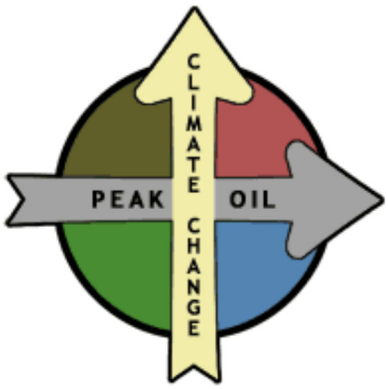
Introduction



The simultaneous onset of climate change and the peaking of global oil supply represent unprecedented challenges for human civilisation.

Global oil peak has the potential to shake if not destroy the foundations of global industrial economy and culture. Climate change has the potential to rearrange the biosphere more radically than the last ice age. Each limits the effective options for responses to the other.

The strategies for mitigating the adverse effects and/or adapting to the consequences of Climate Change have mostly been considered and discussed in isolation from those relevant to Peak Oil. While awareness of Peak Oil, or at least energy crisis, is increasing, understanding of how these two problems might interact to generate quite different futures, is still at an early state.

FutureScenarios.org presents an integrated approach to understanding the potential interaction between Climate Change and Peak Oil using a scenario planning model. In the process I introduce permaculture as a design system specifically evolved over the last 30 years to creatively respond to futures that involve progressively less and less available energy.

– David Holmgren, co-originator of the permaculture concept. May 2008

Sunset in Cuba silhouetting powerlines and oil fired power station smokestack in a country still recovering from the fuel and electricity shortages
Click photos on this site for larger versions and descriptions.

How to use this site

This site is arranged as a long essay broken into micro-chapters. Ideally you'd read it in order, navigating via the left hand menu.

The gallery contains extensive photographs and commentary which illustrate various aspects of the four energy descent scenarios.

Please leave your comments in the guestbook.

[News 13 Aug 08] A two hour interview with David by Jason Bradford on the future scenarios is now available in two parts at Global Public Media: part one | part two. David has also recently signed a contract with Chelsea Green for a book version of Future Scenarios to be published in the US early in 2009.

[Site updates 13 Aug 08] A new page explores how one scenario is likely to lead to another in a stepwise transition. Due to all the new pages, we've split off Reactions to the Scenarios into a new section.

[Major update 31 Jul 08] The site now has five new pages in the Descent Scenarios section, including much content which was left out inadvertently from the original version of the site. Also a new menu item on the top right 'print' allows you to read and print the entire main content of the site.

Next Page: 1.1 The energetic foundations of human history

Last Updated (Wednesday, 13 August 2008)

The Energetic Foundations of Human History

The broad processes of human history can be understood using an ecological framework that recognises primary energy sources as the strongest factors determining the general structure of human economy, politics and culture. The transition from a hunter-gatherer way of life to that of settled agriculture made possible the expansion of human numbers, denser settlement patterns and surplus resources. Those surplus resources were the foundations for what we call civilisation including the development of more advanced technologies, cities, social class structures, standing armies and written language. Archaeology records a series of civilisations that rose and fell as they depleted their bioregional resource base. Lower density simple agrarian and hunter-gatherer cultures took over the territory of collapsed civilisations and allowed the resources of forests, soils and water to regenerate. That in turn, gave rise to new cycles of growth in cultural complexity.

Archaeology records a series of civilisations that rose and fell as they depleted their bioregional resource base.

In the European renaissance, the medieval systems that evolved from the remnants of the Roman empire were reinfused with knowledge and culture from the Islamic and Asian civilisations and grew into competing nation states. A combination of the demands of internal growth and warfare between nations almost exhausted the carrying capacity of Europe. As this ecological crisis deepened in the 14th and 15th centuries, European exploration in search of new resources carried the "diseases of crowding" around the world. In the Americas up to 90 percent of many populations died, leaving vast resources to plunder. Starting with the repatriation of precious metals and seeds of valuable crop plants such as corn and potatoes, European nations soon moved on to building empires powered by slavery that allowed them to exploit and colonise the new lands well stocked with timber, animals and fertile soils, all rejuvenating in the wake of the collapse of indigenous populations.

As industrialisation spread oil quickly surpassed coal as the most valuable energy source, and accelerated the jump in human population.

European population, culture (especially capitalism) and technology grew strong enough to then tap vast stocks of novel energy that were useless to previous simpler societies. European coal fuelled the Industrial Revolution while food and other basic commodities from colonies helped solve the limits to food production in Europe. As industrialisation spread in North America and later in Russia, oil quickly surpassed coal as the most valuable energy source, and accelerated the jump in human population from 1 billion in 1800 to 2 billion in 1930 and now over 6 billion in one lifetime. This massive growth in human carrying capacity has been made possible by the consumption of vast stocks of non-renewable resources (in addition to expanding demand on the renewable biological resources of the planet). Rapid rates of urbanisation and migration,

technology change, increasing affluence and disparity of wealth as well as unprecedented conflicts between global and regional powers have accompanied this transition. The history of the 20th century makes more sense when interpreted primarily as the struggle for control of oil rather than the clash of ideologies.[1] In emphasising the primacy of energy resources I am not saying that the great struggles between ideologies have not been important in shaping history, especially Capitalism and Socialism. But most teaching and understanding of history under-estimates the importance of energetic, ecological and economic factors.

The history of the 20th century makes more sense when interpreted primarily as the struggle for control of oil rather than the clash of ideologies.

The fact that conflict has increased as available resources have expanded is hard to explain using conventional thinking. One way to understand this is using older moral concepts about more power leading to greater moral degradation. Another equally useful way to understand this is using ecological thinking. When resources are minimal and very diffuse, energy spent by one human group, tribe or nation to capture those resources can be greater than what is gained. As resources become more concentrated (by grain agriculture and more dramatically by tapping fossil fuels), the resources captured through diplomacy, trade and even war are often much greater than the effort expended.

The final phase in the fossil fuel saga is playing out now as the transition from oil to natural gas and lower quality oil resources accelerates.

The final phase in the fossil fuel saga is playing out now as the transition from oil to natural gas and lower quality oil resources accelerates, with massive new infrastructure developments around the world as well as increasing tension and active conflicts over resources. We can only hope that nations and humanity as a whole learns quickly that using resources to capture resources will yield less return and incur escalating costs and risks in a world of depleting and diffuse energy.

Next page: 1.2 The Next Energy Transition

Last Updated (Thursday, 12 June 2008)

The Next Energy Transition

Quite early in the exploitation of fossil resources the debate began about what happens after their exhaustion, but it has remained mostly academic. The post WWII period of sustained growth, affluence and freedom from the adverse effects of war had the effect of entrenching the faith[2] in human power and the inexorable arrow of progress that would lead to more of whatever we desired. Consideration of external limits or cultural constraints on individualistic affluence remained at the fringe. Throughout most of the 20th century, a range of energy sources (from nuclear to solar) have been proposed as providing the next "free" energy source that will replace fossil fuels[3].

In so called developing countries, the power of the dominant globalist culture both as a model to emulate and a mode of exploitation to resist, preoccupied most thinkers, leaders and activists. The key issue was how to get a share of the cake, not the limits to the size of the cake.

But the super accelerated growth in energy per person of the post WWII era came to an end with the energy crisis of 1973, when OPEC countries moved to exert their power through oil supply and price. The publication of the seminal *Limits To Growth* report in 1972 had defined the problem and the consequences by modelling how a range of limits would constrain industrial society in the early 21st century. After the second oil shock in 1979 the debate about the next energy transition intensified, but by 1983 a series of factors pushed energy supply off the agenda. Economic contraction not seen since the Depression of the 1930's had reduced demand and consequently prices for energy and natural resources. In affluent countries conversion from oil to gas and nuclear for electricity generation reduced demand for oil. Energy efficiency gains in vehicles and industry further reduced demand. Most importantly, the new super giant oil fields in the North Sea and Alaska reduced Western dependence on OPEC and depressed the price of oil. All other primary commodity prices followed the downward trend set by oil because cheap energy could be used to substitute for other needed commodities.[4]

The economies of the affluent countries were further boosted by two important changes. The shift from Keynesian to Friedmanite free market economic policies reduced regulatory impediments to business and enlisted public wealth for new private profits. At the same time, the Third World debt crisis in developing countries triggered by collapsing commodity prices didn't slow the flow of interest repayments into the coffers of western banks. In line with the new free market ideology, Structural Adjustment Packages from the IMF and World Bank provided more loans (and debt) on the condition that developing countries slash education, health and other public services, to conserve funds for repayments.

The scientific consensus about Global Warming in the late 80's and early 90's renewed the focus on reducing fossil fuel use. Not to conserve resources, which were widely thought to be abundant, but to reduce carbon dioxide additions to the atmosphere. But with energy prices low due to a glut of oil, the main action was an acceleration in the shift to gas as a cheap and relatively "clean" fuel.

Half a century earlier in 1956, the startling predictions by eminent petroleum geologist M. King Hubbert that oil production in the USA, the world's largest producer, would peak in 1970, had almost destroyed Hubbert's career and reputation. Ironically the controversy within the oil industry over Hubbert's methodology and predictions was not known the authors of the Limits To Growth Report and was not part of the 1970's public debate over limits of resources. It was nearly a decade, at the depth of the greatest economic recession since the 1930's, before the industry would acknowledge that the 48 lower states of the US had in fact peaked and declined despite the greatest drilling program in history. Hubbert has also made a more approximate estimate of a global peak early in the 21st century.

In the mid 1990's the work of independent and retire petroleum geologists who were colleagues of Hubbert reviewed his original predictions using new information and evidence, triggering the debate about peak oil that grew and spread along with the internet in the last years of the millennium. But with the cost of oil as low as $10/barrel, the gurus of economics and oil supply quoted in the mainstream media thought that oil was on the way to becoming worthless and redundant through glut and technological advances. The delusions of cheap energy were widespread. Ironically, many environmentalists concerned about the mounting evidence of, and inaction of governments about climate change, put their faith in the "hydrogen economy" powered by clean renewable technologies to save us from polluting the planet to death.

Freeway in Raileigh, North Carolina at peak hour, 2005. The classic symbol of automobile dependence in the USA where personal mobility in private automotives consumes about 60% of total oil production and imports.

While energy and consequently food costs in affluent countries remained the lowest in human history, the evidence for energy descent rather than ascent made little impact, outside the counterculture. Since 2004 the rising cost of energy, and now food, is focusing the attention of leaders and the masses to the questions of sustainability not seen since the energy crises of the 1970's.

The research, activism and awareness of energy and climate issues provide a context for the growing debate about the ecological, economic and social sustainability of everything from agriculture to human settlement patterns and even

fundamental human values and beliefs. There is a huge body of evidence that the next energy transition will not follow the pattern of recent centuries to more concentrated and powerful sources.

But the likelihood that this transition will be to one of less energy is such an anathema to the psycho-social foundations and power elites of modern societies that it is constantly misinterpreted, ignored, covered up or derided. Instead we see geopolitical maneuvering around energy resources, including proxy and real wars to control dwindling reserves and policy gymnastics to somehow make reducing carbon emissions, the new engine of economic growth.

Next page: 2. Energy Futures

Last Updated (Tuesday, 12 August 2008)

Energy Futures

There is still much debate about the basic nature of the current energy transition, driven most notably by climate change and peak oil.[5] Most of that debate focuses on the immediate future of the next few decades, though I think it is essential to first see these changes on a larger temporal scale of centuries if not millennia. I have set the scene by characterising the debate about the future as primarily one about whether energy available to human systems will rise or fall. These are outlined in the next section, Four Energy Futures.

Next page: 2.1 Four Energy Futures

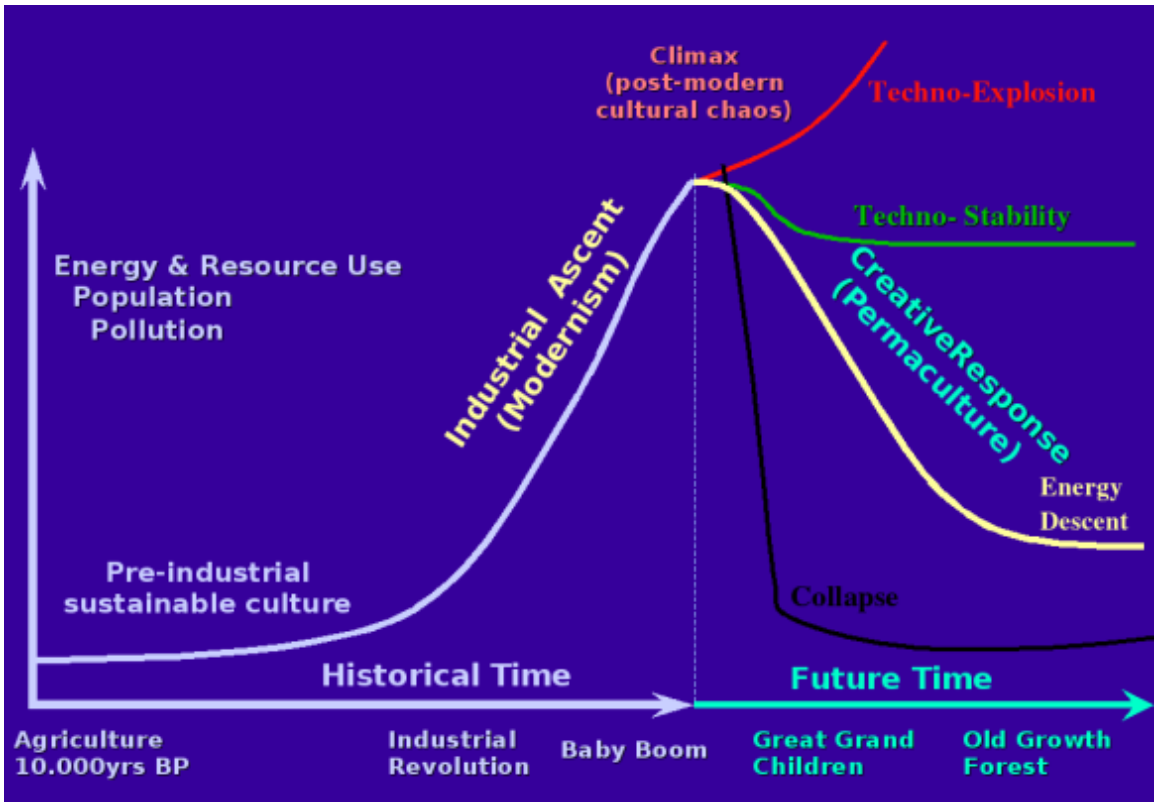
Last Updated (Thursday, 12 June 2008)

Four Energy Futures

Four broad energy scenarios provide a framework for considering the wide spectrum of culturally imagined, and ecologically likely, futures over the next century or more.

I've labeled these:

- **Techno-explosion,**
- **Techno-stability,**
- **Energy Descent** and
- **Collapse**



Four Energy Futures

Techno-explosion depends on new, large and concentrated energy sources that will allow the continual growth in material wealth and human power over environmental constraints, as well as population growth. This scenario is generally associated with space travel to colonise other planets.

Techno-stability depends on a seamless conversion from material growth based on depleting energy, to a steady state in consumption of resources and population (if not economic activity), all based on novel use of renewable energies and technologies that can maintain if not improve the quality of services available from current systems. While this clearly involves massive change in almost all aspects of society, the implication is that once sustainable systems are set in place, a steady state sustainable society with much less change will prevail. Photovoltaic technology directly capturing solar energy is a suitable icon or symbol of this scenario.

Energy Descent involves a reduction of economic activity, complexity and population in some way as fossil fuels are depleted. The increasing reliance on renewable resources of lower energy density will, over time, change the structure of society to reflect many of the basic design rules, if not details, of pre-industrial societies. This suggests a ruralisation of settlement and economy, with less consumption of energy and resources and a progressive decline in human populations. Biological resources and their sustainable management will become progressively more important as fossil fuels and technological power declines. In many regions, forests will regain their traditional status as symbols of wealth. Thus the tree is a suitable icon of this scenario. *Energy Descent* (like *Techno-explosion*) is a scenario dominated by change, but that change might not be continuous or gradual. Instead it could be characterised by a series of steady states punctuated by crises (or mini collapses) that destroy some aspects of Industrial culture.

Collapse[6] suggests a failure of the whole range of interlocked systems that maintain and support industrial society, as high quality fossil fuels are depleted and/or climate change radically damages the ecological support systems. This collapse would be fast and more or less continuous without the restabilisations possible in *Energy Descent*. It would inevitably involve a major "die-off" of human population and a loss of the knowledge and infrastructure necessary for industrial civilization, if not more severe scenarios including human extinction along with much of the planet's biodiversity.

Next page: 2.2 Views of the Future

Last Updated (Thursday, 26 June 2008)

Views of the Future

The views of academics and commentators about the future are coloured by their beliefs about the degree to which human systems are the product of our innate "brilliance" that is independent from nature's constraints, or alternatively, beholden to biophysical deterministic forces. Those with plans and actions to shape the future (especially current power elites) tend to focus on scenarios where they see options for effective influence.

Over the last 60 years we have seen substantial achievements as well as many dreams and promises towards the *Techno Explosion* future that might free us from the constraints of energetic laws or at least those of a finite planet. This belief in perpetual growth has survived the scorn of mathematicians explaining how constant exponential growth even at low rates leads to explosion, literally. The term "negative growth" used by economists to describe economic contraction shows that anything other than growth is unthinkable. The dream of infinite growth from free energy and colonising space have not been realised[7] despite the novel and substantial contributions of computers and information technology towards this goal.

This belief in perpetual growth has survived the scorn of mathematicians explaining how constant exponential growth even at low rates leads to explosion, literally.

Brasilia, capital of Brasil. Modernist hotel reflective of the rapid growth of the Brasilian economy as one of the emerging "energy super powers". *Click image for more commentary.*

The unstated assumptions of "business as usual"

At a more pragmatic and immediate scale, the reasons for the faith in future growth are rarely articulated but can be summarized by a few common assumptions that seem to lie behind most public documents and discussion of the future. These do not represent specific or even recognised views of particular academics, corporate leaders or politicians but more society wide assumptions that are generally left unstated.

- Global extraction rates of important non-renewable commodities will continue to rise.
- There will be no peaks and declines other than through high energy substitution such as the historical transitions from wood to coal and from coal to oil.
- Economic activity, globalisation and increases in technological complexity will continue to grow.
- The geopolitical order that established the USA as the dominant superpower may evolve and change but will not be subject to any precipitous collapse such as happened to the Soviet Union.
- Climate change will be marginal or slow in its impacts on human systems, such that adaption will not necessitate changes in the basic organisation of society.
- Household and community economies and social capacity[8] will continue to shrink in both their scope and importance to society.

> Being more transparent about our assumptions becomes essential in times of turbulent change and historical transition.

All of these assumptions are based on projections of past trends extending back over a human lifetime and drawing more broadly on patterns that can be traced to the origins of industrial civilization and capitalism in Europe hundreds of years ago. Simply exposing these assumptions makes it clear how weak the foundations are for any planned response to the issue of energy transitions. Being more transparent about our assumptions becomes essential in times of turbulent change and historical transition if our aim is to empower personal and community action.

> Mainstream approaches to sustainability assume that the *Techno Stability* long term future is inevitable.

Since the environmental awareness and energy crises of the 1970s, we have had a parallel stream of thinking and modest achievements towards the *Techno Stability* future that, in theory, is compatible with the limits of a finite planet. The principles and strategies of mainstream approaches to sustainability assume that the *Techno Stability* long term future is inevitable in some form, even if we go through some crises along the way. The focus is on how to make that transition from growth based on fossil energies to a steady state based on largely novel renewable sources.

Hydrogen powered fuel cell buses at the World Expo in Aichi Japan 2005. *Click image for more commentary.*

The tricky issue of dependence of the financial systems on continuous economic growth has been largely ignored or side-stepped by the assumption that the economy maybe able to keep growing without using more and more materials and energy. The explosion of economic activity based on financial services and information technology in the dominant economies during the early 90's gave some credibility to this concept of the "weightless economy", although it is now clear that globalisation simply shifted the consumption of resources to other countries to support this growth in the service economies.

The next section applies insights from systems thinking to reflect on the relationship between innovation, human capital and fossil fuels.

Next page: 2.2.1 Human Capital

Last Updated (Thursday, 14 August 2008)

Human capital

Much faith in both growth and steady state scenarios rests on the observation that human ingenuity, technology, markets and social capital are at least as important in shaping history as raw energy and resources. The stunning power and spread of computers and information technology into all sectors of industrial society is seen as much a product of human capital as it is of natural capital. The rise of the service economy promised continued economic growth without using more energy and materials. But these service economies and the human capital that helped create them were themselves created through the flows of energy and resources. For example, mass education, and especially mass tertiary education, is a very expensive investment in technical capacity and social capital that has been possible because of economic wealth from the extraction of

cheap fossil energy and non-renewable resources.

> Mass education has been possible because of the extraction of cheap fossil energy.

In pre-industrial societies it was not possible to have so many potential workers outside the productive economies of agriculture and manufacturing, or to build the educational infrastructure necessary for mass education. Human capital, in the form of mass education, the media, democracy and other characteristics of industrial culture has greatly expanded the apparent power of human rather than ecological factors in determining our future. While these new forms of wealth are clearly important, they are in reality "stores" of high quality embodied fossil energy. Like more material forms of wealth, they depreciate over time and must be used and renewed to remain useful.

Much of the technological and economic innovation since the oil shocks of the 1970's can be attributed to society's capacity to draw on this human capital and, by further cycles of reinvestment, further build human capital. Several factors suggest the continuous growth in human capital and capacity is an illusion.

Firstly, much of this growth is in forms that are increasingly dysfunctional. For example the increasingly sedentary lifestyle created by the computer and other innovation is requiring escalating expenditure in the health care system and in the health and fitness industry to compensate for lifestyles that are incompatible with human biology.

Secondly, much of the economic growth since the energy crises of the 1970's has come through economical rationalist policies such as privatisation. Many academics and social commentators have identified how much of the apparent economic growth has come at the cost of decline in many social indicators of well-being. We can think of this growth as being driven as much from mining (rather than maintaining) social capital as it has from mining the earth. For example, the privatisation of many electricity and other utilities has resulted in the loss of detailed knowledge about the maintenance of infrastructure, while maintenance budgets have been cut to the bone. Gains in productivity and efficiency have been achieved at the cost of resilience and long term capacity.

One of the characteristics of a robust, enduring and mature civilization is the capacity to consider the longer term, aim for desirable but achievable futures, but have fall-back strategies and insurance policies to deal with surprise and uncertainty. Given the globalised nature of culture, knowledge and wealth, our industrial civilisation should have been able to devote resources to serious redesign strategies at the technological, infrastructural, organisational, cultural and personal levels which are able to respond to the potentials of all four long term scenarios. Instead we see remarkably short term behaviour and a cavalier disregard of the fate of future generations. While this is often explained as "human nature" of fallible individuals, this explanation should not apply to institutions such as corporations let alone governments. History and systems theory suggest that powerful and long lived human institutions should embody longer term cultural wisdom and capacity.

We can interpret the short sighted nature of information and decision making in our largest organisational structures as one of the many signs of cultural decay, reflecting the fact that our stocks of human capital may be declining just as our stock of natural capital is. Applying the concept of resource depletion to that of social capital in both affluent and poor countries over the last 40 years is more than metaphorical. This depletion suggests these less material forms of wealth may be subject to the same laws of energy and entropy that govern the natural capital of the earth, air and water.[9]

19th century castle in Czech village of Buzov with waste straw from cropping field in foreground. *Click image for more commentary.*

Consequently, we should be skeptical of the notion that innovation in technology and organisation is a continuously expanding human resource that we can rely on to solve ever more complex challenges. This is not to say that given the right conditions humanity cannot rise to the energy transition challenge we face. However the conditions that could harness that human capacity are unlikely to include the continuation of endless economic growth, maintenance of current world power structures and the idolising of consumption. A smooth conversion to a steady state economy running on renewable energy without massive geopolitical and economic crises is unlikely. In fact an increasing number of commentators recognise that we are already in the crisis that has been unfolding since the turn of the millennium.

The next section considers the likelihood of collapse.

Next page: 2.2.2 Collapse

Last Updated (Thursday, 14 August 2008)

Collapse

For a minority of intellectuals and ordinary citizens, unimpressed by the likelihood of *Techno Explosion* or *Techno Stability*, the logical future seems to be some kind crisis leading to implosion and the collapse of civilisation. The old adage "what goes up must come down" still has some truth but several factors lead to people jumping to the conclusion that the *Collapse* scenario is inevitable without thinking about the possibilities of *Descent*.

Several factors lead to people jumping to the conclusion that the *Collapse* scenario is inevitable without thinking about the possibilities of *Descent*.

Firstly there is a long tradition of millennialism in Judeo-Christian culture which periodically leads to predictions of the "end of the world as we know it" based on the idea that our current world is fundamentally flawed in some way. The simplicity and mostly incorrect nature of these past predictions suggest caution when considering current predictions of doom. The fable of the "boy who cried wolf" is sometimes cited to suggest current concerns are also false alarms. But this history also has the effect of inoculating society against considering the evidence. Exposure to a small dose of millennialism leads to resistance to the effects of larger doses. Ironically, the point of the fable is that the threat of the wolf is real but that no one takes any notice because of past false alarms.

Ironically the point of the "boy who cried wolf" fable is that the threat of the wolf is real but that no one takes any notice because of past false alarms.

Another factor reinforcing this tendency of some to believe in *Collapse* is the rapid rate of recent cultural change and the very short term perspective of modern people despite the huge increase in knowledge about the distant past. Life in cities and suburbs, surrounded by technology and sustained by reliable income and debt is "normal" for many people in

affluent counties, even though these features only emerged in the latter half of the 20th century. If future change were to sweep away this way of life, many people would see this as "the end of civilisation" even if these changes were quite modest from an historical perspective. For example, a return to the conditions of the Great Depression is clearly not "the end of civilisation" but the idea that any downturn from the current peak of affluence represents "the end of civilisation", is quite widely assumed. Perhaps this reflects the egocentric nature of modern mentality where we consider our own survival and well being as being more important than was perhaps felt by past generations. It may also be interpreted as an intuitive recognition that this peak of affluence, like peak oil, is a fundamental turning point that will break the illusion of the, more or less, continuous arrow of growth and progress into the distant future.

The concept of overshoot in animal carrying capacity has been used by population ecologists to model past and potential future collapses in human populations.[10] There is substantial evidence that current, let alone projected human populations cannot be sustained without fossil fuels. Historical evidence from the Black Death and other pandemics show that societies can survive significant die-off in human numbers even if they do go through great setbacks and changes as a result. Because human systems are now global in scope and integration, the more limited regional collapse of economies and civilisations in the past is not necessarily a model of the scale, intensity and likely recovery from any global collapse. Also these societies were less complex with less specialisation of critical functions. It is possible that loss of critical numbers of engineers, technologists, medical specialists or even large scale farmers in a pandemic could cause modern industrial society to collapse very rapidly.

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...but the best documented historical case, that of the Roman empire, suggests a more gradual and less complete decline process.

The consideration of collapse has been strongly influenced by some ecological historians such as Catton, Diamond and Tainter. While Catton emphasises the concept of overshoot leading to severe collapse, Diamond emphasises the aspect of societal myopia leading to unnecessary collapse. Tainter provides a systemic view of how failure of energy capture strategies leads to decline in complexity that can play out over centuries. In turn, the conditions for ordinary people may actually improve when the resources devoted maintaining societal complexity are freed for meeting more basic needs. While all these perspectives and understanding are useful, I think the all-encompassing use of the term collapse is too broad a definition and inconsistent with our normal understanding of the term as a rapid and complete process. Historical examples of relatively complete and/or sudden civilisational collapse from the Minoans in the eastern Mediterranean to Mayans in Mexico are potential models for what could happen to global industrial civilisation. The best documented historical case, that of the Roman empire and Greco-Roman civilisation more broadly, suggests a more gradual and less complete decline process.

Ruins from the massive earthquake that devastated Valdivia Chile in 1960 now a wetland conservation zone. *Click image for more commentary*

I don't want to underplay the possibility of a total and relatively fast global collapse of complex societies that we recognise as civilisation. I think this is a substantial risk but the total collapse scenario tends to lead to fatalistic acceptance or alternatively, naïve notions of individual or family survivalist preparations. Similarly, the *Collapse* scenario is so shocking that

it reinforces the rejection by the majority of even thinking about the future, thus increasing the likelihood of very severe energy descent, if not total collapse. Perhaps a majority of people think civilisational collapse is inevitable but think or hope that it won't happen in their lifetime. A more realistic assessment of the possibilities and adaptive responses to the *Collapse* long term scenario is only possible after a deep and nuanced understanding of the diverse possibilities and likelihoods of the *Energy Descent* long term scenario.

Next page: 2.2.3 Energy Descent; The Ignored Scenario

Last Updated (Wednesday, 13 August 2008)

Energy Descent: The Ignored Scenario

Public discussion of energy descent is generally seen as unrealistic, defeatist and politically counterproductive although many activists promoting sustainability strategies privately acknowledge that energy descent maybe inevitable. I want to expand the systems approach to future energy transitions by focusing on the most ignored of the long term scenarios for the following reasons.

- We do not have to believe that a particular scenario is likely before making serious preparations. For example most people have fire insurance on their homes, not because they expect their primary asset to be destroyed by fire but because they recognise the severity of this unlikely event. Similarly, energy descent scenarios, by their very nature, require more forethought and proactive planning than energy growth or steady state scenarios (to avert catastrophic consequences) .
- The rapidly accumulating evidence on both climate change and peaking of world oil supply, to name the two most important factors, makes some sort of energy descent increasingly likely despite the deep structural and psychological denial of this evidence.
- The likelihood that permaculture principles and strategies (not necessarily by that name) could inform societal-wide redesign and re-organisation in an energy descent future. Since this scenario is the one in which permaculture is naturally at the fore, it is logical for those committed to permaculture to think more deeply about energy descent.[11]

Amish horse cart outside of SUV's in auto sales lot, Railegh North Carolina. 2005. A model for energy descent in more ways than the obvious. The Amish driver is likely to be a farmer, a symbol of the greater number of people who will be involved in food production both domestically and commercially in a future of less energy; in ironic contrast to the Burger King take away food sign in the background

Ecological modeling suggests an energy descent path that could play out over a similar time frame to the industrial ascent era of 250 years. Historical evidence suggests a descent process that could involve a series of crises that provide stepwise transitions between consolidation and stabilisation phases that could be more or less stable for decades before another crisis triggers another fall and then another restabilisation.[12]

> There is a desperate need to recast energy descent as a positive process that can free people from the

strictures and dysfunctions of growth economics and consumer culture.

There is a desperate need to recast energy descent as a positive process that can free people from the strictures and dysfunctions of growth economics and consumer culture. This is now apparent to many people around the world[13] and is far more fundamental than a public relations campaign to paint a black sky blue. It is a necessary process to provide a sense of hope and connection to fundamental human values expressed by every traditional culture throughout human history; that the pursuit of materialism is a false god.

One of the positive aspects of energy descent that is often overlooked is that it is a culture of continuous and novel change over many human generations. Ironically the growth culture of the previous several hundred years provides us with some conceptual and cultural experience at dealing with change that traditional peoples in more stable societies lacked. We are now familiar with continuous change, that we must do something different to our parent's generation and that our children must do something different again. This may seem a small bright spot when considering the challenges of energy descent but it is a real asset that we must harness if we are to deal with energy descent in the most graceful way possible.[14]

The next section explores the relevance of permaculture design systems to an era of energy descent.

Next page: 2.2.4 Permaculture

Last Updated (Wednesday, 13 August 2008)

Permaculture

Serious and thoughtful responses to energy descent futures over the last 30 years (from both sociological and ecological perspectives)[15] have received limited attention academically. In affluent countries, movements advocating low energy lifestyles, such as permaculture, have contributed mostly to action and changes at the fringes of society. Permaculture has been stress tested in poor countries and in crisis situations, and as fossil fuel depletion hits levels of affluence globally, its relevance will likely increase radically.

Permaculture was one of the environmental design concepts to emerge from the 1970's debate over energy and resource availability and was founded on the assumption that the next energy transition would involve the re-emergence of biological systems as central to economics and society. The vision that informed permaculture design, teaching and action saw relocalised food and renewable energy production, revitalised household and community economies and bioregional political structures establishing a permanent (ie. sustainable) human culture. The opportunistic use of fossil fuelled wealth and waste to fund the transition was an integral part of the permaculture strategy. I see permaculture design generating more appropriate biological and human capital in ways less demanding of physical resources and with low depreciation rates that are useful to a world of energy descent. In my book *Permaculture: Principles and Pathways Beyond Sustainability*, I explained the title in terms of the *Energy Descent* future undermining the steady state notions inherent to most thinking about sustainability and even permaculture.

Permaculture has spread around the world but has an extraordinary, perhaps unique role in Australia, as a concept, a collection of design strategies, and as an environmental movement. A definition is included in the Macquarie dictionary and it is almost a household word.[16]As a "brand" it carries a great deal of good will but also much baggage and is generally regarded in policy and planning circles as marginal to mainstream decision making. Some more thoughtful people recognise it as tuned to a world of declining resources that will require adaptive strategies quite different from those being pursued currently.

Melliodora central Victoria 2004. View over poultry deep litter yard, roof runoff garden, olive and fruit trees to house with solar clerestory showing above trees. *Click image for more commentary.*

Permaculture is already contributing to changing Australian suburbs and lifestyle via bottom up and organic processes. Increasing community awareness of environmental issues combined with rises in the cost of energy, water and food are likely to lead to an explosion in permaculture inspired activity in Australian cities, towns and rural landscapes. It is now essential that academics, educators, activists, planners and policy makers understand permaculture as both a factor in the social and physical fabric of Australian society and a conceptual framework for the organic redesign of society and culture for the energy descent future in Australia as well as globally.

Not surprisingly, Permaculture solutions have been more effectively applied in community and agricultural development work in many majority world communities where energy descent has been a reality for many people. While these conditions can be understood in terms of inequitable distribution of resources rather than fundamental limits, they provide models for behaviour in response to energy descent. The most dramatic example is the role that permaculture strategies and techniques played in rapidly increasing urban food production as part of a multi pronged strategy to avert famine in Cuba in the early 1990's following the collapse of the Soviet Union. What is particularly interesting about this model is that Cuba is a middle income country with a long history of industrialised agriculture and an urbanised and dependent population similar to many affluent countries. Today Cubans have life expectancy and other indices of development comparable with the USA while using one seventh the energy and resources.[17]

Permaculture is, intuitively, most relevant to the *Energy Descent* scenarios in which there is a major decline in the power from non-renewable resources but many of the strategies are synergistic with those focused on appropriate responses to the *Techno Stability* scenario which demands a degree of relocalisation of food supply and other key economies and a shift from centralised to distributed energy sources.

> One way to understand permaculture is as a post-modern integration of elements from different traditions and modernity that involves continuous change and evolution.

Sometimes permaculture is understood as simply returning to traditional patterns from the past and is consequently criticised as impractical. While it is true that older, more traditional patterns of resource use and living provide some of the elements and inspiration for permaculture, it is certainly more than this. One way to understand permaculture is as a post-modern integration of elements from different traditions and modernity that involves continuous change and evolution. This builds on the human experience of continuous change rather than static tradition as well as the more recent emergence of design as a new literacy that allows us to effectively and efficiently respond to and redesign our environment and ourselves.[18]

Next page: 3. Climate Change and Peak Oil as Fundamental Drivers of Change

Last Updated (Wednesday, 13 August 2008)

Climate Change and Peak Oil as Fundamental Drivers of Change

The simultaneous onset of climate change and the peaking of global oil supply represent unprecedented challenges driving this energy transition but historians may look back with the verdict that the efforts at transition were too little too late. The immediacy of the problems undermines many of the options for longer term restructuring around renewable energy and appropriate infrastructure. The systemic interlocking of human/environment systems suggests other apparently independent crises from the psychological to the geopolitical are being drawn together to reinforce an historic inflection point.

Next page: 3.1 Climate Change

Last Updated (Thursday, 29 May 2008)

Climate Change

While Peak Oil has remained a concept at the fringe of public debate and policy, climate change has gathered speed as the key environmental issue demanding attention alongside more traditional concerns about economics and security. The creation of the IPCC in 1988 reflected the scientific consensus in the mid 1980's that increasing atmospheric carbon dioxide was caused by human emissions but the realisation that climate change was already happening began to take shape in the 1990's and by 2007 even political leaders in the USA and Australia (who had become infamous for denying climate change) began to accept it as a reality. It has been the increase in drought and extreme weather events more than increases in average temperatures or subtle ecological changes that have spurred the political and public realisation that climate change is already happening. The focus has shifted from impacts on nature to impacts on humanity.

Strategies for reducing greenhouse gas emissions have become almost synonymous with the sustainability concept. New financial instruments such as carbon trading have developed despite the uncertainty about international agreements to underpin and sustain them. Renewable energy sources have grown significantly especially in countries with the most progressive responses to climate change. At the same time geological sequestration of carbon dioxide has been strongly promoted as a way to allow coal-fired power stations to continue to provide the bulk of the world's electric power without creating climate chaos. The nuclear industry has been recast as an environmental saviour. Despite all the focus on the issue, the emissions of greenhouse gases world wide has continued to parallel economic growth. Consequently the emissions increases have been higher than even the worst case (business as usual) scenarios produced in the earlier reports by the IPCC (Intergovernmental Panel on Climate Change).

Thunderstorm cell over New Guinea 2005. ***Click image for more commentary.***

The most recent evidence on climate change is showing that the rate of onset of warming in the Arctic[19] make the IPCC's fourth report look incompetent in its failure to be alarmist enough. Greenland ice cap melting and sea ice retreat are occurring now far faster than expected. This new evidence has been ignored by the IPCC's ponderous processes for its reports. James Hansen's research suggests that sea level rises could be 5 metres by 2100 rather than the 0.5m

> Hansen's report suggests that the onset of severe impacts from climate change are now inevitable even if there is a huge world wide effort at mitigation.

used in the IPCC's fourth report. This suggests that the onset of severe impacts from climate change is now inevitable, even if there is a huge world-wide effort at mitigation.

There is also very little evidence that mitigation within the context of modern affluent society will radically reduce greenhouse gas emission in any case. Most of the increases in efficiency and other gains through technology have been countered by increases in emissions elsewhere. This may appear to be due to the small scale and spread of these gains but there is a more fundamental problem that is known to systems theorists as the "rebound effect" or the "Jevons' paradox". A gain in resource efficiency in one part of a system is immediately used to drive growth in another part. For example, the savings made in reducing house heating costs is typically being spent on something like an overseas holiday by a householder. This suggests that without radical behavioural and organisational change that would threaten the foundations of our growth economy, greenhouse gas emissions along with other environmental impacts will not decline. Economic recession is the only proven mechanism for a rapid reduction of greenhouse gas emissions and may now be the only real hope for maintaining the earth in a habitable state.

Economic recession is the only proven mechanism for a rapid reduction of greenhouse gas emissions

Further, most of the proposals for mitigation from Kyoto to the feverish efforts to construct post Kyoto solutions have been framed in ignorance of Peak Oil. As Richard Heinberg has argued recently,[20] proposals to cap carbon emissions annually, and allowing them to be traded, rely on the rights to pollute being scarce relative to the availability of the fuel. Actual scarcity of fuel may make such schemes irrelevant.

Next page: 3.2 Energy Reserves and Production Peaks

Last Updated (Wednesday, 13 August 2008)

Energy Reserves and Production Peaks

Most of the comparative discussion about energy resources has focused on "Proven, Probable and Possible Reserves". These are economic concepts about what can be profitably extracted using current technology and prices. Banks lend massive amounts of money to develop energy projects over long periods with risks of price collapses that can reduce or eliminate profits. The Proven reserves represent assets that can be considered as collateral by the lender. There is a long history of "reserve growth" of Proven reserves. While some of this is due to technology improvement, and more recently price rises, very little is due to finding more oil. Most is simply due to shifting reserves from the Probable to the Proven category driven by reporting policies and regulations.

An oil well jack pump Cuba 2007.

Nationalisation of oil reserves in the 1970's allowed OPEC countries to report reserve growth with less scrutiny by western banks and in the 1980's radical revision upward of reserve figures were made without finding any more oil. This hopeless corruption of reserve figures, of arguably the most important set of accounts in the world, was not exposed until the late 1990's with the work of Campbell and Laherrere[21] beginning the current debate about peak oil. It is still yet to be accepted or acknowledged by governments or intergovernmental agencies such as the International Energy Agency,[22] charged with

providing transparent and accurate information on energy resources.

The debate about Peak Oil has also highlighted the confusion in economic and political discourse about the importance of production rates and their potential to keep expanding. This collective myopia on the part of the intelligentsia is all the more stunning because it has been increasing rates of energy production (not reserve growth) that has underpinned economic growth. The orthodox view that healthy reserves, by themselves, can ensure expanding production has been show to be false.

The collective myopia on the part of the intelligentsia is all the more stunning because it has been increasing rates of energy production that has underpinned economic growth.

Similarly, the conventional wisdom that coal reserves are so great that we can expand coal based electricity with or without carbon sequestration, and make liquid fuel from coal is now being widely challenged[23]. As with oil, we see that reserve figures are of dubious reliability and large reserves do not mean that production rates can necessarily increase. The slow rate of increase in oil production from the Canadian tar sands, despite massive investment, heroic logistics (and massive environmental damage) proves that large reserves do not necessarily lead to high production rates. The fact that Canada, overnight, became the nation with the largest oil reserves in the world because it was allowed[24] to classify its tar sands as oil, highlights the arbitrary nature of the reserve concept. It is highly likely that nowhere near enough fossil fuels can be mined fast enough to generate the worst case emission scenarios of the IPCC. It is just unfortunate that climate change seems to be happening at much lower levels of atmospheric carbon dioxide than predicted in those same models.

The evidence on peak oil is gathering so fast that it is now certain that the world has already peaked in the production of cheap (conventional) oil

The evidence[25] on peak oil is gathering so fast that it is now certain that the world has already peaked in the production of cheap (conventional) oil and that the peak production of "crude plus condensate" (the standard measure of oil) may have already passed despite vigorous debunking of peak oil that continues in policy circles and the media. The steady climb in prices for eight years should have been enough to lift production if that were possible. The impacts of peak oil are unfolding all around us in the world but they are being regularly interpreted in the media as caused by more familiar (above ground) factors such as terrorism, oil nationalism, corporate greed or incompetence, speculators etc. The combination of rolling crises and obfuscation of the issues is leading to confusion and inappropriate responses (from oil wars to biofuels from agricultural crops) that are compounding the problems.

The debate amongst peak oil analysts has now shifted from when, to at what rate, the world will decline

The debate amongst peak oil analysts has now shifted from when, to at what rate, the world will decline after we move off the current plateau in production. The decline rates in the UK and Mexico have provided progressively stronger evidence that the application of modern management and technology in oil production, while delaying peak, ultimately leads to faster decline rates than had been expected (based on past rates of national decline). If these higher decline rates follow through into global decline, then mitigation and adaption strategies, without economic collapse will be very difficult. Given the accelerating consumption of natural gas and coal we should assume peak production of both will quickly follow oil peak.

Access to oil will likely decrease far more rapidly in importing nations as explored in the next section.

Next page: 3.3 Collapsing Oil Exports

Last Updated (Wednesday, 13 August 2008)

Collapsing Oil Exports

Another factor is already accelerating the impact of global peak on the importing countries. Almost all of the oil producing countries have rapidly growing economies driven by large oil revenues and in many cases rapidly growing populations. Internal consumption in these countries is ensuring that after peak, the rate of exports declines much faster than production. The two largest producers and exporters Saudi Arabia and Russia are the prime examples. Global economic growth may continue for some years in oil and resource rich countries, but not in the importing countries that have been used to affluence and continuous economic growth for the longest. [26]

The rising cost of intercontinental shipping costs is threatening to reverse the globalisation of manufacturing.

Alternatively, a constant state of corruption, dysfunction and/or open war, in oil exporting countries can have the effect of enforcing exports in the face of shortages at home. Although this appears counter-intuitive, the failure of functional governance in the national interest combined with a shattered or stunted economy reduces the capacity of the national market to pay for oil and allows foreign oil companies to gain favourable concessions and military protection from corrupt governments. Aspects of this scenario are at work to maintain the flow of oil from Nigeria and Iraq to the USA and other large importers.

Thus, we can see both the collapsing exports, and enforced export scenarios unfolding simultaneously as the major expression of the struggle for declining production. This suggests at the very least, massive shifts in geo-political and economic power over the next few years, even if global growth continues

The next section considers one other compounding factor, that of decreasing net energy returns.

Next page: 3.4 Net Energy Return

Last Updated (Wednesday, 13 August 2008)

Net Energy Return

An even more fundamental issue is that of net energy return. It takes energy to get energy. Fossil fuel resources have been such an abundant source of concentrated energy that the investment of energy we make in exploration, mining, transport and processing has been relatively small. Even when we consider all the energy embodied in equipment and infrastructure, the net energy return or profit has been very high. Adding all the energy and resources needed to train and support all the engineers and other employees in the energy industries still leaves a huge net energy profit which explains why the oil industry has been such a profitable one. However now that we have passed the peak of production of conventional oil, the net energy yield from new projects tapping the heavy, deep ocean, arctic and small remaining amounts in old oil fields, using advanced recovery methods, is less and less.

This decline in net energy yield results in an increasing proportion of society's real wealth being devoted to the energy harvesting sectors of the economy, leaving less and less for all other sectors.

Other resources sectors with rapidly increasing demand for energy include mining and metal processing, which currently use about 10% of world energy supply, have an escalating demand as lower quality ore bodies are mined.[27] The

implications of declines in Energy Return On Energy Invested (ERoEI) are so shocking that there is much confusion and denial about the concept of net energy.

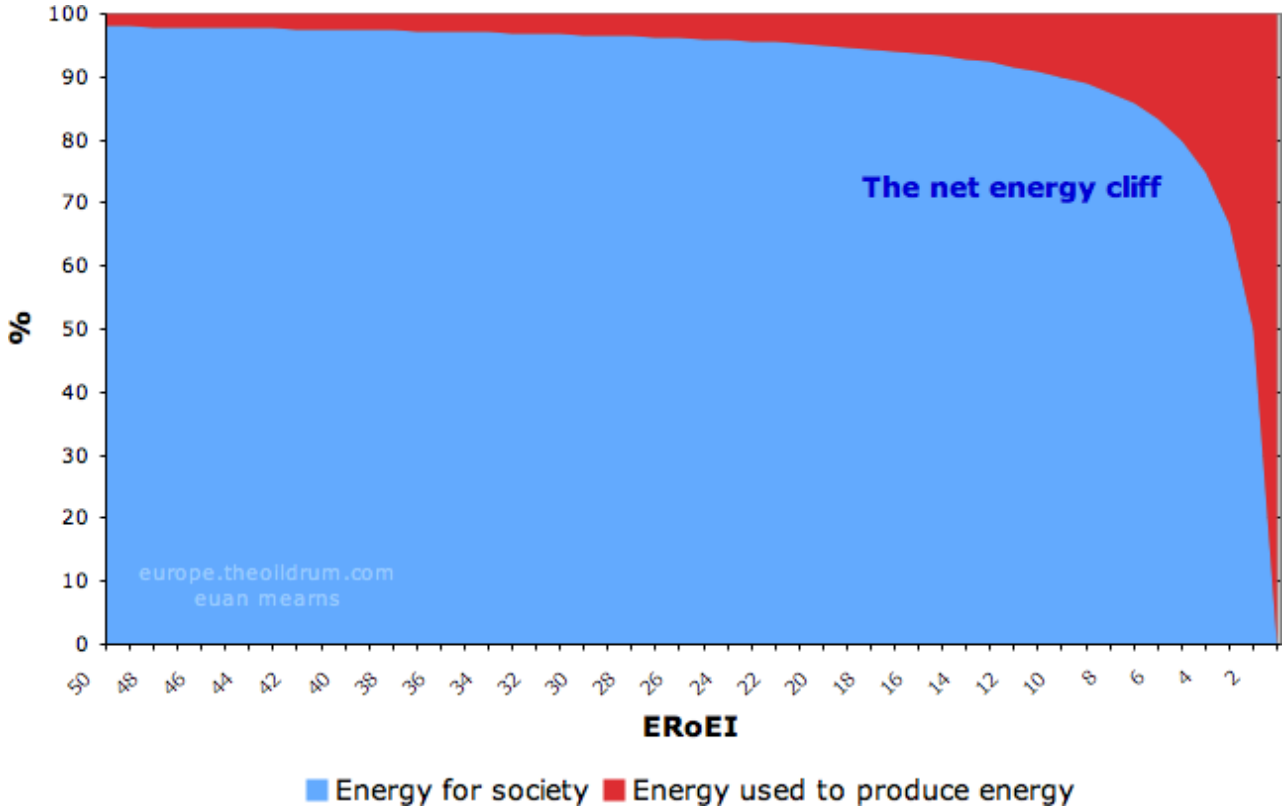
The idea that biofuels or coal to liquids will simply replace oil and gas the way oil and gas have replaced wood and coal shows an astonishing degree of ignorance of the concept of net energy. When we moved from wood to coal and on to oil, the increase in power available to humanity was not just from the increasing quantity of energy, but from the increasing quality. The quantity is easily measured in joules (heat energy released) but the quality is something scientists are more confused about. It is widely accepted by scientists that energy quality is real and determines the usefulness of energy, but without an agreed way to measure quality, it is largely ignored.

The net energy concept is just beginning to surface in the media and policy circles as a way to assess alternative energy sources and strategies, especially in the debate over corn ethanol in the USA. While different methods of accounting for net energy produce substantially different net energy profit figures, they all show a pattern of higher returns for current and past sources of fossil energy than new ones. Economic power and profit from past development of different energy sources also reflects these general patterns revealed by net energy calculation methods. This suggests they can be used to predict real economic impacts of future energy systems.

> The declining net energy yields of our energy resources results in an increasing proportion of society's real wealth being devoted to the energy harvesting sectors of the economy, leaving less and less for allother sectors.

The promotion by the US dept of Agriculture of research showing a Energy Return On Energy Invested of 1.6[28]as a good result, indicates how the understanding of these issues is very poor, even by the scientifically literate. A society based on an energy source of this quality would be constantly investing 62% of its energy back into the energy industry (the 1 in 1.6), leaving only the remaining 38% of the total energy in society for everything else, ie. health, education, culture, food production, law, leisure and so on. Our modern industrial society has been fueled by energy sources with Energy Return on Energy Invested as high as 100 and at least 6 (requiring between 1% and 17% of the wealth created being invested to get the yield)

Ironically conventional economics is blind to this shift because one type of economic transaction is considered as good as another, so growth in the energy sector at the expense of say personal consumption is not seen as indicative of any fundamental problem.

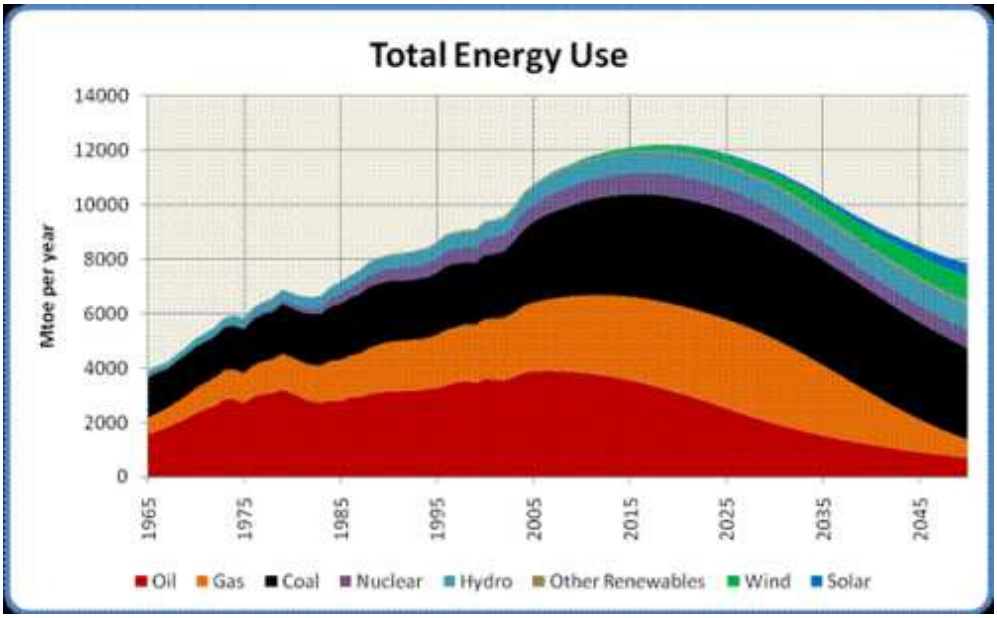


The dramatic effect as ERoEI falls below 10 is illustrated by the above graph.

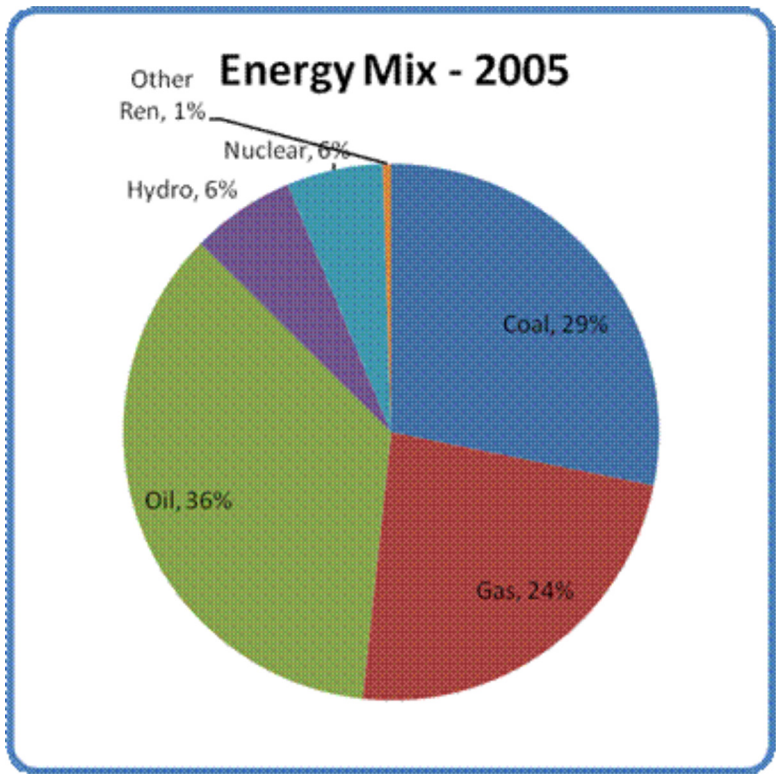
My own tracking of these issues over the last thirty years leads me to the conclusion that the next energy transition is to sources with lower energy production rates and lower net energy yield which in turn will drive changes in human economy and society that are without precedent since the decline and/or collapse of previous complex civilisations such as the Mayans and the Romans.

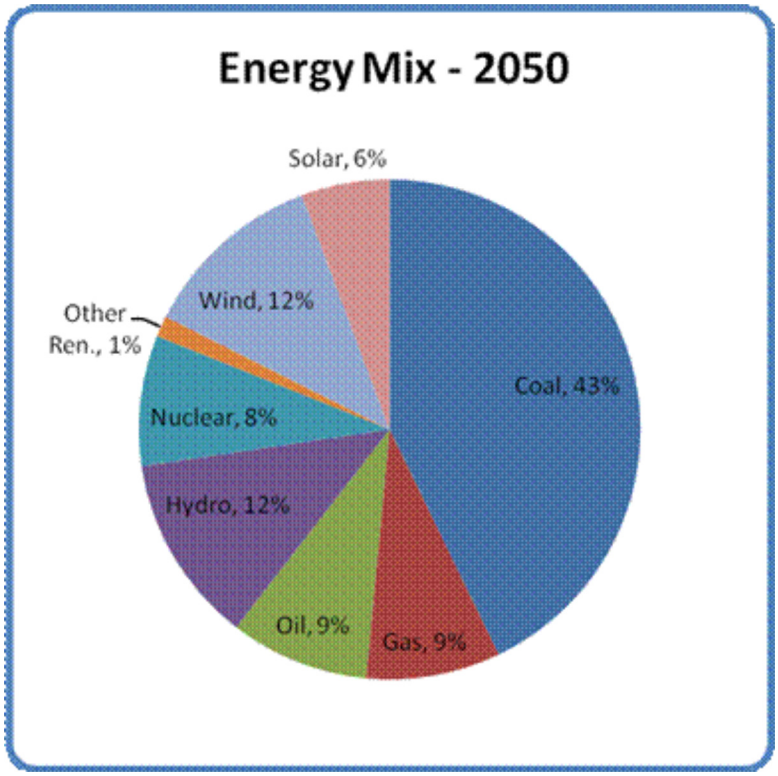
The most sophisticated method of evaluating net energy, with the longest history of development, is EMergy Accounting developed by Howard Odum and colleagues.[29] It has informed my own development of permaculture principles and strategies over the last 30 years but unfortunately it remains unknown or at best misunderstood in academic and policy circles. EMergy accounting includes ways of measuring energy quality (called "Transformity"). This makes it possible to account for small quantities of very high quality energy in technology and human services that undermine many of the more optimistic assessments of alternative energy sources including biomass, nuclear and solar.

To test the relative impact of net energy compared with declines in energy production rates, I used a recent assessment of global energy production through to 2050 by Paul Chefurka published and discussed on The Oil Drum website[30]. The study was well referenced and its assumptions and methodology were clear. It took account of likely reductions from oil, gas and coal but included reasonably optimistic figures for future production from renewables and nuclear. It shows a peak in total energy production about 2020 followed by a decline to 70% of 2005 production by 2050. This is a very serious reduction given an expected global population of 9 billion. Below are the key production projections and energy mix pie charts from the study.



The above graph models gross energy availability. Due to decreasing net energy yields of many of the above resources, actual available energy for society will likely decrease more dramatically.





Using published EMergy accounting studies[31] I multiplied these current and projected global energy sources by their net EMergy yield ratios. This shows that the energy quality of 2050 energy mix will be 58% of the 2005 energy mix. This suggests that declining net energy is a greater factor than projected declines in production. Multiplying these factors together suggests real energetic power available to humanity will be 40% of current yields. This does not allow for the energetic cost of carbon sequestration (still unknown) to ameliorate the otherwise disastrous impacts on the climate of the increased use of coal.

> The net energy return from fossil fuels including coal will decline so thatthe above calculation of humanity having about 40% of current net energy by 2050 may still be optimistic.

Further it does not take account of decline (or increase) in the average net energy return for a particular source. While it is possible that net energy return from newer renewable sources (such as solar and even wind) could conceivably improve with time, it is more likely that they will decline as the embedded fossil energy contribution (to the new energy sources) declines. What is more certain is that net energy return from fossil fuels including coal will decline so that the above calculation of humanity having about 40% of current net energy by 2050 may still be optimistic. A new evaluation of the net energy return of gas production in North America[32] using a methodology developed by Cleverland and Costanza suggests net energy return is in the process of a collapse so severe that net energy yield from gas in Canada will effectively fall to almost nothing by 2014 and that similar results apply to US production. This is very different from the official view that claims the USA has 86 years of production at 2004 levels based on production to reserves ratios.

The implications of some of this information is so shocking that the naïve and simplistic idea that we are running out of oil and gas (rather than just peaking in production) may be closer to the truth than even the most pessimistic assessments of peak oil proponents a decade ago.

The next section considers briefly some other major factors besides Peak Oil and Climate Change which will determine the future.

Next page: 3.5 Associated Issues

Last Updated (Wednesday, 13 August 2008)

Associated Issues

Many other factors beyond Climate Change and Peak Oil are increasing the stress on global ecosystems and humanity making some form of energetic descent if not collapse, seem inevitable. A few of the more fundamental ones need at least a mention.

Critical materials depletion

Accelerating economic growth and energy extraction over the last decade has greatly increased depletion of other essential non-renewable resources, especially phosphates [33] for food production and non ferrous metals for industry. Almost all the unfolding plans and projects for energy transition beyond oil will place more demand on these depleting resources. For example, the demand for nickel steel alloys required for high pressure natural gas pipelines is pushing up the price of nickel and further depleting the remaining stocks. As lower quality deposits of critical materials are tapped, energy demands for extraction and processing will escalate dramatically and production rates will fall. The title of Richard Heinberg's latest book *Peak Everything* [34] sums up the situation.

Water depletion

Water is the most abundant resource used by humanity, but the growing demand, is so vast that the limits once specific to a bioregion, are now being expressed at the global scale. Although I don't subscribe the view that global water shortage will constrict global growth before or more severely than liquid fuel supplies, the global water crisis is already quite severe. Even if we attribute the most dramatic impacts of droughts directly to climate change, other factors are independently contributing to the water crisis. The loss of wetlands, perennial vegetation and forests as well as soil humus are all reducing the capacity of catchments and soils to catch and store water between periods of rain, which in turn, escalates demand for irrigation. Increasing affluence is directly and indirectly increasing water consumption especially through intensive livestock husbandry dependent on irrigated fodder crops. The extraction of ground water beyond recharge rates, including huge reserves laid down after the last ice age, makes many water resources as depletable as fossil fuels, giving rise to the term "fossil water". Finally, the decline in water quality is increasing death and illness from water borne diseases, demand for expensive water filtration and treatment as well as bottled water supplies.

Food supply

The unfolding global food crisis can be largely attributed to the manifold interactions and knock on effects of energy costs and climate change including droughts and bad seasons, biofuel demand and escalating costs of (energy intensive) fertilisers, pesticides, and irrigation. Other factors exacerbating the crisis include rising affluence increasing demand especially for beef and cotton, past low prices destroying farming as a livelihood and failure of the land reform agenda in most countries. Fixing these secondary factors is technically possible, but seems unlikely. But there is also evidence that agriculture is running up against fundamental yield limits for our main crops that, despite all the promises, genetic engineering has failed to break through. Widespread application of organic methods and permaculture design, especially when applied to small scale systems could reduce the impact of the crisis but this will not be simple or quick.

Population Pressures

The continued growth in human numbers is now pushing well beyond that which could be sustainably supported without fossil fuels. Although affluence, conflict and other human created factors are multiplying the impact of population, there are structural factors that make the large and growing human population more important than it might otherwise be. The total size of the human population, its density of settlement in cities and the constant interchange of microbes due to travel and trade are all powerful factors increasing the likelihood of new and old diseases creating pandemics on an unprecedented scale.

Financial Instability

The accelerating growth and concentration of debt and financial assets especially in the housing and derivatives markets is

destabilising the global economy. The virtual impossibility that future growth in the real economy could ever be large enough to justify those debts and assets suggests a major and enduring economic contraction in the near future. Alternatively we may see the financial crisis in the USA trigger a collapse similar to that which happened in the Soviet Union. If China, India, Russia and other growing economies survive relatively unscathed, completely new global power and economic systems could emerge quite quickly.

Psychosocial limits to affluence

The psychosocial limits of affluent consumer culture[35] suggest that multi generational mass affluence may burn itself out in a few generations, through dysfunctional behaviour, addictions and depression. While the "Roaring 20s" in affluent countries gave some examples of the excesses of affluence that were swept away by the Great Depression and Second World War, the three generations of affluence since then have stimulated lifestyles and behaviours that are amplifying unsustainable resource consumption to new heights. The onset of severe psychosocial dysfunction in the long affluent western world could be as powerful a force as the financial system instability.

Species extinction

The accelerating rate of species extinctions suggests humans have initiated a wave of extinctions on the scale of the asteroid that is believed to be the cause of the mass extinction that wiped out the dinosaurs 65 million years ago. Apart from the ethical and psychological issues involved, it is hard to predict how, and when this will result in major adverse impacts on humanity other than to recognise that it is eroding the genetic base that we will increasingly depend on in the future, as well as increasing ecological instability that is undermining our ability to produce food.[36]

Despite the severity of these and other associated problems I see climate change and peak oil as the most fundamental ones for the following reasons:

- They both are inevitable consequences of the accelerating use of fossil fuels, the undeniable primary factor in creating the explosion of human numbers, cultural complexity and impacts on nature.
- They both appear to be generating immediate and severe threats to humanity
- They both show a long term pattern of accelerating intensity
- They both contribute directly or indirectly to the impact of the other serious problems threatening humanity and nature.

To suggest that the next energy transition will fall well short of the past patterns of human collective expectations is a gross understatement. My quick overview of evidence around the most critical issues suggests we need to refocus our assumptions about the future around energy descent while developing the psycho-social and eco-technical capacity to respond to the range of possible scenarios that we could face.

While continued efforts to better understand the rate of onset of climate change and the decline in oil production is very useful, an equally important task is to understand how these factors will combine to create differing futures.

The next section considers the interaction of peak oil and climate change to consider four distinct energy descent scenarios.

Next page: 4. Descent Scenarios

Last Updated (Friday, 01 August 2008)

Descent Scenarios

Scenario Planning

The systems approach to the energy descent future can be taken further by using a scenario planning model that combines two fundamental, and largely independent variables that generate four scenarios, one for each of the quadrants of a conceptual graph. Scenarios in this context are plausible and internally consistent stories about the future that help organizations and individuals to achieve a broad and open ended adaptability to inherent unpredictability.

In classic corporate scenario planning the two variables might be the growth rate in the wider economy and the regulatory framework that constrains or encourages business. Climate Change and Oil Production Decline are the variables I use as the primary drivers in creating the four energy descent scenarios because I believe these are the strongest forces shaping human destiny over the 21st century and beyond. Consequently they are central to consideration of the energy transition across nations and cultures and in both urban and rural environments.

Next page 4.2 The Interaction of Peak Oil and Climate Change

Last Updated (Sunday, 25 May 2008)

Interaction of Peak Oil and Climate Change

Although both variables are caused by collective human behaviour and potentially can be ameliorated by human behaviour, they arise from geological and climatic limits beyond human control. The debate over amelioration vs adaption to climate change is often portrayed as a potent moral choice between burning coal and accepting a changed world, or a shift to renewable energy to save nature. The emerging evidence suggests that this choice was one that humanity collectively fudged in the 1980's.

Similarly the actions necessary to make an orderly transition from oil to other energy sources has been assessed as taking at least two decades.[37] Again society had the evidence from the peaking of US oil production in1970 but with the return of cheap oil in the 1980's the energy problem appeared to have simply gone away due to "better" economic policies. Now climate change is accelerating and peak oil is upon us.

As well as having to adapt to both of these new realities, we also grapple with the interactions both positive and negative. The accelerating shift to increased dependence on natural gas is often portrayed as a positive reduction in carbon intensity but this is simply accelerating the depletion of our children's remaining inheritance of high quality transport fuel. Similarly projects developing tar sands and other low grade sources of oil massively increase greenhouse gas emissions. Perhaps more surprising to some, the huge push in the US and Europe to make biofuels from corn and oil seed crops is increasing land degradation, resource consumption and contributing to driving up the cost of grains and oil seeds. Many authorities[38] are warning of global famine due to climate and energy crisis factors (including biofuels) coming together. The low EROEI of biofuels, especially corn based ethanol, suggest biofuels may be a way to deplete natural gas while degrading agricultural land and starving the world's poor.

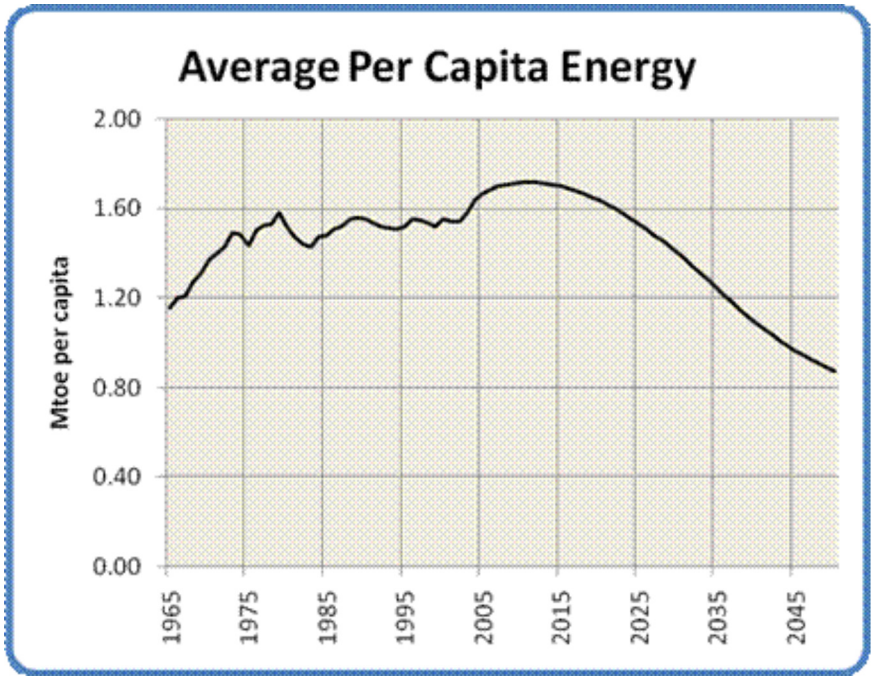
> We can build local resilience at the same time as we make the greatest contribution to reducing greenhouse gas emissions.

On the other hand, radical reductions in consumption due to transformative lifestyle change, creative reuse of wastes generated by industrial and consumer systems, and a shift to truly productive work within revitalised home and community economies, show how we can both build local resilience and capacity to adapt to the destructive change at the same time as we make the greatest contribution to reducing greenhouse gas emissions and fossil fuel depletion rates. While this strategy would be most productive and effective in the most affluent countries, it has increasing relevance world wide.[39]

The reluctance to seriously consider positive reductions in consumption in public debate about climate solutions could be swept away by the unfolding global energy and food crisis. Developing some of the harder and longer term ecological and modest technological adaptions to ongoing and relentless energy descent will take decades to have widespread impacts (as do all high energy, high-tech centralised approaches) but radical and rapid human behavioural change is possible and even

likely (given the right psycho-social conditions). The emerging energy and economic crisis will make these reductions a reality with or without a planned and creative response.

The alternate scenarios I have constructed provide more detail about how the Energy Descent future might evolve over the next few decades rather than the hundreds of the years of the long term scenarios. As well as combining the effects of slow or rapid oil production decline, and slow or rapid global warming, they cover a very broad spectrum of human possibilities that can be recognised by various symptoms and signs in different places in the world today. They are all energy descent scenarios in that they depict possible futures with progressively declining net energy. This must be understood against the historical background in which energy use per capita globally has been on a bumpy plateau for thirty years after the previous thirty years of rapid growth per capita from the end of World War II. The graph below from the previously mentioned study suggests per world wide capita energy use may continue to rise to about 1.7 tonnes of oil equivalent (toe) by 2020 before falling to 0.9 toe by 2050.[40]



However when we use net energy ratios to convert these undifferentiated joules of energy, I believe that we are already into a global decline in net energy per person and will soon be into absolute global net energy decline.

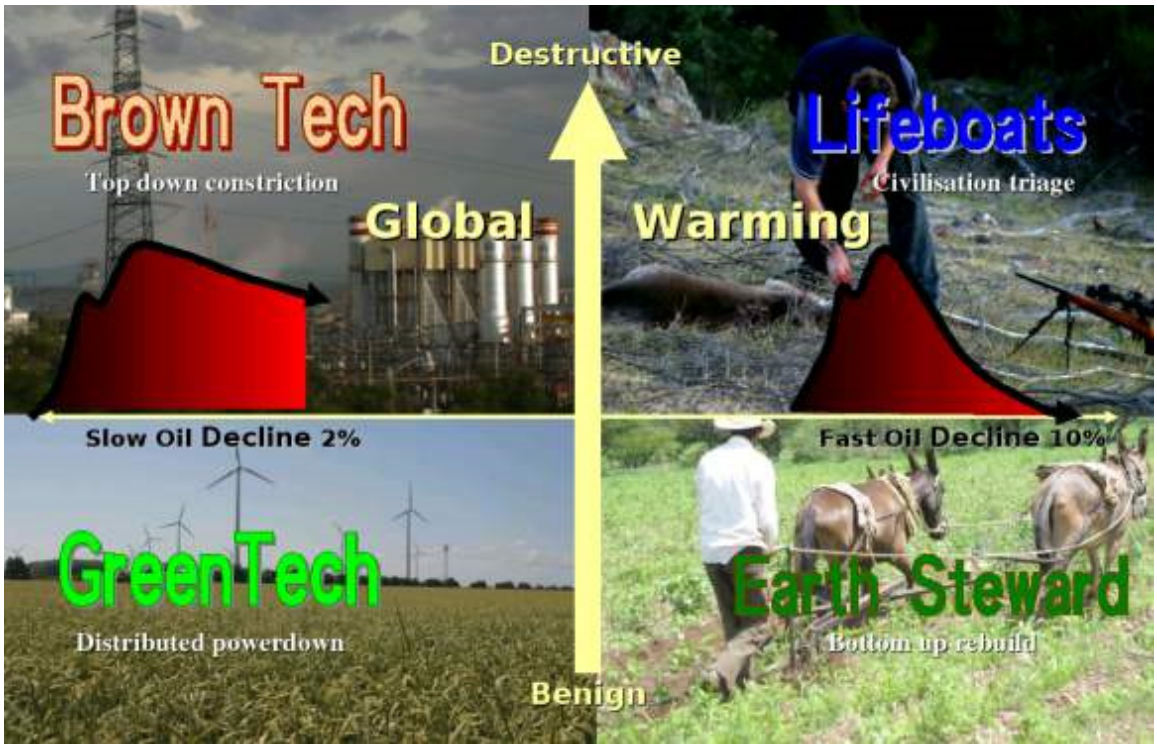
Next page: Four Energy Descent Scenarios

Last Updated (Friday, 30 May 2008)

The Four Energy Descent and Climate Scenarios

Four Energy Descent scenarios are considered, each emerging from a combination of either fast of slow oil decline and either mild or severe climate change over the next 10-30 years.

- Brown Tech: (slow oil decline, fast climate change)
- Green Tech: (slow oil decline, slow climate change)
- Earth Steward: (fast oil decline, slow climate change)
- Lifeboats: (fast oil decline , fast climate change)



The Four Global Climate Change & Energy Descent Scenarios

While the characterisation of the four scenarios is difficult and inevitably speculative, they do provide a framework for considering how Peak Oil and Climate Change could interact to reshape global and local energy resources, settlement patterns, economy and governance. They also provide some insight into what could be effective responses for aware activists to secure their own and family's future while contributing to society in a positive way. Those responses might include potentially effective policies that could be adopted by relevant forms of government that might be functional in each of these scenarios.[41]

Finally they clarify the relevance of permaculture principles in a world of energy descent and focus our attention on the strengths and weaknesses of various strategies in adapting to the differing scenarios.

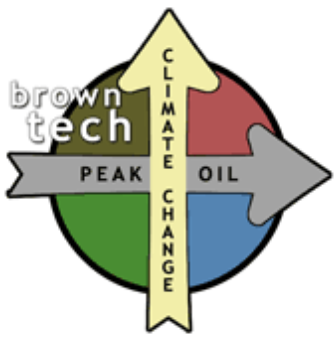
The next section considers the first scenario, Brown Tech.

Next page: 4.3.1 Brown Tech: Top Down Constriction

Last Updated (Thursday, 26 June 2008)

Brown Tech: Top Down Constriction

Slow energy decline rates, severe climate change symptoms



The *Brown Tech* world is one in which the production of oil declines after a peak 2005-2010 at about 2% per annum and the subsequent peak and decline of natural gas is also relatively gentle, but the severity of global warming symptoms is at the extreme end of current mainstream scientific predictions. In this scenario strong, even aggressive, national policies and actions prevail to address both the threats and the opportunities from energy peak and climatic change. The political system could be described as Corporatist or Fascist (which Mussolini described as a merger of state and corporate power).

See also the Brown Tech gallery.

The tendency in existing systems for massive centralised investment by corporations and governments, give priority to getting more energy out of lower grade non-renewable resources (eg. tar sands, coal and uranium) and biofuels from industrial agriculture and forestry. "Breakthrough" technologies provide the

constant promise of a better future but much of the investment in energy harvesting accelerates global warming, at least in the short term.

At the same time the cost of defending or replacing urban infrastructure threatened by storms and future sea level rise consumes more resources, while droughts and chaotic seasonal changes reduce food production from broadacre and small scale agriculture.

Flows of energy from more expensive sources such as tar sands, deep ocean oil, gas to liquids and coal to liquids slow the decline in fuels from crude oil. This transition requires a huge mobilisation of the technical and managerial capacity held mostly by global corporations, along with the financial, legal and military security that only sovereign governments can provide. This resource nationalism by government break down free trade and the faith in international markets that underpins the global economy.[42]

By 2007, we had already seen the shift from a buyers to a sellers market for energy cascading through all commodities markets and reshaping geopolitical relations.[43] The profits from both non-renewable resources and large scale industrial agriculture rise on the back of high commodity prices, reversing many of the economic patterns and trends of recent decades. The wealth of farmers and miners as well as corporations and nations in control of these resources increases even as depletion reduces the flows of resources and climate change causes chaos in farming and land management.

The demand for biofuels in affluent countries reduces world food stocks and raises prices to levels that result in famine and chaos in many poor countries unable to sustain subsidies for staple food.[44] In other countries, food riots by the poor force government to pay for escalating subsidies. The wealth left over for education, health etc. collapses. Wars to secure fuel and food increase and refocus public attention on external threats. In richer countries, consumer led economic growth falters or is actively shut down by government policies to focus limited resources on food, fuel and climate security. Some type of global economic depression unfolds from the combined effects of high energy and food prices, superpower contest, resource nationalism and the fragility of the financial system.

Rapid onset of climate change tends to support centralised nationalist systems for several reasons...

Rapid onset of climate change also tends to support centralised nationalist systems for several reasons. First the consequences of chaotic weather, food supply problems, radical land use change and abandonment of marginal land, leads to demands for strong government action to protect people from high food and fuel costs, natural disasters, the consequences of strong action by other nations, and mass migration by displaced people. Rates of urbanisation increase as climate change impacts and withdrawal of government supported services in more remote rural regions accelerates.

A decline of the middle class already evident in many western countries accelerates leading to discontent and suppression by government including internment camps either for migrants or homelesspeople.[45] Strong approaches to population control, even forced sterilization are introduced in some countries.

A series of short but intense international conflicts confirm major shifts in global power balances while accelerating resource depletion. Control of non-renewable fossil fuel and mineral resources remains critical, while the (relative) importance of distributed renewable wealth from agriculture and forestry continues to decline as the climate deteriorates especially in my home country of Australia where greater severity of droughts hit hard. With food supply under threat, fossil fuels and other resources are redirected from personal mobility and consumption to intensive factory farming in greenhouses and other controlled environments, mostly clustered around urban centres and managed by agribusiness corporations.

Desalination and other high energy ways to maintain water supply systems are built at huge

cost and further increase demand for energy. The threat of sea level rises leads to large scale urban redevelopment driven by strong government policies. Some very bold initiatives for energy efficient medium density urban development and public transport infrastructure are funded. A key characteristic of this scenario is the sense of divide between the reducing numbers of "haves" dependent on a job in the "system" and the relatively lawless, loose but perhaps communitarian "have nots" with their highly flexible and nomadic subcultures living from the wastes of the "system" and the wilds of nature. Security of the "haves" is a constant issue with gated communities, and apartheid style townships and barrios for the "have nots". While economic depression and reduction in consumption slow greenhouse gas emissions, the rapid expansion of strategic investment by government in new energy and urban infrastructure more than replaces the reduced private consumption, leading to a positive feedback loop that accelerates global warming.

While the elites continue to be driven by a commitment to super rationalist beliefs[46], a sense of hollowness and lack of purpose characterises the shrinking middle class, while fundamentalist religions and cults plays a stronger role in the lives of the working and unemployed classes partly through genuine reactions to the failures of modern humanism and partly manipulated by the elites to deflect anger and disenchantment. The Brown Tech scenario could be dominant and even more or less socially stable for many decades until ongoing climatic breakdown and reduced net energy return drive a shift to the Lifeboats scenario.

"*Top down constriction*" summaries the essence of this scenario in that national power constricts consumption and focuses resources to maintain the nation state, in the face of deteriorating climate and reduced energy and food supply.

Next page: 4.3.2 Green Tech: Distributed Powerdown

Last Updated (Monday, 16 June 2008)

Green Tech: Distributed Powerdown

Slow energy decline rates, mild climate change symptoms.

The *Green Tech* scenario is the most benign, in that adverse climate changes are at the low end of projections. Oil and gas production declines slowly as in the Brown Tech future, so the sense of chaos and crisis is more muted without major economic collapse or conflict. This allows resources to flow to a greater diversity of responses at the global, national, city, community and personal level. In some already densely populated poor countries, conditions worsen.

See also the Green Tech gallery.

However higher commodity prices allows some poorer producer economies to escape their debt cycle while programs to empower women result in rapid reduction in the birth rate. The gradual reduction in capacity of countries to project power globally due to rising energy costs, increases national security and redirection of resources away from defense and resource capture to resource conservation and technological innovation. The consolidation of the global communication systems maintains global outlooks and understandings if not global economics.

As in the *Brown Tech* scenario, electrification is a key element in the energy transition but the renewable energy sources of wind, biomass, solar, hydro, tidal, wave etc. grow rapidly developing a more diverse and distributed mix. The relatively benign climate allows a resurgence of rural and regional economies on the back of sustained and growing prices for all natural commodities including feedstocks for biofuels.

The principles behind organic agriculture and ecological management and resource allocation become the norm in many farming systems, helping to stabilise agriculture challenged by increasing cost of energy inputs and (albeit mild) climate change.

The accelerating conflict between biofuels and food is stabilised if not resolved by government subsidies to support food supply from agriculture, with biofuels coming mainly from forestry wastes. In many regions with prime agricultural land and small populations, wealthy farmers and agribusiness corporations are the main beneficiaries employing both high technology and cheap labour from migrant workers. In some regions, with poorer and steeper land and more diversified land ownership, smaller scale polyculture systems designed using permaculture principles spread wealth more evenly through local communities.

Continuous contraction affects large sections of the economy but the energy, resource and agriculture sectors along with recycling and retrofit industries experience rapid growth based on high commodity prices that are sustained despite economic recession in the main consuming economies. In some affluent countries, reform of monetary systems lowers the scale of financial collapses and refocuses capital on productive and socially useful innovation and investment.

Information technology continues to yield gains in energy and resource management; from real time pricing and self-healing electrical grids, to internet based ride sharing systems and telecommuting. Conservation yields the greatest gains with major public policies to change personal and organisational behaviour. In other countries, especially the USA, the apparent opportunities for continued economic growth, combine with political policies to support a low carbon economy, leading to a renewable energy investment bubble followed by a severe recession.

State and city governments[47] responsible for providing services are able to lead much of the restructuring to more compact cities and towns with increasing public transport infrastructure. Growth in large cities (especially in coastal lowlands) is reversed by public policies ahead of the worst effects of energy cost and global warming, while regional cities, towns and villages see modest growth on a compact urban model that preserves prime agricultural land and develops mixed use neighbourhoods with more local work and radically less commuting.

The placing together of many of the more optimistic aspects of energy descent may seem artificial, but there are reasons to believe that the Green Tech scenario will tend towards a more egalitarian structure with the relative shift of power from control of oil wells and mines to control of the productivity of nature via traditional land uses such as agriculture and forestry and more novel renewable technologies.

The inherently distributed nature of these resources will lead to more distributed economic and political power at the level of cities, their hinterlands and organisations focused at this scale. For example, successful large scale farmers who have reduced their dependence of energy intensive inputs through permaculture strategies and organic methods may find new profits in more localized markets with prices sustained by policies that encourage regional self reliance. Any profits beyond farming are likely to be invested into local energy systems that generate more employment and further reduce economic dependence on central governments and large corporations. It is possible that these same processes could lead to highly inequitable, even feudal systems. However the universal focus on more sustainable production and reduced consumption that is not forced by remote and arbitrary central power, has the tendency to foster more egalitarian responses than in the *Brown Tech* scenario.

The substantial reductions in greenhouse gas emissions that result from this scenario keep climate change impacts to a minimum, thus stabilising and reinforcing the scenario's basic characteristics for at least several decades.

The success in radically reducing consumption of resources while sustaining modest growth in some local economies combined with stabilization of the climate, encourages a new "sustainability" elite to consider further changes to consolidate these achievements in the face of ongoing net energy decline. The worse excesses of consumer capitalism are controlled by restriction and reforms of advertising and other dysfunctional forces.

Civic culture strengthens where further transition towards a non-materialistic society combines with the maturation of

feminism and environmentalism, and a resurgence in indigenous and traditional cultural values. These trends stabilise the accelerating loss of faith in secular humanism allowing the evolution of more spiritual "cultures of place". Over time an evolution toward the *Earth Steward* scenario seems an obvious and natural response to the inexorable decline of non-renewable resources. "Distributed Powerdown" summarises this scenario by emphasising both the distributed nature of resources and power, and the planned contraction involved.

At their extremes the *Green Tech* and *Brown Tech* scenarios also describe many of the elements that could be expected in the *Techno Stability* Long Term Scenario where new energy sources manage to replace fossil fuels without the stresses that lead to system wide contraction. The current levels of ecological, economic and socio-political stress are the indirect indicators that we are entering the energy descent scenarios rather than simply a transition from energetic growth to stability. Relative insulation from those stresses and the persistence of faith in the monetary accounting "house of cards" by the upper middle class (if not the global elites) continues the confusion.[48] The lack of understanding of net energy accounting and disagreement amongst the experts on appropriate methods, combined with political pressures from the unfolding crisis lead to energetic descent being mistaken for "business as usual".

Next page: 4.3.4 Earth Stewardship: Bottom Up Rebuild

Last Updated (Friday, 01 August 2008)

Earth Steward: Bottom Up Rebuild

Rapid energy decline rates, mild climate change symptoms

See also the Earth Steward gallery.

In this scenario the decline in oil production after a peak in total liquids production before 2010 is at the extreme end of authoritative predictions (about 10%)[49] and is followed by an even faster decline in gas production plus a simultaneous peak in coal production. The shock to the world's fragile financial systems is overwhelming, resulting in severe economic depression and perhaps some further short, sharp resource wars.

This economic collapse and these political stresses, more than the actual shortage of resources, prevents the development of more expensive and large scale non-renewable resources that characterise the *Brown Tech* scenario or the renewable resources and infrastructure of the *Green Tech*. International and national communications networks break down.

Electricity grids become non-functional as cost and availability of fuels and spare parts reduce production and lack of paying businesses and customers reduces revenues. International tensions remain but capacity of stronger countries to use military force is constrained by unreliable energy and parts supplies and the strong evidence that war uses more resources than it captures. Global warming is slowed dramatically and reversed by the collapse of the global consumer economy and absence of large scale investment in new energy infrastructure.

There is a radical reduction in mass mobility of both people and goods. The food supply chain is severely affected both on farms and through the distribution system. Energy intensive large scale farming supplying central marketing chains is the worst affected leading to abandonment of even highly productive land. Shortages lead to rationing, black markets, and riots for food and energy.

Increases in crime, malnutrition and disease lead to a rising death rate accelerated in some countries by epidemics and pandemics that have a major impact on social and economic capacity. The collapse in the tax base available to national and state governments reduces their power and even city level restructuring of infrastructure is difficult, but local government retains some degree of effective services, decision making and possibly democracy.

Collapse of larger businesses and the difficulties in maintaining urban infrastructure leads to a hollowing out of the cities. Loss of jobs and houses leads to migration of people out of

cities to smaller towns, villages and farms with more robust local economies able to take advantage of the influx of labour. Impacts and demands on local soil, water and forest resources increases, to severe levels in many poor countries as people move out of the cities to harvest fuel, wildlife and restart food production. In long affluent countries, the underuse of local biological resources in the late 20th century provides some buffer against these impacts.

> Large numbers of homeless exurbanites form a new underclass lacking even the skills of poverty.

Large numbers of homeless ex-urbanites form a new underclass lacking even the skills of poverty. They provide basic labour in exchange for food and accommodation on farms needing the labour. Surviving structures of power may adapt to impose a more feudal structure based on concentrated control of productive farms and forests and built assets in large farming estates.

Organic and small farmers, close to markets and able to make use of labour and animal power, thrive (to the extent security allows) in a context of relatively benign and slow climate change. An explosion of home businesses based on building and equipment retrofit, maintenance and salvage starts to build a diversified economy. Further afield biofuels from crop waste allow farmers to continue to use machinery while wood and charcoal gasification based on regrowth forest resources near settlements and towns provide an increasing proportion of limited transport fuel. This small business growth in turn provides a new tax base for some form of effective local government. In some places new bioregional governments institute land reform and debt cancellation following collapse of financial institutions and central banks, allowing people to stay on their properties.

Suburban landscapes around smaller cities and regional towns with greater social capital are transformed with a booming and relatively egalitarian society sustained by bio-intensive/permaculture farming and retrofitting and reuse supported by resources from both the immediate rural hinterland and inner urban salvage.

This ruralisation of suburban landscape to produce food on all available open space, private and public provides most of the fresh fruit and vegetables, dairy and small livestock products. Local currencies, food, car and fuel co-ops, community supported agriculture all grow rapidly. Informal and household economies provide an increasing proportion of basic needs as corporate and government systems fail to deliver.

Around the larger cities especially in countries where social capital and community capacity is severely eroded, most of these new developments are in gated communities providing the basic needs and security of their residents with trade outside the community being more difficult or dangerous. Outside the gated communities salvage, fuel harvesting and animal husbandry are the main economic activities with trade controlled by gangs and local warlords.

> While the impacts on people and local environments of this scenario are severe there is also a cultural and spiritual revolution as people are released from the rat race of addictive behaviours

While the impacts on people and local environments of this scenario are severe, in previously affluent countries at least, there is also a cultural and spiritual revolution as people are released from the rat race of addictive behaviours and begin to experience the gift of resurgent community and the simple abundance of nature to provide for basic needs.

The biggest difference from the *Green* and *Brown Tech* scenarios is that the rebuilding and stabilisation is no longer based on dreams of sustainability or restoring the old system. Instead people accept that each generation will have to face the challenges of further ongoing simplification and localisation of society as the fossil resource base continues to decline. This simplification in the material domain is seen as the opportunity for growth in the spiritual domain. There is a resurgence in

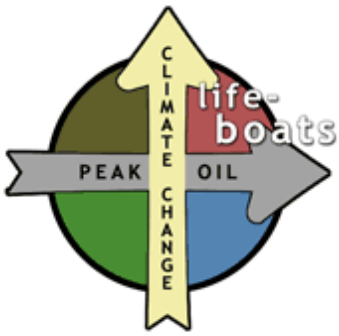
leadership by women and a celebration of the feminine in nature and people. "Bottom Up Rebuild" summarises this scenario by emphasising the new growth from biological and community foundations. In some ways this scenario might be considered as the archetypal one of the Energy Descent future and the one in which permaculture principles and strategies are most powerfully applied.

Next page: 4.3.4 Lifeboats: Civilization Triage

Last Updated (Friday, 01 August 2008)

Lifeboats: Civilization Triage

Rapid energy decline rates, severe climate change symptoms.



See also the Lifeboats gallery.

In this scenario, supplies of high quality fossil fuels decline rapidly, the economy fails and human contributions to global warming collapse but lag effects and positive feedbacks in the climate system continue to drive an acceleration of global warming. As of 2007, an increasing number of scientists believe it may already be too late to avoid catastrophic climate change.[50] In the *Lifeboat* scenario the adverse symptoms of the *Brown Tech* and *Earth Steward* scenarios combine to force a progressive collapse in most forms of economy and social organisation. Local wars, including use of nuclear weapons accelerate collapse in some areas but the failure of national systems of power prevent global warfare. Successive waves of famine and disease breakdown social and economic capacity on a larger scale than the Black Death in medieval Europe leading to a halving of global population in a few decades.

New forms of oasis agriculture that are low input versions of the *Brown Tech* intensive systems evolve that stabilise food production as chaotic seasons make traditional field agriculture and horticulture almost impossible. Forest and rangeland hunting and harvesting become the predominant use of resources over large regions supporting nomadic bands. Warrior and gang cults provides meaning in a world of grief and violence, leading to the development of new religions and even languages that attempt to make sense of people's lives.

Urban areas are largely abandoned and dangerous but remain valuable as quarries for salvaging materials especially metals. Suburban landscapes become ruralised into defensive hamlets making use of salvaged materials, urban storm water and surplus building space for mixed household economies.

The impacts are very patchy with worse effects in high density previously affluent and urbanised countries. In the most remote regions remnants of hunter-gatherer and pioneer farmer cultures are better able to weather the changes. The relative abundance and ongoing availability of high quality metals and other materials make a critical technological distinction from that of ancient traditional hunter gatherer cultures.

Mountain regions, especially with surviving glacier fed rivers allow hydroelectric systems to be maintained and rebuilt on a smaller scale. Nutrient rich glacier fed rivers also sustain intensive irrigated agriculture. In some localities, especially in favourable regions with accessible energy and agricultural resources, communities analogous to the monasteries of the early medieval period provide basic knowledge and skills to their surrounding communities and are thus protected by the locals from the ravages of local warlords and pirates. These communities, mostly in rural and suburban areas, and based on pre-collapse

efforts of intentional communities or rich benefactors, pursue the task of saving and condensing knowledge and cultural values for the long dark ages ahead.

"Civilisation triage"[51] refers to the processes by which remaining social capacity (beyond meeting immediate basic needs) are focused on conserving technology and culture that could be useful to a future society, once energy descent is stabilised after a precipitous but limited collapse process. This is not the dominant process of the scenario but the most significant in terms of future cultural capacity. The Christian monasteries that saved many of the elements of Greco-Roman culture and later provided the foundations for the Renaissance of Western civilisation is one historical example that could serve as a model for understanding how this process might work.

At its extreme, this scenario describes many of the elements of the *Collapse* Long Term future in which there is a complete breakdown in the lineage of industrial civilisation such that future simple societies retain nothing from what we created through industrial civilisation. Drawing a distinction between this scenario and total collapse may seem pedantic but the reasons are important. In the *Collapse* Long Term scenario, any future civilisation that could emerge only learns from the lessons of ours via archeology and perhaps long attenuated mythic stories. In the *Lifeboat* scenario the retention of cultural knowledge of the past combined with a moderately habitable environment allow new civilisations to emerge that build on at least some of the knowledge and lessons from ours.

> Three factors may prevent the continuous free fall to a very low global population of hunter gatherers

Three factors may prevent the continuous free fall to a very low global population of hunter gatherers surviving on the fringes of the Arctic of a hotter planet.

- The first is the wild card created by the mixing of the world's biota, most notable the large numbers of tree and other species that exhibit what foresters call "exotic vigour".[52] This allows new recombinant ecosystems to stabilize many environments that climate scientists are now saying will become uninhabitable in extreme climate change. The release of critical minerals, most notably phosphorus over the last 200 years into the biosphere may allow these new ecosystems to ultimately achieve biological productivity exceeding that possible from pre-existing systems.
- Secondly the flooding of large areas of coastal lowlands complete with complex reef structures from flooded cities and infrastructure may also create the conditions for highly productive shallow waters and estuaries. These types of ecosystem are some of the most biologically productive ecosystems on the planet.[53]
- Thirdly, the precipitous drop in human numbers and their initial tendency to remain relatively aggregated to make use of the huge resources from industrial salvage materials (and for security) should see very large regions able to recover without harvesting and other impacts from people.

If the knowledge of ecological processes and their creative manipulation using minimal resources are retained and developed in the *Lifeboat* communities, then survival and resurgence of a more than minimalist culture may allow global human population to be sustained at perhaps half, rather than one tenth, of current levels. More importantly it may be possible to embed the wisdom of the lessons learnt so that unconstrained human growth does not repeat such an intense cycle. Clearly these last thoughts are highly speculative but build from the same linage of permaculture thinking developed over the last thirty years that informs the rest of the scenarios.

Next page: 4.3.5 Summaries of the Four Climate/Energy Descent Scenarios

Last Updated (Friday, 01 August 2008)

Summary of the Four Climate/Energy Descent Scenarios

The following table summaries the main elements and characteristics of the four scenarios.

Scenario	Energy & Agriculture	Settlement form & mobility	Economy & Money	Politics	Gender	Culture & Spirituality
Brown Tech Top down constriction	Centalised power High tech efficiency Non convent. oil gas, coal, nuclear Bio shelter agric.	High density cities, Electric private transport. Hinterland abandonment Mass migration	National banks & currencies	Nationalist /fascist Class structure & rights Price rationing Pop control	Male dominated & blended	Super rationalist/ fundamentalist dichotomy
Green Tech Distributed powerdown	Distributed network Conservation, Gas, wind, solar, Forest, Organic agric	Compact towns & small cities, Electric public transport Telecommuting	Regional currencies & funds	City state & hinterland Markets/rationing Democracy?	Balanced & blended	Humanist/ Eco-rationalist
Earth Steward Bottom up rebuild	Distributed local hydro, methane Industrial salvage Forest, organic & garden agric,	Ruralisation of suburbia, Rural resettlement, minimal mobility	Local currency, barter	Town and bioregion Participatory democracy? Neo-feudalism	Female dominated & gendered	Earth spirituality
Lifeboats Civilisation triage	Distributed local Forest, rangeland, Industrial salvage Oasis agric.	Hamlet and gated communities, Nomads	Household & barter, precious metals	Feudal system Patriarchal authority	Male dominated & gendered	Warrior cult

Next page: 5. Reactions to the Energy Descent Scenarios

Last Updated (Wednesday, 13 August 2008)

Reactions to Energy Descent Scenarios

Global and Local Perspectives

The scenarios as described are biased towards looking at the future for the billion or so relatively affluent persons who mostly live in the long industrialised nations mostly of Europe and North America but including Japan, Australia and New Zealand. For many people outside these countries the promise of benefits from global industrial culture are just that; promises. The general history tells of local and self reliant economies and communities decaying or collapsing as they are displaced by monetary economies, media and consumer ideologies. This is a process often associated with migration from rural to urban areas. The debate about the balance of benefits and disadvantages from these changes has been intense for thirty years.[54]

Very few proponents or even critics of conventional economic development are yet considering energy descent scenarios, or the increased vulnerabilities to them which result from this loss of self reliance. Poor people crowded into barrios around super cities completely dependent on meagre cash flows to maintain access to food and fuel are less able to provide for themselves when these systems fail. Five months in Latin America has given me cause to think deeply about these vulnerabilities that are already unfolding in many places where, compared to wages, fuel prices are ten times more than what they are in Australia.

It is not just the ability to cope with deprivation but more the pyscho-social capacity to accept life as it happens On the other hand one cannot experience life in many poorer countries without also considering how recent the changes have been. In many places people still know how to grow food and some cases can return to their home villages as soon as economic conditions suggest this will be more rewarding (even if it is only to labour on a relative's farm) than hustling in the city for a dollar. Even when this is not possible, the sense of how resourceful and flexible people can be in what we might think extreme conditions, is a strength.

It is not just the ability to cope with deprivation but more the pyscho-social capacity to accept life as it happens without fixed expectation that lead to inevitable disappointment. While teaching a course in Mexico I was summarising the energy descent scenarios session with reference to the house fire insurance analogy, that it was not necessary to believe your house would burn down to have fire insurance. The mostly middle class Mexicans laughed at my analogy because most Mexican homeowners don't have fire insurance. It is this easy going acceptance of life that may be one of the characteristics that enables Mexicans to weather the storms that are surely coming.

> In Australia many generations of steady growing affluence and high expectations have created a psychological and social brittleness.

On the other hand, in Australia and other long affluent countries, many generations of steady growing affluence and high expectations have created a psychological and social brittleness that suggests we may not weather the storms as well as we should. As a teenager I came to the conclusion that Australia was vulnerable to the attractions of fascism if and when social and economic conditions became much tougher. This early insight provided a foundation for the *Brown Tech* scenario.

In some nations, economic collapse and sustained conflict over the last few decades have simulated some aspects of energy descent. Most of the evidence is not good, with breakdown of law and order, food insecurity, falling life expectancy and mass migration. Russia, Argentina, Cuba, Zimbabwe and North Korea are examples of relatively affluent and industrialised countries that have experienced sustained conditions analogous to those possible from more general and global energy descent. An increasing amount of research and analysis within the Peak Oil network has focused on these countries to gain greater understanding of the hazards and opportunities of energy descent futures.[55]Most notable is the Cuban experience that is remarkably positive and has provided a great boost to permaculture and other activists trying to show the opportunities from energy descent.

Cuba: Brown Tech, Green Tech or Earth Steward?

During the crisis of the "Special Period" in the early 1990's the power of strong central government did not weaken, let alone fail. In some ways the government lead by Fidel Castro represents many of the elements of the *Brown Tech* world. On the other hand Cuba is not a very large country and can be considered as one bioregion with Havana as its capital so the scale of governance is more akin to that proposed for the *Green Tech* scenario. Further, many of the strategies for coping with the crisis from urban agriculture[56] to bicycle and public transport are emblematic of the *Green Tech* scenario. Health and education statistics for Cuba also rule out the more severe conditions associated with *Earth Steward*, let alone *Lifeboat*. However while in Cuba in 2007 I became aware of some aspects of the crisis that did give insight into likely conditions in the more extreme scenarios.

During two trips in the countryside I observed extensive growth of Marabou (a spiny leguminous shrub) over large areas that appeared to have been farmland. The rapid spread occurred during the crisis and today cover about 20% of the farmland.[57] These species were previously common in the landscape mostly as a component of living fences and hedges. When the crisis hit, supplies of grains to feed the industrialised dairy industry collapsed and many of the dairy cows died in the dry season.

My hypothesis[58] is that prior to dying, the cows would have eaten the dry pastures to bare ground and the living fences to sticks. The seeds of the Marabou consumed by the cows pass through in manure so in the succeeding wet season a complete crop of thorn shrubs would have emerged and dominated the recovering pastures. Despite the desperate need for food, the absence of fuel to plow the land for crops or resow pastures, allowed the shrubs to take over the land. This example illustrates how valuable resources can lie idyll in the face of desperate need.

The process of recovering the land from the thicket forests is a slow one even with better economic conditions but it also has produced benefits that are slow to be recognised. Increased carbon sequestration has been substantial and plant diversity and wildlife is increasing as the shrub legumes mature. The soil rejuvenating characteristics of these spiny legume shrubs may be building an asset that will be more valuable to Cuba as global energy descent begins to impact. Two low energy

pathways to more productive and sustainable use of the land are possible. One is to use goats to reclaim the land back to pasture.[59] Alternatively, accelerated succession to mixed food forest by selective seeding and planting could create agroforestry systems that continue to increase the woody biomass and food production both from fruit and nuts.

It is significant that both of these changes would require further changes in Cuban eating habits. This is connected to another sobering impression in the otherwise quite positive picture, that Cubans remained reluctant to change their traditional food habits even during the crisis and mostly have gone back to those habits after the crisis. The fact that a diet with less meat and dairy and a greater diversity of tropical vegetables, fruits and nuts could be more easily and sustainably produced will require continued efforts on many fronts and/or a longer cycle of deprivation to shift the deeply entrenched European food culture heritage in this tropical country.

Perhaps more relevant to countries with less government controls over the economy, Argentina provides some interesting examples of revitalisation of local economies as central currencies and economies broke down, although most of these stopped once the monetary economy was re-established.[60]

One of the uncertainties that emerges from reflecting on these examples of economic contraction is how different the situation will be when the dominant economic powers experience these problems. While this will create some more general global conditions it will also dramatically reduce the capacity to project power through globalisation. Consequently we can expect conditions in local bioregions and nations to increasingly reflect the local resources, economy and culture, and be less driven by remote and global forces. As always this will precipitate new threats but also opportunities.

The next section considers how these scenarios can be both depressing and empowering, and can help us direct our energy towards positive change effectively.

Next page: 5.1 Depressing and Positive Scenarios

Last Updated (Wednesday, 13 August 2008)

Depressing and Positive Scenarios

Another reaction to the scenarios by some participants on courses is that the Brown Tech scenario seems a depressing but realistic assessment of the situation in many affluent countries while the Green Tech scenario looks more utopian and unrealistic, but one that could be almost be "sold" as a desirable future by Green parties of western democracies.[61]

The argument that the distributed power provided by resurgent rural economies will ameliorate the centralised and inequitable structures that lead to the *Brown Tech* world may be seen as a weak one, especially for people who are suspicious of the concept that fundamental energy and resources drive economic, social and political systems. Similarly the relative positive nature of *Earth Steward* compared with *Lifeboat* is partly predicated on the distributed rather than concentrated nature of resources and wealth (and of course the gift of a relatively benign climate).

> We can better shape our responses to each of the scenarios if we recognise the constraining forces that are beyond our control.

It is possible to see some good and bad potentials, depending in part on our philosophical bent, in all four scenarios. Perhaps as an act of faith in human values and maturity, I believe we can better shape our responses to each of the scenarios if as individuals and as communities and nations we recognise the constraining forces that are beyond our control. We can then consider how basic human values and needs can be sustained without wasting resources on projects or objectives that may have little chance of altering the fundamental dynamics of our world.

Of course this reaction can be seen as negative, defeatist or even contributing to the realisation of these undesirable scenarios. In the ad hoc internet community of Peak Oil activism that has sprung up the last few years, the divide between the "doomers" and the "optimists" has been a notable one. Since 2005 the worsening evidence on climate change has led to more of the experts in that field moving towards a "doomer" perspective on the climate front. Part of the process of moving

beyond this simplistic and mostly counterproductive debate, is to see some of the positive potentials that exist in energy descent scenarios.

> Permaculture activism has a long history of being informed by a negative view of the state of the world. But these perspectives drive an optimistic opportunity-based response.

Permaculture activism has a long history of being informed by a negative view of the state of the world. But these perspectives drive an optimistic opportunity-based response that can empower people to creative action and adaption in the face of adversity. The fact that permaculture activists privately and even publicly look forward to some aspects of these scenarios may be seen by some as naive or even immoral. On the other hand, an increasing number of people around the world find permaculture an empowering focus for ethical and practical action.

My recent experience from presenting the Energy Descent scenarios in Australia, New Zealand, Brazil, Cuba, Mexico and Argentina on permaculture courses as well as other gatherings of sustainability professionals, is that they can be very empowering, although I recognize the risk that they still pose, in triggering denial or depression and paralysis.

The next section considers how different regions look likely to tend towards different scenarios.

Next page: 5.2 Different Scenarios in Different Places

Last Updated (Wednesday, 13 August 2008)

Different Scenarios in Different Places

Australia and New Zealand provide examples of two very similar affluent countries in the South Pacific that may already be on very different trajectories and that reflect the dynamics of these scenarios. As the previous Prime Minister John Howard, proclaimed, Australia is one of the new energy superpowers. This claim is supported by the fact that Australia is the largest global exporter of coal, one of the largest exporters of gas with the seventh largest reserves, and has the largest reserves of uranium as well as many other minerals.

> Australia exhibits the essential conditions for the emergence of the *Brown Tech* scenario.

On the other hand climate change modelling suggests Australia is perhaps the most vulnerable of OECD countries, a vulnerability highlighted by the recent and continuing drought. These are the essential conditions for the emergence of *Brown Tech*. The "debate" about nuclear power initiated by the Australian government and the rush to build desalination plants and super-pipelines to address the water crisis are emblematic of this trend. The change of federal government to the Labor Party is likely to further concentrate power at the federal level and could lead to a more rapid abandonment of free market capitalism, further entrenching the *Brown Tech* scenario.[62]

> New Zealand looks like a strong candidate for *Green Tech*.

New Zealand on the other hand has very little in the way of minable energy and resources, but, relative to its population, has extremely rich biophysical resources to support agriculture, forestry and renewable energies. The local impacts of climate change are predicted to be much less severe, allowing New Zealand to take advantage of these distributed rural resources. This looks like a strong candidate for *Green Tech*.

Without going into a detailed analysis of the emerging trends in the Australian and New Zealand economies and politics, it is sufficient to say Australia and New Zealand have been diverging for some time. This suggests that these underlying differences between the energy and resource bases of these two countries may have been contributing to the emerging differences at the political and even the social levels.

The next section looks at how planning for these scenarios occurs at different scales.

Next page: 5.3 Stepped Energy Descent Pathways Linking the Scenarios

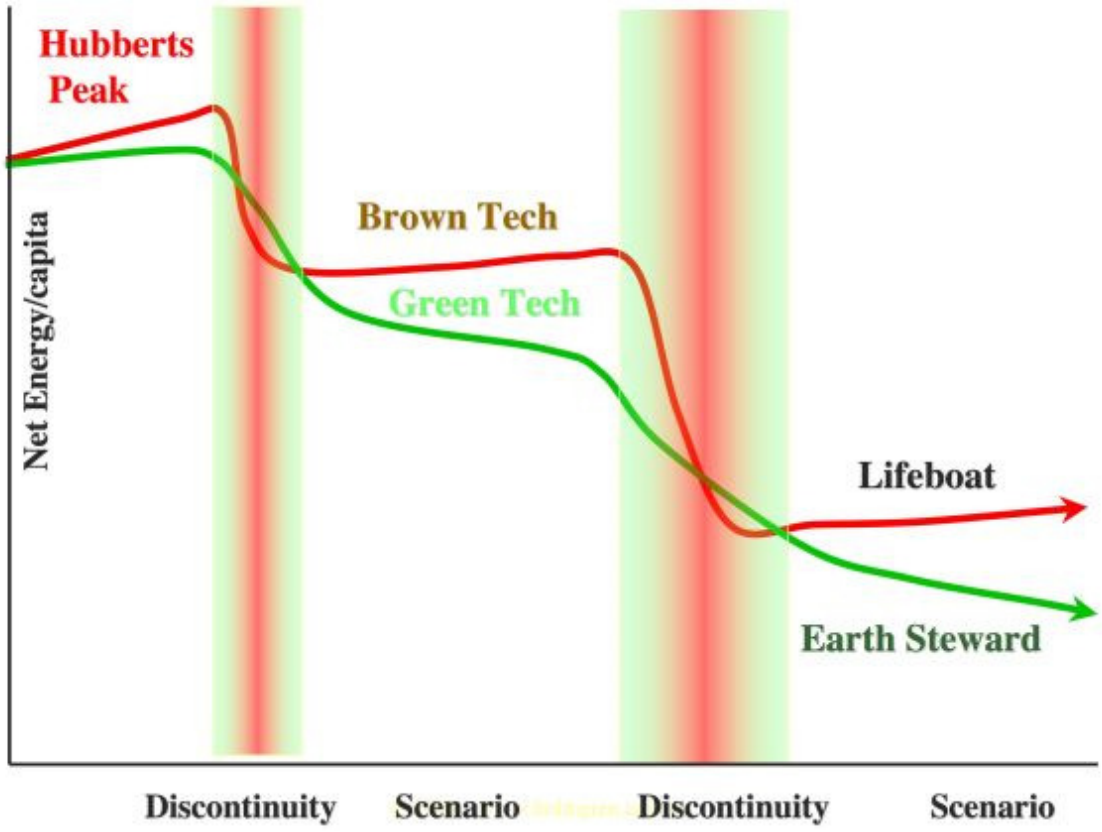
Last Updated (Wednesday, 13 August 2008)

Stepped Energy Descent Pathways Linking the Scenarios

As previously mentioned, energy descent may not be a continuous gradual process. Instead it could be characterised by an initial crisis that sets the conditions for a new order that is stable for some time before another crisis leads to further descent. The growth of energy and resultant technological complexity over the last two hundred years has involved varying rates of change, plateaus and even regressions during wars and depressions, but energy descent is likely to be much more variable than energy ascent. This is consistent with our common sense understanding that growth is a more consistent process than decline.

Natural ecosystems tend to maintain homeostasis under stress through the allocation of stored resources. If the conditions continue to deteriorate, then further stress can fracture the homeostasis. If the stress involves a reduction in energy availability, the system may collapse. But total collapse and system disintegration is rare, at least in the short term. More typically a re-stabilisation at a lower level of energy processing and organisational complexity occurs. The new homeostasis will typically be stable for some time before declining energy availability precipitates another crisis. This may also be a model for how human societies respond to the crisis of resource and energy decline. It also makes sense that natural disasters, or a crisis such as war, rarely continue for very long but they shape the new state that emerges in their aftermath. If crisis does persist at an intense level for years then psychosocial systems reorganise around the crisis as the new normality.

The following conceptual graph shows these two pathways from Hubbert's Peak of Oil (and net energy production). The discontinuities are periods of extreme crisis, conflict and/or breakdown. Each scenario represents a homeostasis that tends to be self-maintaining until further stress precipitates a further unravelling.



Energy Descent Pathways

The red pathway is more extreme after continued growth leads to a precipitous drop through natural disasters, economic depression and/or war. *Brown Tech* emerges as the new world order allowing recovery and modest growth before further natural disasters/climate change and oil depletion precipitate another discontinuity leading to a *Lifeboat* world. The green pathway is less extreme with a lower peak and a gentler decline through the first discontinuity to the *Green Tech* scenario while the descent to *Earth Steward* is even more continuous driven by on-going depletion and decay of infrastructure from the Hubbert's Peak and *Green Tech* worlds.

The chart also shows the relative levels of net energy availability per capita. This is much more speculative than the general concept of the stepwise descent or the relationships between the scenarios, because it depends on many variables. I've shown the *Brown Tech* and *Lifeboat* scenarios as processing more net energy per capita than the *Green Tech* and *Earth Steward* scenarios respectively. A range of factors contribute to this speculative maths, and hide some harsh realities. Depending on how net energy is understood and evaluated, a higher total energy base in *Brown Tech* may maintain greater organisational and technological complexity but *Green Tech* may be more energetically efficient at providing real human services.

A harsher discontinuity leading to *Brown Tech* may produce a higher death rate in the more urbanised populations while more severe controls on births may further reduce populations. The numbers of people the energy base needs to support strongly affects the per capita level so a higher per capita figure may reflect lower birth rates and/or higher death rates rather than a more energy rich society. Alternatively the lower death rate during the gentler discontinuity leading to *Green Tech* combined with a higher birth rate to tap the more distributed rural resources of the *Green Tech* world may result in overall higher populations. Although net energy per capita is lower, life may on average be better than in the *Brown Tech* scenario.

Similarly in the second discontinuity crisis, the death rate increases but more so in the red pathway to the *Lifeboat*. The lack of community capacity in the midst of massive material salvage opportunities, combine with the lower population, to deliver relatively high net energy per capita even though life is very harsh. The more abundant distributed renewable resources of the *Earth Steward* scenario leads to a higher birth rate (to tap those resources). Combined with the lower death rate, the higher overall population gives a very low net energy per capita. Efficient communitarian economies and a spiritual rather than material culture may make for higher wellbeing despite limited resources per person.

Next page: 5.4 Nested Scenarios

Last Updated (Wednesday, 13 August 2008)

Nested Scenarios

Yet another way to consider these scenarios is as all emerging simultaneously one nested within the other. The following figure shows the scenarios nested with their associated organisational and energetic scale. This suggests that the four organisational levels represented by the scenarios from the household to the national will all be transformed as global systems weaken and contract but none will fail completely. In a sense this is implicit in each scenario in any case and resolves the difficulty in imagining the *Earth Steward* and *Lifeboat* scenarios with a complete absence of city and national level power structures even if their functions and influence are very weak or attenuated away from the centres of power.

In explaining this on the afore mentioned course in Mexico, I suggested that in the *Earth Steward* and *Lifeboat* scenarios there could still be a government in Mexico city issuing edicts, but that no one, outside the much reduced city, would hear or take any notice. Like the reaction to my insurance example, my Mexican students laughed and suggested that no one took any notice of the government in Mexico now. This humorous response actually reflects an ongoing process of fragmentation in Mexico where autonomous movements in some regions and drug lords in others already rival the central and state governments in the provision of security, extraction of taxes and provision of services.

The other reason for considering that aspects of all scenarios will simultaneously emerge in all regions

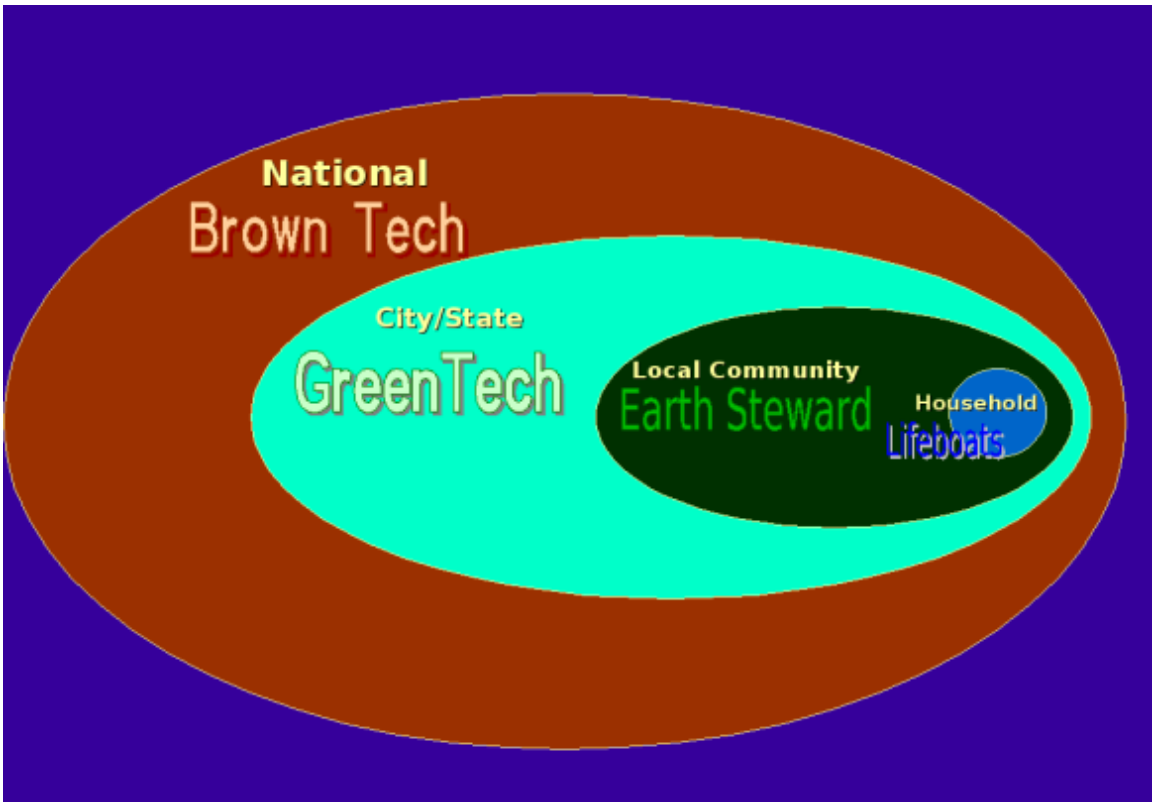
It is natural for national governments and large

is the structural commitment of each level of governance to systems that can work at their respective levels. It is natural for national governments and large corporations to implement the systems that characterise the *Brown Tech* scenario because these systems are commensurate with the organisational scale in which they work. Similarly it is natural for city and bioregional (state) governments to implement the somewhat more distributed, diverse and smaller scale systems of the *Green Tech* scenario. Middle sized business using regional resources and serving regional markets will naturally work to reinforce this scenario.

corporations to implement the systems that characterise the *Brown Tech* scenario

Following this logic we can see smaller forms of organisation (small business and local government) could manage many of the strategies applicable to the *Earth Steward* scenario while the household or closed community is the natural level of organisation to contemplate the *Lifeboat* scenario. This nested hierarchy of scenarios explains why any planning for *Lifeboats* is mostly a private activity of people who lack total faith in the stability of our economy and society. Similarly many community activists work towards strategies that level the playing field, develop communitarian cultures and would be potent in an *Earth Steward* world, just as earnest middle level managers and planners work towards the *Green Tech* world as the best progressive evolution from what we have. Many of the elite "movers and shakers", often from long established wealthy families in affluent countries, who move between the upper levels of corporations, governments and global governance organizations, believe the *Brown Tech* world is the hard reality that must be worked with (although this can hardly be acknowledged publicly).[63]

Any planning for *Lifeboats* is mostly a private activity of people who lack total faith in the stability of our economy and society



Energy Descent Scenarios nested by scale of related system

I think this is one of the most insightful and empowering ways to think about these scenarios because it helps us understand the apparent contradictions between different perspectives and motivations of different groups in society and even contradiction within our own thoughts and behaviours. For example, it is common for people to have private thoughts about the *Lifeboats* or perhaps *Earth Steward* futures, while most of people's public behaviour as workers and consumers reinforce *Brown Tech* or perhaps *Green Tech*. The private thoughts are often internally critiqued as anti-social or at least naïve, while the public actions are often internally critiqued as driven by powerful outside forces. This nested model can help us better

integrate these different aspects of ourselves.

The next section considers the assumptions of current mainstream sustainability efforts and their relevance within the four Energy Descent Scenarios.

Next page: 5.5 Relevance of Mainstream Sustainability to Energy Descent

Last Updated (Wednesday, 13 August 2008)

Relevance of Mainstream Sustainability to Energy Descent

Mainstream approaches to sustainability tend to assume stability if not expansion in the energy flows available to humanity even if there are major transitions in the nature of the energy sources. Consequently, continuity of many of the structures underpinning current social and economic systems is assumed.

For example, modern affluent urban life in a society dominated by service economies may be transformed by revolutions in efficiency but will remain the norm for future sustainable society. Further, it is widely assumed that food production and management of biological resources to provide for human needs will remain a minor part of future economies, and that geopolitical stability will allow globalised trade and other global governance regimes to become increasingly effective as instruments to establish sustainable systems.

These are not so different from the business as usual assumptions about constant growth, but they require not only herculean efforts to build a new energy infrastructure before energy becomes too expensive and unreliable, but also massively reducing our greenhouse gas emissions today, if not yesterday.

There is also the small problem of reforming the monetary system away from dependence on perpetual growth without inducing financial collapse. I say "small problem" with irony of course because growth in economic activity is essential to support the debt based currency which is the very foundation of our money and banking system stretching back to the beginnings of capitalism and its economic precursors.

For these reasons I feel the Techno Stability long-term future has even less prospects than the default future of Techno explosion. Maybe this also helps explain the deep resistance and antagonism in the centres of political and economic power to questioning of the logic of growth. Whether it comes from an ecological or sociological perspective questioning economic growth threatens the very basis of our economic system. The lip service to environmental sustainability – so long as it can maintain essential growth – reflects this understanding.

Consequently more idealistic notions of steady state green economics are automatically rejected as throwing the "baby out with the bathwater". While I have been as critical of the concept of continuous economic growth as most environmentalists and scientists, I also recognise that attempts to avoid the ecological precipice by reducing economic growth could bring down the whole system just as Gorbachev's Glasnost contributed to the unravelling of the Soviet system. The economic hard liners could be right. There is no way to stop the train of global industrial capitalism (other than by crashing).

Despite these doubts about the logic behind many mainstream approaches to sustainability, they have contributed greatly in spreading new environmental thinking. For example the Natural Step concept[64] aims to protect biophysical systems by creating closed loop industrial manufacturing through continual improvements in performance. It has been very influential in Scandinavia and has been adopted by some of the more progressive manufacturing corporations. Rapidly rising costs of energy and commodities will reinforce many of the Natural Step strategies but these will also increase the costs of adopting some of the more elaborate environmental technologies that have been used to ensure no contamination of natural or human environments.

Natural Step might work to some degree in the *Green Tech* world but would seem futile in the *Brown Tech*, technically and organisationally impractical in the *Earth Steward*, and meaningless in the *Lifeboat*. The vast majority of sustainability concepts and strategies to reduce ecological footprint and greenhouse gas emissions could be similarly analysed as having

uncertain relevance at best to energy descent scenarios.

> In general, fundamental principles will have more utility than specific strategies and technologies

The following table quantifies my view that mainstream approaches to sustainability have quite low relevance to energy descent scenarios. Low scores do not mean that these ideas will completely disappear but that they will tend to shift from their current status as the innovative cutting edge of the economy to reflecting a past era – rather than their objective of becoming the norm within a sustainable society. The table also shows that in general, fundamental principles will have more utility than specific strategies and technologies that are currently being applied as good examples of these concepts.

Relevance of Mainstream Sustainability to Energy Descent Scenarios

The next section considers the relevance of permaculture and environmental principles to an era of energy descent

Next page: 5.6 Examples of the Relevance of Principles

Last Updated (Wednesday, 13 August 2008)

Examples of the Relevance of Principles

Renewable Energy Sources

A good example of likely greater relevance of environmental principles when compared with specific strategies and technologies can be seen in relation to future energy sources. In fossil fuelled global industrial systems, energy supply has been generally concentrated in a few big powerful sources. A common principle in sustainability thinking is that a greater diversity of smaller and more distributed power sources will replace current fossil fuel, large hydro and nuclear sources.

The current roll out of wind power and to a lesser extent solar electric are technologies that illustrate this general principle and are widely recognised as central to the Techno Stability future. But energy descent may see growth in these particular energy sources slow or fail while older distributed sources such as wood and small scale hydro could grow rapidly. In a rapidly changing world appropriate design principles provide more guidance than specific strategies and technologies.

Biodiversity in Natural Resource Management

In the field of natural resource management the general principle of valuing biodiversity is likely to persist to some degree, at least in the *Green Tech* world, but the examples of vegetation management exclusively focused on local indigenous

species, which are common today, will seem very dated as reflecting a world of rising wealth and constant climate.[65]

Arguably, the principle of valuing biodiversity may even grow in strength as the current economic drivers favouring monoculture in agriculture and forestry weaken and are overtaken by viral forms of polyculture better able to use soil and water resources without inputs, and better able to serve mixed local markets. This process will allow the principle of valuing biodiversity to spread from the relative "cultural ghetto" of conservation management in affluent countries, to a more powerful expression of the permaculture version of the principle "Use and Value Diversity". This very change may be experienced by those wedded to the current dominant views within the field of Conservation Biology as heresy to be resisted.

> Energy descent demands that we consider more radical approaches to achieving environmental and social objectives.

This is just one example of how energy descent scenarios will challenge some cherished beliefs within the environmental movement, while making others natural and obvious. Energy descent demands that we consider more radical approaches to achieving environmental and social objectives.

Permaculture Design Principles

Permaculture as an environmental design concept with a long and evolving lineage of action around the world provides one such framework for developing new and reinforcing existing strategies that should be adaptive in energy descent scenarios.

In *Permaculture: Principles and Pathways Beyond Sustainability*, I explain the importance of design principles as the basis for generating new strategies and techniques in a world of change and uncertainty. The following table shows how permaculture, especially when it is understood through its design principles more so than currently applied strategies, has a closer fit with energy descent scenarios than many other sustainability concepts that have achieved more mainstream acceptance in affluent counties. While the numerical scores compared with those for "Mainstream Sustainability" can be taken with a grain of salt, the broad thrust is clear.

This table may reflect a claim of permaculture's central relevance to energy descent, but it also suggests an equal challenge to permaculture educators, activists and designers to more effectively use design principles to identify strategies, techniques and working models that are tuned to emerging rather than past conditions.

Relevance of Permaculture to Energy Descent Scenarios

The next page helps permaculturists and other social activists consider their roles in the various energy descent scenarios.

Next page: 5.7 Meta-scenarios of Permaculture

Last Updated (Wednesday, 13 August 2008)

Meta-scenarios of Permaculture

Each scenario presents quite different opportunities and challenges including ethical dilemmas for permaculture and related environmental and social activists. The analysis of the relevance of permaculture to the energy descent scenarios makes it possible to imagine meta-scenarios of how permaculture and related activism might influence society in ways different from today. Clearly these meta-scenarios are even more speculative than the energy descent scenarios, but provide a stimulus, especially for young people, to imagine oneself in the energy descent future.

I imagine that permaculture – by principle and model, if not in name – will become the dominant paradigm in the *Earth Steward* scenario. Those with a long track record of achievement will become the natural leaders within new emergent power structures, primarily at the local level, that will be more effective than higher levels of governance and organization. The ethical and design challenges will be those associated with leadership and power. Because "power"at this (and all levels) will be very weak, it will be more characterised by inspiration and wise council than the capacity to make binding decisions. Transparent and collaborative leadership that draws from the whole community and accepts slow evolutionary change and avoids the imposition of ideology is likely to be most effective in conserving resources and continuing to build a nature based culture.

I imagine that permaculture – by principle and model, if not in name – will become the dominant paradigm in the *Earth Steward* scenario.

In Lifeboats the focus of permaculturists is on provision of basic needs first and maintenance of seed and skills.

Permaculture is also highly relevant to survival in the *Lifeboat* scenario. The focus on provision of basic needs first and maintenance of seed and other genetic resources and skills to salvage and 'make do' will all be essential. Those with considerable knowledge, skills and ability to provide for others, as well as having good communication and organization skills in difficult conditions, are likely to become natural leaders of lifeboat households and communities. The ethical and design challenges are less those of broader and collaborative leadership and more those represented by having to decide who to let into the lifeboat without threatening the survival of those already on board. The ability to integrate and defend the group without sentimentality while providing for the community and maintaining knowledge critical to long-term cultural survival, is the task of those able to think beyond everyday survival.

In the *Green Tech* scenario "sustainability" has become the dominant paradigm of more localised city and bioregional governance structures. Permaculture and related concepts have high status and receive resources from government and businesses to help further develop local food production and community economies that can buffer against further energy and ecological crises. For the permaculture activist this is a more familiar condition where there is ongoing, even rapid growth in influence but where the dominant paradigm is still focused in the economic and technological domains rather than the ecological domain as the source of wealth and meaning.

In *Green Tech*, the dominant paradigm is still focused in the economic and technological domains rather than the ecological.

The primary ethical dilemma is that of comfortable co-option by the new sustainability elites, in the context of their heroic successes in avoiding the worst impacts of energy descent. Should permaculture activists quietly accept the status and resources that flow from these sustainability elites and focus on the slow change of society through practical works or should

they critique the new elite for not accepting that energy descent will precipitate further crises unless we localise and simplify our economies further? The ability to lead by example and provide clear and persuasive articulation of values and goals beyond the prevailing mainstream lead to progressively more influence as the ongoing realities of energy descent unfold.

In the *Brown Tech* scenario the challenges for permaculture activists are somewhat analogous to those working in some poorer countries today.

In the *Brown Tech* scenario, permaculture remains marginal to the mainstream, although it provides hope and some solutions for the increasing numbers of disenfranchised and alienated who reject, or are rejected, by the systems controlled by powerful central governments. The challenges for permaculture activists are somewhat analogous to those working in some poorer countries today; trying to assist the disadvantaged with simple technologies and solutions while avoiding threats from repressive central power.

Too much structure, organization and prominence could see such activism ruthlessly crushed as a threat to the system. Anarchistic and invisible modes of activism are likely to be more effective. Of course there are also those attempting to use ethical and design principles to reform the system from within (with all the attendant contradictions). Quiet and persistent collaboration between these two levels of activism could see a graceful descent to *Earth Stewardship* while failure could lead to the *Lifeboat* as the last option for the salvage of civilisation.

Next page: 6. Conclusion

Last Updated (Wednesday, 13 August 2008)

Conclusion

This exploration of energy descent scenarios has been an organic one which began with a didactic intention to highlight how large scale energetic and environmental factors shape history more than ideologies and the heroic actions of individuals. But my purpose was to empower those committed to ecological values and social justice to be effective in their quest to create the world we want, rather than just resist the world we don't want. Finally it has become about telling a story that can help bring that world to life, an apparent contradiction to the premise I began with. Although the primary lesson about the large scale forces that control the course of history may be true for the long periods of stability, during periods of ecological and cultural chaos, small groups of people have been instrumental in those transitions.

In nature, disturbance events (such as fire, flood or drought) or eruptive disturbances from within an ecosystem, such as insect plagues or fungal disease, are often understood as examples of system dysfunction. Alternatively they can be understood as either initiating another succession cycle that brings renewed life or a novel force that deflects the ecosystem in different directions determined by the chance arrival of new species or other factors. The ecosystems that emerge from these periods of disturbance can be quite different from those that preceded them and these changes can be characterised from a systems ecology perspective as either degradation of biophysical resources and productivity, and/or ones involving new evolutionary pathways. The lesson from nature is that evolution of life works in strange ways that cannot be fully predicted.

The historian William Irwin Thompson's[67] interpretation of creation of the world's "first university" by Pythagoras suggests similar processes at work when civilisation finds itself in a cultural dead end or design cul de sac. Pythagoras had been an initiate of the Egyptian mystery schools that were part of a decaying theocracy in the 6th century BC. Pythagoras and his followers secularised some of the hidden and arcane knowledge but his school in Calabria was burnt to the ground in some local political dispute. Pythagoras died a broken man but his followers, the Pythagoreans fled to Greece where they found fertile social conditions for their ideas and values. This was the beginning of the flowering of classical Grecian culture that we recognise as the origins of western civilisation. In a similar story Thompson describes how the penniless monks of Lindisfarne converted the British Isles to Christianity in the 6thcentury AD. They had no power but their spiritual message shaped to reflect the Celtic traditions, was transformative in a country in the aftermath of the collapse of the Roman empire and where no one any longer knew the function of Stonehenge. For a couple of generations a form of free anarchic

Christianity provided spiritual meaning, but the monastery was burnt to the ground by the Vikings.

Like Pythagoras and the monks of Lindisfarne we live in a world of collapsing culture where we have to choose what is worthwhile at this great turning point in history. We are faced with the mixed pieces of the myriad of broken traditional cultures of the world and the novel and shining bits of unravelling industrial modernity. All of this will end in the dustbin of history. Our task is to choose which pieces of these jigsaw puzzles will be useful in creating an energy descent culture, the boundaries, features and colours of which, we can scarcely imagine. What is worth saving? What are the limits of our capacity? We have little time to decide and act. We must commit to concrete actions and projects. We must stake our claim, not for ourselves but for the future. In committing to our task we should remember the stories of Pythagoras and the monks of Lindisfarne. It is not the project but the living process that will be the measure of our actions.

Let us act as if we are part of nature's striving for the next evolutionary way to creatively respond to the recurring cycles of energy ascent and descent that characterise human history and the more ancient history of Gaia, the living planet. Imagine that our descendants and our ancestors are watching us.

Last Updated (Friday, 01 August 2008)

Endnotes

1 *The Prize* by Daniel Yergin, 1991 is often quoted as the "definitive history" of oil and its role in shaping the 20th century. It certainly corrects ignorance on the importance of energy. With the perspective of almost two decades hindsight however, it is easier to see the author's bias in portraying the power plays of the West as protecting national interest while those of competing powers and ideologies as evil, greed and stupidity (see this review by Derrick Jensen).

Yergin's focus on the technology and politics of oil, while reinforcing the orthodoxy of the 80's and 90's that resource limits were not a concern, also laid the foundations for the currently widespread and dangerous view that current supply restriction are due to "above ground factors" rather than geological limits of Peak Oil.

For a recent and up to date overview of oil history from a left perspective see *Infinity's Rainbow: The Politics of Energy, Climate and Globalisation* by Michael P. Byron 2006. For a very humorous but informative introduction to the history of oil (including the Iraqi invasion and Peak Oil), see *A Short History of Oil* by Robert Newman (downloadable from Google Video).

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2 This faith derives from European Enlightenment thinking.

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3 In 1950 Sir Earnest Titterton, the chief advisor to the Australian government on nuclear power at the time, asserted that by 1980 nuclear power would be too cheap to bother metering the use.

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4 For example, cheap energy allowed energy dense plastic, aluminium, steel and concrete to replace wood in the building industry, thus depressing the demand and price for wood and value of forests. Similarly fossil fuel based fabrics reduced the demand for cotton and wool, depressing their price with flow on effects to all agricultural commodities. The Green Revolution increased grain production by increased use of energy dense fertilisers and pesticides. This in turn increased food surpluses and depressed prices.

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5 Since 2001 many of the positions of established players in the global economy including corporations, governments and multi-lateral institutions have constantly shifted. This could be interpreted as open and flexible response to new evidence, or more cynically, as defensive repositioning to protect established interests for as long as possible from public awareness of

the problems. This process in relation to climate change is now widely understood.

Ironically the evidence for the approximate timing of Peak Oil was around for decades before the evidence for Climate Change, so the potential misleading of the public (and the intelligentsia) by those with the best information about global oil production and reserves is greater.

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6 Some very influential authors such Joseph Tainter (*The Collapse of Complex Societies*, 1988) and Jared Diamond (*Collapse: How Societies Choose to Fail or Succeed*, 2005) use the term collapse to describe any ongoing reduction in complexity of the organization of civilisations. While their work is of great importance, I want to draw a distinction between what I mean by "Collapse" as the sudden failure and loss of most of the organisational complexity (such that succeeding generations retain little use or even memory of such systems) and "Descent" as a progressive if erratic process where the loss of complexity is gradual and succeeding generations have some awareness of, and knowledge from, that peak of complexity.

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7 From advice to governments that nuclear power would be too cheap to bother metering the use, to children's magazines promising holidays to Mars, the hubris about the *Techno-explosion* in the boom era of the 1950s and 60's was exceptional.

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8 By social capacity, I mean the informal processes of mutual support and conflict resolution that allow communities to provide education, welfare, insurance and other functions, with or without support from the formal structures of government. The level of volunteerism is one widely recognised measure of social capacity, but even this measure only captures the more formal end of social capacity which mostly works as a by-product of very ordinary interactions between citizens.

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9 EMergy accounting as developed by Howard T Odum provides a systematic and quantitative synthesis of how these forms of wealth combine, with more basic energy and resources, to drive human systems.

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10 See William R. Catton. *Overshoot: the ecological basis of revolutionary change*, 1980.

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11 Clearly by pinning the relevance of permaculture to an energy descent future, I may contribute to the current perception of its marginal relevance to a world of energy growth. But on balance I believe this transparency about our own assumptions and biases is a strength rather than a weakness. In this way we acknowledge ourselves as activists rather than simply observers.

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12 See article by John Michael Greer at the Energy Bulletin website http://www.energybulletin.net/20157.html

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13 See *Downshifting in Australia* (pdf), The Australia Institute 2003, suggesting that "down-shifters" moving to a lower consuming, more satisfying lifestyle, make up as much as 23% of the Australian population.

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14 The Transition Towns process in Britain, initiated by permaculture activist Rob Hopkins, is an excellent example of this

positive community response to the realities coming from Peak Oil and Climate Change. *The Transition Handbook: From oil dependency to local resilience* by Rob Hopkins 2008 is an invaluable resources for this positive change process.

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15 For example, Australian sociologist Ted Trainer's *The Simpler Way: Working For Transition from a Consumer Society to A Simpler More Cooperative, Just and Ecologically Sustainable Society,* and Swedish systems ecologist Folke Gunther.

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16 This apparent familiarity with permaculture can be misleading. For an in depth understanding see Holmgren, D. *Permaculture Principles and Pathways Beyond Sustainability* 2002. For an overview see The Essence of Permaculture at www.holmgren.com.au (Writings Page).

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17 The **2007 Living Planet Report** recently released by the World Wildlife Fund claims that the only truly sustainable country in the world is Cuba--Sustainable development being defined as a commitment to "improving the quality of human life while living within the carrying capacity of supporting ecosystems". The two key parameters employed by WWF for measuring sustainable development were the United Nations Development Program's (UNDP) **Human Development Index** (HDI) as the indicator of human wellbeing --calculated from life expectancy, literacy and education, and per capita GDP; and **Ecological Footprint** calculated at 1.8 global hectares per person to measure the demand on the biosphere.

Cuba was the ONLY country on earth to achieve both criteria for sustainable development.

In terms of ecological footprint, Australia rates as the 6th highest nation on earth. If everyone lived like the average Australian we'd need almost 4 planets to support the earth's current population.

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18 This theme about permaculture as a change process is one that runs right through *Permaculture: Principles and Pathways Beyond Sustainability.*

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19 See the review of recent evidence by Carbon Equity, *The Big Melt: Lessons from the Arctic summer of 2007* (pdf).

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20 See Richard Heinberg's Big Melt Meets Big Empty, 2007.

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21 See Colin Campbell & Jean Laherrere, *The End of Cheap Oil*, Scientific American 1998 (preview & pdf).

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22 In late 2007 the IEA Chief Economist Fatih Birol gave a presentation that marked a major turning point in the official position of the the IEA on future energy supplies. The presentation acknowledged peaking of oil production outside core OPEC countries and the likelihood that global demand will now grow faster than supply. See Oil Drum http://europe.theoildrum.com/node/3336#more

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23 See Chris Vernon, COAL - The Roundup, which looks at five studies released in 2007 suggesting that there is less coal than previously thought, and the Energy Watch Group report (pdf) 2007.

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24 By the International Energy Agency.

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25 See the Energy Watch Group's Oil Report, 2007.

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26 Australia is one of the few long-affluent countries that might continue to "prosper" based on nonrenewable resource extraction. These longer term prospects do not detract from the potential of a short term crisis, due to Australia losing 20-30% of its oil imports by 2012 from collapsing production and rapidly rising consumption in its main sources of supply in South East Asia. See Australia and the Export Land Model, by Aeldric on The Oil Drum, 2008.

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27 See Universal Mining Machines by Ugo Bardi on The Oil Drum, 2008.

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28 EROEI (Energy Return On Energy Invested) is a measure of the degree to which any energy source (those with a EROEI above one) can sustain the rest of society outside the energy-harvesting sector and so lead to the creation of real wealth.

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29 See Emergy Systems for a current explanations of these methods.

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30 See Paul Chefurka, World Energy to 2050, The Oil Drum: Canada, November 2007. See original article at Paul Chefurka's website, http://www.paulchefurka.ca/WEAP2/WEAP2.html

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31 See Howard T Odum, *Environmental Accounting*, Wiley 1996.

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32 By Jon Friese, published on the Oil Drum website http://www.theoildrum.com/node/3673#more

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33 See article Peak Phosphorus on Energy Bulletin http://www.energybulletin.net/33164.html

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34 http://www.richardheinberg.com/books

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35 See for examples Hamilton, C Growth Fetish

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36 Daniel Quinn gives the analogy of the loss of 200 species a day being equivalent to people who live in a tall brick building and every day knock 200 bricks out of the lower floor walls to continuously build new stories on the top. See *What A Way To Go: Life at the End of Empire* DVD 2007, a hard hitting but inspiring overview of climate change, peak oil, population overshoot and species extinction, their cultural origins and what sane responses remain open to us at this late stage.

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37 The well credentialed Hirsch Report to the US government made these assessments assuming a collective societal effort similar to that mobilised in WWII. http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf

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38 E.g. Lester Brown World Watch Institute

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39 See *The Transition Handbook: From oil dependency to local resilience* given more of the rationale and methods for stimulating this change

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40 The key finding is that energy inequities between countries will increase

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41 It may be unrealistic to expect any open acknowledgement by governments and institutions of the severity of the challenges posed by these scenarios without major crisis that breaks the paradigm of continuous economic growth.

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42 The failure of global trade negotiations at Cancun Mexico in 2003 to lock in global trade agreements can now be seen as the last desperate effort to maintain the fruits of globalisation for the corporations before the onset of resource nationalism.

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43 For example, Russia has being using the tight supply of gas and oil to enforce world prices on eastern European countries and in the process giving warning to western European countries about their vulnerabilities and dependence. Turning off the gas for even short periods has acted as a powerful enforcer. Similar actions by Argentina in cutting flows through new pipelines to Chile in response to shortages at home may force Chile to negotiate supplies from its old enemy Bolivia.

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44 An increasing amount of evidence suggests the explosion in biofuel production is a major factor driving grain prices higher and reducing world grain stocks. See for example work of Lester Brown at the World Watch Institute Washington USA.

Also modelling by Stewart Staniford (Fermenting The Food Supply on The Oil Drum website http://www.theoildrum.com/node/2431), suggests that steeply rising oil prices can accelerate demand for biofuels to consume unlimited proportions of world grain production within 7 years leading to global famine on a massive scale. Without regulation by government, free and global markets will see motorists in rich countries outbid the global poor for food.

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45 The very large but unused detention facilities built for the US government by the Halliburton corporation in several states of the USA raises questions about their likely use. http://www.prisonplanet.com/articles/february2006/010206detentioncamps.htm

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46 Super rationalism in this context recognises the energetic/ecological basis of human systems without any recognition of higher values or consciousness typified by spiritual and ethical frameworks that constrain the exercise of power.

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47 In Australia where a single large city dominates in each state, state governments may be thought of as a bioregional government controlling a city and its economic hinterland.

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48 For example increases in medical intervention, legal litigation and even crime and accidents all contribute to GDP.

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49 An increasing number of peak oil experts are suggesting the current peak of crude production in May 2005 may mark the beginning of a plateau that will end about 2010 in an accelerating decline

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50 See a review of the latest evidence of acceleration in climate change well beyond any previously credited predictions see The Big Melt:Lessons from the Arctic Summer of 2007 http://www.carbonequity.info/PDFs/Arctic.pdf

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51 Triage is a process for managing the medical care of the injured during war or natural disasters where not all victims can be saved with the available resources. Those that have a chance of survival are the focus of most attention while the others are given palliative care to ease their pain.

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52 Plants that grow better in foreign environments than in their original environment. Usually called invasive species by conservationists. See "Weeds or Wild Nature " at Holmgren Design Services website

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53 In the 1960's a massive earthquake around Valdivia in southern Chile created huge new wetlands following subsidence of the land. These wetlands had very high biological productivity based on an exotic aquatic plant that supported huge new populations of swans. The wetlands were recognised as being of global conservation significance under the RAMSAR convention. More recently pollution from a local cellulose plant has lead to a collapse in the population of swans.

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54 Helana Norbert-Hodge and Vandana Shiva are perhaps the most articulate critics of how these globalisation processes have adversely affected traditional communities in Ladakh and India respectively.

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55 In *Powerdown* (2004) Richard Heinberg provides an overview of some of the lessons from Cuba, Zimababwe and North Korea. Dmitry Orlov has used his experience and study of the collapse of the Soviet Union as a model to understand the likely effects of Peak Oil on the USA. See Closing the Collapse Gap: the USSR was better prepared for collapse than the US on Energy Bulletin http://www.energybulletin.net/23259.html

The Power of Community: How Cuba Survived Peak Oil a film by The Community Solution has popularised the positive aspects of the Cuban case study. See website http://www.powerofcommunity.org/cm/

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56 For detailed documentation of the development of Urban Agriculture in Cuba see *Agriculture In the City: A Key to Sustainability in Havana Cuba* by M.C. Cruz and R.S. Medina, Ian Randle Publisher 2003 translated from the original Spanish edition 2001

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57 Personal communication, Roberto Perez, Cuban permaculturist featured in the documentary film The Power of Community .

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58 I was not able to confirm this while in Cuba.

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59 A shift to greater use of goats and less use of cattle would make Cuban agriculture more productive and sustainable

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60 Permaculture course participant discussion at Gaia Ecovillage and personal communication Pam Morgan, research in progress.

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61 The projection of energy descent as an opportunity for economic and community renewal at the local level is illustrated by the rapidly growing Transition Towns movement in Britain, inititated by permaculture teacher Rob Hopkins see Transition Culture website and new book *Transition Handbook*.

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62 Clearly this is only likely if there also remains enough of a global economy to buy Australia's mineral and fossil fuel wealth (and to generate the greenhouse gas emissions that are fundamental to the *Brown Tech* scenario).

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63 Some of the documents and statement from some of the American neo-conservatives are almost open in acknowleging this future.

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64 See Wikipedia for summary and links
http://en.wikipedia.org/wiki/The_Natural_Step

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65 Rising energy costs will see less resources available for conservation projects that are not also productive of food, fodder and/or fuel. Changing climate will involve migration of plant and animal species on a scale that will overwhelm efforts to maintain and reinstate locally indigenous ecologies.

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66 See *Do We Need Principles* in David Holmgren Collected Writings 2nd edition (eBook)

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67 See http://en.wikipedia.org/wiki/William_Irwin_Thompson

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