Is Living the Good Life Possible in a Lower EROI Future?

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In order to assess the prospect of living the good life in an energy-short, climate-compromised future, we need to address the issue of what constitutes the good life. Neoclassical economics would have us believe, or assume, that increased consumption of goods and services indefinitely improves our welfare, as does increased choice. Yet, if one views the empirical evidence (see Fig. 24.5) or reads the advances in behavioral psychology, the strength of the relation is rather weak. According to psychologist Tim Kasser, those who are the most acquisitive and materialistic have the highest levels of clinical depression and the most tenuous personal relationships [1]. But even if there were a strong positive connection between mass consumption and human happiness, the prospect of continuing the acquisitive lifestyle, which has long been limited to a small share of the population, will likely be limited in the future, both by limitations of the energy and materials required and by the environmental consequences, as summarized in the previous chapter. If future growth is so constrained, where will we seek happiness? Can a life of lower material and energy consumption be a happy one?

Traditionally, economists have thought not. In 1996, John Kenneth Galbraith produced a short book entitled *The Good Society* [2]. For Galbraith, the good society provided for stability of employment, where no one was denied the income to allow them access to the basic requirements of nutrition, shelter, and safety. It was a society that minimized an entrenched bureaucracy and an imperialistic military, and one that welcomed immigrants and improved the lot of the planet's poor while protecting the environment. It is a vision your authors share. But 20 years ago, few economists recognized the biophysical limits to human activity. Consequently, Galbraith declared:

"Very specifically, the good society must have substantial and reliable economic growth—a substantial and reliable increase in production and employment from year to year."

However if biophysical limits and the inability to absorb economic surplus lead to slow, and sometimes declining, rates of economic growth, the question becomes one of how do we live the good life in the absence of economic growth? While we may not need another brand of toothpaste or underarm deodorant, how do we provide sufficient employment in the absence of economic growth? We certainly do not have all the answers, but we know enough to realize we have to raise the questions, and that we must do so within a biophysical context.

We do not see this automatically as a bad future, depending on how we deal with it. As boys, we both had a wonderful childhood on opposite coasts in the 1950s and 1960s during a period when the US energy use was only 20% of what it is now. We could go fishing and surfing (respectively) on our bicycles and had no need for soccer moms driving us around in an SUV. We played sports all the time with neighborhood friends and went camping and hiking to our heart's content. Nature was abundant, everywhere, exciting, and fascinating. Even today's perspective that there are dangerous people out there and children must be driven everywhere for protection was not valid—and even today youngsters are considerably more likely to die or be hurt in an automobile accident than be kidnapped!

For the record, we, deeply involved in all this stuff as professional ecologists, economists, and energy analysts for the last four to five decades, are neither optimists (which is our nature) nor pessimists about our energy and economic future because we really have no way to predict the future beyond some easy and very coarse extensions of present trends (for demographics, probably oil, possibly gas, conceivably coal). The hardest things to predict would be human behavior—will we go quietly into declining affluence (as we are sort of doing now)? Will the unemployed or never to be employed cause riots or become terrorists? Will people vote in an authoritarian government who promises to bring back better days? Will we be able, in some way that we do not yet know, to do things with human hands we do now with fossil fuel? Will we be able to make some kind of transition to a new energy source? If the economic pie must shrink, will the rich respond by attempting to keep their absolute amount constant—while the poor get a smaller part of a shrinking pie? Or what? Will society get behind the proposal to spend the falling share of income that does not go to acquiring energy on perpetual war over the scraps that remain? For the record, we, deeply involved in all this as professionals and modelers since the 1960s and 1970s, can be neither optimists nor pessimists because we cannot predict these things and do not trust anyone who says we can. We think we have to go into the future with the following model and something like the following probabilities (you can choose your own percentages): we will go off the cliff, energetically,

economically, or environmentally (25%), we will make a transition to a new energy source that will benevolently replace oil and gas (25%), or we will muddle along, gradually getting materially poorer but adjusting to that (50%). The point is that we do not think anyone knows those percentages, and so we must go into the future with a huge breadth of possibilities. That in itself might be pretty difficult. Some would trust the market to adjust, others might not, and others might think we can all move to communes and grow our food or have other mechanisms of adjustments. Many people who think about these things retreat to a bunker mentality and are stocking their country houses with food and ammunition. Paul Raskin, of the Tellus Institute, offers three possible scenarios: Conventional Worlds, Barbarization, and Great Transitions. The *Conventional Worlds* scenario can take the form of Market Forces or Political Reform. In the first approach, all one must do is trust that the market will produce solutions that are not only efficient and equitable, but also sustainable. In the second, incremental reforms, without challenging the inner workings of the system, will lead to a sustainable future. A less optimistic scenario is *Barbarization*. In this scenario, the privileged of the world retreat to a Fortress World, militarizing their borders, and keep what resources remain to themselves. It is a very repressive world that is likely to represent Breakdown, or the second variant of Barbarization, which is complete chaos, or Thomas Hobbes' "war of all against all." *Great Transitions* is the transformation of the present system into a more humane and livable future. These include Eco-communalism, where groups of like-minded people live collectively and pastorally in small-scale communities in touch with nature and culture, or as a New Sustainability Paradigm, where sustainability is defined as progressive global social evolution, and is extended to the world's poor, not just to those affluent enough to live peacefully in rural communes. Related to this perspective are calls for "the end of growth," "degrowth," and the steady-state economy [3].

24.1 What Are the Main Issues for Transitioning to the Future?

The main problem that we face is that we (the United States, the world, wherever) will require massive new investments in whatever might be the next energy source at a time when most citizens will be experiencing a decline in their own purchasing power. For example, if gasoline costs $10 a gallon (and this is just to extract that gallon from an aging, energy-requiring field), who will want to pay an additional 5 dollars a gallon as an investment in whatever fuel or other technology will replace that gallon? The answer is probably few, if any, and that implies that we just continue on the path of using ever-lower-grade, more expensive conventional resources, slowly grinding into ever-greater poverty. Will the rising price of fossil fuels make renewable energy technologies more competitive? Alternatively, will their intermittency and inflexibility limit their ultimate use [4]? It depends on the structure of markets and the power of the largest corporations, but also the EROI and flexibility of the alternatives. Moreover, in a world of expensive energy and excess capacity, *Conventional Worlds* scenarios such as a reduction in corporate tax rates are highly unlikely to produce economic growth, as promised by its proponents.

If one accepts the importance of a biophysical basis for economics, then there are some important implications of our analysis for economics and for society. The first issue pertains to the economic pie and how we will cut it. As we developed in some detail in ▶ Chap. 7, "the American dream" gave for perhaps the first time in human history the hope of significant and ever-increasing prosperity to a broad swath of people through a number of generations and for an entire nation. As we believe, this book makes clear it is not clear at all that this prosperity is continuing or will or can continue, and in fact, there is a great deal of evidence that we have reached the end of any increase in affluence: The GDP and the average take-home pay for workers in of the United States have barely budged for decades, there is increasing evidence that such growth as took place from the mid-1990s until 2017 was based in large part on debt or speculation. Many state governments are broke or are cutting back on such former entitlements such as good university education for all or many. Underemployment remains stubbornly high, colleges and universities are having increasing difficulties balancing their budget, many people's retirement plans have lost a great deal of their net worth, and housing prices are again inflated. Of course, none of this is new, for the United States has gone through depressions and recessions often enough before, and many Conventional Worlds thinkers believe that if we just wait, we will come out of the present period of meager growth. As of the

publication of this book, we are still waiting, and we believe we will wait for a long time, as there is ample evidence to show that a monopolized economy tends to produce stagnation instead of rapid growth.

What if the recent recession is not part of a cycle but is the new reality, one in which new and unprecedented energy constraints exacerbate the already existing tendency of a concentrated economy to grow very slowly, if at all? What if energy restrictions, such as David Murphy's concept, developed in Fig. 4.8 that any increase in growth sets into motion its own demise because of the need to use much more expensive oil? In other words, what if the national (and global) economic pie can no longer grow?

Traditionally, as we developed in ▶ Chap. 7, the concept of the American dream, that is the continually growing pie, had previously resolved or defused many contentious issues in the United States for some time: labor had made more in their salaries (at least until the late 1990s), while management has made much more, large portions of total wealth were "skimmed off" by Wall Street and other entities and it was hardly noticed. Government could be corrupt or inefficient and still the roads got fixed and public universities expanded. Each generation still had the sense that they were better off than their parents, and so on. There were few complaints because everyone made more, at least a little more. But that seems no longer to be the case. So if any one group does better now, it has to be at the expense of some other group or some other use of the money—in other words, the question is if the pie is no longer getting larger, indeed if because of energy constraints it can no longer get larger, how will we slice it? This is forcing some ugly debates back into the public vision, and provides fodder for both responsible politicians and demagogues. And indeed, if total energy availability and economic largess is actually shrinking, then we will need to ask some very hard questions about how we should share and spend what is left.

Probably, this will force individuals and our nation to focus on what is most important. One way to think about this, a commonly used perspective, is "Maslow's hierarchy of human needs." This theory, proposed by Abraham Maslow in his 1943 paper "A theory of human motivation" [5], proposes that humans will attempt to meet their needs in more or less the following order: First, they will meet their physiological needs which are the literal requirements for human survival, including breathing, nutrition, water, sleep, homeostasis, excretion, and sexual activity. These require clean air and water, food, clothing, and shelter. Second, once physiological needs are satisfied, an individual will attempt to meet safety needs in an attempt to derive a predictable, orderly world in which perceived unfairness and inconsistency are under control, the familiar frequent and the unfamiliar rare. These include personal security, financial security, health and well-being, a safety net against accidents/illness, and their adverse impacts. For example, in the world of work, these safety needs manifest themselves in such things as a preference for job security, grievance procedures for protecting the individual from unilateral authority, savings accounts, insurance policies, reasonable disability accommodations, and the like. Third, once the above needs are met, humans seek love and belonging, i.e., emotionally based relationships in general, such as friendship, intimacy, and family. These include large social groups, such as clubs, office culture, religious groups, professional organizations, sports teams, gangs, or small social connections (family members, intimate partners, mentors, close colleagues, confidants). They need to love and be loved by others. Fourth, again once the above have been met, humans seek esteem, to be respected and to have self-esteem and self-respect and also the esteem of others. Also known as the belonging need, esteem presents the normal human desire to be accepted and valued by others through a sense of contribution in, for example, a profession or hobby. Finally, according to Maslow, people seek self-actualization, the need to understand what a person's full potential is and to realize that potential, to become everything that one is capable of becoming, for example, an ideal parent, athlete, scholar, painter, or inventor.

Maslow's theory has been criticized from a number of angles including the lack of evidence that humans in fact follow that hierarchy, or indeed any such hierarchy, and from the perspective that his pyramid may be more representative of people from an individualist vs. socialist society. Nevertheless, his theory is broadly accepted in psychology and even marketing.

Our own research on the implications of declining net energy, while not consciously based on Maslow's theories, is consistent with them in that we have the sense that discretionary spending will be increasingly abandoned as humans attempt to meet their needs for food, shelter, and clothing, what we call "staples" (see Fig. 19.7). Presumably if and as the amount of net energy declines in our society due to having gone through peak oil and

declining EROI, humans will increasingly give up categories higher on the pyramids (fifth above) and concentrate increasingly on the more basic requirements including food, shelter, and clothing. What this may mean in modern society is that expensive vacations, then education, and then health care would be abandoned if and as the economy is increasingly restricted. On the other hand, the first author's mother said that during the depression, people would give up a lot of basics to go to the movies, which were an escape from the often grim daily reality.

24.1.1 Labor

During the last four decades under the pressure of cost minimization, the economies of the United States, Japan, and Germany have been driven into substituting powerful, cheap energy and increasingly automated capital for weak, expensive labor. The low price of fossil fuels relative to their productive power has tended to generate large profits. In other words, labor productivity, the amount of value added per hour that the laborer works, has been greatly increased by subsidizing the efforts of a laborer with more fossil energy, for example, a larger tractor for a farmer. This substitution has not occurred to the degree that it might for various reasons [6] but nevertheless has contributed enormously to unemployment. Will robots put more people, such as truck or taxi drivers, out of work? Heterodox labor economists have known for a long time that an increase in productivity without a subsequent growth in spending manifests itself as unemployment and excess capacity. New resource and environmental constraints may further preclude growth to a degree unimaginable to mainstream economists who do not include energy in their employment models. Will an increase in the price of energy relative to labor increase substantially the amount of labor employed? If labor can again be more valuable in production, real wages would have to fall because goods and services would become more expensive relative to real purchasing power of salaries (otherwise, the labor would not become relatively cheaper). Jean Laherrere has shown an uncanny relation between oil price and unemployment (Fig. 24.1) which may be something to worry about.

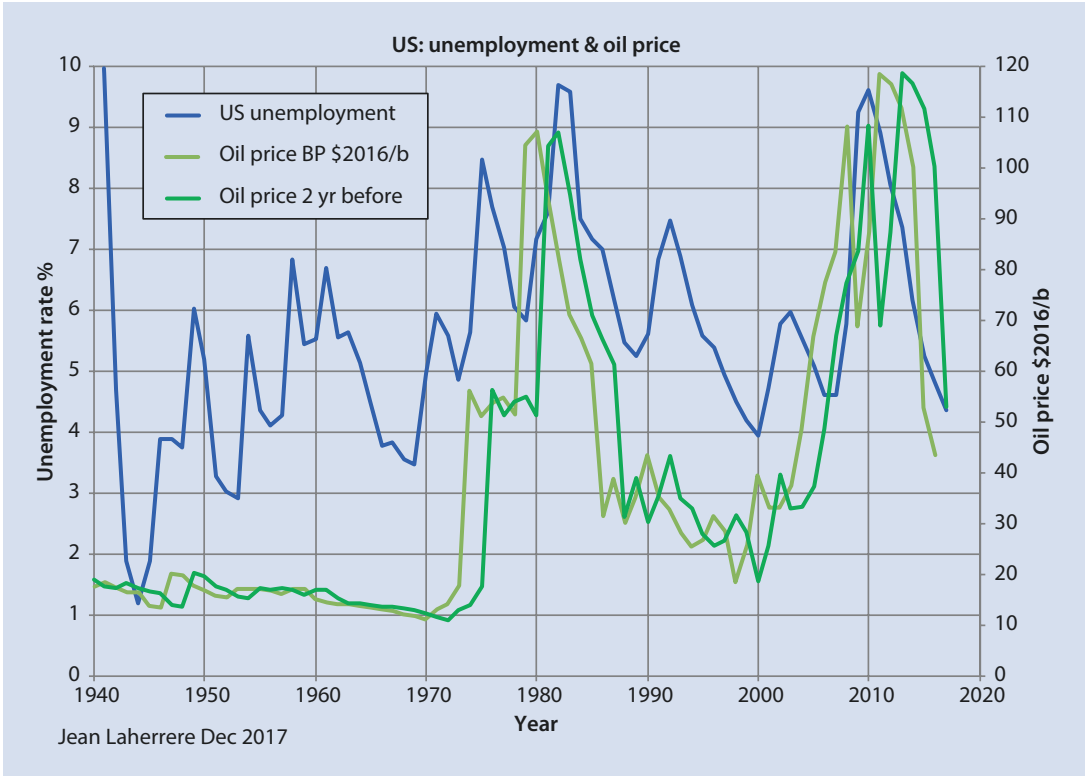


Fig. 24.1 The relation between oil price and unemployment the following year for the United States

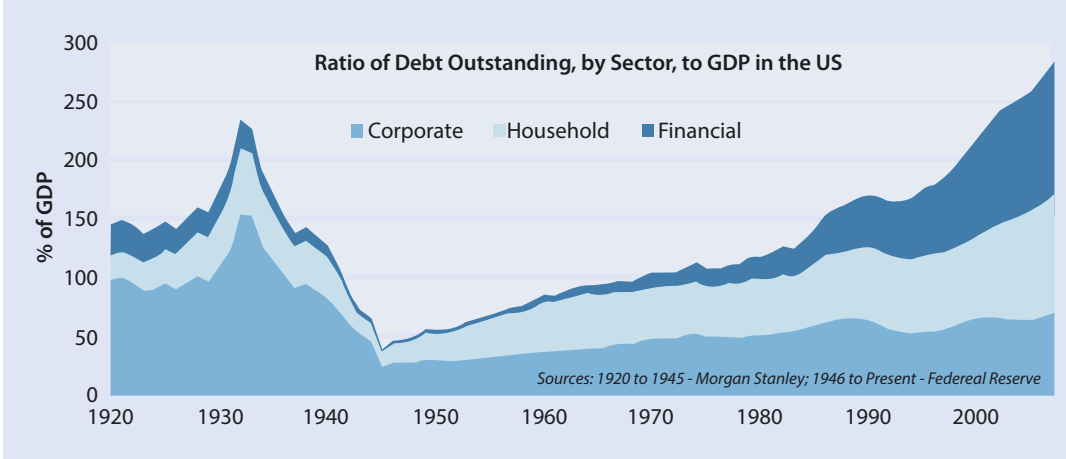
24.1.2 Debt

An enormous, perhaps overwhelming, aspect of our future will be debt. The concept and importance of debt to the American dream were presented in ▶ Chap. 7, and the connection of debt to energy in ▶ Chaps. 4 and 7. Where once we could grow our way out of the importance of debt, this looks more and more difficult if growth becomes a thing of the past. Debt has become an enormous political football with some very curious political dimensions because nominally fiscal conservatives in the past generated the largest part of our debt, at least until the current situation. Few know that the Reagan administration generated far more debt, even corrected for inflation, than Franklin Roosevelt! Given our belief that debt is a lien against future energy use (i.e., if debts are to be honored, then some portion of a nation's future energy use must be diverted to nonproductive, nonconsumptive payment of interest or principle on debt), then it is worrisome to consider that in the future when we will need large amounts of our energy resource to invest in new energy technologies (including conservation), then we must consider that some significant portion of whatever energy is available will be just dissipated on meeting debt loads. Of course, our huge debt load (◘ Fig. 24.2) may never be paid unless we greatly reduce the energy/dollar relation through massive inflation.

24.1.3 International

This book focuses on the United States, and it must seem clear that we have problems enough with energy. But it is worse for many other countries. For example, the United States imports about one-quarter of its energy, while Europe and Asia import two-thirds, making the countries there far more vulnerable to whatever the future energy situation becomes. Europe had a momentary respite with the enormous North Sea oil fields, from which nearly 50 billion barrels of oil have been extracted and another 10–30 billion might yet be from smaller fields. This oil bonanza allowed Britain to have a few decades of tremendous affluence and led many to believe that Margaret Thatcher's political policies had somehow saved the day. But now the oil and gas reserves of the British portion of the North Sea are nearly gone. Britain is struggling with the fact that the oil was essentially spent in a wild binge, and a new cold hard reality is upon her as civil servants and students explode with the drastic cuts in government largess. Norway, on the other hand, has developed its oil and gas at a more measured pace and placed much of the revenues into a trust fund to help all future Norwegians, one of the relatively few examples we have of a mineral bonanza being used to help all citizens, although that too has suffered from falling returns on investments [7].

At the extreme, many tropical developing countries are especially vulnerable because of their



◘ **Fig. 24.2** Total American debt (Sources: 1920 to 1945 – Morgan Stanley; 1946 to Present – Federal Reserve)

increasing reliance on oil for their increasing populations, increasing use of fertilizer and other inputs required for agriculture, and importance of tourism. The first author has a great deal of experience attempting to understand the relation of energy to what is normally called "development" in the tropics. Many tropical countries are poor, or at least not affluent, and essentially all wish to become more wealthy. Hall was initially attracted to the country of Costa Rica which was promoting itself as a "laboratory for green, sustainable development." Unfortunately, his experience from years of living there and studying quantitatively all major aspects of its economy, detailed in two large books on the subject [8], was that Costa Rica, no matter how lovely and how well developed the ecotourism and solar energy (mostly hydroelectric) industries, was at least as dependent upon petroleum as any place else, was far from sustainable for at least 18 reasons, and had no real plan as to how to continue its moderate standard of living without oil. This is for a country that is relatively well-off with respect to its sustainability and its government! Thus, unfortunately, I think peak oil is likely to hit the developing world especially hard. Likewise, even the modest increases in the price of oil have already impacted fully developed, but highly oil-dependent, Puerto Rico (a "dependent" of the United States) especially hard as it has recently declared bankruptcy and an inability to service its debts. These regions, whose economy once depended almost entirely on agricultural production unsubsidized by fossil fuel, cannot possibly feed their swollen populations now from indigenous agriculture. They have no contingency plans for peak oil. This is all the more true in the aftermath of Hurricanes Irma and Maria. The island, before the hurricanes, was completely dependent upon electricity produced by means of diesel generators, whose very maintenance was crippled by an unelected financial control board. Now the vast majority of the island is without electricity. Agriculture and tourism have ground to a halt, and the infrastructure lies in ruins. Will development mean a reconstruction of the fossil economy or will the new electricity system be built upon renewable energy? It probably depends more upon the vested interests of fossil fuel industries and neoliberal politicians than upon the technology of alternative forms of energy. How much net energy is required to deal with the inevitable storms and floods, which appear to be increasing?

Likewise, agricultural production for the world more generally may be very susceptible to peak oil and gas (which would limit the production of nitrogen fertilizer) and peak other requirements. The site ironically called "Sustainable Phosphorus Futures" suggests global peak phosphorus by 2030 [9, 10]. Irrigation, used on perhaps 15% of US crops, is often dependent upon deep groundwater that requires more energy over time as it is pumped from deeper and deeper depths as the fossil water is depleted. More generally around the world, agriculture has shifted to procedures that are energy intensive in many ways, and we expect all to be impacted in various ways by peak oil. Since the growth of the global population is not too different from the growth of fossil energy, we would not be surprised to see those curves to continue to be related on the downslope of the energy curve. As the physicist Albert Bartlett states [11], there is little doubt that populations will decline, what we have is a choice about whether it is due to procedures that we might like (i.e., reproductive control) or the things we like much less, such as starvation, disease, pestilence, and war.

24.2 Choosing a Better Future

To the best of the authors' imperfect ability to predict, it appears very unlikely that there is a "supply" approach out of the circumstances that peak oil will leave us with. Every analysis that we respect as realistic shows a future with peak oil either about now, an "undulating plateau" for not many additional years at best, and then declining oil into the future. Coal and natural gas may be able to fill in part of the gap (but with enormous difficulty for liquid fuels) for some additional decades, but growth or probably even a steady-state energy economy seems unlikely after a decade. To us, it seems that the die is inevitably cast because we simply are not finding oil as rapidly as we are using it (◘ Fig. 8.3). Globally 80% of our oil comes from some 400 large oil fields discovered before 1970, and at least a quarter of these are presently subject to declines in production and EROI, and more will join that group soon. Thus, whatever new oil we find, and we will find a lot, will have to make up for some of that decline

and is almost ensured not to add to any increase in oil supplies worldwide (Fig. 8.9). There are indeed enormous quantities of low-grade fossil fuels left in the ground, but their low EROI and huge investments required make it unlikely that they can replace the role of oil or the forthcoming shutdown of 100 nuclear plants. Other low-grade types of oil such as tar sands are making a small difference but are almost inconsequential on a global basis. All new oil supplies are likely to be much more expensive than the existing oil production. Natural gas may not peak for several decades but is unlikely to more than compensate for declining oil at best.

Coal is harder to predict. There is a lot of talk about "peak coal" (e.g., Patzek [12]; Mohr et al. [13]) much of which is based on the difficulty in mining increasingly thin seams, and the estimate of the total size of the resource is much smaller than was the case a decade or two ago [14]. Peak coal has already come to the world's largest coal user, China (Qi, Tsinghua University. Personal communication) see also [15], but clearly in the United States, Russia, and some few other regions, coal remains extremely abundant. Alaska alone has huge resources of exploitable high-quality coal. US production in 2009 was about one billion tons, and the Powder River formation in Wyoming alone contains some 40 billion recoverable tons. The total recoverable coal base estimated by the US EIA is about 500 billion tons. But Rutledge [14] gives a much smaller number based on what is recoverable. Thus, it seems that if we are willing to make the investment and suffer the environmental consequences, coal can be as abundant as we wish it to be in the United States for a century at least. But coal is currently being displaced by natural gas, so it is a bit hard to predict the future patterns of consumption.

Few if any alternatives, including conservation, appear to be able to fill in for the anticipated decline of oil and then gas. The most recent estimates for all fossil fuels show a projected peak in all fuels by 2025 or 2050, earlier than previously anticipated [13, 16] (Fig. 24.3). Replacing them, if possible, will take an enormous investment in money, energy, and time to be viable. Replacing oil for trucking will be especially difficult [17]. There are some very ambitious plans for replacing all or most use of fossil fuels with solar renewables (e.g., Jacobson [15]), but the actual ability to do that is hard to predict and has been severely criticized by Clack et al. among others [4]. Biomass (other than traditional solid forms such as firewood) can make a certain gross contribution but unless things change considerably little net difference. New solar technologies (including wind turbines and photovoltaics) are a great hope for the future but to date contribute no more than about 2% (Fig. 4.1) and the pace of development has slowed recently. All of these alternatives would have a much lower EROI than what we are used to if provisions for intermittency are included. Thus, we do not necessarily foresee a future United States without energy but rather substantial problems in providing or substituting for the liquid and gaseous hydrocarbons that have been our lifeblood and the engines of rapid economic growth.

Unless we as a country decide to increase our coal use enormously, which would be difficult but certainly not impossible, given present environmental concerns and infrastructure limitations, it seems likely that the future will be one of an increasingly constricted energy supply. This implies, as developed again and again in this book, the end of economic growth and some extremely large adjustments of our citizens to a new steady-state or declining economic condition. If we pay off our huge international debts, this implies an even more constricted economic situation. While for many this will seem like a very gloomy future, for us this is not necessarily the case. Given the environmental destruction we have observed in our lives due to rampant development, we will not miss its continuation, should that be. It depends upon how we adjust, including the fairness of dividing what is left. While others have written better or at least more comprehensively on this issue, we do wish to summarize some few aspects of this issue.

24.3 What We Need to Do: A Biophysical Plan for a Sustainable Future

The conventional wisdom, consistent with Raskin's *Conventional Worlds* scenario, suggests that we can reach sustainability without fundamentally changing ourselves or our institutions. Those in the wealthy, industrialized, world can maintain their energy-intensive and elevated levels of consumption merely by means of technological change. For example, we can

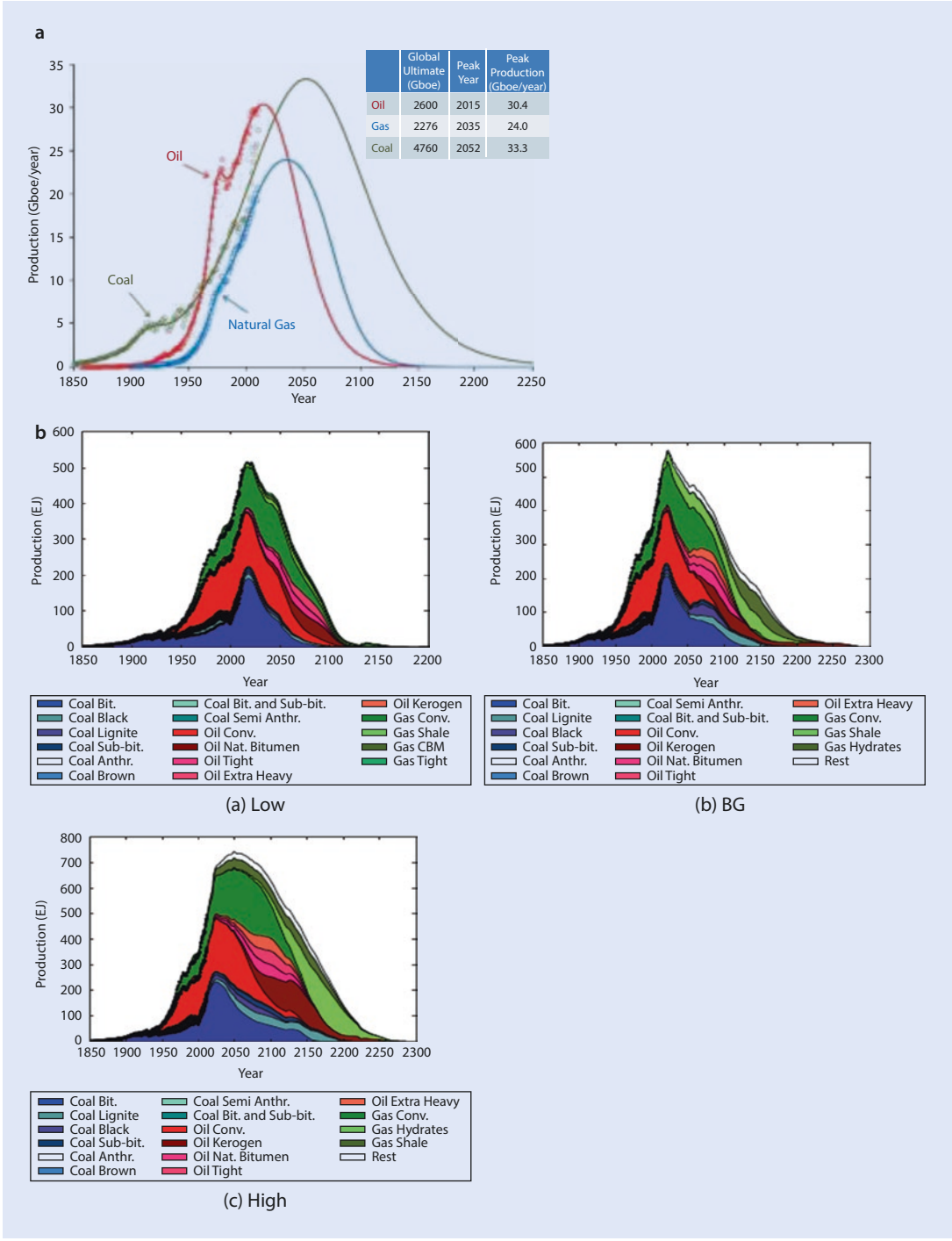


Fig. 24.3 Two new estimates of fossil fuel supplies for the future: **a** from Maggio and Cacciola [16]; **b** low, medium, and high estimate from Mohr et al. [13]

continue to grow as long as we use renewable energy. For the most vociferous adherent of the free-market approach, this will be assured as long as regulations that stifle entrepreneurial innovations are removed. The idea that a mass consumption society represents the zenith of human development is deeply entrenched in the American psyche, perhaps most explicitly

enunciated by Walt Whitman Rostow in *The Stages of Economic Growth: A Non-Communist Manifesto* [19; see criticism by Thorstein Veblen]. This idea that humans are capable of dominating nature is itself long lived, perhaps dating to Jehovah's encouragement to the ancient Hebrews to "be fruitful, multiply and subdue the earth." This Promethean view is a fundamental tenant in western philosophy from Francis Bacon to present-day Marxists, who argue that technological change will be sufficient to overcome declining resource quality and degradation of Earth systems [20].

But "subduing the Earth" without violent repercussions is a large and imposing task. The perspective from conventional wisdom is that incremental changes, reliance on abiding faith in technology, and a belief that the necessary changes will somehow be found by compromise. Unfortunately the science, partially summarized in ▶ Chap. 23, leads one to the conclusion that such incremental steps will be insufficient to cope with the recurrent and potentially destabilizing crises that seem to be accelerating in the global system. The task is made all the more difficult by the existence of nonreversible tipping points that we do not comprehend fully at this time. So far, the degradation of natural and social systems has simply overwhelmed our piecemeal attempts at reform within the system [21]. We are especially concerned about the poorly understood connections between biophysical processes and social systems, as brilliantly laid out by Ahmed [22].

Scientists, especially natural scientists, are often uncomfortable about prescribing policy alternatives. But our job is not always over when we publish a book or an article in a respected journal. We need to confront the messy arena of human volition, as well as the more ordered world of the controlled laboratory experiment. In order to attempt to achieve something called sustainability the best we can do is to provide some suggestions. They are derived from our analysis of nature and of the economy, and they reflect our idea of what would make a good society.

Howard Odum was our mentor and guide, and we respected his contributions to systems analysis, ecological modeling, ecological energetics, and an understanding of the relation of humans to nature and to energy enormously. He understood how the world worked in so many fundamental ways. So it is fitting to choose the title of his last book "A prosperous way down" as a guide for where we should be going.

Odum believed that a lower-energy future was inevitable as fossil fuels peaked and declined. He did not write too much about the details, for to him it was just a fact. But he was interested in how humans might respond to this. He believed that a lower-energy future could be a good future, even as its title indicates a prosperous time. The authors of this book agree, for as we said we grew up in the United States during a time when per capita US energy use was only about a quarter or a third of what it is now. Our childhoods were great, our parents drove us almost nowhere (except occasional family vacations), and whatever we wanted we had to get for ourselves. If we wanted to be somewhere else, we got on our bicycles and pedaled there. If we wanted to play sports (which we did nearly every day), we joined our neighborhood friends and played whatever the season dictated on local school fields or sandlots. We had plenty of friends within walking or certainly biking distance because the automobile did not isolate us from our neighbors. There were plenty of places for Charlie to fish in and to explore and for Kent to swim and even surf. Charlie grew up on fresh vegetables his father grew and fish he caught locally. Life was good, even idyllic. Our houses were not opulent to say the least, our parent's cars (one per family) were not bought new and were not driven many miles in a year, and the only place we took vacations was to go to see relatives, who did not live too far away.

So here are some aspects that might actually be better in an energy-constrained world but only one where people had adjusted well to this new reality.

First, is wealth as measured by GDP necessarily something that leads to happiness? In fact, this has been studied (which is not easy) considerably. The answer is yes, but that other things are more important. For example, Richard Layard of the London School of Economics found a peak in US happiness in 1956, which is not too different from the results that the NGO Redefining Progress came up with a "genuine progress indicator" that found a peak for the United States in 1977 (◘ Fig. 24.4). Inglehart and Inglehart and Klingemann (and others) [e.g., 17] have measured subjective estimates of happiness in the world and found that after a given

minimum level of income, there was no correlation between either income or long-term growth in income and personal happiness (Fig. 24.5). The countries with the largest number of happy people—Ireland, Nigeria, Mexico, and Venezuela—were certainly not the wealthiest, and the countries with the least number of self-described happy people, Russia, Armenia, and Romania, were not among the poorest. Instead, happiness seemed to depend a great deal on a sense of personal freedom and control over one's life. The "Eurobarometer" ranking of the happiness index, that is, how much people enjoy their life as a whole on scale 0 to 10, again found little correlation with GDP. Here are the rankings from this study: Colombia 8.1, Denmark 8, Malta 8, Switzerland 8, Iceland 7.8, Ireland 7.8, Ghana 7.7, Canada 7.6, Guatemala 7.6, Luxembourg 7.6, the United States 7, France 6.6, Nigeria 6.5, Bulgaria 4.5, Russia 4.4, Belarus 4.3, Georgia 4.1, Georgia 4.1, Armenia 3.7, Ukraine 3.6, Moldova 3.5, Zimbabwe 3.3, and Tanzania 3.2. So, overall, the answer to this question appears to be that some level of wealth, as measured by GDP, is a necessary component of personal happiness if you are poor but has little importance above some minimum level (Fig. 24.5). We can start educating our young people to this perspective now.

Second, there are many indications that a less energy-intensive lifestyle can be one of much greater community. This is the explicit objective of various grassroots groups such as "The New Road Foundation" and "the evolution of transition" groups [18, 19], where transition means a transition to a post-peak oil world. Surely our present success-driven, affluence-seeking, status-driven world is not one that generates the greatest happiness and respect for others.

Third, our economy is so wasteful that it should be easy to use only half as much energy and maintain something very much like the same lifestyle. For example, our railroads could be electrified, generating less energy-intensive freight transfer [17]. Sedans that deliver essentially the same services on half the gasoline can

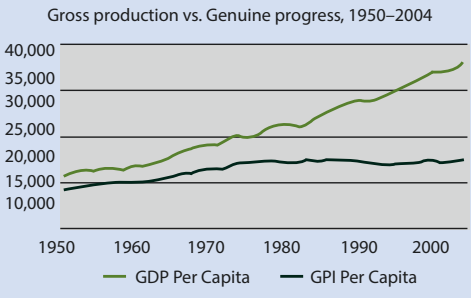
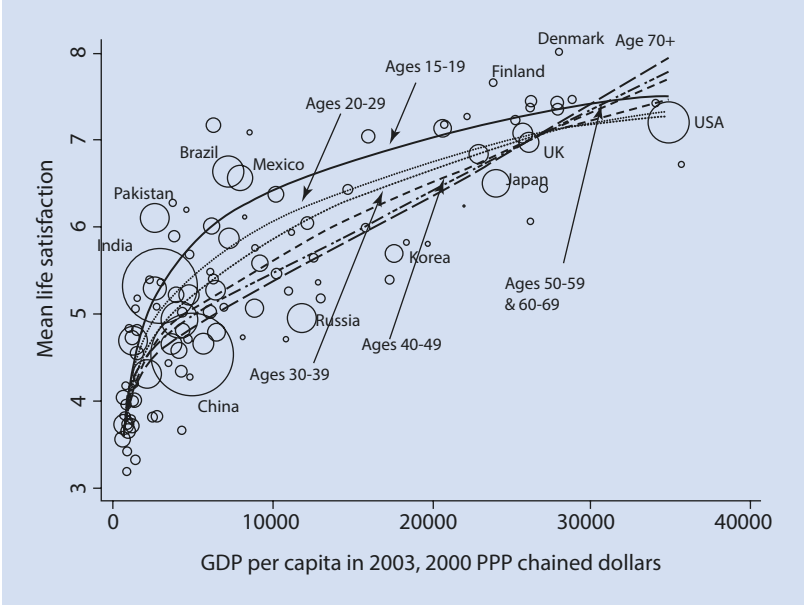


Fig. 24.4 The "genuine progress indicator" has remained constant, while the official estimates of GDP have increased substantially

Fig. 24.5 Asymptotic relation of happiness and wealth



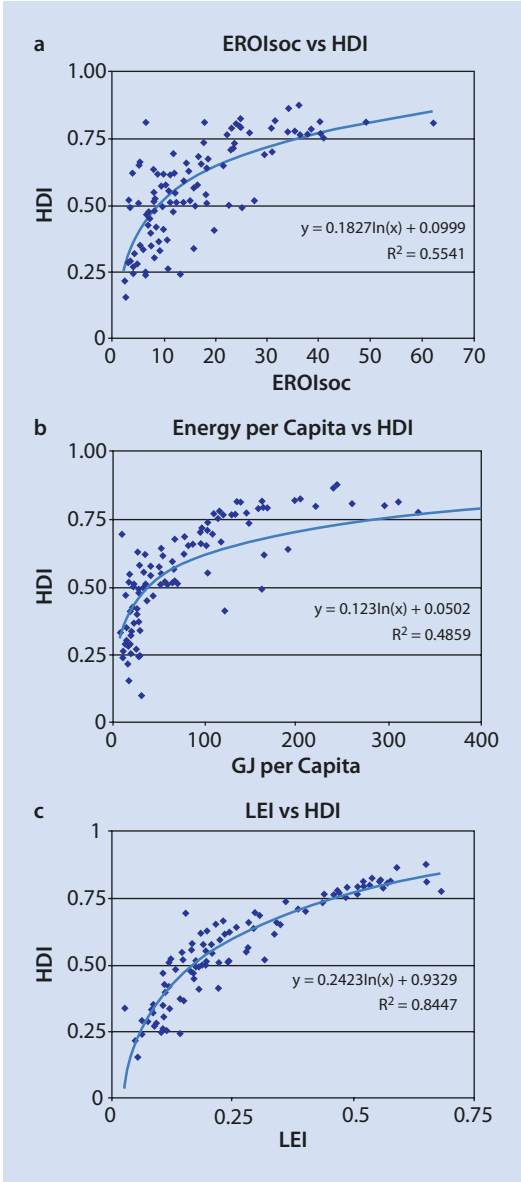


Fig. 24.6 Asymptotic relation of three indices of energy use and human welfare (From Lambert et al. [25])

easily be used, and older buildings can be retrofit with insulation (Fig. 24.5).

Another analysis that shows that human welfare becomes asymptotic with increasing wealth, or in this case energy use, is provided by examining the HDI, the human development index (devised as an alternative to GDP as an index of human well-being) vs. an index of energy use (Fig. 24.6).

24.3.1 What We Must Do if We Are to be Truly Sustainable

We are besieged nearly daily by many different "green" plans that promise, usually through some kind of technology or improvement in efficiency, sustainability, or at least progress in that direction. There is a certain logic and appeal of such plans because they offer indefinite "sustainability" with less impact on the Earth or the supplies of its critical resources.

Unfortunately, we believe that most such technologies are in fact counterproductive because of some manifestation of Jevons' paradox. Stanley Jevons originally believed that given the ultimate depletion of England's coal it was necessary to make the machines that used it more efficient [24]. But, in fact, he found that in the past such efficiency improvements made the use of steam engines cheaper so that more uses were found for them and technical changes designed to save coal actually ended up causing more coal to be used. More recent examples are that more efficient automobiles have led to more miles driven, more efficient refrigerators to larger refrigerators, more insulation to larger houses, and so on. Even cheap solar energy, should that be obtainable, allow the continued exacerbation of all the global problems given in Figs. 23.4 and 23.5. While we do think that efficiency improvements of many sorts certainly do have their place, *they must be implemented within the context of constraints of total use, or they are likely to be counterproductive*.

Thus to continue as a species with reasonable prospects for a decent life for the next hundred years, humanity must do two very difficult things. We must learn to live in harmony with nature and with one another. Neither of these can be obtained in a world where growth of human populations or human economies is the goal or indeed is even allowed. In order to move towards these goals, the changes given in Table 24.1 need to be implemented. Suggestions 1–3 involve ending growth and fundamentally altering present social relations, and are likely to be seen as our most controversial suggestions. Nonetheless, if we do not make these changes *first*, then other changes will probably be ineffective. Suggestions 4–5 focus on technological change, which can be effective if changes 1–3 are operational. Suggestions 6–9 involve transforming ourselves.

Table 24.1 Actions required for true sustainability

Fundamental social changes
1. Stabilize population growth
2. Stabilize economic growth
3. Create a more just distribution of income
Some technological changes
4. Improve energy efficiency
5. Move towards renewable power
Changing ourselves
6. Raise consciousness about embodied energy
7. Truth in labeling to include energy and resource requirements
8. Restore the dignity of meaningful work
9. Adjust our expectations

The fundamental social changes that we see as necessary are the direct opposite of the conventional wisdom regarding economic and political objectives and goals. However, we see most conventional sustainable objectives by others as also eventually doomed to failure without also achieving these goals. We are not naïve enough to believe that the world is about to abandon its growth mania, but believe without that, any economic policy will be insufficient to produce as society in which we can live well within nature's limits. Stated frankly, we have exceeded nature's limits as of today. We must shrink to live within them. At the same time, a market economy must grow to sustain capital accumulation. It is difficult to attain both goals for we cannot grow our economy and shrink our impact at the same time. While it is highly unlikely that the conventional political process itself will institute these changes, it is very likely that nature will make them for us, as may be occurring already (see Figs. 24.3 and 4.6).

Stabilize and reduce population. As can be seen from Figs. 23.1–23.5, humanity has already exceeded crucial planetary boundaries and is rapidly approaching even more. The stability of the Holocene climate most probably cannot withstand the continued growth of socioeconomic systems and the exponential degradation of the Earth systems. Moreover, the ability to feed more than seven billion people depends largely on fossil fuels. The Green Revolution commenced when there were only about 3 billion people on the planet. If our ability to use 10 calories of fossil energy per calorie of food disappears, then we can feed only the number living before the worldwide commitment to fossil agriculture. We cannot get to that number, in the absence of mass starvation or genocide, unless we voluntarily control fertility. We believe that voluntary control of fertility is a vastly superior alternative to the more Malthusian options of mass starvation and genocide. At the same time, we do not expect this process to be smooth and stable. The individual right to conceive and raise children is among the most dearly held of human rights – but it is enormously detrimental to Earth and the human population. Developed nations that have reduced their population growth rates below replacement rate have witnessed a declining and aging population. This leads to its own problems. In the long term, this means a smaller, and most often a less affluent, population of the young must try to support a growing population of the elderly that can no longer work as they once did. If, as the cheese slicer model implies, more of our national income must be spent to acquire energy, where will we get the money to support our old in the absence of economic growth?

Stabilize and reduce economic activity. Even if we reduced the world's population by eliminating the poorest half, the impact upon climate and other planetary boundaries would be minimal. Nearly all the impact comes from already existing rich nations, and from the rapidly industrializing nations, such as India and China. Put simply: a system in overshoot cannot grow its way into sustainability. The signs of the human economy are everywhere. Wealthy nations use up 3–5 planets' worth of resources to maintain their lifestyles. Every location where hydrocarbon development occurs is an environmental sacrifice area. As we have seen in ▶ Chap. 11, every increment of economic activity requires a more or less proportional increase in energy use, most often with an additional release of climate-modifying gases. The weight of plastics will exceed the weight of fish in the world's oceans by 2050.We can only live within

nature's limits by shrinking the economy, then maintaining the smaller economy indefinitely. It is important to note that the Limits to Growth studies also could not generate a stable future without eliminating investments: i.e. growth.

Create a more just distribution of income. One way to meet the requirements of the poor of the world and the retirees mentioned above is through more equitable distribution of such wealth as is produced. More generally, a sustainable society must be a just society. A world in which a small wealthy elite live so opulently as islands of prosperity in a sea of misery cannot persist indefinitely. Attempts to create a fortress world will cause social breakdown and barbarism. We are already seeing this everyday. While it is called "terrorism" and blamed on "the other" with different customs and religion, the basis of social breakdown in unequal access to energy needs to be explored to a much greater degree [22].

Improve energy efficiency, but within constraints. Our present system of burning fossil fuels in concentrated locations and transmitted over long distances is pressuring our remaining fuel sources, is environmentally destructive, and creates unjust and inequitable access to energy. At the same time, social mechanisms must be put in place to avoid Jevons' Paradox, whereby increases in efficiency lead to greater resource use. We are unaware of any technological change in the twentieth century that did not improve "efficiency" without also increasing resource and energy use.

Along with increased efficiency, we must move towards renewable power. We will have neither the availability of high-quality fossil hydrocarbons at reasonable cost, nor the assimilative capacity of the atmosphere to accommodate the fossil economy for more than the next half century, if that. Moreover, since the construction of the solar economy depends upon fossil fuels to produce and move the wind turbines, concrete pads upon which to locate them, and the photovoltaic panels to generate electricity, we need to start now, and not wait until fossil fuels are in desperately short supply.

Raise consciousness about embodied energy. Few people living in wealthy, energy-intensive societies think about the energy embodied in their day-to-day actions. How many extra tons of carbon are emitted when an able-bodied person uses the electric door opener mandated for the handicapped, or when one does not turn off their computer at night? How many people have actually calculated the volume of water used in a shower, or the amount of electricity needed to run the pumps, or the fuel used to heat the water?

Truth in labeling. Along with calories ingested by consumption on food labels, we should include calories used to produce the foodstuff. Energy returns on investment should be displayed explicitly on all consumer products.

Restore the dignity of meaningful work, which allows each and every worker to combine the brain work with the manual work to produce something of value that improves society. Although this will raise the price of consumer goods, it will also go a long way in reducing inequality and waste. Few psychologists believe that more consumption leads to more happiness, beyond a minimum of survival. The community of meaningful work among associated producers could easily produce a happier society, even if this means longer hours of physical labor. The human body was not designed to sit behind a screen for long hours. Get moving!

Adjust our expectations. We cannot conspicuously consume our way into happiness. In the United States, only about 1–2% of our energy is produced by renewables. Would the elements on the Periodic Table exist in sufficient quantities to produce the same level of output for all people of the Earth that citizens of the wealthy nations now consume? We doubt it. Perhaps we need to realize that our comfort, convenience, profits, and income are not as important as the proper functioning of the Earth's biophysical systems.

► Chapter 23 showed that many of our socioeconomic and earth systems are already in overshoot, and a system in overshoot simply cannot grow its way into sustainability. Yet our present economic system requires continual economic growth in order to maintain employment and provide income. We are convinced that we will not achieve sustainability simply by recycling more. We must transform the economic system from one that is growth dependent to one that can provide a decent standard of living without growth. John Bellamy Foster enunciated our challenge well when he said:

» To achieve these things we will need to break with "business as usual," that is, with the current logic of capital, and introduce an entirely different logic, aimed at the creation of a fundamentally different social metabolic system of reproduction [20].

24.3.2 Why We Are Not Entirely Optimistic

While we believe that a relatively smooth transition to a lower-energy future with a good lifestyle is quite possible, we are not necessarily optimistic that it will occur. The first reason is that the American public is almost completely ignorant about peak oil—which indeed is the simplest part of the dilemma, "the energy mess," that we have inherited [21]. Quite curiously, neither the press nor the national funders of science (NSF, DOE, etc.) have any particular interest in this issue and, if anything, have attempted to suppress any research or discussion on the subject [22]. This is quite surprising considering the enormous amount of attention given to possible climate change. While we wish in no way to belittle the importance of the attention paid by both the press and the science community to climate change, we find it curious that peak oil, a situation that seems to be more immediate, more certain, and perhaps more devastating, receives essentially zero press or funding, at least as of 2017. As part of this problem, the public is fed a constant stream of advertisements and programs promising green clean energy when the quantitative nature of the contributions—all trivial—is never mentioned. Likewise, the energy cost of so many "green" things, from trips to ecotourism sites to LEED buildings, is rarely mentioned.

A second reason we are not optimistic is that Americans (and most others in the world) have been conditioned by a lifetime of television and other advertisements all indicating that happiness and sexual fulfillment, you name it, are possible only through a never-ending stream of purchases. This seems to be so ingrained in our culture and our economy that it is hard to imagine it otherwise.

A third important reason we cannot be too optimistic that we will make the needed transition will be the political response to this situation. This of course requires that people understand what is happening and that the political situation can adjust to this new reality in a reasonable way. There are many thoughtful papers that have attempted to examine the potential transition in various and often quite sophisticated ways [21, 23]. All agree that a critical first step is to question a belief in, and policies attempting to promulgate, growth. How this can be undertaken in the current political climate where even far less controversial legislation is stalled is beyond our comprehension. Possibly, peak oil will put some sense into the electorate's head, but more likely there will simply be a blame game for the fact that no political parties can bring back the good old days where the American dream was realized for generation after generation. If there is to be a new American dream, it has to be based on something besides ever more affluence, and that will be tough. But there are simple things we can start doing. Two simple things are to live near where you work and contribute to making sure your neighborhood, and neighborhoods in general, provides the necessities of life to decrease your and our dependence upon automobiles. We like the ideas of Will Allen (Growing Power, Inc.) and others to bring agriculture into the central cities.

We do not believe that simply by "doing simple things" we can save the Earth, nor do we believe that technology alone will save us. We have to do big and complicated things if we want the planet of the future to be similar to the one on which our species evolved. If we do not achieve a stabilization of growth and justice, then the rest of our suggestions will not matter very much. These are difficult and complex changes which will require a fundamental reordering of economy and society.

Another reason that simple changes or some magic technology will not, by themselves, produce sustainability is the need for perpetual economic growth in a capitalist economy to produce profits, avoid poverty, and reduce unemployment. If individuals live within nature's limits the planet, their lives, and especially those of their progeny, will be better off. Yet the economy may collapse from the reduced consumption. While legions of economics teachers implore their students to believe that capitalism is about efficiency, without copious amounts of waste enough economic surplus could not be absorbed to maintain prosperity.

Thus, a good future and even a prosperous way down are, we believe, quite possible for economic and political reasons but very unlikely due to psychological and conditioning issues relating to the attitude of the American people relating to advertisement, growth, and wealth as status. We conclude that what we need most is to create a biophysically based approach and model for economics, one that would serve on at least equal footing with the present firm-household-market-based model. This is

our next project and the annual meetings of the International Society for BioPhysical Economics is one important place to start.

24.3.3 Why We Have Reason to Be Optimistic

To begin with, there are a lot of very smart people who are working on these problems. They range from academics to those in nongovernmental organization to political activists. The Occupy movement did more to raise questions about income distribution than did the sum of peer-reviewed academic journals. The Women's March for Science was just one example of how the recent election shocked many people out of their complacency. Student organizations such as Power Shift are raising the issues with today's students about things their lives will depend upon and urging them into action. Organizations such as *Via Campesina* and the Unity Council of the Cayuga Nation are showing those of us in the global North that our ways are not necessarily the ways. Paul Raskin of the Tellus Institute put it well. "The future will depend upon decisions that have not yet been made." The most recent recipient of the Global Development and Environment Institute's Leontief Prize, Joan Martinez-Alier, said that the alternatives will emerge in the struggle. We do not know what sustainability will look like, but we know what it will not look like. A sustainable society will not be the business-as-usual strategy of globalized monopoly finance capitalism guided by neoclassical economics: perpetual growth and resource depletion, no matter the consequences. Neither will it be the top-down Stalinist repression of Soviet-era heavy industry. But there is a lot of room in between or perpendicular to these two poles with many options. The time is now to start exercising them. It might be helpful to remember the words of Margaret Mead. "Never doubt that a small group of thoughtful citizens can change the world; indeed, it's the only thing that ever has." We hope the analyses in our book can help guide you down the path of living the best life possible in a resource-constrained world.

We can envision a future of a stable economy using half the resources of today, but sufficient to provide basic dignity for all while maintaining incentives. However, this cannot be done within the confines of conventional economics and our present social order. What we have presented in this book, BioPhysical Economics, provides the logic and tools to begin the transition to a just and truly sustainable world.

Questions

1. Are you an optimist or a pessimist about the future? Why? About what?
2. What is Maslow's hierarchy of human needs? Can you list them in order?
3. What are some ways that we can make more jobs available for labor? What would be some good and some bad sides to that?
4. Name five ways that food production depends upon oil.
5. What are your views about the future of coal in the world economy? What factors might be especially important in influencing this?
6. Do you think that GDP is an adequate measure of our wealth? Why or why not?
7. What are some of the advantages that might come from a less energy-intensive lifestyle?
8. What ideas do you have to provide for a better future for all Americans and all people of the world?

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