Toward an Economy of Sustainable Energy[i]

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All modern, industrial economies are dependent upon fossil energy. Fossil energy is non-renewable, at least within any reasonable human timeframe. If we continue to rely on non-renewable energy to fuel our economy, we eventually will run out. Experts may disagree about how long different types of fossil energy will last, however, no one disputes the fact that we eventually will have to find alternative energy sources or we will have no economy, no society, and thus, no civilized human life on earth. Our major disagreements arise from questions concerning what, if anything, we ought to do about running out of fossil energy.

Most conventional economists, meaning neoclassical economists, argue that we should do nothing, that we should allow energy from various sources to be rationed by rising markets prices as they become increasingly scarce. As prices rise for energy from one source, exploration and development of alternative energy sources also will become more economically attractive. Long before any given energy source is exhausted, alternative sources will not only be discovered but will become economically feasible. Thus, if we simply trust the market economy, they say, we will never run out of energy.

Ecological economists, on the other hand, have less faith in the market economy. They are concerned with market failures, meaning situations in which markets fail to reflect the full societal costs and benefits associated with economic decisions. Ecological economists believe that alternative energy sources will be more costly or simply will not be available, representing a cost and a risk to future generations that are not reflected in current market prices. Thus, energy sources are being depleted at rates far faster than would be optimal from a long-run societal perspective. They propose using public policies to "internalize" these "external" costs, bringing them into the marketplace, so today's market prices will reflect the "full economic costs" of energy, including the risks of future energy depletion.

Neither of these approaches, however, can ensure a sustainable source of energy for today's neoclassical, industrial economy. Many people seem to believe that America is moving away from industrialization, which they define as transition from agriculture to manufacturing as the primary source of income and wealth within a society. While the U.S. is rapidly moving from manufacturing to information manipulation as its primary source of income and wealth, it still seems firmly committed to the industrial economic paradigm of resource development. Industrialization is a mental model or paradigm for organizing and managing resources. The transition from agriculture to manufacturing is simply a consequence of applying this model in developing the natural resources of a nation. The fundamental flaw of the industrial economy is that it uses energy but it does nothing to renew, restore, or regenerate energy. To address the "energy problem," we ultimately must move toward an economy based on sustainable energy.

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The differences between *industrial* and *sustainable* approaches to resource development, meaning energy use, are deep and fundamental. The fundamental purposes of industrial and sustainable organizations are very different, and nothing can be more important to any organization – a farm, business, factory, economy, or society – than its *purpose* for being. All organizations are formed by bringing together and organizing collections of resources, which may include land or other natural resources, labor or other human resources, capital or financial resources, and the capacity to manage those resources. Farms, businesses, and government agencies are all organizations of natural, human, and financial resources, as are economies and societies. No logical approach to organizing and managing these resources exists in the absence of a clear purpose for bringing people, materials, and money together. The basic nature of any organization is determined by its purpose.

The central purpose of all *industrial* organizations is *productivity*. Industrial organizations are organized and managed to achieve maximum output with minimum input, which in economic terms, translates into maximum total profits. Larger industrial organizations typically are able to produce a greater value of output with lower costs of inputs, so ever-greater profitability and productivity are made possible by organizational growth. Therefore, the guiding principles of any industrial organization are *maximum profits and growth*.

The purpose of all *sustainable* organizations, on the other hand, is *permanence* – meaning sustained productivity. Sustainable organizations must be organized and managed to conserve, renew, and regenerate their resource bases, as well as to be productive and profitable. Rather than maximize or minimize, sustainable organizations must manage for balance and harmony among the ecological, social, and economic functions. They must care for the natural resource base, in order to preserve its regenerative capacity as well as its productivity. They must care for their customers, workers, and neighbors, in order to preserve the society within which and for which the organization exists.

All organizations are inherently dependent upon nature and society for their sustainability. Only through caring for nature and caring for people, can organizations sustain their productivity, maintain economic viability, and thus, achieve permanence. The guiding principles of any sustainable organization must be *balance and harmon*y among *ecological* integrity, *social* responsibility, and *economic* viability.

At first, many people may see little to be gained from thinking about such abstract concepts as purpose and principles. They are interested in making a living, not philosophizing. However, nothing is more critical, not only in sustaining the energy sources that must sustain economies and societies in the future, but also in sustaining a desirable quality of life for people today. If we fail to pursue permanence, if we reject the ecological, social, and economic principles of sustainability, we not only threaten the future of humanity, we threaten our own pursuit of happiness. This isn't just about philosophy; it's about our businesses, our professions, our families, our lives.

Industrial organizations quite simply are not sustainable – ecologically, socially, or economically.[1] The first law of thermodynamics states that the total of energy and matter is conserved. Energy may change in form, energy may change into matter, or matter may change

into energy, but total energy, including energy embodied in matter, remains unchanged. However, the second law of thermodynamics states that each time energy changes in form, or energy changed into matter or matter to energy, some of the *usefulness* of energy is lost.

The *usefulness* of energy, meaning the capability of energy to perform *work*, is directly related to the *concentration* of energy. Work dissipates energy, changing it from more- to less-concentrated forms. As energy becomes less concentrated, as when matter is transformed into energy, it becomes less useful. Dissipated energy can be *reused*, but it must be *re-concentrated* and *re-stored* to restore its usefulness. Unfortunately, the energy required to concentrate and to store energy is not available to do work; its *usefulness* is lost. Unless *new* energy in made available to offset this loss, the total supply of useful energy in any system eventually will be depleted. Scientists refer to this process as a natural tendency toward *entropy*, "the ultimate state reached in degradation of matter and energy; a state of inert uniformity of component elements; absence of form, pattern, hierarchy, or differentiation." A barren desert, without form, structure, or pattern, without life, is about as close to entropy as most of us have seen.

All *work* involves the release or dissipation of energy. When a person performs physical labor or an engine burns fuel, or soil organic matter feeds a plant, energy performs work, but becomes less useful in the process. When a log is burned to provide heat, energy is released from matter; it performs useful work but also becomes less concentrated and less useful in the future. When food is digested in the stomach, energy is released from matter; it creates human energy but becomes less concentrated and less useful in the process. All *useful* processes dissipate energy.

Industrial systems are very efficient in doing *work* because they focus on *extracting* energy and *using* energy, but do nothing to *re-concentrate, restore, or regenerate energy*, unless such processes improve the efficiency of energy extraction and use. When they deplete one source of energy – natural or human – they simply find other sources. Resource regeneration and renewal are *non-productive* energy uses; it is more efficient to extract and exploit new sources. Once all sources of energy have been depleted, however, energy-extracting systems lose their ability to do *work*; they reach entropy. Industrial organizations are not sustainable – a plain, simple, and scientifically sound fact.

The same scientific concepts apply to *non-material* forms of production, specifically to personal services such as those provided by doctors, lawyers, teachers, waiters, and janitors. The energy resources in this case are social rather than physical in nature. Social capital or social energy is embodied or stored in the ability of people to benefit from relationships with each other, within families, communities, and societies. Kinships within families, friendships within communities, and civility within societies contribute directly to our happiness and quality of life but also contribute to our ability to *work* together, to be *productive* and *useful* to each other.

Industrial organizations are very efficient in producing personal services because they focus on using existing social relationships to facilitate production, but do nothing to regenerate or restore the social capital that is inevitably lost. When families become business organizations, friendships become business relationships, and citizens become nothing more than consumers the social cohesiveness that makes societies productive as well as personally rewarding is lost. Establishing, maintaining, and renewing positive social relationships are *non-productive* uses of

social energy; it is more efficient to find new people, communities, and societies to exploit. Exploited societies, left without a sense of fairness, equity, or justice, are inherently unstable and destructive. They fall into patterns of reoccurring internal conflicts, which result in the senseless destruction of both natural and human resources, as may be witnessed in many parts of the world today. An industrial society inevitably tends toward *social entropy*. It is not sustainable.

Economics simply provides an alternative means of evaluating physical and social productivity. Economic systems are the means by which complex societies transform physical energy and social energy into forms that can be valued by uniform measures – dollars and cents – so that *work*, and the ability to do *work*, can traded or exchanged in impersonal marketplaces. All economic capital, meaning anything capable of producing economic value, is extracted from either natural capital or social capital. Thus, when all of the natural and social capital in a system have been extracted and exploited, all of the energy in the system has been dissipated, and it can no longer produce anything of economic value; it has reached a state of *economic entropy*.

Industrial organizations are very economically efficient because they focus on extracting and exploiting natural and social capital, but invest nothing in regenerating or renewing the physical or social energy they have depleted, unless such investments improve the efficiency of extraction and exploitation. Even industrial farming, forestry, and fishery operations use the natural regenerative capacities of living ecosystems as means of extracting non-renewable energy resources from the land, air, and water, and dissipate more energy than they renew.

Equally important, industrial systems not only destroy the future productive capacity of natural, social, and economic systems, they also diminish the quality of life of people within society. Nature provides direct benefits to people, through a healthy living environment, clean air and water, aesthetically pleasing landscapes, and opportunities to connect and commune with nature. Society also provides direct benefits to people, through personal relationships within families and communities and through equity and justice within societies. Direct personal relationships among people and between people and nature also help give purpose and meaning to our lives. The quality of our life, our happiness, is directly related to a sense of *rightness* in our relationships with people and nature. This rightness is determined within a higher order of things, which transcends the economy, society, and nature. Within this order, the unrestrained extraction and exploitation violates our common sense of rightness. Industrialization may enhance our material well-being, but it diminishes our social and spiritual happiness and quality of life.

If we are to develop an economy of sustainable energy, we must learn to manage our energy resources, both natural and social, for permanence rather than maximum productivity. Industrial organizations maximize productivity through specialization and standardization (facilitating routinization, mechanizations, and automation), which allows consolidation of management into ever-larger production units. Industrial management is inherently mechanistic; the industrial organization operates like a sophisticated machine with many interrelated and replaceable parts, each performing a specific specialized function by a predefined standard procedure. These mechanistic strategies have proved very effective in extracting and exploiting natural and human resources for short run individual economic benefits.

Sustainable systems, on the other hand, must mimic the processes of living, biological systems. Only living systems are self-making, self-renewing, reproductive, and regenerative. Only living systems have the capacity to capture and store solar energy to offset the energy that is inevitably lost in the processes of re-concentrating and re-storing energy. Obviously, individual living organisms are not permanent or sustainable in the sense that they never die. But, communities of living organisms, including living organizations, have the capacity to devote part of their productivity to regeneration and reproduction, thus sustaining the life of the community. All living systems – living organizations and communities – are capable of permanence as well as productivity. A sustainable economy must utilize these capacities.

Agriculture is the living system upon which modern society is most critically dependent. People are still as dependent upon the land as when all humans were hunters and gatherers. The dependence is more complex and less direct, but is no less critical. Unfortunately, the industrial approach to agriculture, which dominates today, is no more sustainable than are the industrial approaches to mining and manufacturing. The industrial paradigm has recently made deep inroads even into organic agriculture. A sustainable economy, however, must be built upon the foundation of a self-renewing, regenerative, sustainable agriculture. A sustainable agriculture *must* be a self-renewing, regenerative source of food and fiber but also *can* be a metaphor for a sustainable economy.

Sustainable agriculture is a critical element of sustainable resource development, a concept gaining in credibility and popularity among environmentally and socially responsible people all around the world. Sustainable agriculture, like sustainable development, must meet the needs of the present while leaving equal or better opportunities for those of the future. Legitimate approaches to sustainable agriculture certainly are not limited to organics, and "industrial organic" systems obviously are not sustainable, but the fundamental purpose and principles of sustainability can be found in the *historic* purpose and principles of organic farming.

Sir Albert Howard, one of the fathers of organics, emphasized *permanence* as the central purpose of organic agriculture. Howard began his book, *An Agricultural Testament,* with the assertion, "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture."[2] He contrasted the permanent agriculture of the Orient with the agricultural decline that led to the fall of Rome. He concluded, "The farmers of the West are repeating the mistakes made by Imperial Rome." Rudolph Steiner, who founded biodynamic farming, wrote in 1924, "A farm is healthy only as much as it becomes an organism in itself – an individualized, diverse ecosystem guided by the farmer, standing in living interaction with the larger ecological, social, economic, and spiritual realities of which it is part."[3] Steiner defined an organic farm as a living system, as an organism, whose health and productivity depended on healthy relationships among its ecological, social, economic, and spiritual dimensions. He considered the *rightness* of relationships among the farm, farmer, food, and eater to be divinely or spiritually determined. In living systems, *right* relationships are mutually beneficial relationships, not extractive or exploitative. Even when two organisms seem to compete, they still must serve to strengthen and sustain the living community. A sustainable economy must be guided by thoughtful and sensitive individuals, standing in living interaction, and working in harmony with the "larger ecological, social, economic, and spiritual realities."

A shift from conventional to sustainable agriculture could make a significant contribution to energy sustainability, but agriculture cannot possibly generate enough renewable energy to offset the energy lost through the depletion of fossil fuels. In the United States, renewable energy produced annually by all types of plants amounts to only about two-thirds as much as total annual use of non-renewable fossil energy.[4] However, agriculture is able to harvest only a little more than 35% of total of total plant energy produced – an amount equivalent to about 25% of total U.S. fossil energy use. (Forestry harvests an additional 5% fossil energy equivalent.) Energy used for U.S. food production, including food processing and distribution, is equivalent to about 17% of total fossil fuel used. Agriculture accounts for about one-third of total food energy use, an amount equivalent to about 6% of total fossil fuel use.

This might appear to indicate a significant energy surplus for agriculture. However, crops that could be consumed directly by humans account for only about 20% of total agricultural energy production. The remaining 80% is produced by pastures and forages, which are utilized by livestock in producing meat, milk, eggs, and other food products. In addition, about 90% of all food crops produced in the U.S. is fed to livestock and poultry, which on average may require more than 15 kcal of fossil energy for each kcal of food products. As a result, the U.S. food system requires approximately 10 kcal of fossil energy to produce each kcal of food energy, in addition to the solar energy harvested by agricultural plants.

Shifting to a vegetarian diet would be one obvious means of reducing energy use in agriculture, since most food crops are net energy producers rather than net users. It has been estimated that a vegetarian diet could cut the food energy input/output ratio in half.[5] However, the loss food energy and use of fossil energy processing and distribution would still leave a net fossil energy deficit for food production of about five to one. In addition, the 20% fossil fuel equivalent produced by pastures and forages – large net energy producers – would be lost. Shifting from confinement livestock feeding operations to grass-based operations could be a more logical means of reducing the energy used in animal agriculture. A shift to grass-based systems could save an estimated 35% of total energy now used in beef, dairy, and lamb production. The elimination of confinement animal feeding operations also would result in significant social, environmental, and diet benefits, as well as energy savings.

Sustainable farming practices could reduce agricultural energy use even farther. For example, recent research, based on more than 20 years of data, indicates that shifting from conventional to organic farming practices could save as much as 30% of the fossil energy used in cropping systems, without reducing total production.[6] Sustainable grass-based livestock systems, utilizing management intensive grazing, are capable of producing from 50% to 100% more protein per acre than conventional pasture/forage system, while using less fertilizer, pesticides, and fuel. Free-range and pasture-based pork and poultry operations also are far more energy efficient that confinement feeding operations. In addition, hogs and chickens are natural scavengers and thus could get a significant portion of their diets from waste products, as Cubans discovered when they lost access to cheap fossil energy. Significant fossil energy savings for sustainably produced livestock and poultry might well be achievable without any significant reduction in animal protein. Changes in food processing and distribution, such as increased use of raw and minimally processed foods, more meals prepared at home, and a shift to more community-based, local food systems, could increase the efficiency of energy use in food marketing by comparable amounts.

To my knowledge, no detailed estimates are available, but energy savings from shifting to a more-sustainable agricultural system, using currently available methods and technologies, probably could cut total fossil energy use in agriculture by one-half, resulting in a savings equivalent to about 3% of total fossil energy use. Similar efficiencies in processing and distribution could save an additional 6% or so in fossil energy use, but would still leave total food production with an 8% fossil energy deficit. It seems unlikely that agriculture will ever be able to produce more energy than will be needed to meet the increasing food and fiber needs of people. Current agricultural energy initiatives, specifically those utilizing grain and oilseeds to produce ethanol and bio-diesel, have shown little promise of generating more energy they consume. Their primary value seems to be in changing the form of energy, rather than increasing the amount of energy. With a growing world population, reducing the amount of fossil energy required for food production would seem a far higher priority than turning food for hungry people into fuel for automobiles.

Ultimately, sustainable agriculture's greatest contribution to sustainable energy may be in its role as a metaphor for organizing and managing other types of organizations. All sustainable organizations, as with true organic farms, must be managed as living systems: nurturing rather than manipulating, respecting rather than dominating, trusting rather than controlling. Specialization, standardization, and hierarchal control exist within nature as well as within industrial organizations. However, living systems – cells, organisms, and ecosystems – have natural internal controls, which regulate their growth and maintain an appropriate healthy size and shape for each organ, organism, or organization. When these instructions are damaged or destroyed, the cells of organisms become cancerous, multiplying and growing without control, and threatening the life of the host organism. Industrial organizations, on the other hand, are like mechanisms rather than organisms. They have no internal controls to moderate or limit their rate of growth. Industrial organizations are like cancerous growths, growing uncontrollably until they threaten the health and life of their ecological and social hosts. Sustainable organizations may specialize, standardize, and consolidate to achieve efficiency, as do healthy living systems; but they must maintain internal ethical and social controls to limit their rate of growth and size to healthy, sustainable levels.

The *neoclassical* economy is incapable of addressing the energy problem because it is driven by the unfettered pursuit of profit and growth; it has no internal social or ethical controls. *Classical* economists, such as Smith, Ricardo, and Malthus, had been very much concerned with social and ethical principles. Adam Smith wrote in his 1776 classic, *Wealth of Nations*, "improvement in the circumstances of the lower ranks" should never be regarded as "an inconvenience to the society… what improves the circumstances of the greater part can never be regarded as an inconvenience to the whole."[7] He also wrote that *land*, nature's resources, "constitutes by far the greatest, the most important, and the most durable part of the wealth of every extensive country,"[8] suggesting that the "public" must accept responsibility for protecting their common wealth. Classical economists understood that a capitalistic economy must function within the social and ethical bounds of a moral and just society.

The neoclassical economy, on the other hand, values only those things that provide tangible, sensory benefits to individuals. In economics, relationships have only *instrumental* value in that

they contribute to one's individual wealth or tangible well-being. Strictly *personal* relationships have no economic worth. The well-being of others, including those of future generations, can never be allowed to misguide neoclassical economic decisions. Equal rights can never be afforded to all without misallocating economic resources, because people are inherently unequal in their ability to produce and acquire things of economic value. In the neoclassical economy, ethics, morality, and social responsibility are economically irrational motives that place needless restraints on economic productivity, profits, and growth.

Consequently, neoclassical free markets will not ration energy use among generations because those of future generations cannot participate in today's markets to bid for those resources. To economists, a *one-million dollar* cost or benefit to be realized two hundred years from now is worth less than *two dollars* today – its discounted net present value, using a seven-percent discount rate. Markets simply don't place much value on anything expected beyond the lifetime of current traders and heavily discount anything more than a decade in the future.

The popular economic *belief* that an alternative can be found for any energy source we deplete is not a *fact* or even logical theory. We are virtually certain that all of the energy resources of the earth eventually will be depleted if we do nothing to regenerate and re-store the energy inevitably lost with every economic process and transaction. However, if an energy source won't be depleted for another hundred years, the markets simply don't care, and even if it will only last another decade, the markets don't care very much. A neoclassical economy is all about me, now, not about future society. Anything else is just a rationalization to make me feel good about my greed.

Neither is internalizing externalities the answer to sustainability, because values that are purely social and ethical in nature cannot be translated into dollars and cents. Any attempt to do so inevitably focuses on the indirect economic benefits of social and ethical relationships, ignoring the far larger direct benefits of our relationships within nature and society. In matters of social value, such as equity and justice, each person must be afforded an equal worth, regardless of their wealth or productive capacity. Ethical matters, such as stewardship of non-renewable energy for future generations, must be addressed through a process of societal consensus. Even if such values could be measured and internalized as market values, their benefits would go to the highest bidder, not equally to all or to those most deserving. A neoclassical economy simply cannot ensure sustainability.

Fortunately, those of us in democratic nations have the ability to regain control of our cancerous economies, but only if we accept our democratic responsibilities. Within constitutional democracies, we have the power to ensure social justice and environmental stewardship, not only within our own countries but also in our relationships with other countries around the world.

We, the people, have the right and responsibility to amend our constitution as necessary "to promote the general welfare and to ensure the blessings of liberty for ourselves and our posterity."[9] We have both the authority and the ability to add a constitutional amendment to ensure intergenerational equity – ensuring that all political and economic rights are extended equally to those of present and future generations. We can amend the constitution to protect all people from economic exploitation, as they are now protected from political oppression. We

have a government that can be empowered to translate these ecological and social principles into laws, which will establish the social and ethical bounds within which a free market economy could function for the good of all of all generations.

However, such changes must begin in the hearts and minds of the people; they cannot be imposed by the few upon the masses. People defy laws in which they have no faith. New sources of non-renewable energy may be found to fuel our industrial economy for a hundred or perhaps a thousand years. Eventually, however, humans will deplete the energy resources of the earth unless they are willing to restrain their depletion of energy to levels that can be renewed by energy from the sun. This means we ultimately must willingly choose to limit both population and per capita energy use to renewable levels or face extinction of our species. We can begin by making these choices individually, one by one, extending those choices to the whole of society.

We will choose an economy of sustainable energy when we realize that our happiness depends on our relationships with people and with nature, as well as our individual, material well-being. We will choose a life of social responsibility when we realize that caring for others is not a sacrifice, but instead enhances our quality of happiness. We will choose a life of ecological integrity when we realize that stewardship of the earth's precious resources is not a sacrifice, but instead enhances our individual well-being and quality of life. One by one, we will create an economy of sustainable energy as we realize that working and living sustainability is a simply better way to work and a better way to live.

End Notes

[1] For a complete discussion of differences in industrial and sustainable systems, see John Ikerd, *Sustainable Capitalism: A Matter of Common Sense*, 2005, Kumarian Press, Inc., Bloomfield, CT, available through <http://kpbooks.com>.

[2] Sir Albert Howard, 1940, *An Agricultural Testament*. Oxford University Press: Oxford, England. also in Small Farms Library <http://journeytoforever.org/farm_library/howardAT/ ATtoc.html>

[3] Rudolph Steiner.1924. *Spiritual Foundations for the Renewal of Agriculture.* Gardner, M (1993) (ed). Bio Dynamic Farming and Gardening Association of USA: Junction City, OR, USA. also available at <http://www.biodynamics.com/ index.html>

[4] All energy percentages for agriculture, calculated using data from, David and Marcia Pimentel, ed., 1996, *Food, Energy, and Society*, University Press of Colorado, Niwot, CO.

[5] Pimentel, *Food, Energy, and Society*, 146.

[6] David Pimentel, Paul Hepperly, James Hanson, David Douds, and Rita Seidel, 2005,"Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems," *BioScience*, 55, No. 7: 573–582.

[7] Adam Smith, 1904, original copyright 1776, *An Inquiry into the Nature and Causes of the Wealth of Nations, fifth edition***,** ed. Edwin Cannan ,Methuen and Co., Ltd., London, Book I, Chapter 8, paragraph 55, also available at <http://www.econlib.org/library/Smith/smWN.html> .

[8] Smith, *Wealth of Nations*, I, 11, 237.

[9] Quoted from the preamble to the United States Constitution