



## Temporary Recession or the End of Growth?

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*This is a guest post by Richard Heinberg. Richard is a Senior Fellow of the Post Carbon Institute and author of five books on resource depletion and societal responses to the energy problem. He can be found on the web at [www.richardheinberg.com](http://www.richardheinberg.com) and [www.postcarbon.org](http://www.postcarbon.org).*

Everyone agrees: our economy is sick. The inescapable symptoms include declines in consumer spending and consumer confidence, together with a contraction of international trade and available credit. Add a collapse in real estate values and carnage in the automotive and airline industries and the picture looks grim indeed.

But why are both the U.S. economy and the larger global economy ailing? Among the mainstream media, world leaders, and America's economists-in-chief (Treasury Secretary Geithner and Federal Reserve Chairman Bernanke) there is near-unanimity of opinion: these recent troubles are primarily due to a combination of bad real estate loans and poor regulation of financial derivatives.

This is the Conventional Diagnosis. If it is correct, then the treatment for our economic malady might logically include heavy doses of bailout money for beleaguered financial institutions, mortgage lenders, and car companies; better regulation of derivatives and futures markets; and stimulus programs to jumpstart consumer spending.

But what if this diagnosis is fundamentally flawed? The metaphor needs no belaboring: we all know that tragedy can result from a doctor's misreading of symptoms, mistaking one disease for another.

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Something similar holds for our national and global economic infirmity. If we don't understand why the world's industrial and financial metabolism is seizing up, we are unlikely to apply the right medicine and could end up making matters much worse than they would otherwise be.

To be sure: the Conventional Diagnosis is clearly at least partly right. The causal connections between subprime mortgage loans and the crises at Fannie Mae, Freddie Mac, and Lehman Brothers have been thoroughly explored and are well known. Clearly, over the past few years, speculative bubbles in real estate and the financial industry were blown up to colossal dimensions, and their bursting was inevitable. It is hard to disagree with the words of Australian Prime Minister Kevin Rudd, in his July 25 essay in the Sydney Morning Herald: "The roots of the crisis lie in the preceding decade of excess. In it the world enjoyed an extraordinary boom.... However, as we later learnt, the global boom was built in large part on a ... house of cards. First, in many Western countries the boom was created on a pile of debt held by consumers, corporations and some governments. As the global financier George Soros put it: 'For 25 years [the West] has been consuming more than we have been producing ... living beyond our means.'" (1)

But is this as far as we need look to get to the root of the continuing global economic meltdown? A case can be made that dire events having to do with real estate, the derivatives markets, and the auto and airline industries were themselves merely symptoms of an even deeper, systemic dysfunction that spells the end of economic growth as we have known it.

In short, I am suggesting an Alternative Diagnosis. This explanation for the economic crisis is not for the faint of heart because, if correct, it implies that the patient is far sicker than even the most pessimistic economists are telling us. But if it is correct, then by ignoring it we risk even greater peril.

## **Economic Growth, The Financial Crisis, and Peak Oil**

For several years, a swelling subculture of commentators (which includes the present author) has been forecasting a financial crash, basing this prognosis on the assessment that global oil production was about to peak. (2) Our reasoning went like this:

Continual increases in population and consumption cannot continue forever on a finite planet. This is an axiomatic observation with which everyone familiar with the mathematics of compounded arithmetic growth must agree, even if they hedge their agreement with vague references to “substitutability” and “demographic transitions.” (3)

This axiomatic limit to growth means that the rapid expansion in both population and per-capita consumption of resources that has occurred over the past century or two must cease at some particular time. But when is this likely to occur?

The unfairly maligned Limits to Growth studies, published first in 1972 with periodic updates since, have attempted to answer the question with analysis of resource availability and depletion, and multiple scenarios for future population growth and consumption rates. The most pessimistic scenario in 1972 suggested an end of world economic growth around 2015. (4)

But there may be a simpler way of forecasting growth’s demise.

Energy is the ultimate enabler of growth (again, this is axiomatic: physics and biology both tell us that without energy nothing happens). Industrial expansion throughout the past two centuries has in every instance been based on increased energy consumption. (5) More specifically, industrialism has been inextricably tied to the availability and consumption of cheap energy from coal and oil (and more recently, natural gas). However, fossil fuels are by their very nature depleting, non-renewable resources. Therefore (according to the Peak Oil thesis), the eventual inability to continue increasing supplies of cheap fossil energy will likely lead to a cessation of economic growth in general, unless alternative energy sources and efficiency of energy use can be deployed rapidly and to a sufficient degree. (6)

Of the three conventional fossil fuels, oil is arguably the most economically vital, since it supplies 95 percent of all transport energy. Further, petroleum is the fuel with which we are likely to encounter supply problems soonest, because global petroleum discoveries have been declining for decades, and most oil producing countries are already seeing production declines. (7)

So, by this logic, the end of economic growth (as conventionally defined) is inevitable, and Peak Oil is the likely trigger.

Why would Peak Oil lead not just to problems for the transport industry, but a more general economic and financial crisis? During the past century growth has become institutionalized in the

very sinews of our economic system. Every city and business wants to grow. This is understandable merely in terms of human nature: nearly everyone wants a competitive advantage over someone else, and growth provides the opportunity to achieve it. But there is also a financial survival motive at work: without growth, businesses and governments are unable to service their debt. And debt has become endemic to the industrial system. During the past couple of decades, the financial services industry has grown faster than any other sector of the American economy, even outpacing the rise in health care expenditures, accounting for a third of all growth in the U.S. economy. From 1990 to the present, the ratio of debt-to-GDP expanded from 165 percent to over 350 percent. In essence, the present welfare of the economy rests on debt, and the collateral for that debt consists of a wager that next year's levels of production and consumption will be higher than this year's.

Given that growth cannot continue on a finite planet, this wager, and its embodiment in the institutions of finance, can be said to constitute history's greatest Ponzi scheme. We have justified present borrowing with the irrational belief that perpetual growth is possible, necessary, and inevitable. In effect we have borrowed from future generations so that we could gamble away their capital today.

Until recently, the Peak Oil argument has been framed as a forecast: the inevitable decline in world petroleum production, whenever it occurs, will kill growth. But here is where forecast becomes diagnosis: during the period from 2005 to 2008, energy stopped growing and oil prices rose to record levels. By July of 2008, the price of a barrel of oil was nudging close to \$150—half again higher than any previous petroleum price in inflation-adjusted terms—and the global economy was beginning to topple. The auto and airline industries shuddered; ordinary consumers had trouble for buying gasoline for their commute to work while still paying their mortgages. Consumer spending began to decline. By September the economic crisis was also a financial crisis, as banks trembled and imploded. (8)

Given how much is at stake, it is important to evaluate the two diagnoses on the basis of facts, not preconceptions.

It is unnecessary to examine evidence supporting or refuting the Conventional Diagnosis, because its validity is not in doubt—as a partial explanation for what is occurring. The question is whether it is a sufficient explanation, and hence an adequate basis for designing a successful response.

What's the evidence favoring the Alternative? A good place to begin is with a recent paper by economist James Hamilton of the University of California, San Diego, titled "Causes and Consequences of the Oil Shock of 2007-08," which discusses oil prices and economic impacts with clarity, logic, and numbers, explaining how and why the economic crash is related to the oil price shock of 2008. (9)

Hamilton starts by citing previous studies showing a tight correlation between oil price spikes and recessions. On the basis of this correlation, every attentive economist should have forecast a steep recession for 2008. "Indeed," writes Hamilton, "the relation could account for the entire downturn of 2007-08.... If one could have known in advance what happened to oil prices during 2007-08, and if one had used the historically estimated relation [between price rise and economic impact]... one would have been able to predict the level of real GDP for both of 2008:Q3 and 2008:Q4 quite accurately."

Again, this is not to ignore the role of the financial and real estate sectors in the ongoing global economic meltdown. But in the Alternative Diagnosis the collapse of the housing and derivatives markets is seen as amplifying a signal ultimately emanating from a failure to increase the rate of supply of depleting resources. Hamilton again: "At a minimum it is clear that something other

than housing deteriorated to turn slow growth into a recession. That something, in my mind, includes the collapse in automobile purchases, slowdown in overall consumption spending, and deteriorating consumer sentiment, in which the oil shock was indisputably a contributing factor.”

Moreover, Hamilton notes that there was “an interaction effect between the oil shock and the problems in housing.” That is, in many metropolitan areas, house prices in 2007 were still rising in the zip codes closest to urban centers but already falling fast in zip codes where commutes were long. (10)

## **Why Did the Oil Price Spike?**

Those who espouse the Conventional Diagnosis for our ongoing economic collapse might agree that there was some element of causal correlation between the oil price spike and the recession, but they would deny that the price spike itself had anything to do with resource limits, because (they say) it was caused mostly by speculation in the oil futures market, and had little to do with fundamentals of supply and demand.

In this, the Conventional Diagnosis once again has some basis in reality. Speculation in oil futures during the period in question almost certainly helped drive oil prices higher than was justified by fundamentals. But why were investors buying oil futures? Was the mania for oil contracts just another bubble, like the dot.com stock frenzy of the late '90s or the real estate boom of 2003 to 2006?

During the period from 2005 to mid-2008, demand for oil was growing, especially in China (which went from being self-sufficient in oil in 1995 to being the world's second-foremost importer, after the U.S., by 2006). But the global supply of oil was essentially stagnant: monthly production figures for crude oil bounced around within a fairly narrow band between 72 and 75 million barrels per day. As prices rose, production figures barely budged in response. There was every indication that all oil producers were pumping flat-out: even the Saudis appeared to be rushing to capitalize on the price bonanza.

Thus a good argument can be made that speculation in oil futures was merely magnifying price moves that were inevitable on the basis of the fundamentals of supply and demand. James Hamilton (in his publication previously cited) puts it this way: “With hindsight, it is hard to deny that the price rose too high in July 2008, and that this miscalculation was influenced in part by the flow of investment dollars into commodity futures contracts. It is worth emphasizing, however, that the two key ingredients needed to make such a story coherent—a low price elasticity of demand, and the failure of physical production to increase—are the same key elements of a fundamentals-based explanation of the same phenomenon. I therefore conclude that these two factors, rather than speculation per se, should be construed as the primary cause of the oil shock of 2007-08.”

## **Aftermath of the Peak**

There is also controversy over to what degree troubles in the automobile, trucking, and airline industries should be attributed to the oil price spike or the economic crash. Of course, if the Alternative Diagnosis is correct, the latter two events are causally related in any case. However, it may be helpful to review the situation.

Everyone knows that GM and Chrysler went bankrupt this year because U.S. car sales cratered. The current forecast is for sales of about 10.3 million vehicles in the U.S. for 2009, down from last year's 13.2 million and 16.1 million in 2007. U.S. car sales have not been this low since the 1970s.

Sales of light trucks, the most profitable vehicles, took the biggest hit during 2008, as fuel prices soared and car buyers avoided gas-guzzlers. It was at this point that the auto companies really began feeling the pain.

The airline industry's ills are summarized in a recent GAO document: "After 2 years of profits, the U.S. passenger airline industry lost \$4.3 billion in the first 3 quarters of 2008 [as jet fuel prices climbed]. Collectively, U.S. airlines reduced domestic capacity, as measured by the number of seats flown, by about 9 percent from the fourth quarter of 2007 to the fourth quarter of 2008.... To reduce capacity, airlines reduced the overall number of active aircraft in their fleets by 18 percent.... Airlines also collectively reduced their workforces by about 28,000, or nearly 7 percent, from the end of 2007 to the end of 2008.... The contraction of the U.S. airline industry in 2008 reduced airport revenues, passengers' access to the national aviation system, and revenues for the Trust Fund." (11)

For the trucking industry, fuel accounts for nearly 40 percent of total operational costs. In 2007, as diesel prices rose, carriers began losing money and added fuel price surcharges; meanwhile the volume of freight began falling. After July 2008, as oil prices crashed, tonnage continued to decline. Overall, the cumulative decrease in loads for flatbed, tanker, and dry vans ranged between 15 percent and 20 percent just in the period from June to December 2008. (12)

This last set of statistics raises a couple of questions crucial to understanding the Alternative Diagnosis: Why, if global oil production had just peaked, did petroleum prices fall in the last five months of 2008? And, if oil prices were a major factor in the economic crisis, why didn't the economy begin to turn around after the prices softened?

### **Why Did Oil Prices Fall? And Why Didn't Lower Oil Prices Lead to a Quick Recovery?**

The Peak Oil thesis predicts that, as world oil production reaches its maximum level and begins to decline, the price of oil will rise dramatically. But it also forecasts a dramatic increase in the volatility of prices.

The argument goes as follows. As oil becomes scarce, its price will rise until it begins to undermine economic activity in general. Economic contraction will then result in substantially reduced demand for oil, which will in turn cause its price to fall temporarily. Then one of two things will happen: either (a) the economy will begin to recover, stoking renewed oil demand, leading again to high prices which will again undermine economic activity; or (b), if the economy does not quickly recover, petroleum production will gradually fall due to depletion until spare production capacity (created by lower demand) is wiped out, leading again to higher prices and even more economic contraction. In both cases, oil prices remain volatile and the economy contracts. (13)

This scenario corresponds very closely with the reality that is unfolding, though it remains to be seen whether situation (a) or (b) will ensue.

Over the past three years, oil prices rose and fell more dramatically than would have been the case if it had not been for widespread speculation in oil futures. Nevertheless, the general direction of prices—way up, then way down, then part-way back up—is entirely consistent with the Peak Oil thesis and the Alternative Diagnosis.

Why has the economy not quickly recovered, given that oil prices are now only half what they were in July 2008? Again, Peak Oil is not the only cause of the current economic crisis. Enormous bubbles in the real estate and finance sectors constituted accidents waiting to happen, and the

implosion of those bubbles has created a serious credit crisis (as well as solvency and looming currency crises) that will likely take several years to resolve even if energy supplies don't pose a problem.

But now the potential for renewed high oil prices acts as a ceiling for economic recovery. Whenever the economy does appear to show renewed signs of life (as has happened in May-July this year, with stock values rebounding and the general pace of economic contraction slowing somewhat), oil prices will take off again as oil speculators anticipate a recovery of demand. Indeed, oil prices have rebounded from \$30 in January to nearly \$70 currently, provoking widespread concern that high energy prices could nip recovery in the bud. (14)

A barrel of oil from newly developed sources costs in the neighborhood of \$60 to produce, now that all of the cheaper prospects have been exploited: finding new oilfields today usually means drilling under miles of ocean water, or in politically unstable nations where equipment and personnel are at high risk. (15) So as soon as consumers demand more oil, the price will have to stay noticeably above that figure in order to provide the incentive for producers to drill.

Volatile oil prices hurt on the upside, but they also hurt on the downside. The oil price collapse of August-December 2008, plus the worsening credit crisis, caused a dramatic contraction in oil industry investment, leading to the cancellation of about \$150 billion worth of new oil production projects—whose potential productive capacity will be required to offset declines in existing oilfields if world oil production is to remain stable. (16) This means that even if demand remains low, production capacity will almost certainly decline to meet those demand levels, causing oil prices to rise again in real terms at some point, perhaps two or three years from now. Volatile petroleum prices also hurt the development of alternative energy, as was shown during the past few months when falling oil prices led to financial troubles for ethanol manufacturers. (17)

One way or another, growth will be highly problematic if not unachievable.

### **Big Picture Diagnosis: Continuing the Trail of Logic**

At this point in the discussion many readers will be wondering why alternative energy sources and efficiency measures cannot be deployed to solve the Peak Oil crisis. After all, as petroleum becomes more expensive, ethanol, biodiesel, and electric cars all start to look more attractive both to producers and consumers. Won't the magic of the market intervene to render oil shortages irrelevant to future growth?

It is impossible in the context of this discussion to provide a detailed explanation of why the market probably cannot solve the Peak Oil problem. Such an explanation requires a discussion of energy evaluation criteria, and an analysis of many individual energy alternatives on the basis of those criteria. I have offered brief overviews of this subject previously and a much longer one is in press. (18)

My summary conclusions in this regard are as follows.

About 85 percent of our current energy is derived from three primary sources—oil, natural gas, and coal—that are non-renewable, whose price is likely to trend sharply higher over the next years and decades leading to severe shortages, and whose environmental impacts are unacceptable. While these sources historically have had very high economic value, we cannot rely on them in the future; indeed, the longer the transition to alternative energy sources is delayed, the more difficult that transition will be unless some practical mix of alternative energy systems can be identified that will have superior economic and environmental characteristics.

But identifying such a mix is harder than one might initially think. Each energy source has highly specific characteristics. In fact, it has been the characteristics of our present energy sources (principally oil, coal, and natural gas) that have enabled the building of an urbanized society with high mobility, large population, and high economic growth rates. Surveying the available alternative energy sources for criteria such as energy density, environmental impacts, reliance on depleting raw materials, intermittency versus constancy of supply, and the percentage of energy returned on the energy invested in energy production, none currently appears capable of perpetuating this kind of society.

Moreover, national energy systems are expensive and slow to develop. Energy efficiency likewise requires investment, and further incremental investments in efficiency tend to yield diminishing returns over time, since it is impossible to perform work with zero energy input. Where is there the will or ability to muster sufficient investment capital for deployment of alternative energy sources and efficiency measures on the scale needed?

While there are many successful alternative energy production installations around the world (ranging from small home-scale photovoltaic systems to large “farms” of three-megawatt wind turbines), there are very few modern industrial nations that now get the bulk of their energy from sources other than oil, coal, and natural gas. One example is Sweden, which obtains most of its energy from nuclear and hydropower. Another is Iceland, which benefits from unusually large domestic geothermal resources not found in most other countries. Even for these two nations, the situation is complex: the construction of the infrastructure for their power plants mostly relied on fossil fuels for the mining of the ores and raw materials, for materials processing, for transportation, for the manufacturing of components, for the mining of uranium, for construction energy, and so on. Thus a meaningful energy transition away from fossil fuels is still a matter of theory and wishful thinking, not reality.

My conclusion from a careful survey of energy alternatives, then, is that there is little likelihood that either conventional fossil fuels or alternative energy sources can be counted on to provide the amount and quality of energy that will be needed to sustain economic growth—or even current levels of economic activity—during the remainder of this century. (19)

But the problem extends beyond oil and other fossil fuels: the world’s fresh water resources are strained to the point that billions of people may soon find themselves with only precarious access to water for drinking and irrigation. Biodiversity is declining rapidly. We are losing 24 billion tons of topsoil each year to erosion. And many economically significant minerals—from antimony to zinc—are depleting quickly, requiring the mining of ever lower-grade ores in ever more remote locations. Thus the Peak Oil crisis is really just the leading edge of a broader Peak Everything dilemma.

In essence, humanity faces an entirely predictable peril: our population has been growing dramatically for the past 200 years (expanding from under one billion to nearly seven billion), while our per-capita consumption of resources has also grown. For any species, this is virtually the definition of biological success. And yet all of this has taken place in the context of a finite planet with fixed stores of non-renewable resources (fossil fuels and minerals), a limited ability to regenerate renewable resources (forests, fish, fresh water, and topsoil), and a limited ability to absorb industrial wastes (including carbon dioxide). If we step back and look at the industrial period from a broad historical perspective that is informed by an appreciation of ecological limits, it is hard to avoid the conclusion that we are today living at the end of a relatively brief pulse—a 200-year rapid expansionary phase enabled by a temporary energy subsidy (in the form of cheap fossil fuels) that will inevitably be followed by an even more rapid and dramatic contraction as

those fuels deplete.

The winding down of this historic growth-contraction pulse doesn't necessarily mean the end of the world, but it does mean the end of a certain kind of economy. One way or another, humanity must return to a more normal pattern of existence characterized by reliance on immediate solar income (via crops, wind, or the direct conversion of sunlight to electricity) rather than stored ancient sunlight.

This is not to say that the remainder of the 21st century must consist of a collapse of industrialism, a die-off of most of the human population, and a return by the survivors to a way of life essentially identical to that of 16th century peasants or indigenous hunter-gatherers. It is possible instead to imagine acceptable and even inviting ways in which humanity could adapt to ecological limits while further developing cultural richness, scientific understanding, and quality of life (more of this below).

But however it is negotiated, the transition will spell an end to economic growth in the conventional sense. And that transition appears to have begun.

### **How Do We Know Which Diagnosis Is Correct?**

If the patient is an individual human and the cause of distress is uncertain, more diagnostic tests can be prescribed. But to what sorts of blood tests, x-rays, and CAT scans can we subject the national or global economy?

In a sense, the tests have already been done. During the past few decades thousands of scientific surveys of natural resources, biodiversity, and ecosystems have showed increasing rates of depletion and decline. (20) The continuing increase in human population, pollution, and consumption are likewise well documented. This information formed the basis for the Limits to Growth studies, previously mentioned, which use computer modeling to show how current trends are likely to play out—and most resulting scenarios show them leading to an end of economic growth and a collapse of industrial output some time in the early 21st century.

Why are the results of such diagnostic tests not universally accepted as a challenge to expectations of continued growth? Primarily because their conclusion runs counter to the beliefs and proclamations of most economists, who maintain that there are no practical limits to growth. They deny that resource constraints provide an eventual cap on production and consumption. And so their diagnostic efforts tend to ignore environmental factors in favor of easily measured internal features of the human economy such as money supply, consumer confidence, interest rates, and price indices.

Ecologist Charles Hall, among many others, has argued that the discipline of economics, as currently practiced, does not constitute a science, since it proceeds primarily on the basis of correlative logic rather than through the building of knowledge by a continuous, rigorous process of proposing and testing hypotheses. (21) While economics uses complex terminology and mathematics, as science does, its basic assertions about the world—such as the principle of infinite substitutability, which holds that for any resource that becomes scarce, the market will find a substitute—are not subjected to careful experimental examination. (It is worth noting that Hall and others have made the effort to lay the conceptual foundations for a new economics based on scientific principles and methods, which they call “biophysical economics.” (22)

Moreover, mainstream economists failed on the whole to foresee the current crash. There was no consistent or concerted effort on the part of Secretaries of the Treasury, Federal Reserve



Chairmen, or “Nobel” prize-winning economists to warn policy makers or the general public that, sometime in the early 21st century, the global economy would begin to come apart at the seams. (23) One might think that this predictive failure—the inability to foresee so historically significant an event as the rapid contraction of nearly the entire global economy, entailing the failure of some of the world’s largest banks and manufacturing companies—would cause mainstream economists to stop and re-examine their fundamental premises. But there is little evidence to suggest that this is occurring.

At the risk of repetition: physical scientists from several disciplines have indeed foreseen an end to economic growth in the early 21st century, and have warned policy makers and the general public on many occasions.

### **Whom should we believe?**

The specifics of the Alternative Diagnosis are falsifiable. If economic activity were to rebound above 2007 levels, or if oil production were to rise above the July 2008 high-water mark, then the attribution of the current economic crisis to resource-tied limits to growth may be considered at least partly disproven. However, even if these things were to occur, the underlying reasoning behind the Alternative Diagnosis might still be correct. If the world oil production peak is delayed until, let us say, 2015 or 2020, and if another—this time bottomless—global economic crash results then, the ultimate outcome will be essentially the same. But if, meanwhile, the Alternative Diagnosis were to be taken seriously and acted upon, the consequences of doing so would be beneficial: a decade would have been spent preparing for the event.

Could the Alternative Diagnosis be altogether wrong? That is, might conventional economists be right in thinking that growth can continue forever? It is often said that anything is possible, but some things are clearly much more possible than others. The perpetual growth of human population and consumption within the confines of a finite planet seems like a very long shot indeed, especially since warning signs are everywhere apparent that ecological limits are already being reached and surpassed. (24)

### **What Not to Do: Prescribe Punishingly Expensive Placebos**

If the physical scientists who warn about limits to growth are right, confronting the global economic meltdown implies far more than merely getting the banks and mortgage lenders back on their feet. Indeed, in that case we face a fundamental change in our economy as significant as the advent of the industrial revolution. We are at a historic inflection point—the ending of decades of expansion and the beginning of an inevitable period of contraction that will continue until humanity is once again living within the limits of Earth’s regenerative systems.

But there are few signs that policy makers understand any of this. Their thinking appears to be shaped primarily by mainstream economists’ assurances that growth can and must continue into the indefinite future, and that the economic contraction the world is currently experiencing is only temporary--a problem that can and must be solved.

Still, the problem is not a minor one in the eyes of economists and policy makers. Consider the gargantuan size of the Treasury and Federal Reserve bailouts and stimulus packages that have been deployed in the possibly futile attempt to end contraction and restart growth. According to the special inspector general of the U.S. government’s Troubled Asset Relief Program (TARP), in remarks submitted to the House Committee on Oversight and Government Reform on July 21, \$23.7 trillion have been committed in “total potential federal government support.” This is expensive medicine indeed. It takes a moment to even begin to comprehend the enormity of the

figure. It represents about half of annual world GDP, and is over three times the total amount spent by the U.S. government, in inflation-adjusted dollars, on all wars combined, from 1776 to the present. It is nearly fifty times the cost of the New Deal.

Other nations, including Britain, China, and Germany have committed to paying for stimulus packages and bailouts that, while much smaller in absolute terms, represent an impressive (or should we say frightful?) share of national GDP.

If the Alternative Diagnosis is valid, none of this will work in the end, because existing financial institutions—with their basis in debt and interest and their requirements for constant expansion—cannot be made to function in a context where energy and resource constraints impose effective caps on manufacturing and transport.

Are the bailouts and stimulus packages working? Much evidence suggests that they are not, except in limited ways. In the U.S., unemployment continues to increase, while real estate values continue to fall. And most of the reputed “green shoots” in the economy so far sighted amount merely to an arguably temporary decline in the rate of contraction. For example, the home price index released July 28 of this year showed that in May, seasonally adjusted prices fell just 0.16 percent from the previous month. That represents an annual rate of decline of a little under 2 percent, which is a substantial improvement over the annualized rate of more than 20 percent that prevailed from September 2008 through March of 2009. Many commentators seized upon this news as a sign of an imminent turnaround. Nevertheless, new home sales are down from 1.4 million per year in 2005 to 350,000 per year today, and house prices are down 50 percent from the bubble peak and still declining in most places. Moreover, manufacturing is still shrinking, small businesses are in trouble, there are still significant danger signs on the horizon, including a new round of mortgage resets, a likely dive in commercial real estate values, and the looming reality that toxic assets at the center of the banking crisis have yet to be dealt with. (25)

President Obama has made the argument that bailouts are justified to stabilize the system long enough so that leaders can make fundamental changes to institutions and regulations, enabling the economy to then go forward healthier and more immune to similar crises in the future. But there is little to suggest that the kinds of systemic changes that are actually needed (ones that would enable the economy to function during a prolonged period of contraction) are under way or even contemplated. Meanwhile, as growth-based institutions are temporarily propped up, the ultimate scale of the damage is likely only to increase: when the inevitable collapse of those institutions does come, the consequences will likely be even worse because so much capital will have been squandered in attempting to salvage them.

In using up non-renewable resources like metals, minerals, and fossil fuels, we have stolen from future generations. Now in effect we are stealing from those generations the financial wherewithal that could have been used to build a bridge to a sustainable economy. The construction of a renewable energy infrastructure (including not only generating capacity, but distribution and storage systems, as well as post-petroleum transport and agriculture systems) will require enormous investments and decades of work. Where will the investment capital come from if governments are already buried in debt? If we have committed nearly \$24 trillion to propping up an old economy with no real survival prospects, what’s left with which to finance the new one?

If the current prescription for our economic malady is wrong-headed, the same is true of many proposed cures for our energy problems. According to the Conventional Diagnosis, today’s high oil prices are due to speculation; the cure must therefore lie in the tighter regulation of oil futures trading (which may be a good idea, though it doesn’t get to the heart of the problem), while providing more opportunities to oil companies to explore for domestic oil (even though the likely

production rates from currently off-limits reserves would be relatively paltry, and would have a negligible effect on oil prices). In fact, though, investing further in fossil fuel energy systems (including “clean coal” technology) will yield declining returns, given that the highest quality resources have already been used up; meanwhile, doing so takes investment capital away from the development of renewable energy, which we will have to rely on increasingly as fossil fuels deplete. (26)

What is required but is still utterly lacking is a fundamental recognition that circumstances have changed: what worked decades ago will not work now.

### **What To Do: Adapt to the New Reality**

If the Alternative Diagnosis is correct, there will be no easy fix for the current economic breakdown. Some illnesses are not curable; they require that we simply adapt and make the best of our new situation.

If humanity has indeed embarked upon the contraction phase of the industrial pulse, we should assume that ahead of us lie much lower average income levels (for nearly everyone in the wealthy nations, and for high wage earners in poorer nations); different employment opportunities (fewer jobs in sales, marketing, and finance; more in basic production); and more costly energy, transport, and food. Further, we should assume that key aspects of our economic system that are inextricably tied to the need for future growth will cease to work in this new context.

### **What can we do to adapt most rapidly and successfully?**

Rather than attempting to prop up banks and insurance companies with trillions in bailouts, it would probably be better simply to let them fail, however nasty the short-term consequences, since they will fail anyway sooner or later. The sooner they are replaced with institutions that serve essential functions within a contracting economy, the better off we will all be. (27)

Meanwhile the thought-leaders in society, especially the President, must begin breaking the news—in understandable and measured ways—that growth isn’t returning and that the world has entered a new and unprecedented economic phase, but that we can all survive and thrive in this challenging transitional period if we apply ourselves and work together. At the heart of this general re-education must be a public and institutional acknowledgment of three basic rules of sustainability: growth in population cannot be sustained; the ongoing extraction of non-renewable resources cannot be sustained; and the use of renewable resources is sustainable only if it proceeds at rates below those of natural replenishment.

Without cheap energy, global trade cannot increase. This doesn’t mean that trade will disappear, only that economic incentives will inexorably shift as transport costs rise, favoring local production for local consumption. But this may be a nice way of putting it: if and when fuel shortages arise, fragile globe-spanning systems of provisioning could be disrupted, with dire effects for consumers cut off from sources of necessary products. Thus a high priority must be placed on the building of community resilience through the preferential local sourcing of necessities and the maintenance of larger regional inventories—especially of food and fuel. (28)

It currently takes an average of 8.5 calories of energy from oil and natural gas to produce each calorie of food energy. Without cheap fuel for agriculture, farm production will plummet and farmers will go bankrupt—unless proactive efforts are undertaken to reform agriculture to reduce its reliance on fossil fuels. (29)

Obviously, alternative energy sources and energy efficiency strategies must be high priorities, and must be subjects of intensive research using a carefully chosen spectrum of criteria. The best candidates will have to be funded robustly even while fossil fuels are still relatively cheap: the build-out time for the renewable energy infrastructure will inevitably be measured in decades and so we must begin the process now rather than waiting for market forces to lead the way.

In the face of credit and (potential) currency crises, new ways of financing such projects will be needed. Given that our current monetary and financial systems are founded on the need for growth, we will require new ways of creating money and new ways of issuing credit. Considerable thought has gone into finding solutions to this problem, and some communities are already experimenting with local capital co-ops, alternative currencies, and no-interest banks. (30)

With oil becoming increasingly expensive in real terms, we will need more efficient ways of getting people and goods around. Our first priority in this regard must be to reduce the need for transport with better urban planning and re-localized production systems. But where transport is needed, rail and light rail will probably be preferable to cars and trucks. (31)

We will also need a revolution in the built environment to minimize the requirement for heating, cooling, and artificial lighting in all our homes and public buildings. This revolution is already under way, but is currently moving far too slowly due to the inertia of established interests in the construction industry. (32)

These projects will need more than local credit and money; they will also require skilled workers. There will be a call not just for installers of solar panels and home insulation: millions of new food producers and builders of low-energy infrastructure will be needed as well. A broad range of new opportunities could open up to replace vanishing jobs in marketing and finance—if there is cheap training available at local community colleges.

It is worth noting that the \$23.7 trillion recently committed for U.S. bailouts and loan guarantees represents about \$80,000 for each man, woman, and child in America. A level of investment even a substantial fraction that size could pay for all needed job training while ensuring universal provision of basic necessities during the transition. What would we be getting for our money? A collective sense that, in a time of crisis, no one is being left behind. Without the feeling of cooperative buy-in that such a safety net would help engender, similar to what was achieved with the New Deal but on an even larger scale, economic contraction could devolve into a horrific fight over the scraps of the waning industrial period.

However contentious, the population question must be addressed. All problems that have to do with resources are harder to solve when there are more people needing those resources. The U.S. must encourage smaller families and must establish an immigration policy consistent with a no-growth population target. This has foreign policy implications: we must help other nations succeed with their own economic transitions so that their citizens do not have to emigrate to survive. (33) If economic growth ceases to be an achievable goal, society will have to find better ways of measuring success. Economists must shift from assessing well-being with the blunt instrument of GDP, and begin paying more attention to indices of human and social capital in areas such as education, health, and cultural achievements. This redefinition of growth and progress has already begun in some quarters, but for the most part has yet to be taken up by governments. (34)

A case can be made that after all this is done the end result will be a more satisfying way of life for the vast majority of citizens—offering more of a sense of community, more of a connection with the natural world, more satisfying work, and a healthier environment. Studies have repeatedly

shown that higher levels of consumption do not translate to elevated levels of satisfaction with life. (35) This means that if “progress” can be thought of in terms of happiness, rather than a constantly accelerating process of extracting raw materials and turning them into products that themselves quickly become waste, then progress can certainly continue. In any case, “selling” this enormous and unprecedented project to the general public will require emphasizing its benefits. Several organizations are already exploring the messaging and public relations aspects of the transition. (36) But those in charge need to understand that looking on the bright side doesn’t mean promising what can’t be delivered—such as a return to the days of growth and thoughtless consumption.

## Can We? Will We?

It is important to state the implications of all this as plainly as possible. If the Alternative Diagnosis is correct, there will be no full economic “recovery”—not this year, or the next, or five or ten years from now. There may be temporary rebounds that take us back to some fraction of peak economic activity, but these will be only brief respites.

We have entered a new economic era in which the former rules no longer apply. Low interest rates and government spending no longer translate to incentives for borrowing and job production. Cheap energy won’t appear just because there is demand for it. Substitutes for essential resources will in most cases not be found. Over all, the economy will continue to shrink in fits and starts until it can be maintained by the energy and material resources that Earth can supply on ongoing basis.

This is of course very difficult news. It is analogous to being told by your physician that you have contracted a systemic, potentially fatal disease that cannot be cured, but only managed; and managing it means you must make profound lifestyle changes.

Some readers may note that climate change has not figured prominently in this discussion. It is clearly, after all, the worst environmental catastrophe in human history. Indeed, its consequences could be far worse than the mere destruction of national economies: hundreds of millions of people and millions of other species could be imperiled. The reason for the relatively limited discussion of climate here is that (assuming the Alternative Diagnosis is correct) it is not climate change that has proven to be the most immediate limit to economic growth, but resource depletion. However, while there is not as yet general agreement on the point, climate change itself and the needed steps to minimize it both constitute limits to growth, just as resource depletion does. Moreover, if we fail to successfully manage the inevitable process of economic contraction that will characterize the coming decades, there will be no hope of mounting an organized and coherent response to climate change—a response consisting of efforts both to reduce climate impacts and to adapt to them. It is important to note, though, that the measures advocated here (including the development of renewable energy sources and energy efficiency, a rapid reduction of reliance on fossil fuels in transport and agriculture, and the stabilization of population levels) are among the steps that will help most to reduce carbon emissions.

Is this essay likely to change the thinking and actions of policy makers? Unfortunately, that is unlikely. Their belief in the possibility and necessity of continued growth is pervasive, and the notion that growth may no longer be possible is unthinkable. But the Alternative Diagnosis must be a matter of record. This essay, composed by a mere journalist, in many ways represents the thinking of thousands of physical scientists working over the past several decades on issues having to do with population, resources, pollution, and biodiversity. Ignoring the diagnosis itself—whether as articulated here or as implied in tens of thousands of scientific papers—may waste our last chance to avert a complete collapse, not just of the economy, but of civility and organized

human existence. It may risk a historic discontinuity with qualitative antecedents in the fall of the Roman and Mayan civilizations. (37) But there is no true precedent for what may be in store, because those earlier examples of collapse affected geographically bounded societies whose influence on their environments was also bounded. Today's civilization is global, and its fate, Earth's fate, and humanity's fate are inextricably tied.

But even if policy makers continue to ignore warnings such as this, individuals and communities can take heed and begin the process of building resilience, and of detaching themselves from reliance on fossil fuels and institutions that are inextricably tied to the perpetual growth machine. We cannot sit passively by as world leaders squander opportunities to awaken and adapt to growth limits. We can make changes in our own lives, and we can join with our neighbors. And we can let policy makers know we disapprove of their allegiance to the status quo, but that there are other options.

Is it too late to begin a managed transition to a post-fossil fuel society? Perhaps. But we will not know unless we try. And if we are to make that effort, we must begin by acknowledging one simple, stark reality: growth as we have known it can no longer be our goal.

## Notes

1. "Pain on the Road to Recovery" (<http://www.smh.com.au/national/pain-on-the-road-to-recovery-20090724-dw6...>).
2. Here, for example, are a few relevant excerpts from the present author's book *The Party's Over: Oil, War and the Fate of Industrial Societies* (Gabriola Island, BC: New Society, 2003): "Our current financial system was designed during a period of consistent growth in available energy, with its designers operating under the assumption that continued economic growth was both inevitable and desirable. This ideology of growth has become embodied in systemic financial structures requiring growth.... Until now, this loose linkage between a financial system predicated upon the perpetual growth of the money supply, and an economy growing year by year because of an increasing availability of energy and other resources, has worked reasonably well—with a few notable exceptions, such as the Great Depression.... However, [when global oil production peaks] the financial system may not respond so rationally.... This might predictably trigger a financial crisis...."
3. See Albert Bartlett, "Arithmetic, Population and Energy" (lecture transcript), (<http://www.globalpublicmedia.com/transcripts/645>).
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens III, *Limits to Growth* (New York: Universe Books, 1972); Donella H. Meadows, Dennis L. Meadows, and Jorgen Randers, *Beyond the Limits* (Post Mills, VT: Chelsea Green, 1992); Donella H. Meadows, Dennis L. Meadows, and Jorgen Randers, *Limits to Growth: The 30 Year Update* (White River Junction, VT: Chelsea Green, 2003). See also the recent CSIRO study, "A Comparison of the Limits to Growth with Thirty Years of Reality" (2009) ([www.csiro.au/files/files/plje.pdf](http://www.csiro.au/files/files/plje.pdf)).
5. See, for example, Robert U. Ayers and Benjamin Warr, *The Economic Growth Engine: How Energy and Work Drive Material Prosperity* (Cambridge, UK: Edward Elgar Publishing, 2005); and Robert Barro and Xavier Sala-i-Martin, *Economic Growth* (Cambridge, MA: MIT Press, 2003) (<http://www.bookrags.com/research/economic-growth-and-energy-consumpt-mee...>).
6. See Richard Heinberg, *The Party's Over: Oil, War and the Fate of Industrial Societies* (2003, 2005); *Powerdown: Options and Actions for a PostCarbon World* (2004); and *The Oil Depletion Protocol: A Plan to Avert Oil Wars, Terrorism, and Economic Collapse* (2006); as well as books by Kenneth Deffeyes, Colin Campbell, and Matthew Simmons; and websites [www.theoil drum.com](http://www.theoil drum.com) and [www.energybulletin.net](http://www.energybulletin.net). The Association for the Study of Peak Oil organizes international conferences to study issues related to oil and gas depletion ([www.peakoil.net](http://www.peakoil.net) and [Page 14 of 17](http://www.aspo-</a></li></ol></div><div data-bbox=)

[usa.com](http://usa.com)), and the U.S. chapter of ASPO publishes a weekly survey of relevant news, “Peak Oil Review,” compiled by former CIA analyst Tom Whipple. At the annual Association for the Study of Peak Oil conference in Cork, Ireland, in September 2007, former U.S. Energy Secretary, James Schlesinger, said: “Conceptually the battle is over. The peakists have won. We’re all peakists now.” See also Steve Connor, “Warning: Oil supplies are running out fast,” *The Independent*, August 3, 2009 (<http://www.independent.co.uk/news/science/warning-oil-supplies-are-runni...>).

7. The declining rate of discovery of new oilfields, and the list of past-peak oil producing countries, are widely documented; e.g.: Roger D. Blanchard, *The Future of Global Oil Production: Facts, Figures, Trends and Projections by Region* (Jefferson, NC: McFarlane and Co., 2005).

8. A May 4, 2009 report from Raymond James Associates (“Stat of the Week”) argued that world oil production peaked in July 2008 (<http://blogs.wsj.com/environmentalcapital/2009/05/04/peak-oil-global-oil...>). In a subsequent interview, Marshall Adkins, author of the report, suggested that most knowledgeable players within the petroleum industry now accept the Peak Oil thesis in some form, whether or not they acknowledge it publicly ([www.aspousa.org/index.php/2009/07/interview-with-marshall-adkins/](http://www.aspousa.org/index.php/2009/07/interview-with-marshall-adkins/)).

9. Brookings Papers on Economic Activity, March 2009. [www.brookings.edu/economics/bpea/~media/Files/Programs/ES/BPEA/2009\\_spr...](http://www.brookings.edu/economics/bpea/~media/Files/Programs/ES/BPEA/2009_spr...)

10. See Joe Cortright, “Driven to the Brink: How the Gas Price Spike Popped the Housing Bubble and Devalued the Suburbs,” Discussion paper, CEOs for Cities, 2008 (<http://www.ceosforcities.org>).

11. U.S. Government Accountability Office, “Commercial Aviation: Airline Industry Contraction Due to Volatile Fuel Prices and Falling Demand Affects Airports, Passengers, and Federal Government Revenues,” April 21, 2009 ([www.gao.gov/products/GAO-09-393](http://www.gao.gov/products/GAO-09-393)). For a detailed discussion of the likely future impacts of high oil prices and oil shortages on the airline industry, see Charles Schlumberger, “The Oil Price Spike of 2008: The Result of Speculation or an Early Indicator of a Major and Growing Future Challenge to the Airline Industry?” *Annals of Air and Space Law*, Vol. XXXIV, [2009], McGill University ([http://www.globalpublicmedia.com/the\\_oil\\_price\\_spike\\_of\\_2008](http://www.globalpublicmedia.com/the_oil_price_spike_of_2008)).

12. American Trucking Association ([www.truckline.com/Pages/Home.aspx](http://www.truckline.com/Pages/Home.aspx)).

13. This scenario is implied in Robert L. Hirsch, Roger Bezdek, and Robert Wendling, “Peaking of World Oil Production: Impacts, Mitigation and Risk Management” (U.S. Department of Energy: 2005): “As peaking is approached, liquid fuel prices and price volatility will increase dramatically....” ([http://www.netl.doe.gov/publications/others/pdf/Oil\\_Peaking\\_NETL.pdf](http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf)).

14. See, for example, “Troubling Signs That Oil Prices Could Hamper Recovery,” *Wall Street Journal*, May 8, 2009 (<http://247wallst.com/2009/05/08/troubling-signs-that-oil-prices-could-ha...>).

15. See, for example, James Herron, “Low Oil Prices, Credit Woes Could Spell Trouble for UK North Sea,” *Rigzone*, November 14, 2008 ([www.rigzone.com/news/article.asp?a\\_id=69507](http://www.rigzone.com/news/article.asp?a_id=69507)).

16. Jad Mouawad, “Big Oil Projects Put in Jeopardy by Fall in Prices,” *New York Times*, December 15, 2008 ([www.nytimes.com/2008/12/16/business/16oil.html](http://www.nytimes.com/2008/12/16/business/16oil.html)).

17. See David R. Baker, “Low oil prices take wind out of renewable fuels,” *San Francisco Chronicle*, October 27, 2008 ([www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/10/26/MNSK13NNK4.DTL](http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/10/26/MNSK13NNK4.DTL)).

18. See *The Party’s Over*, Chapter 4; *Powerdown*, Chapter 4; *The Oil Depletion Protocol*, pages 23-31. A longer treatment of the subject, tentatively titled *Energy Limits to Growth*, will be published by International Forum on Globalization and Post Carbon Institute in September.

19. This conclusion is echoed in, for example, Ted Trainer, *Renewable Energy Cannot Sustain a Consumer Society* (Dordrecht, The Netherlands: Springer, 2007); and (with some reservations), David J. C. McKay, *Sustainable Energy Without the Hot Air* (Cambridge, UK: UIK Cambridge,



2008), ([www.withouthotair.com](http://www.withouthotair.com)).

20. Just one example, from a press release April 20, 1998 describing the results of a poll commissioned by the American Museum of Natural History: "The American Museum of Natural History announced today results of a nationwide survey titled Biodiversity in the Next Millennium, developed by the Museum in conjunction with Louis Harris and Associates, Inc. The survey reveals that seven out of ten biologists believe that we are in the midst of a mass extinction of living things, and that this loss of species will pose a major threat to human existence in the next century."

21. Charles A. S. Hall and Kent A. Klitgaard, "The Need for a New, Biophysical-Based Paradigm in Economics for the Second Half of the Age of Oil," International Journal of Transdisciplinary Research, Vol. 1, NO. 1 (2006), (<http://74.125.155.132/search?q=cache:DtdKR2ZWgNoJ:www.peakoil.net/files/...>); Charles A. S. Hall, D. Lindenberger, R. Kummell, T. Kroeger and W. Eichorn, "The Need to Reintegrate the Natural Sciences with Economics." Bioscience 51:663-673, 2001.

22. Cutler J. Cleveland, "Biophysical Economics," The Encyclopedia of Earth ([www.eoearth.org/article/Biophysical\\_economics](http://www.eoearth.org/article/Biophysical_economics)). See also the related field of Ecological Economics, especially the books of Herman Daly, including Toward a Steady State Economy (New York: Freeman, 1973); and, with Joshua Farley, Ecological Economics: Principles and Applications (Washington: Island Press, 2004).

23. The quotation marks around the Nobel name are justified because the Nobel family has never acknowledged economics as a science: the so-called "Nobel prize in economics" is awarded by a Swedish Bank.

24. See The Millennium Ecosystem Assessment ([www.millenniumassessment.org/en/index.aspx](http://www.millenniumassessment.org/en/index.aspx)).

25. See, for example, J. S. Kim, "Irrational Exuberance of the Green Shoots," July 24, 2009 (<http://seekingalpha.com/article/151101-irrational-exuberance-of-the-gree...>).

26. See Richard Heinberg, Blackout: Coal, Climate and the Last Energy Crisis (Gabriola Island, BC: New Society, 2009), pages 137-143, 145-168.

27. The opinion that banks and insurance companies should be allowed to fail rather than being bailed out was voiced by many knowledgeable observers throughout late 2008 and early 2009. See for example Ambrose Evans-Pritchard, "Let banks fail, says Nobel economist Joseph Stiglitz," London Daily Telegraph, Feb. 2, 2009 ([www.telegraph.co.uk/finance/newsbysector/banksandfinance/4424418/Let-ban...](http://www.telegraph.co.uk/finance/newsbysector/banksandfinance/4424418/Let-ban...)).

28. See Jeff Rubin, Why Your World Is About to Get a Whole Lot Smaller: Oil and the End of Globalization. (New York: Random House, 2009).

29. See Richard Heinberg and Michael Bomford, "The Food and Farming Transition" (Sebastopol, CA: Post Carbon Institute, 2009), (<http://postcarbon.org/food>).

30. See Bernard Lietaer, "White Paper on All the Options for Managing a Systemic Bank Crisis" ([www.lietaer.com/images/White\\_Paper\\_on\\_Systemic\\_Banking\\_Crises\\_final.pdf](http://www.lietaer.com/images/White_Paper_on_Systemic_Banking_Crises_final.pdf)). JAK in Sweden is a cooperative, member-owned bank that operates without interest ([http://en.wikipedia.org/wiki/JAK\\_members\\_bank](http://en.wikipedia.org/wiki/JAK_members_bank)).

31. See Richard Gilbert and Anthony Perl, Transport Revolutions: Moving People and Freight Without Oil (Gabriola Island, BC: New Society, 2009).

32. The Passivhaus Institute pioneers construction methods that reduce energy input to buildings in many cases to zero ([www.passivehouse.us](http://www.passivehouse.us)). Roughly 20,000 Passivhauses have been built in Europe, only about 12 in the U.S.

33. See websites of Population Media Center ([www.populationmedia.org/issues/](http://www.populationmedia.org/issues/)), and SUSPS ([www.susps.org/overview/immigration.html](http://www.susps.org/overview/immigration.html)).

34. The organization Redefining Progress has developed a Genuine Progress Indicator (GPI) that incorporates many such indices ([www.rprogress.org/sustainability\\_indicators/genuine\\_progress\\_indicator.htm](http://www.rprogress.org/sustainability_indicators/genuine_progress_indicator.htm)).



35. See, for example, “Understanding Human Happiness and Well-Being,” The Sustainable Scale Project (<http://www.sustainablescale.org/AttractiveSolutions/UnderstandingHumanHa...>).

36. The burgeoning Transition Town movement ([www.transitiontowns.org](http://www.transitiontowns.org)) proceeds from the premise that “life can be better without fossil fuels.” YES! Magazine ([www.yesmagazine.org](http://www.yesmagazine.org)) is a publication of the Positive Futures Network and highlights examples of low-impact ways of living that bring personal and social benefits. And the Simple Living Network ([www.simpleliving.net](http://www.simpleliving.net)) provides “resources, tools, examples and contacts for conscious, simple, healthy and restorative living.”

37. See Jared Diamond, *Collapse How Societies Choose to Fail or Succeed* (New York: Viking, 2005); Joseph Tainter, *The Collapse of Complex Societies* (Cambridge, UK: Cambridge University Press, 1988); and John Michael Greer, *The Long Descent* (Gabriola Island, BC: New Society, 2008).



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