Is sustainable development an oxymoron?

Sagar Dhara[1]

Development implies energy use. But fossil fuels, which meet 85% of the world's commercial energy needs, are exhausting as we have overdrawn energy from nature primarily to serve the greed of developed countries and the rich. No other viable alternative energy sources are currently in a position to replace fossil fuels. Sustainability implies reducing energy consumption. Sustainable development, today's catch-phrase, is an oxymoron[2]. For sustainable living, we need to reduce our energy consumption by at least 40%, move towards energy equity and replace today's dominant global outlook of "Gain maximization for a few" by "Risk minimization for all."

Energy is central to development

In an interaction with some engineering college students some months ago, I asked my young friends what they thought was the relationship between human development and engineering sciences. The responses broadly defined development as 'upgrading' entities such as land, infrastructure, city spaces, markets, etc. For example, land development meant upgrading the utility of land.

We stayed with that understanding and I posed my next question, "What factors affect upgrades the most?" After some discussion, the dialogue isolated two factors—knowledge and energy use. Knowledge of what? Of energy conversion.

We felt that we had made a good beginning, so we decided to continue the dialogue. After I posed each question, the students provided various answers and there was heated discussion before we arrived at a consensus.

Why is energy so very central to development? Because no physical, chemical, geological, and biological transformation is possible without energy expenditure; for example, plants grow using sunlight, transport happens using some form of energy—animate, fossil fuels, wind, water, continents, and seas are shaped by geo-thermal energy, goods and services are produced expending energy.

Energy in history

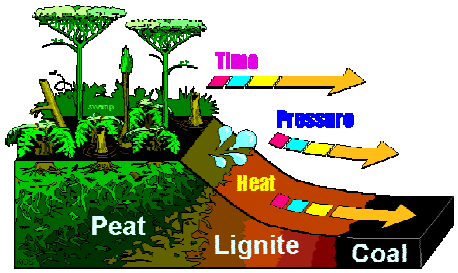
Now the discussion was getting interesting. Historically, what were the energy sources that humans used? Humans have always been solar farmers, i.e., they have used solar energy, either directly or indirectly to fulfill their needs.

From the time Cro-Magnon appeared 50,000 years ago till the time agriculture was invented 10,000 years ago, humans used their muscle power and biomass as energy sources. Early farmers domesticated animals and used them for transport. Animate energy (human

[1] The author belongs to the most rapacious predator tribe that ever stalked the earth—humans, and to a net destructive discipline—engineering, that has to take more than a fair share of the responsibility for bringing earth and human society to tipping points. You can write to him at: *sagdhara@gmail.com*

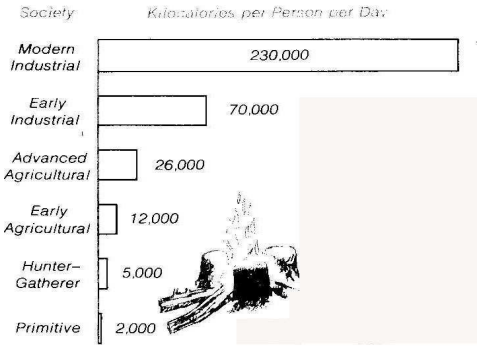
[2] An oxymoron is a figure of speech that combines contradictory terms

and animal energy) is a product of sunlight. Plants use sunlight to convert atmospheric carbon dioxide (CO_2) into biomass. Animals and humans are dependent either on plants or herbivores for their energy intake.

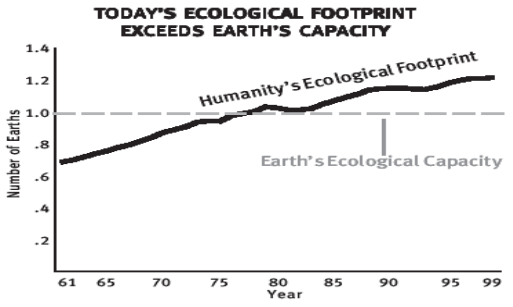


Fossil fuels (coal, oil, gas) began to be used 500 years ago, and have gradually replaced biomass and animate energy as the primary energy source for powering human society. Fossil fuels are products of ancient sunlight and were formed by the Earth exerting pressure and temperature on dead plants and animals from the Carboniferous period (300 million years ago). Today, we use 12,000 million tones of oil equivalent (toe is the energy in one tone of oil), 85% of which is from fossil fuels.

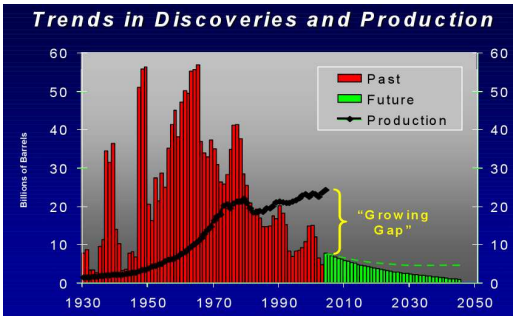
Energy consumption has grown by leaps and bounds between when humans were primitives and now. Every major technological shift in human civilization has more than doubled per capita energy consumption. Per capita energy consumption grew at a slow rate until the industrial revolution, after which it exploded. A third of the energy consumed in the last two centuries was consumed in just the last two decades. Today, each of us consumes more than 100 times more energy that our primitive ancestors did.



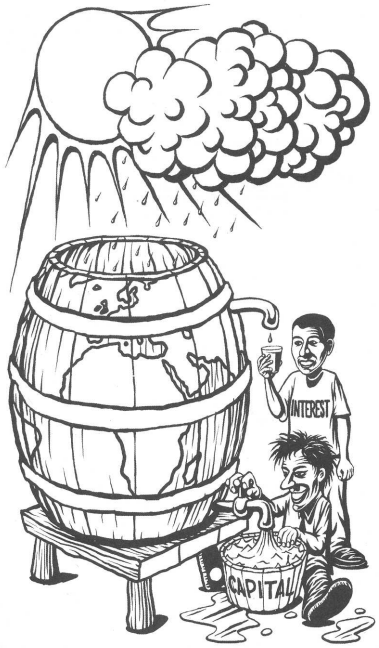
Energy overdraw



Humanity's consumption and waste production today exceed the Earth's capacity to create new resources and absorb waste. We are currently liquidating natural capital to support current resource use, reducing the Earth's ability to support future life.



In recent times we have overdrawn on the Earth's capacity to deliver energy and natural resources and the Earth is groaning in its attempt to meet our demands. We now require 1.5 Earths in order to satiate our energy needs. We have dipped into the Earth's natural capital rather than live off its interest; for instance, rather than using only rainfall for agriculture, we are using increasing amounts of groundwater, thus lowering groundwater levels each year. Rampant environmental degradation (pollution, freshwater depletion, etc.,) around the world and global warming are manifestations of this.



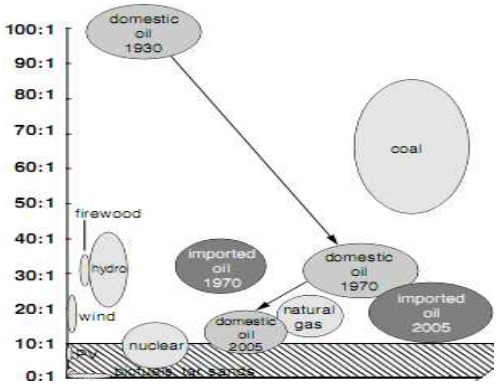
At this point one student interjected, "But isn't oil getting over?" True. This is called peak oil, i.e., global oil production is peaking as new oil finds have been few and far between in the last 3-4 decades, and gas will also peak in a couple of decades.

The consequences of the massive energy overdraw that we have done are beginning to be realized now. Global warming is one of them. Despite a lot of public discussion in the last few years, global warming impacts are yet to be understood properly.

A far less understood consequence is civilizational collapses. The collapse of many past civilizations—Roman, Mayan, Polynesian—can be traced to energy overdraws. Each of these collapses remained specific to one civilization. Today the world is globalized and tightly integrated. An economic slow-down in one part of the world caused by an energy shortage could very quickly spread to other countries, as happened in 2008. And if the crisis is sufficiently severe, it could lead to a global economic meltdown.

Are there alternative energy sources?

"What about coal?" Yes, the world has coal reserves to last another century or so. But, if coal replaced current oil and gas consumption, global warming would happen even faster. For every toe of energy delivered, coal emits twice the CO_2 that oil does, and more than 2.5 times that gas emits.



What about other energy sources that can replace fossil fuels? There are only two noteworthy alternatives—green and nuclear energies. Unfortunately, neither is capable of replacing fossil fuels. Green energies have a 0.5-2.5 EROEI[3], whereas fossil fuels have a 20-80 EROI. The significantly higher energy density of fossil fuels allows them to yield more energy for every unit of energy invested in harvesting them. Moreover, the environmental costs (cost of injury to human health, crops, forests, water bodies, etc.), of fossil fuels are not considered, making them very cheap.

As for nuclear power plants, there is uranium ore sufficient only to power the current nuclear reactors for another 80 years. Moreover, they have intractable safety and waste disposal problems.

Sustainable development is an oxymoron

By now my audience, even the skeptics, had really got into the discussion. One boy quipped, "But humans are very creative. I am sure we will come up with something to beat the problem." A girl immediately asked him if he believed in world peace, to which he said he did. "How come we have not come up with any worthwhile solution for wars in the last 10,000 years of human civilization?" No answer to that. Someone else chipped in, "Or for that matter for hunger and poverty, despite all the high technology that we have, which takes us to the moon and beyond?"

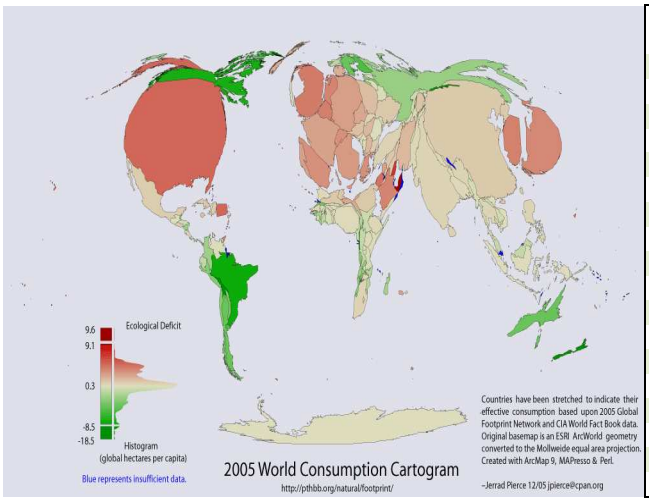
[3] EROEI is Energy released for energy invested. An EROEI of 20 indicates that one unit of energy is required to explore, mine, refine and deliver 20 units of energy. A negative EROEI, as is the case with some bio-fuels, means that more energy has to go into making and delivering them that the energy they will yield. A low EROEI makes the energy source unattractive.

I then posed another question, "What is sustainable living?" The students made a serious attempt to define sustainable living, and after a while the group veered around to the collective understanding that sustainable living meant that we must not overdraw on the Earth's resources.

What is over drawl, and how do we measure it? Now that was a tough one and nobody could come up with a good definition, so I offered a way around by giving them economist Herman Daly's definition of sustainability, *"The rate of use of renewable resources should not exceed their regeneration, the rate of use of non-renewable resources should not exceed the rate at which sustainable renewable substitutes are developed, and the rate of pollution emission should not exceed the assimilative capacity of the environment."*

This definition did not deal with overdraw or how to measure it, but it posed another question, "Who is responsible for over drawl?" Pat came the answer from several quarters. Increase in global population was responsible for over drawl. And where is population growth happening? In developing countries.

But is this argument supported by facts? Certainly not! It is not population growth in developing countries that is responsible for over drawl, but increase in consumption by the developed countries and the rich in different countries.



Per capita primary energy consumption

Region	*toe/yr*
Central Africa	0.34
Northern Africa	0.69
Southern Africa	1.18
Australia-New Zealand	5.56
Central Asia	3.43
NW Pacific + East Asia	1.28
South Asia	0.49
SE Asia	0.73
Central Europe	1.81
Eastern Europe	3.49
Western Europe	3.86
Caribbean	1.11
Meso America	1.29
South America	1.13
North America	8.08
Arabian Peninsula	3.62
Mashriq	1.23

Per capita energy consumption and CO_2 emission are good ways to measure human consumption. The average per capita annual energy consumption is a little over 1.7 toe/yr for the world as a whole; for North America it is 8.1 toe/yr, Western Europe 4 toe/yr, Central Africa 0.3 toe/yr, South America 1.1 toe/yr, South Asia 0.5 toe/yr, and India 0.4 toe/yr. Clearly, it is people in the developed countries that are consuming significantly more than those in the developing countries.

Year	Percent income		
	Richest 25%	***Middle 50%***	***Poorest 25%***
1860	58%	30%	12%
1913	69%	25%	6%
1960	72%	25%	3%
	Richest 20%	***Middle 60%***	***Poorest 20%***
2000	74%	24%	2%

Developed countries have been responsible for 78% of CO_2 emissions since the beginning of the industrial revolution. And the energy gap between the developed and developing nations and that between the rich and the poor is growing; and that is a sure prescription for conflict between energy-haves and the have-nots.

Quite clearly, Daly's prescription for sustainability is a step forward, but is inadequate as it does not address the cause for over drawl, i.e., consumption of developed countries and the rich in all countries.

At this stage, one bright young student put two and two together and asked a really fundamental question, "Isn't sustainable development an oxymoron?" Why? Because development implies greater energy use. But sustainability implies reducing our gross energy use. I agreed. The phrase, ***sustainable development, is an oxymoron.*** You cannot have sustainability and development, as understood today, at the same time.

The Brundtland report made sustainable development a buzz-phrase 25 years ago. The report defined sustainable development as, *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

The definition makes two very important points. First, it talks about human needs and not wants. Needs are food, clothing, and housing and not luxury items. Second, it gives equal importance to meeting the needs of current and future generations. However, the definition fails to stress the equity of entitlement to energy and other natural resources between people, i.e., it does not tackle the root cause of over drawl.

Sustainable living

I suggested to my audience that to arrive at a reasonably satisfactory definition of sustainable living, we have to add to Daly and Brundtlands' definitions. They agreed. After much struggle, they did not get very far, so I decided to step in and offer my understanding.

Sustainable living requires that:

- The sustenance needs of the present generation may be met without compromising the ability of future generations to meet their sustenance needs.
- The rate of use of renewable resources should not exceed their regeneration, the rate of use of non-renewable resources should not exceed the rate at which sustainable renewable substitutes are developed, and the rate of pollution emission should not exceed the assimilative capacity of the environment.
- There is equity of entitlement to energy and other natural resources for all people, and to achieve that it is essential to treat all energy resources (energy sources, energy converters, energy conveyors and storage devices) as common property rather than as private property, except where the energy resource is purely for personal use to meet sustenance needs. These entitlements will have to take into account nature's needs for these resources, as nature is the maker and owner of these resources, and not humans.

This definition required a complete re-think in the way we relate to nature and to each other. To drive that point home, I told them the story of a survey we had conducted as engineering students in the Indian Institute of Technology, Mumbai in the early 1970s. The respondents comprised everyone from the senior faculty, including the Deputy Director of the institute, to the first year students. We asked them what differentiated technology from engineering. The junior students, as expected, could not come up with meaningful answers, but to our surprise, neither did the faculty.

Engineering deals with the science and art of applying energy to raw materials to obtain products and services. Engineering is a science and art that helps execute the upgrade necessary for human society to *develop*.

Technology does the same thing but in a given social context. Engineering deals with the science that goes into the design and production of goods and services. Technology deals more with the applications that engineering science can be used for. For example, when we talk about today's transport technologies, we refer to mechanized (trains, buses, etc) and animal (camels, donkeys, etc). No matter how unsophisticated animal transport may be, it is still widely used and is appropriate for the class of people and the region where they are used for transporting people and goods.

This survey told us something. Practitioners of a discipline often did not understand the role they played on a larger canvas. I now asked my young friends that if their engineering education had basically taught them to use energy to transform nature into goods and services, what good is this knowledge if there is going to be less energy in future? Had their college ever told them how to help the Earth recover its potential to deliver energy? My young friends were astounded and were at a loss for words for a full two minutes.

Global policies for sustainable living

The implications of my definition of sustainable living are far reaching. It implies that human society must change its outlook from ***"Gain maximization for a few,"*** an outlook that has been predominant since the times of ancient slave societies of 5,000 years ago, to ***"Risk minimization for all."*** The latter is what all living creatures, except humans, do to live in harmony with nature. They take only as much energy and resources from nature as is required for their sustenance. Only humans take more than what is required for their sustenance as they possess what other living beings lack— the ability to create knowledge of energy conversion, and hence have been able to increase their energy drawls throughout history till today.

Effecting this shift in outlook requires two programmes to be put in place:

- ***Powering down global energy to about 40% of the current energy consumption of 12,000 million toe/year and in future relying on the sun for our energy needs.***

  Powering down implies getting rid of extravaganzas like space exploration programmes, standing armies (they consume ~10% of global energy consumption currently) and national borders.

- ***Moving towards energy equity.***

  For the sake of argument, if we were to power down our energy use to 5,000 million toe/year and distribute it equally amongst the world's 7 billion people, each of us would get ~0.7 toe (current global average is 1.7 toe/year), or about the same as the average per capita energy consumption prevalent during the 17th Century. Is a decent living possible with this energy consumption? Yes, because modern technology is more efficient than before. A family of four can afford to live in a

decent-sized home with a fridge, an oven, a music system, and mobile phones for all, eat well, but cannot afford to have air conditioners and private vehicles.

At 0.7 toe/year, an Indian can double her energy consumption over current average levels. But for that to happen, Americans must reduce their consumption by 90% and Europeans by 80%. That is a real challenge. How do we convince the Americans and the Europeans (and the rich in all countries) that if human society is to survive and live in peace, they need to change their way of life and reduce their energy consumption? This is what today's youth will have to think about.

We will also need to have a universal risk standard for all risks—natural and manmade—for all humans, which must be fixed and implemented. This implies that some areas that have higher risks, for example cyclone prone areas, will require higher investments to reduce risk to the residents living there.

Local action for sustainable living

We should not wait for that perfect society to come into existence at some point in future to start implementing community level programmes that can move us towards sustainable living. Wherever possible, we need to reduce energy and material use and move towards energy equity.

People in different parts of the world have started in small ways on this journey. Some have discarded private transport, others have started living in collectives, doing organic farming, growing community forests, and yet others are using solar cookers and have installed photovoltaic panels on their roofs to power their homes.

Such efforts are essentially individual initiatives and cannot solve the social problems of energy over drawl and energy inequity. But such initiatives, in a practical way, challenge the ideology of "gain maximization for all", which engenders unsustainable living. More than a thousand words, it is such actions that will help us re-configure our relationship with nature and with one another to usher a sustainable and equitous society.

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