producing wells would produce in the future," for financial purposes, to avert fraud from firms overstating their oil assets. The industry adopted this standard. Reserves appear to grow because they are based on an oilfield's development. With only a few wells drilled at first, reserves are initially modest. As more wells are drilled, and the field can produce more, reported reserves rise accordingly, until they approach the explorers' original estimates of the field's endowment. Most fields are now maximally drilled, and technology is improving recovery, meaning "the companies have less and less left in their under-reported inventories."

As for the argument that higher prices and tax incentives will bring greater oil discovery, Campbell points out that they did prompt an explosion in exploratory drilling in the early 1980s, yet discovery declined, "underlining that discovery depends on geology not economic incentive." Changes in the oil industry – mergers, fewer drilling rigs, oblique admissions of depletion – offer further evidence, he notes, that depletion is real.

Campbell's discussion of oil's role in business cycles is excellent. Rising demand for oil during expansion will drive demand to the ceiling of supply capacity, driving up oil prices. High oil prices precipitate recession, which reduces demand for oil, reducing pressure on prices. "However, oil demand

is not infinitely elastic, as it becomes increasingly difficult to cut essential needs, especially for agriculture," so oil prices may not remain down for long. Meanwhile, oil extraction, in "the iron grip of depletion," is relentlessly declining. Price spikes again, reimposing recession. Depletion thus traps the economy in a "vicious circle." Campbell's grasp of economics is better than cornucopian economists' grasp of petroleum geology.

Campbell's examination of America as an oil producer will be of special interest to American readers. American oil discovery peaked in 1930; extraction peaked in 1970. In 2001 America consumed 19.63 million barrels daily and pumped only 4.4 million, importing the rest. "The irreversible decline of its production means that even if demand were to be held static, the country would be importing 90% of its needs by 2020." We have much nonconventional oil, but oil shale's net energy yield is negative. Natural gas discovery peaked in 1950, and we are nearing the end of the extraction plateau. New gas wells, producing full tilt, are being depleted in mere months. Total gas output as of late 2002 was "probably about 70% of the total endowment, suggesting that a sharp decline is imminent." Campbell summarizes grimly: "It is difficult to avoid the conclusion that the United States faces a dire energy crisis that will radically affect its entire way of life."

Numerous graphs by Jean Laherrere, Campbell's former Petroconsultants colleague, depict oil and gas discovery worldwide, in the Middle East, and in the U.S.; implausible oil and gas discovery forecasts by the U.S. Geological Survey; and so on, powerfully supporting the case for imminent peak and decline.

A comprehensive statistical review gives a detailed picture of the worldwide oil situation, with tables of country-by-country, region-by-region statistics on oil endowment, annual extraction, past and likely future production, peak production year, and so on, plus discovery and production plots. It emerges that most oil producers other than the Persian Gulf countries have already passed their production peaks, and their annual output is declining. In 1949, geophysicist M. King Hubbert argued that oil is a finite resource and that its extraction would therefore rise from zero, pass through one or more maxima, and decline again. Campbell's production plots, manifesting this pattern without exception, prove irrefutably that Hubbert was right.

Campbell's conclusion notes that some organisms evolved to adapt to their niches, but died off when their niches were erased by environmental change. "They did not manage to evolve backwards to the more sustainable, simpler stock from which they came." Until recently, humans lived sustainably within accessible resources. The Industrial Revolution and abundant oil, however, encouraged belief in limitless progress and man's mastery of existence. They also made possible a much more productive agriculture and a sixfold population explosion, "in parallel with the growth of oil." Saturation advertising goads us to hyperconsumption as the apparent driver of prosperity, "when in reality it simply hastens our demise from resource depletion."

Dr. Campbell is obliquely raising the ghastly possibility that Hydrocarbon Man may be unable to revert to a simpler, sustainable way of life, and is sleepwalking towards a frightful die-off as depletion wipes out his niche. But he ends on a happier note. In the Irish village of Balleydehob, his current residence, people were poor but happy fifty years ago, so "affluence does not necessarily bring happiness." Oil depletion may yield "a better world in which people will live in better harmony with themselves, each other and their environment." A worthy hope.

The Essence of Oil and Gas Depletion is a peerless education in oil and gas depletion at close range. Campbell's expertise is unassailable and his case for imminent peak and decline is overwhelming. His masterful marshaling of evidence and argument makes this the most important work from the depletion camp to date.

Setting Depletion in Context

Journalist Richard Heinberg, who teaches at the New College of California, approaches matters from a different angle. He considers depletion in the context of the ecological realities of the human condition and an ecological interpretation of history, and frighteningly but persuasively surveys depletion's consequences. Dr. Campbell's introduction to *The Party's Over* heartily endorses it, and Campbell's praise is justified.

Heinberg's core message is that industrial civilization depends on inherently finite energy

resources that are "about to become scarce." Competition for them "will trigger dramatic economic and geopolitical events," and industrialism may be unsustainable. He predicts that we will soon enter "a *new era in which each year, less net energy will be available to humankind, regardless of our efforts or choices."* Our "only significant choice" will be how to reduce energy use and shift to renewable energy, which will have "profound ethical and political implications" (original italics).

"Heinberg has a good command of energy concepts and the energy literature, and a gift for explaining technical subjects with deftness and clarity."

Free market economists see energy as just another commodity, governed by market forces which are infallibly guided by prices. Environmentalists believe that switching to renewable energy sources will solve the environmental problems from fossil fuels. Seeing oil depletion as real and peak and decline as imminent, retired petroleum geologists disdain the economists – and are skeptical about renewables. After much research, Heinberg concluded that the geologists are right and offer "a long-range view based on physical reality." After my own immersion in the subject, I concur.

Heinberg has a good command of energy concepts and the energy literature, and a gift for explaining technical subjects with deftness and clarity. He presents a sound, readable primer in basic energy concepts, the laws of thermodynamics, and the nature of ecosystems and how they develop into stable "climax systems" with organisms adapted to one another, stable populations, minimized energy throughput, and maximum nutrient recycling. Drawing on William Catton's *Overshoot*, Heinberg explains how a species invading or colonizing an ecosystem with abundant food-energy will see its population bloom, overshoot carrying capacity, then crash; and how humans have developed strategies for gaining energy subsidies and thereby expanding our carrying capacity – takeover, tool use, specialization, scope enlargement, and drawdown of nonrenewable energy sources. Drawdown has enabled an unprecedented, sixfold population increase, but at terrible costs: pollution, possibly destructive climate change, and worst of all, a decline in carrying capacity parallel to fossil fuel depletion. Moreover, Heinberg points out, citing Joseph Tainter's *The Collapse of Complex Societies,* because complex societies like ours are energy-costly, depletion may make them vulnerable to collapse, i.e., substantial reduction in complexity.

In a concise, illuminating history of Western man's energy use, Heinberg sees America's settlement as an application of takeover by a crowded Europe that had largely deforested itself, going from 95 percent forest cover in 400 AD. to 20 percent in 1600, thus depleting its main energy source. Europeans substituted coal for wood, making the Industrial Revolution possible and radically transforming humanity's way of life. "Nevertheless, a threshold had been crossed: from then on, an increasing proportion of the world's energy budget would be derived from a source that could not be regrown or reproduced on a timescale meaningful to humans."

Still more momentous were the contemporaneous commercial application of electricity and switch from coal to petroleum. Electricity is a very convenient energy carrier, and through its use energy consumption soared. Fossil fuels allowed replacement of draft animals by machinery, enabling farmers to shift land from raising animal feed to raising human food, and to operate larger farms. They also supplied nitrogen fertilizers, pesticides, and herbicides, greatly boosting crop yields. Oil made possible the automobile industry, which unsettled and dispersed families, gutted public transport and the railroads, and drove energy use still higher. Heinberg argues persuasively that America's cheap, abundant energy underwrote her rise to affluence and world domination.

Unfortunately, we thereby gave hostages to hydrocarbons. At the end of the 20th Century, oil producers were working up to capacity to meet rising demand, and an oil price spike triggered recession in 2000. If oil extraction could no longer rise, "the global economy would be structurally imperiled." Although the average person "had no clue whatever" that the world confronted "vast and unprecedented" economic disaster, the Bush Administration, headed

by ex-oilmen, knew it – which, Heinberg argues, explains our Middle East policy.

Hubbert was the first prophet of peak and decline, and Heinberg presents the essentials of Hubbert's work in predicting the peak and decline of oil extraction in America's lower 48 states, as well as the work of Hubbert's followers, e.g., Campbell, Walter Youngquist, L.F. Ivanhoe, and Kenneth Deffeyes.

Cornucopians Peter Huber, Bjorn Lomborg, and Michael Lynch debunk the depletion school. After fairly presenting their arguments, Heinberg briskly and convincingly debunks the debunkers. Huber argues that the more energy we consume, the more we'll be able to find. "Huber appears to be telling us that the more cake we eat, the more we will have." Lomborg has it that reserves are always growing, we are becoming more efficient in using oil, and anyway we can always find substitutes. Depletion is real, Heinberg retorts; oil discovery is dropping. Better efficiency doesn't help unless total oil use drops. Substitutes such as shale oil are costly and have low or negative net energy yields. Dismissing Campbell and Laherrere as alarmists, Lynch relies on overly optimistic U.S. Geological Survey projections. Cornucopian arguments, Heinberg concludes, "break down under close scrutiny," and he is rightly impressed by "the clarity and logic of the analysis, and the depth of expertise," of Campbell, Youngquist, et al.

Heinberg's treatment of the depletion debate is competent and valuable. Inexplicably, alas, he gets Hubbert's projected peak extraction dates wrong, giving them as 1966 (pessimistic) and 1972 (optimistic), when in fact they were 1965 and 1970, the latter proving correct. And, to the likely bewilderment of general readers, he uses but never defines technical terms such as "proved reserves," "logistic function," "Gaussian function," "3D seismic," and "horizontal drilling."

Exactly when oil extraction will peak, Heinberg rightly argues, depends on whether we define oil narrowly, as conventional oil, or broadly, including nonconventional oil, which would postpone the peak; the state of the economy, which affects oil demand and therefore extraction; war in the Middle East, which could disrupt both extraction and demand; and new discoveries and recovery technologies. The world peak for all fossil-fuel liquids, he concludes, is "unlikely to occur before 2006, or later than 2015."

Cornucopians and greens argue that we will simply use non-petroleum energy sources. But Heinberg's well-informed survey of these sources is not encouraging.

To his great credit, Heinberg realizes that energy must be expended to obtain energy. Accordingly, he stresses the crucial concept of net energy, or energy return on energy invested (EROEI). Oil's EROEI has been declining for decades as we have tapped deeper deposits located in more remote areas with more difficult terrain. When it breaks even, i.e., when obtaining a barrel of oil requires expending a barrel's worth of energy, oil extraction "will become almost pointless." Though still useful for plastics, oil will no longer be an energy source. Likewise for substitutes: "if we replace an energy resource that has, say, a six-to-one EROEI ratio with an alternative that has a three-to-one EROEI ratio, we will have to produce twice as much gross energy to obtain the same net quantity. Thus, when a society adopts lower-EROEI energy sources, the amount of energy available to do work in that society will inevitably decline."

Coal is abundant, but inefficient and seriously polluting. Moreover, its EROEI is collapsing, and may hit 0.5 by 2040, meaning it will cost twice as much energy as it yields, terminating its usefulness as an energy source. Nuclear power is unsafe, costly, and hazardous.

Wind energy is renewable, and its technology is improving. Its EROEI is low, but positive, and attractive given the declining EROEIs for fossil fuels. Unfortunately, producing and installing enough wind turbines to avert calamity from oil's decline – perhaps 20,000 turbines a year – would take a huge investment of energy, mostly from fossil fuels. Solar power is promising, in terms of improving technology and declining costs, but its EROEI too is low, and, like wind, solar energy generates electricity, which "cannot easily be made to power our current transportation and agriculture infrastructure."

High hopes rest on hydrogen, mostly as an input for fuel cells, which chemically generate electricity. However, Heinberg observes, almost all hydrogen commercially produced comes from natural gas, and hydrogen enthusiasts assume natural gas will be available as a "transition fuel." Without a transitional hydrocarbon fuel, Heinberg points out, we can't attain a hydrogen economy; "there is not enough net energy available from renewable sources to 'bootstrap' the process while supporting a viable

economy." And with North America's natural gas supply "disturbingly uncertain," we will soon face hard choices among uses for gas.

While alternatives should be pursued, Heinberg concludes, a world run on them will have less energy available than this one – meaning our way of life is doomed. Conservation can help, but efficiency gains manifest diminishing marginal returns, and curtailing energy use eventually reduces economic activity. Some time soon economism's jig will be up.

Bleak as this verdict is, Heinberg does not address one implication of his EROEI analysis which makes it even worse. Since fossil fuels are used to produce, transport, assemble and maintain the inputs for renewable energy sources, it follows that as fossil-fuel EROEIs collapse, EROEIs for renewables must fall too. Think about it – costlier inputs mean costlier outputs, whether the cost is in energy or money.

Looking the Future in the Face

The end of cheap energy "will affect nearly everything that humans care about," Heinberg warns. Our economy, especially its debt-based financial sector, is predicated on continuous growth. Lower net energy necessarily means economic contraction. Productivity will drop, since workers will have less energy to work with. As the economy will no longer support an expanding volume of credit, financial panic is likely. Nearly everything will cost more because the energy its extraction or production uses "will have grown more rare and valuable." Because automobiles are energy-costly to produce and use, eventually fewer will be built. Road-building, which also uses much oil, will halt. Constructing a viable mass-transit system to compensate for the implosion of America's motor-vehicle transport will be energy-costly and difficult. Long distance distribution of goods will be disrupted and we will be forced to produce locally for local markets.

Heating and cooling, public health, and information storage, transmission and retrieval will suffer, too. Our information infrastructure depends on reliable electricity. As net energy declines, electrical power grids will be increasingly vulnerable to brownouts and blackouts. Unless renewable-based electricity is available to compensate, "the information infrastructure of industrial societies will collapse and virtually all electronically coded data will become permanently irretrievable." So much for the Information Economy!

The agricultural outlook is especially horrible. Oil and gas depletion will send prices of fossil fuels and hydrocarbon-based fertilizers, pesticides, and herbicides soaring, Heinberg warns, possibly creating an "agricultural apocalypse." Bereft of cheap energy, agriculture will be able to feed far fewer people than it feeds now. Heinberg's "educated guess" for Earth's "post petroleum carrying capacity" is less than two billion – roughly its pre-industrialization level. Yet our population exceeds six billion. So population will probably have to fall by over four billion persons between now and when oil and gas run out. If voluntary birth control doesn't achieve this, he warns, "famines, plagues, and wars" will. Translation: a hideous human die-off is possible.

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Moreover, Heinberg points out, turning onto a saner path will be hard. Both our economic system and our political system, which runs on "moneyed influence," reward destructive behavior. And most people prefer the narcotic of cornucopian optimism.

Heinberg is not, he stresses, trying to demoralize his readers. Rather, he aims to help those who are willing "to face reality squarely and to take informed action," to manage the collapse so as to minimize the coming suffering. He exhorts readers to cut energy use, consider equipping their homes with solar and wind energy, slash debt, grow their own food, and try to live car-free. Communities should resist chain retailers, support local small businesses, encourage public transportation, walking and bicycles; he supplies a useful list of books and websites to consult. As for national policy, although it is already too late for painlessly switching to alternative energies and conservation, we must switch anyway. Agricultural policy should encourage "regional self-sufficiency."

Many agricultural problems "could be solved simply by ending current farm subsidies" or by using new subsidies to encourage small farms, organic farming, and so on. He also rightly advocates rescinding corporate legal personhood, which has enabled corporations to wreak social and environmental havoc with impunity. Recognizing the close link between immigration, overpopulation, and resource depletion, he calls for reducing immigration. We should also stop subsidizing highways and airlines, and invest in railroads.

Heinberg's policy recommendations are sensible as far as they go. Unfortunately, he ignores the horrible problem of the rapid aging of populations in a depletion context. Social Security, Medicare, and Medicaid outlays, and heath care costs in general, will explode while our oil and gas supply collapses. What shall we do?

Moreover, restructuring agriculture will require more than reversing the polarity of agricultural subsidies. Small-scale, organic farming is labor intensive. But the collapse of our farmer population has necessarily entailed widespread loss of agricultural lore and know-how. Therefore, as Wendell Berry has pointed out, farmers "cannot be replaced anything like as quickly or easily as they have been dispensed with. Contrary to popular assumption, good farmers are not in any simple way part of the 'labor force.' Good farmers, like good musicians, must be raised to the trade."[1] And even if millions of Americans did go back to farming, they would be working with soils badly degraded by decades of abuse. There are problems which can't be solved simply by throwing money, and this is one of them.

But these deductions leave Heinberg's thesis intact. Timely, illuminating, and courageous, *The Party's Over* is an excellent bird's-eye view of what the world runs on, where we've been, where we're going, and what is likely to happen to us if we don't make radical changes soon. Heinberg is all the more persuasive because his tone is calm and reasonable throughout.

Collapse and Die-Off: Precedents for a Believable Future

Campbell and Heinberg see civilizational implosion and die-off as real possibilities. Cornucopians will doubtless use this to dismiss these authors as hysterical doom-criers. But in fact, Campbell and Heinberg have fingered a terrible danger. Every civilization rests on an economy which depends absolutely on an environmental base to supply its population with the water, food, fiber, shelter and energy it needs to survive. It must follow that destruction or overload of the environmental base – which includes energy depletion – can bring even an advanced civilization down.

Civilizational ruin and human die-offs due to environmental destruction or overload have happened before. A brief survey of precedents shows that Campbell's and Heinberg's warnings are cogent.

Sumerian agriculture depended on an elaborate irrigation system. But irrigation gradually salinized the topsoil. Anthropologists Thorkild Jacobsen and Robert M. Adams reported that grain yields collapsed from an average of 2,537 liters per hectare at about 2400 B.C. to 1,460 liters per hectare by 2100 B.C. and 897 liters per hectare by about 1700 B.C. Without agricultural surpluses to support its elaborate social order, Sumerian civilization declined, and "many of the great Sumerian cities dwindled to villages or were left in ruins." While other causes operated also, "that growing soil salinity played an important part in the breakup of Sumerian civilization seems beyond question."[2] Southern Iraq, once part of the renowned "fertile crescent," remains a salt-poisoned desert.

Between 850 and 950 A.D. the Mayan civilization collapsed, and the population plummeted roughly 85 percent. After exhaustive study, archaeologist David Webster argued that the Maya collapse's basic cause was overpopulation leading to unsustainably intensive land use, which degraded the environment and lowered agricultural productivity, bringing on famine, social disruption, loss of confidence in the regime, and population decline.[3]

Similarly, from roughly 1000 to 1300 AD., Europe's population greatly increased, perhaps even doubling. This required a corresponding increase in food production, achieved by expanding the cultivated acreage through deforesting and bringing ever-more marginal land under cultivation. But because the medieval economy needed the forests, this internal expansion stopped. The swelling population pressed against the food supply; cultivation experienced diminishing marginal returns; Europe's margin of safety in its food supply dwindled. The start of the Little Ice Age brought a shorter growing season and torrential rains, touching

off crop failures and a terrible famine in 1315-1317, followed by others. Europe's population declined rapidly, and malnutrition weakened resistance to disease. The horrific Black Death (1348-1351), which killed perhaps a third of the population, and was followed by other epidemics, was the culmination of a protracted population crash.[4]

A more recent die-off was the 1845-1849 Irish Famine. Today's agriculture is as dependent on oil and gas as pre-Famine Ireland's was on the potato. The difference is that whereas the potato failed overnight, oil and gas depletion will take years.

These disasters happened because the natural bottom dropped out of these societies. Hubbert himself pointed out in 1949 that because fossil fuels were finite, the period of their extraction and use would be "but a moment in the total of human history," and that use of fossil fuel energy "can only happen once." Therefore modern conditions are "precarious" and "far from being 'normal,' are among the most abnormal and anomalous in the history of the world." A human population explosion paralleled the tapping of fossil fuels, but the future population level would depend on what energy supplies were available. Decades later Hubbert warned that the finite nature of fossil fuels and metal ores makes sustained exponential growth in population and output impossible; thus the industrial and population growth of the past two centuries was "transient and ephemeral."[5] America's natural gas crisis drives home Hubbert's warnings – and Campbell's and Heinberg's too.

Given all this, the only sane and prudent course is to take Heinberg and Campbell seriously and act accordingly. If they're wrong, we lose little thereby. If they're right and we ignore them, we court disaster.

The global peak of oil and gas is one of the great hinges of human destiny, and it will happen in your lifetime, overturning our way of life forever. Revelations of a shattering reality, Campbell's and Heinberg's works are among the most important books of our time. They nicely complement each other to provide a superb education in depletion and its consequences. Buy, master, and ponder them both. Like immigration, oil and gas depletion is a topic you can't afford to ignore. If you think education about oil and gas is expensive, try ignorance.

NOTES

1. Wendell Berry, *Another Turn of the Crank* (Washington: Counterpoint, 1995), p. 4.

2. Thorkild Jacobsen and Robert M. Adams, "Salt and Silt in Ancient Mesopotamian Agriculture," *Science,* vol. 128, no. 3334 (November 21, 1958), pp. 1251-1252.

3. Richard E. W. Adams and Woodruff D. Smith, "Apocalyptic Visions: The Maya Collapse and Medieval Europe," *Archaeology,* vol. 30, no. 5 (September 1977), p. 293; David Webster, *The Fall of the Ancient Maya: Solving the Mystery of the Maya Collapse* (London and New York: Thames & Hudson, 2002), pp. 251-259, 295-326, 327-343.

4. Adams and Smith, "Apocalyptic Visions," pp. 296-298; N. J. G. Pounds, *An Economic History of Medieval Europe* (London and New York: Longman, 1974), pp. 122, 139, 145-148, 165, 442, 445; Carlo M. Cipolla, *Before the Industrial Revolution: European Society and Economy, 1000-1700,* 2nd ed. (New York and London: W. W. Norton, 1980), pp. 160-161, 214-216; J. C. Russell, "Population in Europe 500-1500," in *The Middle Ages,* ed. Carlo M. Cipolla, vol. 10f *The Fontana Economic History of Europe* (New York: Harvester Press/Barnes & Noble, 1976), pp. 51-56.

5. M. King Hubbert, "Energy from Fossil Fuels," *Science,* vol. 109, no. 2823 (February 4, 1949), p. 108; M. King Hubbert, "Exponential Growth as a Transient Phenomenon in Human History," in Margaret Strom, ed., *Societal Issues, Scientific Viewpoints* (New York and Washington: American Institute of Physics, 1987), pp. 76-77.