Is A Sustainable Society Cost-Effective?
Redefining Goals for Efficiency in Buildings

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ABSTRACT

For more than twenty years, energy efficiency professionals have been pursuing lower energy use in buildings. Most agree that it was steeply higher oil prices that put us on that path. We reasoned that when energy prices rise, it becomes cost-effective to reduce energy use through efficiency improvements rather than pay for more expensive energy supplies. For about 15 years, this concept has served us adequately and led to significant improvements in the efficiency of buildings.

But the world has changed in the last several years as the real prices of oil and other forms of energy have declined to historical lows. Efficiency investments once thought to be cost-effective are now considered economically irrational. But are they?

A much larger question is now being considered by a handful of visionary advocates, and the answer to this question casts serious doubt on the appropriateness of our traditional notions of cost effectiveness. This larger, and far more important, question asks, " is society's current rate of energy and resource use sustainable?"

Intuitively, most in our community will say "No." But the next questions are not so easily answered. What does a sustainable society look like? How do we achieve it? How do we know when we're making progress?

The economic system and tools now in use are wholly inadequate to address these questions. This paper will discuss the work of those who are providing a new set of concepts and tools that can move us far beyond energy efficiency, to creating sustainable building projects, and toward the goal of a sustainable society.

Introduction

The term "cost-effective" has been used since the inception of our concern about energy efficiency. It is generally acknowledged by the energy efficiency community to describe an economically rational investment in a strategy to use less energy in performing a given function. But the term grew up in an era that has passed. The world has changed substantially since the oil crises of the seventies. Global climate change, widespread deforestation, fisheries decline, mineral resource depletion - none of these critical issues were more than blips on the horizon then, if they were acknowledged at all. And the question of societal sustainability was pondered by no more than a tiny handful of critical thinkers around the world. A growing number of such thinkers today believe that issues we now face, nearly 30 years after the first oil crisis, demand that we re-think the framework within which we judge the rationality of our economic decisions.

The very use of the term "rational investment" begs the question, "From whose perspective?" There have been books and long scholarly treatises written on this subject. The California Public Utility Commission (CPUC) issued the most widely used guidelines on how to conduct various "tests" of cost effectiveness, each from a different perspective. The four most-used were the societal, the utility, the ratepayer and the ever popular total resource cost (TRC) test. These tests of cost effectiveness were adopted by utility regulatory commissions throughout the land as part of least cost planning and energy efficiency program evaluation. Each test includes a unique combination of cost and benefit elements derived from the various stakeholders in an isolated transaction at issue. But even though each purports to take a different perspective, they all derive from a single macroeconomic tradition.

This tradition, not surprisingly, is the one that has governed our country's economy, and increasingly that of the rest of the world, throughout most of this century. The most important elements of this tradition are the compounding of interest, the discounting of costs, and the concept of a net present value. For these tools to work, everything in the problem must be monetized. For those of us in the energy efficiency community, this economic analysis model provided reasonable progress in an era when most forecasts of energy prices predicted steady annual real escalation rates of 2 percent or more. Carried out for 20 to 30 years, even a discounted stream of energy costs made significant investments look rational. And many familiar energy efficiency measures were declared cost-effective on the basis of these tests.

But the tests have serious flaws that are now crippling our ability to address a much broader set of societal concerns as we examine our investment decisions.

Traditional Cost Effectiveness Shortcomings

One of simplest flaws to solve is the pervasive practice of balancing all the costs of more efficient technologies or practices against the energy benefits only. A classic case study is clothes washer efficiency programs run by energy utilities. The horizontal axis clothes washer is a resource-efficient product, not just an energy-efficient product. Consumers enjoy lower energy, water and wastewater treatment bills, lower detergent costs, and the satisfaction of keeping their clothes looking better longer. There are other less tangible benefits, as well. But many an energy utility is forced by their regulatory commission to weigh the costs of the program and the product against the electricity or natural gas savings alone in determining if it is "cost-effective" to promote this technology. From a truly societal perspective, the overwhelming answer is "yes." From an energy perspective alone, depending on the cost of the program, the answer could be "no." A common excuse for this shortcoming is that many of the benefits aren't quantifiable. And therefore their value is zero? Some jurisdictions have made an effort to mitigate this last flaw by allowing utilities to count "quantifiable" non-energy benefits. This is clearly a step in the right direction, but improving the wrong analysis model will rarely yield a societally rational investment decision.

This is because the so-called "societal cost test" is rarely what it is purported to be. It usually isn't societal. It frequently counts the obvious present investment costs, but ignores long term societal costs. The biggest failing is the set of benefits and costs that have no place in the analysis. These are the benefits of services provided by natural systems and the costs of diminishing or destroying them. Our current state of knowledge is woefully inadequate to the task of accurately calculating such balances using traditional methods. Most economists simply assume an unlimited supply of clean air or clean water, or fossil fuels, and therefore a market value too low to be of significance (zero). They reason that if these "commodities" come to be in short supply, the price will rise and technology will provide them in greater abundance. But while these benefits and costs are difficult to value in monetary terms, clearly zero is the wrong answer.

This is the "externalities" problem. According to Herman Daly and John Cobb, "An externality occurs when production or consumption by one firm or consumer directly affects the welfare of another firm or consumer, where 'directly' means that the effect is not mediated through any market and is consequently unpriced." (Daly & Cobb 1994, 53)[1] Externalities can also be localized or pervasive. Localized externalities tend to be more easily mitigated and accounted for in the transactions that give rise to them. Pervasive ones, such as CO_2 production and air quality impacts, are not so easily quantified, nor are such costs so easily assigned.

The acknowledgement and naming of these costs is a tacit admission by economists that they occur outside the market, and therefore must be accounted for separately, especially in matters of societal welfare. But this gives rise to a misplaced faith that by so accounting for such costs, the cause of ascertaining the rationality and cost effectiveness of economic investment decisions has been fully served. But there are three critical failings in the application of environmental externality costs in such situations:

Who will pay, for what, and how much? It's fair to say that many future environmental costs cannot be adequately estimated. Neither can one predict who will have to pay. Arguments and legal battles over such issues have often raged for years, frequently without satisfactory resolution. For instance, even if one were able to predict the number of people who would be exposed to nuclear radiation as a result of the mining, refining, use and disposal of fissionable material used for generating electricity, the medical costs of treating these people, or the societal cost of the loss of those who might die, is incalculable. The same is true for the production, use, and disposal of toxic chemical compounds. Further, the effects of such environmental insults are not visited on humans alone, at least directly. The literature is replete with studies documenting the pervasive decline of ecosystems all over the planet due to our long and ongoing global field experiments with chemistry. How does one count these costs to weigh them against the benefits when comparing materials choices?

What are we discounting? One of the most serious transgressions in externality cost accounting is the inter-generational shifting of these costs from the present to future. There are two distinct issues associated with this practice. The first is the moral question of whether the welfare of future generations should be taxed or diminished to provide benefits to today's citizens. Most economists sidestep this issue by declining to acknowledge the possibility that the welfare of future generations might be adversely affected by today's commerce. This seems to be an outgrowth of their denial of the possibility of a limit on the size of the pot of gold at the far end of a compound interest stream. Or in a case more relevant to a sustainable society, a limit to the size of the economy at the far end of a compound growth rate.

The second is that the discounting of streams of money do not equate well to the discounting of supplies of potable water or of the productivity of an ocean fishery. These foundation blocks of a sustainable society are physical elements of an immensely complicated ecological system that sustains all life on the earth. How much of future generations' potable water supply or fisheries production should we consume today? What discount rate should we use to calculate the quantities?

[1] The reader is also referred to Chapter 7 in this enlightening text for an extended discussion of the inadequacy of this method of accounting for social costs.

Sadly, our current accounting system causes this natural capital to be consumed in vast quantities, far exceeding amounts that could be considered our Hicksian income from these resources.[2] In the case of fossil fuels, any consumption at a rate that exceeds the earth's production of new fossil fuels constitutes the consumption of natural capital. No technology can save us from the effects of this fact. However, the most recent climate change research suggests that the more important relationship is on the waste side of the consumption equation. There our production of greenhouse gases exceeds the capacity of the earth's sinks to absorb them. The potential damage from this waste stream makes it inadvisable to consume the supplies, no matter how large.

On a grand scale, human commerce (or that portion of it that is controlled by developed nations) treats the earth and its ecosystems as one large commons, at the service of mankind. The earth's crust contains minerals and fuels for our use, and the ecosystems themselves supply food and forest products. We harvest other species for food, even unto extinction. The land, air, and rivers, lakes and oceans are the sinks for most of our wastes. And we use all of this "efficiently" and cost effectively, using appropriate discount rates in allocating investment capital. But what are we discounting here? Daly and Cobb believe that the maximization of present value, the usual purpose of discounting cost and income streams, speaks tellingly of neoclassical economists' disregard for the welfare of future generations. Their conclusion sets the stage for an entirely different way of making decisions that impact the long term well-being of society and the environment: "Thus we reject in principle the idea of discounting the effects of resource depletion (and environmental damage) on the future. Instead we propose the view that any reduction in economic welfare in the future below the level currently enjoyed should be counted as if the cost occurred in the present." (Daly & Cobb 1994; 152-158, 454) In other words, they propose a discount rate of zero percent.

Subsidies can make cost effectiveness determinations quite arbitrary. Most members of the energy efficiency community are well aware of the insidious nature of subsidies. And we all know that the use of externality costs in our computations is an attempt to count the true costs of energy use, which absent subsidies would be much higher. But these subsidies are embedded in the developed world's economy to a greater extent than many people realize. In a recent report, recycling proponents hint at the depth of the problem: "Estimates of current federal energy subsidies range from the Energy Department's $14 billion figure to the Alliance to Save Energy's value of $36 billion. Military defense of oil supplies alone is estimated to be $10.5 to $23.3 billion. An Environmental Protection Agency study of disincentives to recycling concluded that energy subsidies were the single most important subsidies for primary materials production. By keeping the prices of oil, gas, coal and electricity artificially low, energy subsidies provide a major structural advantage to extractive industries, which are generally far more energy-intensive than recycling and reuse." (Kincella et al.1999)

For many manufacturers, fossil fuel subsidies underwrite feedstock cost as well as process energy use. And energy use is not the only natural capital depletion that is subsidized. Water use, at least in the western U.S., is also heavily promoted with subsidies, especially for agriculture. The wood products and mining industries, major contributors to building construction, are also heavily subsidized. All of these subsidies translate into indirect impacts on building energy use. And these

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[2]Hicksian Income is named after Sir John Hicks, writing in "*Value and Capital.*" It is defined in national terms by Daly & Cobb as "the maximum amount that can be consumed by a nation without eventual impoverishment." (Daly & Cobb 1994)

impacts are seldom accounted for by energy efficiency professionals as they choose building components and systems. But most of these impacts occur outside of the narrow slice of the investment life cycle now considered in our calculations. Energy savings estimates rarely, if ever, count the energy intensity of the materials of which various efficiency measures are made.

Is Cost Effectiveness Sufficient as an Efficiency Investment Criterion?

Given the foregoing discussion, one has to conclude that the cause of energy efficiency would be better served by a broader measure of societal economic welfare. It's hard to imagine a less adequate measure of the rationality of an economic investment than one that:

1) weighs only some costs of an investment against a subset of the benefits, simply ignoring costs or benefits that are not well known or understood for the purposes of accounting,
2) compares benefits accruing to one population against costs that accrue to another,
3) compares a monetary income stream against physical resource depletion impacts,
4) treats the depletion of capital as income,
5) and limits the analysis to a fraction of the life cycle of the investment.

The current use of cost effectiveness calculations as a means for judging investments in efficiency does all of these things. We can do better. Indeed, the long term viability of society probably depends upon it.

Sustainability as a Goal

A growing number of visionary people now question the sustainability of society and its commerce as currently conducted. They believe the economic framework we now accept as a given is leading to a global decline in all living systems and the ability of nature to provide essential life-sustaining services. The ultimate result is an inevitable decline in the welfare of communities in every part of the world.

So if the current economic and social paradigm is not sustainable, how would we define one that is? Many regard the term "sustainable" as fuzzy, and subject to varying degrees of manipulation in its definition. One of the earliest definitions came from a U.N. Commission, the World Commission on Environment and Development (WCED), also known as the Brandtland Commission, in 1987. They suggested that a sustainable society meets today's human needs without compromising the ability of future generations to meet those same needs. (WCED 1987) This definition states clearly an important principle, but it doesn't provide much guidance for critical day-to-day decisions that impact sustainability.

Fortunately, in the same time period, a Swedish cancer researcher, Dr. Karl-Henrik Robèrt, became convinced that much of the pediatric cancer he was observing must have been caused by some kind of systematic degradation of life's basic support mechanisms. He soon recognized that he was dealing with more than human cellular biology; he faced issues that determine the health and survival of all life on the planet.

The Natural Step

So in 1988, he shared, with about 50 of his colleagues in the Swedish scientific community, a draft of his attempt to define the essential, or "non-negotiable" conditions for healthy, sustainable life on Earth. It took more than twenty drafts, but this group produced a consensus on four essential "system conditions" that today form the basis of The Natural Step. All four must be satisfied for a society to be sustainable. They are based on rigorous scientific principles, such as the First and Second Law of Thermodynamics.[3] As a group, the System Conditions provide a compass that tends to focus problem-solving upstream, toward the source of the problem.

According to the consensus, in a sustainable society:

1) nature's functions and diversity are not systematically subject to increasing concentrations of substances extracted from the earth's crust,

   This means that human activities such as the burning of fossil fuels and the mining of metals and minerals will not occur at a rate that causes them to systematically increase in the ecosphere. There are thresholds beyond which living organisms and ecosystems are adversely affected by increases in substances from the earth's crust. Problems may include an increase in greenhouse gases, leading to global climate change, contamination of surface and ground water, and metal toxicity that can cause functional disturbances in animals. In practical terms, the first condition requires society to implement comprehensive metal and mineral recycling programs, and decrease economic dependence on fossil fuels.

2) Nature's functions and diversity are not systematically subject to increasing concentrations of substances produced by society,

   This requires that humans avoid generating systematic increases in persistent substances such as DDT, PCB's and CFC's. Synthetic organic compounds such as DDT and PCB's can remain in the environment for many years, bioaccumulating in the tissue of organisms and causing profound deleterious effects on predators in the upper levels of the food chain. Refrigerants such as CFC's, and other ozone-depleting compounds, may increase the risk of cancer due to increased levels of ultraviolet radiation at the earth's surface. Society needs to find ways to reduce economic dependence on these persistent substances.

3) Nature's functions and diversity are not systematically impoverished by physical displacement, over-harvesting or other forms of ecosystem manipulation,

   This Condition requires humans to avoid taking more from the biosphere than can be

[3]For those who need a short refresher, the First Law concerns the conservation and interchangeability of matter and energy. The Second Law is the law of entropy, which states that all matter "degrades" toward a lower level of order (or higher level of entropy), and that the only way to reverse this trend is by the application of energy from outside "the system."

replenished by natural systems in the same time scale. In addition, people must avoid systematically encroaching upon nature by destroying the habitat of other species. Biodiversity, the great variety of plants and animals found in nature, provides the foundation for ecosystem services, which are necessary to sustain life on this planet. Society's health and prosperity depend on the enduring capacity of nature to renew itself and rebuild waste into resources.

4) and resources are used fairly and efficiently in order to meet basic human needs globally.

Meeting the fourth System Condition is a way to avoid violating the first three. Considering the human enterprise as a whole, we need to be efficient with regard to resource use and waste generation in order to be sustainable. If one billion people lack adequate nutrition while another billion have more than they need, there is a lack of fairness with regard to meeting basic human needs. Achieving greater fairness is essential for social stability and the cooperation needed for making large-scale changes within the framework laid out by the first three System Conditions.[4]

Decision-Making within a New Framework

When an organization first considers the impact of sustainability issues on its operations and investments, the task may seem overwhelming. This is especially true in view of the simplistic nature of the economic framework in use at present. From a Natural Step perspective, the assessment is fairly straight-forward. One simply asks, "Does the choice satisfy each of the four System Conditions?" If the answer to any one of the four is "no," then the choice contributes to a violation of the System Conditions, and it is likely that there is a more sustainable choice that has not yet been considered.

The System Conditions are not prescriptive, however. Each organization must chart its own path to sustainability, one step at a time. The businesses that have used this framework have typically employed a process called "backcasting." It starts with developing a vision of what the organization and its activities would be like if they were sustainable. This is followed by an assessment of where the organization is now, using the same criteria. Then a plan is developed to close the distance between the two over time.

Businesses that have successfully used the Natural Step include Electrolux, AB of Sweden (owners of the American brands Frigidaire and Eureka), Interface, Inc. of Atlanta, GA (the world's largest commercial flooring company), and Collins Pine of Portland, OR (a longtime practitioner of sustainable forestry). Each has found greater profit and competitive advantage while making significant strides toward becoming a sustainable enterprise.

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[4]The foregoing explanations are adapted very rigorously from information on The Natural Step - U.S. web site (www.naturalstep.org). The reader is referred there for a more extensive discussion of the System Conditions and their growing use around the world.

Sustainable Buildings

By now it may be clear that sustainable buildings must be more than just very energy efficient. The built environment affects the sustainability of society in many ways, both during construction and in use. In broad categorical terms, there are material, energy, water, air, and habitat impacts. While our community is very familiar with strategies to make buildings more efficient in use, and many are working on indoor air quality issues, the sustainability impacts of the other categories are infrequently considered.

What would a sustainable building project look like? A group of architects, developers, engineers, contractors and policy people associated with the Oregon Natural Step Network have gone through many months of backcasting and deliberation on this question and have come up with an initial assessment. (Castle et al. 2000) The group started by creating Figure 1. below that depicts the material and resource flows into and out of a building project, for both the construction and use phases. Note that the material flows start all the way back at the natural capital stage, where material and energy resources are still in the ground.

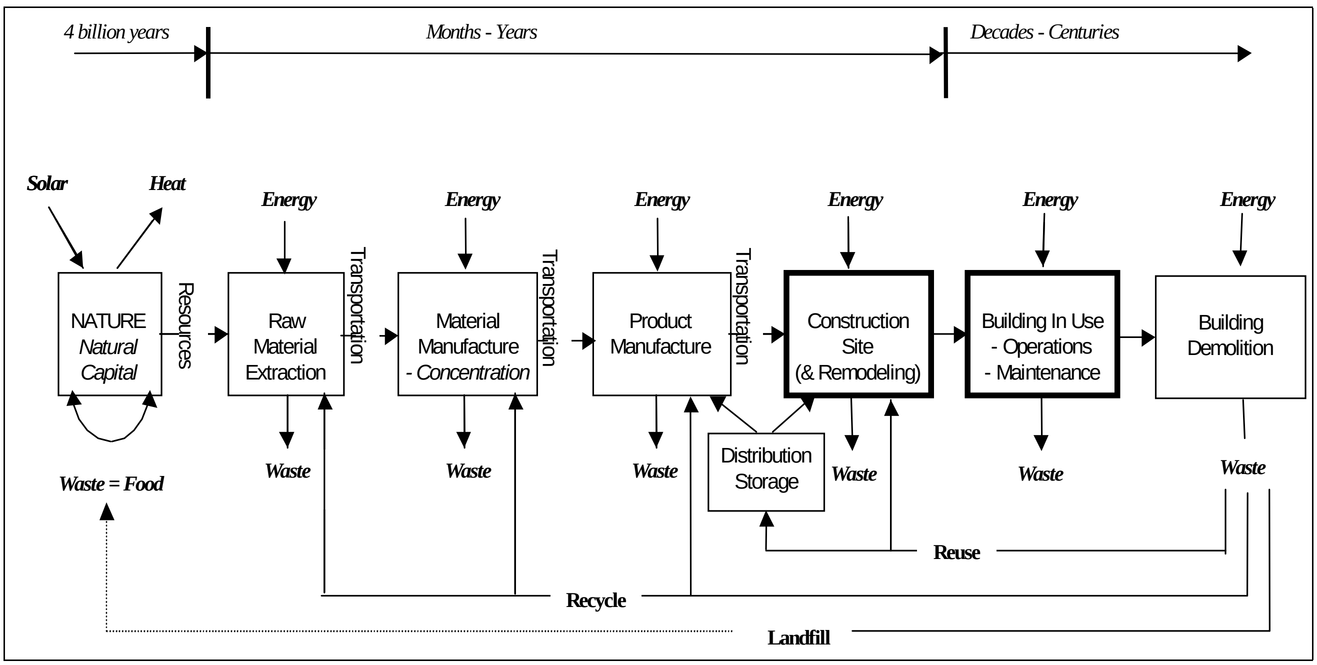

Figure 1. Building Life Cycle Flow Chart

The next step was to create a vision of a sustainable building project, or a "full alignment state," followed by an assessment of how buildings are built today. In key impact areas, the following comparisons were made:

Materials

Aligned: All materials are non-persistent, non-toxic and procured from reused, recycled, renewable or abundant-in-nature sources.

Present: Components have virgin mined and heavy metals, or persistent synthetic material

content. Forest products are harvested unsustainably.
Aligned: Material selection and design favor deconstruction, reuse and durability. Solid waste is eliminated, or reused on-site or nearby, or recycled or composted.
Present: Materials are new, not designed for waste minimization, not durable, and excessively packaged. Waste is landfilled.

Energy

Aligned: All energy sources are renewable and meet the four System Conditions.
Present: Substantial fossil fuel use.
Aligned: Energy use does not exceed the solar income falling on the project's built environment. (Additional renewable energy may be purchased from other sites with excess to sell, however.)
Present: Energy use substantially exceeds that falling on the whole site. Building efficiency is typically poor.

Water

Aligned: Water budget does not exceed amount falling on or flowing through the site. (Additional may be purchased if the source meets these conditions.)
Present: Water budget typically wasteful, especially for landscaping.
Aligned: Quality, temperature, rate of flow on site and leaving site has no damaging impact on natural systems.
Present: Storm water channeled to treatment; erosion, pollution common.

Air

Aligned: Surrounding air is not used as sink for particulates, VOC's or fossil fuel emissions.
Present: Building air emissions are typically significant.

Transportation

Aligned: Energy sources are renewable. Use of existing infrastructure and non-auto transit is maximized. Natural system damage is mitigated or restored.
Present: Remote development sites need new infrastructure, extensive transport of non-local materials & supplies, fossil fuels, auto-oriented.

Habitat

Aligned: Net degradation is zero. Disruption does not extend beyond project built environment limit. Landscaping compatible with local ecosystem.
Present: Use of toxins and persistent synthetic substances on site. Disruption of adjacent habitat. Use of non-native vegetation in landscaping.

Conclusion

While the aligned state may seem unattainable in some respects, existing projects have come surprisingly close to a sustainable model, using today's technologies and practices. It's not likely we're doing the best we can do at this time. The essence of the change called for in a framework for sustainability is the benchmarking of our building project performance from the other end of the scale. In other words, we need to stop measuring ourselves against code or current practice, which is typically the worst we can do, by law, and start measuring how far short of sustainability we fall. This means that with appropriate attention to this newer, more comprehensive analytical framework, or shared mental model, our buildings might become much more than energy efficient. They might become resource efficient and on balance, non-destructive of ecosystems. They would be an integral part of a sustainable society. The alternative, quite frankly, is unthinkable. But if we persist in using the current cost effectiveness framework for our building decisions, we will most assuredly devolve into what Kurt Vonnegut postulated many years ago – "the only society in history that failed to save itself because it wasn't cost-effective." (Vonnegut 1970)

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