Sprott Asset Management

Investment Implications of an Abrupt Climate Change

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EXECUTIVE SUMMARY

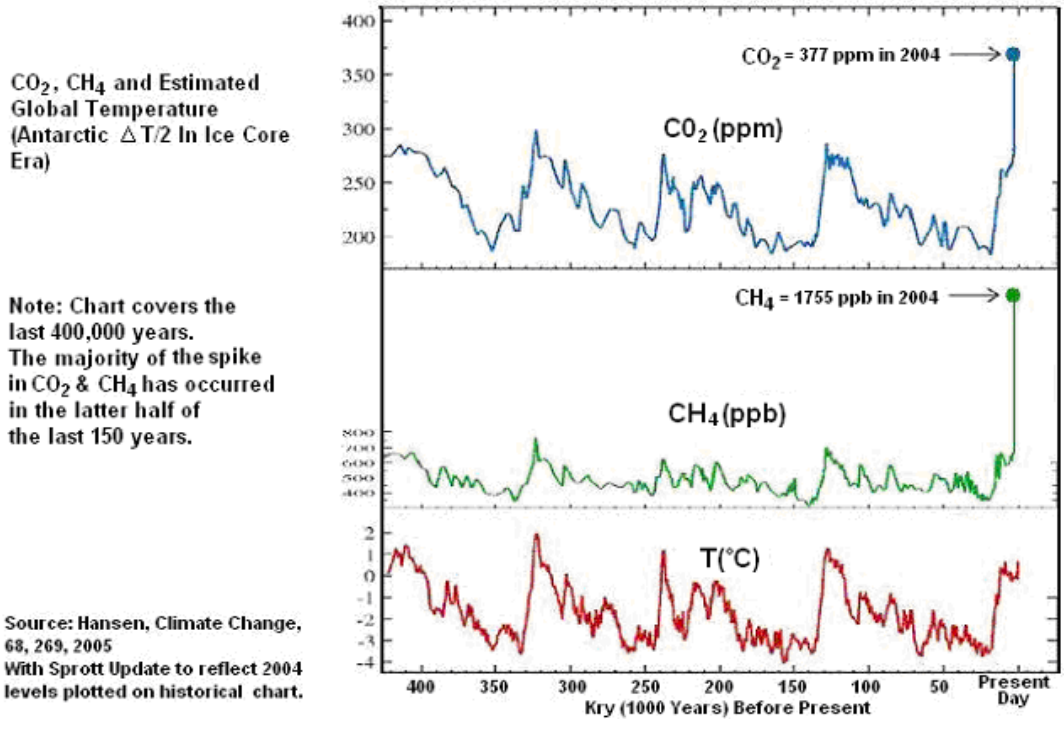
It appears that the debate on global warming is about to come to an abrupt end. One can even say that, among the scientific community, it has already ended. Extreme weather events and continued melting of the polar ice caps in 2005 have exemplified the implications of global warming. The concern has now shifted to focusing on the rate of change and its broad implications for all life on the planet.

The atmospheric conditions of the last 400,000 years have been clearly established by analyzing ice cores from Antarctica. The chart below makes it shockingly clear that we have caused greenhouse gases to spike in an unnatural manner the likes of which the planet has never seen before. Human activity has caused both CO_2 (Carbon Dioxide) and CH_4 (Methane Gas) levels to exceed the upper end of the range for the last 400,000 years. We are now in uncharted territory and may well be on the cusp of experiencing a warming of the planet at a rate well beyond what can be predicted using our limited knowledge of history.

There have been times in the past when an abrupt change in the planet's climate has occurred. We have had eight such episodes in the past 730,000 years. We have also had a few abrupt changes confined to specific regions of the earth over the past 11,000 years. Such episodic convulsions in the earth's climate are entirely natural. However, we are now setting ourselves up for a catastrophic event for which Man is solely responsible.

Rising levels of greenhouse gases are intervening dangerously with natural conditions and, in the process, have been gradually warming our planet. The effects have begun to accelerate and sudden shifts in climate patterns may now be in the offing.

Figure 1: Intricate link between greenhouse gases concentration and temperature established



Source: NOAA, James Hansen, (Sprott Asset Management update)

Man-made emissions are only a fraction of the total emissions of greenhouse gases. Yet, the increase in carbon dioxide in the atmosphere has happened only after the onset of the industrial age. The proportion of carbon dioxide (CO_2) in the atmosphere is now the highest it has been in over a million years. A rise in the atmospheric proportion of carbon dioxide is closely proceeded by an increase in surface temperature.

Some climate scientists assert that we are already committed to the effects of increased greenhouse gases. They believe the earth's temperature will rise further even if we cease emissions now. The chain of events that rising temperature unleashes may mean a rise in sea levels of almost 20 feet is already a foregone conclusion. Alarmingly, greenhouse gas emissions show no signs of a slowdown. The task of instituting a cut in emissions is especially daunting considering that energy demand, the principal cause of global warming, is rising. Developing economies such as India, China and Brazil are growing at a rapid pace. People in these economies are aspiring for a higher standard of living. Their per capita use of electricity and motor vehicles is a small fraction of that in developed countries. If such aspirations lead to increased use of fossil fuels, emissions can only rise. Land use change is also contributing to greenhouse gas emissions as forests give way to farming or buildings.

As emissions rise, the trend of rising surface temperatures will continue unhindered. The ice caps on the extreme edges of Earth, however, do not appreciate the increased warmth. The edges are retreating and the process of conversion of ice to water is ongoing as we speak. Melting ice leads to rising sea levels, reduced ocean salinity, and feedback loops – in effect compounding the warming process.

A rise in sea levels will inundate coastal communities imposing severe economic costs, particularly on developing countries. Reduced ocean salinity is not conducive to transportation of warmer winds inland. This could impede global ocean currents leading to severely cold climate in certain regions. Europe in particular will become colder.

The conditions are also ripe for the formation of powerful hurricanes. Unlike polar ice caps, seawater absorbs the sun's warmth. Rising ocean temperatures are the perfect feedstock for hurricane intensification. Intense hurricanes dump unmanageable quantities of water in certain regions while creating precipitation shortfalls in others.

Harsher summers and intense winters are in the offing and they generally cause agriculture yields to drop sharply. Rising sea levels that intrude into coastal aquifers and lead to hotter summers also sap water resources. Mankind is staring starkly at the possibility of a severe crisis in water and food supply. Potentially tens of thousands of species of flora and fauna are at risk in many ecosystems.

The world is warming and it is because of fossil fuel emissions. Emissions can only be curbed by the large-scale replacement of both transportation and power generation infrastructure. Nuclear energy is the best possible alternative. Advanced technology will continue to make nuclear energy cleaner, cheaper and safer.

Solar, wind and hydro power all suffer from many limitations. They are not yet suitable as base load replacement for coal-based plants. Nuclear energy emerges as the only real alternative under the circumstances. Opposition to nuclear energy is waning. Many forward thinking environmentalists are now endorsing nuclear power. Coal will still be required to play a large roll in the global energy picture but new technologies must be advanced and implemented to sequester CO_2 and reduce overall emissions.

In terms of transportation fuels, we may yet be several decades away from a viable and cheaper environmentally friendly mode of transportation. We may be left with no option but to chip away at the margins. Increased fuel efficiency, introduction of hybrid vehicles and promotion of public transport will remain the main thrust. Biofuels to blend with petroleum products will also gain ground. Their impact will however be limited because their overall

energy efficiency is rather poor, their total production capacity is limited and their emission profile is not significantly different from fossil fuels.

Climate change is an event that would put nations and communities at loggerheads, accentuating the divisions that already exist within us. It would also put government finances under strain the world over. Central bank funded deficit spending on commodity intensive infrastructure projects may combine with a litany of supply disruptions to push us into a hyperinflationary environment. Real returns from traditional asset classes will likely be difficult to achieve but there will also be many unique opportunities for outsized gains in areas such as, emission reducing technologies, the nuclear/uranium sector, synthetic fuels and soft commodities, to name just a few.

It is possible that some of the more extreme consequences of global warming remain preventable and we expect many steps will be taken to combat the forces at work. Global warming thus emerges as both a threat and an investment opportunity. The time to debate has ended. Governments, businesses and the general public are just now waking up to the seriousness of global warming as we witness its consequences unfolding around the planet. The reality is that we are courting with much more than just economic disaster.

INTRODUCTION

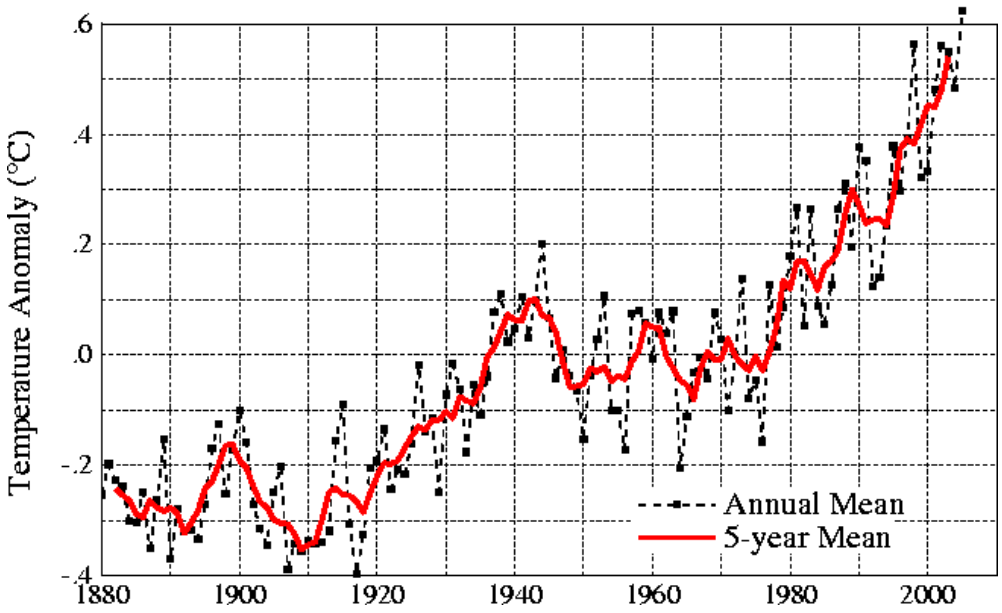
Global Warming – The heat is on…

It appears that the debate on global warming is about to come to an abrupt end. One can even say that, among the scientific community, it has already ended. Extreme weather events and continued melting of the polar ice caps in 2005 have exemplified the implications of global warming. The concern has now shifted to focusing on the rate of change and its broad implications for all life on the planet.

The decade to 2005 is the warmest in history

The rate of warming has accelerated in recent times. The annual average mean global surface temperature for January through December in 2005 was higher than the average for those months in 1998, which was the previous record-breaking warmest year. After 2005 and 1998, the next warmest years are 2002, 2003 and 2004 respectively. The decade to 2005 is the warmest decade on record[1]. Over the past three decades, there has been an increase of 0.5 degree Celsius in the global mean temperature[2].

Figure 2: Changes in global surface temperature over the years



Source: Goddard Institute of Space Sciences, NASA

A report of the Intergovernmental Panel on Climate Change (IPCC) attributes global warming to rising concentrations of greenhouse gases in the atmosphere. The increasing proportion of greenhouse gases such as CO_2 enhances the greenhouse effect leading to a rise in global temperatures.

Carbon dioxide concentration is now the highest in over a million years

The greenhouse effect refers to absorption of heat by certain gases and transfer of some of that heat back to earth. Natural greenhouse effect keeps the earth warm and habitable. Greenhouse effect enhanced by human activity keeps the Earth warmer than usual.

Warmer climate can lead to melting glaciers, which in turn would cause a rise in sea levels and also abrupt climate change. Warmer seas, which in turn would produce powerful hurricanes in one region and severe drought in other regions, are also likely.

[1] Source: Goddard Institute of Space Sciences, NASA
[2] Source: Hadley Centre for Climate Prediction and Research

The effects of global warming may already be playing out. A record 26 tropical storms and hurricanes formed in the Atlantic Ocean in 2005. Human activity is not pausing to take note. We continue to dump more CO_2 into the atmosphere than ever before. Atmospheric concentrations of CO_2, the principal cause of global warming, is now over 380 parts per million. This is a full 100 parts over the level during the pre-industrial era and possibly the highest in over a million years[3].

Rapid Climatic Changes – Implications are far reaching

Rising sea surface temperatures cause hurricanes and droughts

In recent times, we may have failed to take note of the gradual increase in global warming. Nature however has not – or so it would seem if the gloomy weather forecasts are any indication. The Atlantic hurricane season in 2006 threatens to be as active as that of 2005[4].

The same warm sea surface temperatures, which can cause havoc by spawning hurricanes, may also cause droughts. Abnormal sea surface temperatures weaken wind flow, which in turn reduces precipitation in that region[5]. High temperatures and low rainfall due to reduced precipitation could create a drought that is as crippling as the Dust Bowl event that struck the Great Plains between 1931-1939. Activity in the Polar Regions appears more alarming. There has been a significant increase in the number of glacial earthquakes. In a single area of North Western Greenland, more than 24 quakes have been recorded between 2000 and 2005 compared to just one quake recorded between 1993 and 1999. The annual number of glacial earthquakes recorded in Greenland between 1993 and 2002 was between 6 and 15. However, in 2003 alone, seismologists recorded 20 glacial earthquakes. In 2004 they monitored 24 and for the first 10 months of 2005 they recorded 32[6].

Melting glaciers and rising sea levels could trigger abrupt changes

Movement of large blocks of ice causes glacial quakes and is a likely consequence of the melting caused by the higher rate of global warming. Indeed, the rate-of-slide in Greenland ice sheets consequent to increased warming may have doubled and the eventual rise in sea levels may be as much as 20 feet[7]. Coastal regions such as Bangladesh and Florida would be under water. A number of islands such as Maldives and Tuvalu would exist only under the ocean.

Effects of Arctic warming are also more visible. Argentina found two icebergs migrating to its coast. These icebergs broke off from the melting Antarctic ice cap in March 2006. Local scientists have attributed the development to higher temperatures. It is these melting ice sheets and rising sea levels that could set in motion a series of events leading to rapid changes in weather conditions. As a consequence, abrupt climate change is now a probable event[8].

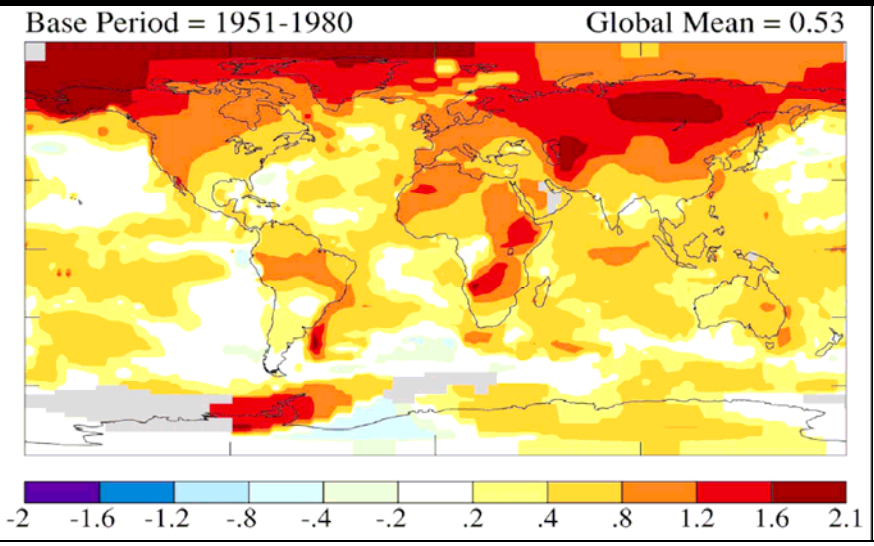
"Earth may be nearing a point of no return"

James Hansen, a director at the Goddard Institute of Space Sciences, who was introduced in the "60 Minutes" program of CBS as the world's leading researcher on global warming, stated that if we look at the average surface temperature anomaly for the past five years, and compare it to the 1951-1980 mean, we can see the warming trend occurring almost everywhere. Warming occurs over the ocean as well as land, and the largest warming is in

[3]Source: BBC report dated March 14, 2006 quoting the UK Chief Scientific Adviser
[4]Source: March 2006 report of Climate Research & Forecasting Teams, Weather 2000
[5] Source: Morris Daily Herald report dated February 27, 2006 quoting Elliot Abrams, Chief Meteorologist, AccuWeather.com
[6] Source: report in the UK-based Independent dated March 24, 2006 quotes a study published in Science journal
[7] Source: Time magazine report dated March 23, 2006 quotes a study published in Science journal
[8] Source: The Australian Greenhouse Office defines abrupt climate change as follows: "when the climate system is forced to cross some threshold, triggering a transition to a new state at a rate determined by the climate system itself and faster than the cause". That is, even continued slow changes can push things beyond a tipping point.

remote regions. "This is a real global warming, not an artifact of thermometers being located close to urban centers." Hansen further adds, "*Earth's climate is nearing but has not passed a point of no return beyond which it will be impossible to avoid climate change with far ranging undesirable consequences...".* Hansen makes it clear that we must make changes now to dramatically reduce emissions and prevent CO_2 from rising to irreversible levels over the next few decades.

Figure 3: 2001-2005 Mean Surface Temperature Anomaly (Degrees Celsius)



Sources: James Hansen, Goddard Institute of Space Sciences, NOAA

Global Warming – Trends in the 20th Century

Link between human activity and climate change established as fact

The Intergovernmental Panel on Climate Change (IPCC) was established in 1998 with the task of assessing the scientific basis of climate change. IPCC asserted in its third assessment report published in 2001 that Earth's climate system has demonstrably changed on both regional and global scales since the pre-industrial era, with some of these changes attributable to human activities.

Figure 4: 20th Century changes in Earth's climate system

Weather Indicators	Scenario
Global mean surface temperature	Increased by between 0.4-0.8 degrees Celsius; Land areas warmed more than ocean
Northern Hemisphere surface temperature	Increase over the 20th century greater than during any other century in the last 1000 years; 1990s warmest decade of the millennium
Hot days / heat index	Increased
Cold / frost days	Decreased for nearly all land areas during the 20th century

Source: IPCC's Third Assessment Report, 2001

The Intergovernmental Panel on Climate Change concluded that the increase in surface temperature over the 20th century for the Northern Hemisphere has been greater than that for any other century in the last one thousand years.

The panel also asserts that there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities. The report also states

that the impacts associated with climate change increase significantly in the scenario where global temperatures rise 2 degrees Celsius from current levels.

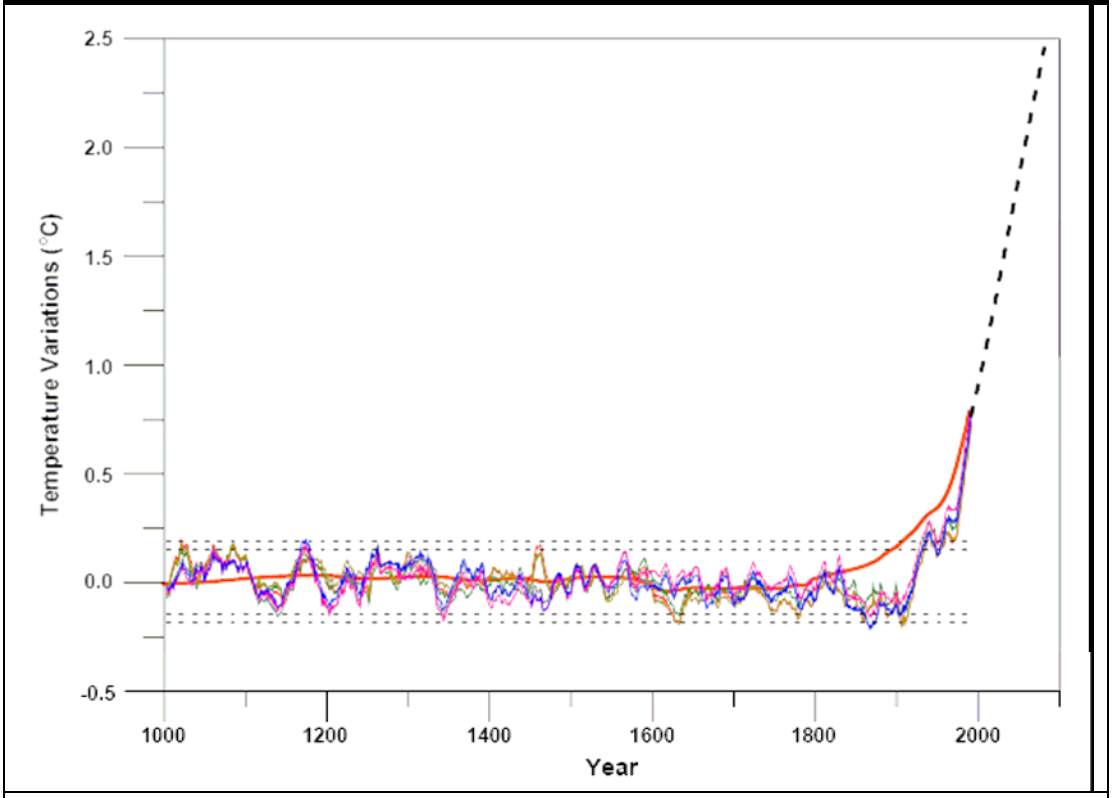
In 2004, a scientific study reported that warming in the Arctic was nearly twice the global average. The multinational Arctic Climate Impact Assessment (ACIA) report concluded that in Alaska, Western Canada, and Eastern Russia, average temperatures have increased as much as 4 to 7 degrees Fahrenheit (2 to 4 degrees Celsius) in the past 50 years.

Holocene – Will the stability last?

Holocene's stable climate is now under an ever increasing threat

Holocene is the period in which we live and covers the past 11,500 years or so. Holocene succeeded Younger Dryas and is characterized by stable climate – a feature that is now under threat. During this entire 11,500-year period, change in the global mean temperature has been within a range of 1-2 degree Celsius[9]. In contrast, during the Younger Dryas the change in temperature could have been as high as 5 degrees Celsius within just a decade.

Figure 5: Temperature changes over the past 1000 years



Source: NOAA

Abrupt climatic changes in specific regions have occurred during Holocene too

Stable global climate did not make Holocene entirely uneventful. Holocene is also characterized by large abrupt events that occurred in regions even as the global temperature remained within a small range overall.

There are at least three such events in which a reduction in global ocean circulation seems to have occurred. Reduction in global ocean circulation follows reduction in salinity of ocean water, which follows the melting of glaciers.

One such event is referred to as the Little Ice Age. In the Little Ice Age, the North Atlantic Region experienced a cooling that began in the 14th century and continued until the mid-

[9] Source: NOAA

19th century. The report says that this period brought severe winters and sudden climatic shifts to Europe.[9]

Another episode of rapid climatic change occurred about 8,200 years ago. This period was marked by the quick onset of cold or dry conditions in the Northern Hemisphere that persisted for decades. This period followed an extended period of global warming. During this time, average annual temperatures in Greenland may have dropped as much as 5 degrees.

The third such event was a nearly 200-year drought in the Middle East, specifically in Northern Mesopotamia. This is estimated to have happened about 5,000 years ago forcing the abandonment of agricultural settlements.

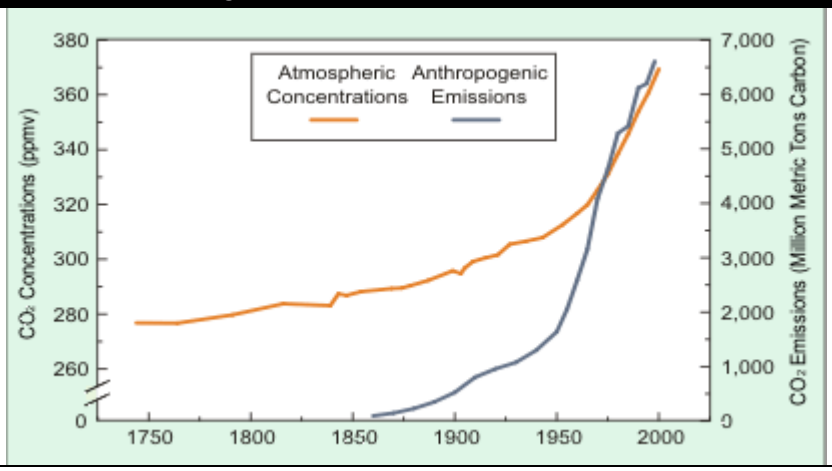
Rapid increase in emissions threatens Holocene

Largest increase in emission of CO2 was recorded in 2005

The X-factor that is threatening the stable climate of Holocene is the rising proportion of heat-absorbing gases in the atmosphere. The human-induced increase in greenhouse gases is warming the globe right now. In the earlier episodes, it was nature that induced the abrupt climate changes that occurred on Earth during the Younger Dryas and Holocene periods.

The atmospheric concentration of CO_2 has increased from 280 parts per million (ppm) during the period 1000–1750 to 368 parts per million in the year 2000.[10] Since 2000, CO_2 emissions have accelerated and concentrations have increased to 381 ppm. The year 2005 witnessed one of the largest increases on record – a rise of 2.6 ppm.[11]

Figure 6: Dramatic rise in global emissions of carbon dioxide in the industrial era



Source: Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center

Greenhouse gases have a long lifetime. They will continue to linger in the atmosphere for an extended period even if we cease emissions now. One additional degree Fahrenheit of warming is expected just from the current levels of carbon dioxide. That alone would raise the Earth's temperature to its highest levels since the end of the Ice Age[12].

[9] Source: Report on Abrupt Climatic change prepared for Environmental Defense
[10] Source: IPCC Report
[11] A BBC news report dated March 14 2006 quotes a study by National Oceanic and Atmospheric Administration
[12] Source: CERES. CERES is a national network of investment funds, environmental organization and public interest groups.

Warming could be even more than a degree Fahrenheit. If fossil fuels continue as the dominant energy source, then atmospheric CO_2 is expected to surpass 550 ppm by the middle of the century.[13]

Curtailing near-term emissions are important. However, James Hansen makes the point that the development of alternative environmentally friendly methods of producing energy will not curtail near-term emissions[14] because countries such as China and India continue to sell more cars and build more conventional energy based power plants. For these reasons, global emissions are forecast to continue rising sharply.

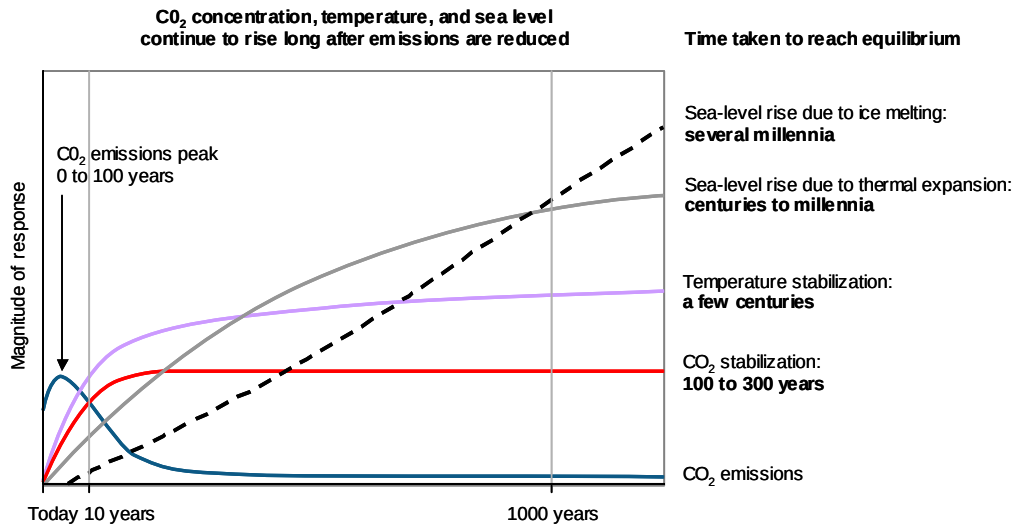
Global warming – Moving towards a tipping point

Abrupt climate change is certain to happen

NOAA says it is certain that abrupt climate change has happened in the past and will happen again. This prophecy will come true sooner rather than later if emissions of greenhouse gases continue unchecked. The elusive global consensus on restriction of emissions has now increased the probability of such an abrupt climate change.

The events in 2005 have been especially worrisome. Rising temperatures, retreating glaciers, and extreme weather events have been a prominent feature in 2005. Despite such a bleak scenario, it appears that we are already committed to a further rise in temperature, as the existing greenhouse gases in the atmosphere will exert their impact. Yet emissions continue to rise. CO_2 emissions are increasing at the rate of 2% per annum – a truly alarming rate of increase.

Figure 7: Greenhouse gases will impact environment long after emissions cease



Source: IPCC

Rising emissions will make abrupt climate changes inevitable. James Hansen asserts, "the evidence shows with reasonable clarity that the level of additional global warming that would put us into dangerous territory is about 1°C, not 2 or 3°C."

Future – Scenario is dangerous

We need to prepare for gradual warming and rapid climatic changes in certain regions

With rising temperatures at least for the next decade a virtual certainty, there is a pressing need to prepare for abrupt climate change.

[13] Source: CERES.
[14] Source: Can We Still Avoid Dangerous Human-Made Climate Change, James Hansen, February 2006

Peter Schwartz and Doug Randell in their report on Abrupt Climate Change prepared for Environmental Defense have outlined such a scenario of climate change modeled on the event that happened 8,200 years ago during the Holocene period. The scenario envisaged the gradual warming of the Earth with rapid changes in certain parts of the globe.

An abrupt change scenario is characterized by the following conditions:

- Annual average temperatures drop by up to 5 degrees Fahrenheit over Asia and North America and 6 degrees Fahrenheit in Northern Europe.
- Annual average temperatures increase by up to 4 degrees Fahrenheit in key areas throughout Australia, South America, and Southern Africa.
- Drought persists for most of the decade in critical agricultural regions and in the water resource regions for major population centers in Europe and eastern North America.
- Winter storms and winds intensify, amplifying the impacts of the changes. Western Europe and the North Pacific experience enhanced winds.

An abrupt climate change scenario could potentially de-stabilize the geo-political environment, leading to skirmishes, battles, and even war due to resource constraints such as:

- Food shortages due to decreases in net global agricultural production.
- Decreased availability and quality of fresh water in key regions due to shifted precipitation patterns, causing more frequent floods and droughts.
- Disrupted access to energy supplies due to extensive sea ice and storminess.

GLOBAL WARMING EMISSIONS – CAUSES AND DRIVERS

Emissions impact climate on earth

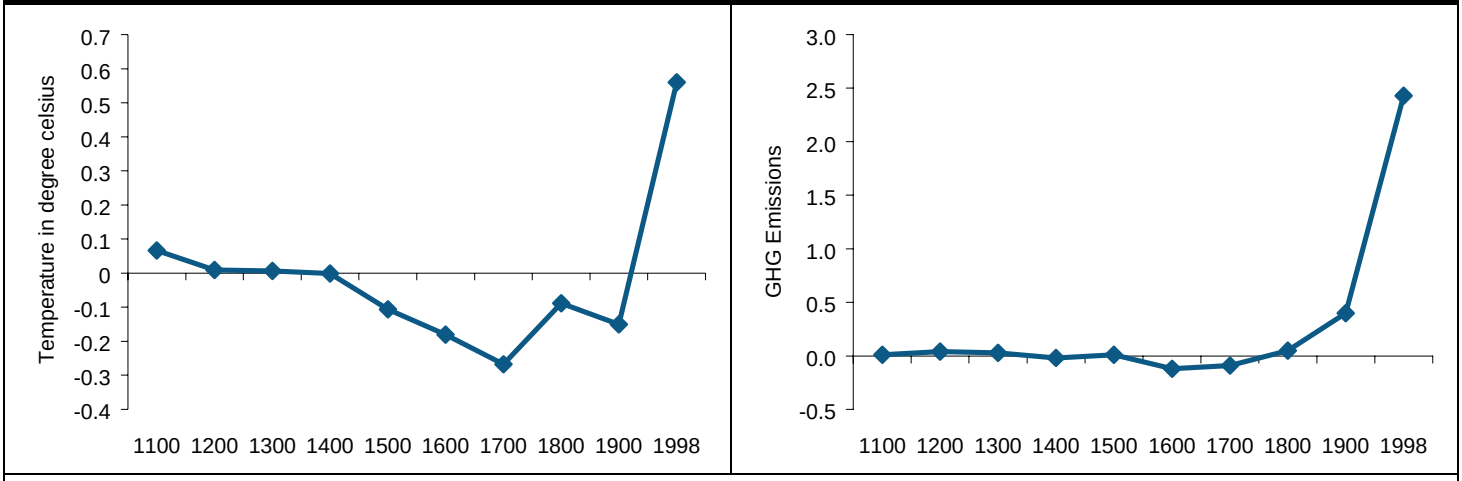
The rates at which glaciers have been melting, sea levels rising, and temperatures increasing have exceeded scientists' projections over the past few years. This acceleration should put the complacent dismissal of global warming into cold storage. Abrupt climate change may already be afoot, a change that is principally driven by continued emissions of greenhouse gases that enhance the natural greenhouse effect.

Human emissions distort the balance between natural emissions and the atmosphere

A natural greenhouse effect, which keeps the earth warm and hospitable, is created by natural emissions of carbon dioxide. At about 150 GtC/year (billion tonnes of carbon in the form of carbon dioxide per year), natural emissions are many times greater than manmade emissions that are estimated at 7 GtC/year.

These natural emissions, however, have been in a state of equilibrium for thousands of years. Precisely because these emissions have been in balance, atmospheric concentrations stayed stable at 280 ppm for thousands of years leading up to the pre-industrial era. Enter manmade emissions and the atmospheric concentration of CO_2 has gone up, leading to changes in climate.

Figure 8: Intricate link between concentration of greenhouse gases and temperature established



Source: NOAA, James Hansen

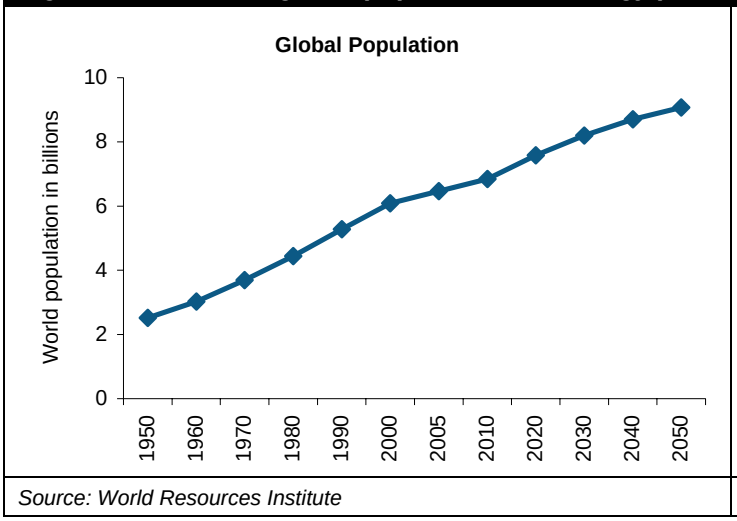
Rising population and energy drives emissions

Rising prosperity and population drive energy consumption

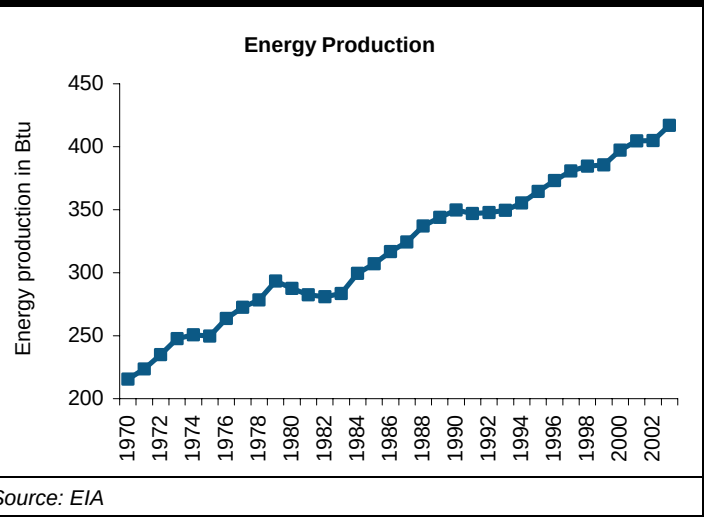
Many factors are behind the increasing rate of greenhouse gas emissions. The principal factors at play, however, have been the rising population and the growing energy use per capita. Global per capita gross domestic product rose at an annual rate of 1.5 % in the period between 1990 and 2002. Growth since then has also been high, as the world economy has continued to enjoy uninterrupted growth, especially in emerging markets, since the 1990s.

Population growth is expected to continue. World population is estimated to rise by nearly 50% from present levels, to top 9 billion by 2050. Similarly, global GDP growth is expected to remain at about 2% with emerging economies accounting for a greater share of the growth.

Figure 9: Growth in global population and energy production



Source: World Resources Institute



Source: EIA

Carbon dioxide emission is the main culprit accounting for nearly 83% of the total man-made greenhouse gas emissions in 2003. Other greenhouse gases include methane, nitrous oxide, and fluorocarbons. The energy sector is the main source of emissions, accounting for 61% of the total greenhouse gas emissions in 2003. Other sectors that cause emissions include land use change, agriculture, industrial processes, and waste.

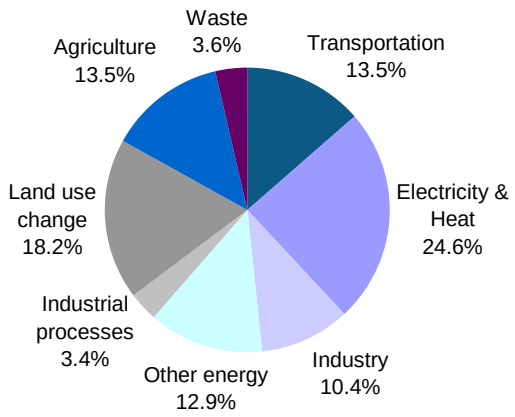
Higher energy usage is the primary cause of emissions

In the past 200 years, 2.3 trillion tons of carbon dioxide have has been released into the atmosphere. 50% of these emissions have occurred between 1974 and 2004. The largest absolute increase has occurred in the past two years.[15]

Energy related emissions – those that come from production and combustion of coal, oil and natural gas – contribute the most. Transportation, electricity, and heat are the principal drivers of energy related emissions. They will also remain the primary source of future emissions. Energy related emissions are growing at a faster rate than other sources.

[15] Source: World Resources Institute

Figure 10: Greenhouse gas emissions by sectors in 2003



Source: World Resources Institute

Deforestation is a large contributor of CO_2 emissions

Land use change accounts for 18% of greenhouse gas emissions and nearly one-fourth of all CO_2 emissions. Emissions from land use change are difficult to estimate. The largest source is deforestation driven by the conversion of forest to agricultural lands, primarily in developing countries. For instance, in 2005, 25,000 square kilometres of Amazon forest were felled, mostly for soya farming.[16]

Agriculture and related activities account for 13.5% of greenhouse gas emissions. Agriculture is the principal source of emissions of methane and nitrous oxide. Livestock is a source of methane emissions. Soil management including fertilizer application is the biggest source of emissions from agricultural activities. Industrial agriculture is estimated to contribute significantly more to emissions than the use of traditional methods. Production of nitrogenous fertilizers and the use of power and irrigation in developing countries adds to emissions.

Industry accounts for a small but significant share of emissions. Chemicals, cement, and iron and steel are the main sources of emissions from industry. The one encouraging thing about industry, particularly large corporations, is that many of them have committed themselves to reductions in emissions. Many corporations now view climate change as a critical factor that will impact shareholder value. Emissions trading started in Europe in 2005 and 35% of the FT500 companies are now participating[17].

Energy usage will continue to increase

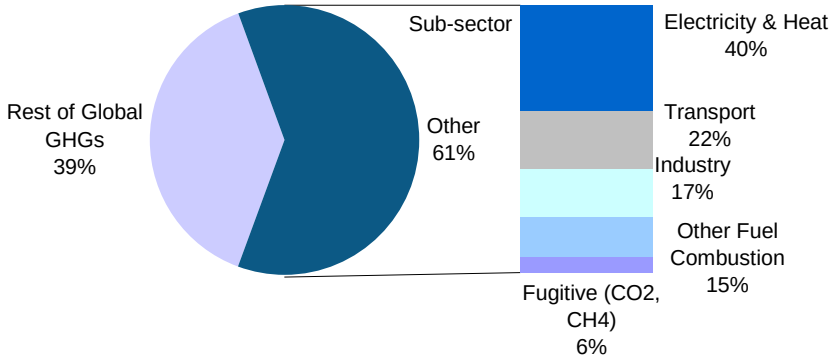
Emissions from energy are intricately linked to the level of their use. The top 25 countries that contribute to greenhouse gas emissions also account for 85% of global energy consumption.

Four principal factors are driving energy related emissions: per capita GDP, population, energy intensity (i.e. energy as a proportion of GDP), and fuel mix (the CO_2 content of the fuel used).[18] There are other reasons why projected demand for energy will go up significantly in the next decade. For one, GDP growth of developing countries is almost twice that of developed countries. The most populous nations in the World – China and India – are also the fastest growing economies.

[16] Source: A report in the Guardian newspaper dated April 8, 2006 indicates that Greenpeace has released a report that documents the clearing of virgin forest due to expansion of soya farming
[17] Source: Carbon disclosure project report dated September 2005
[18] Source: Navigating Numbers, 2005, World Resources Institute

In addition, access to electricity and ownership of motor vehicles in both China and India are a fraction of what they are in developed countries, and energy demand projections reflect this reality. Therefore, to realistically target carbon emissions, fuel mix and conservation should be the main focus of our efforts.

Figure 11: Greenhouse gas emissions by energy sector in 2003



Source: World Resources Institute, IPCC

International co-operation and technology transfers are critical for the promotion of environmentally friendly technologies

There is clearly a need for international co-operation. Technology transfers are required to improve efficiency and for the promotion of renewable energy, as well as capture and sequestration of carbon dioxide and nuclear energy.

Nuclear energy needs to be viewed as the best possible option under the circumstances. The emission content of nuclear energy is lower than even natural gas. Nuclear advancements by Japan, China and South Africa will make nuclear energy safer. Natural gas fired power is already much more expensive and its growth will continue to face challenges in the coming years. In an environment of sudden climatic change, gas prices will likely continue to soar. Costs of nuclear energy are less susceptible to such variation. *Nuclear energy may be the energy source that can save our planet from another possible disaster: catastrophic climate change.*[19]

[19] Source: An article in Washington Post dated April 16, 2006 by Patrick Moore, founder of Greenpeace.

CONSEQUENCES OF GLOBAL WARMING

Melting Ice and its hazards

Arctic sea ice has decreased by a million sq. kilometres since 1970

Carbon dioxide levels account for just part of the warming process. As the atmosphere has warmed, polar ice caps have melted and contributed to a "positive feedback loop". The shrinking of glaciers at the extreme edges of Earth is the catalyst that could transform our planet's climate. – and these glaciers have been melting. Arctic sea ice has decreased by a million square kilometres since 1970.[20] Antarctic ice seems to be melting faster than it was previously thought.[21] The feedback loop operates on the principal that snow and ice are the most solar energy reflective surfaces on earth and that water is the most absorbing. As the Arctic ice cap retreats, it exposes more ocean to sunlight thereby increasing the rate at which the earth absorbs solar energy.

Annually, 20 billion tonnes of fresh water are added to the oceans, and melting ice caps are one of the major contributing factors.[22] Sea levels have risen by about half a foot in the past century, and some forecast that it may rise by as much as 20 feet in the next 100 years. This would cause most of Florida and Louisiana to be under water. Many other coastal areas such as Bangladesh, Maldives, and low-lying areas in New Zealand would be flooded. Hundreds of millions of people around the globe would be displaced from their homes as rising tidewaters consume coastal communities.

Rising sea levels threaten the economies of developing countries

The implications of a rise in sea level are much larger than the flooding of inhabited lands. A higher sea level will provide a higher base for storm surges. The impacts of storm and flood damage would be significantly greater than what it is currently.[23] Storms that cause minimal damage now would create far greater havoc. Erosion to beaches would be significant. Already 70% of today's beaches are retreating. The loss of beaches to erosion will increase as sea levels rise further. Needless to say, the impact on tourism as well as the insurance industry would be severe. Rising seawater would also allow salt water to encroach into land that is farther upstream now. That would affect water supply, coastal farmland, and ecosystems.[24] Developing countries such as India, China, Bangladesh, Sri Lanka, and Indonesia with large populations along the coasts would be vulnerable to such rising sea levels. East Asia would be particularly vulnerable.[25]

Melting Ice – Global Warming, Regional Cooling

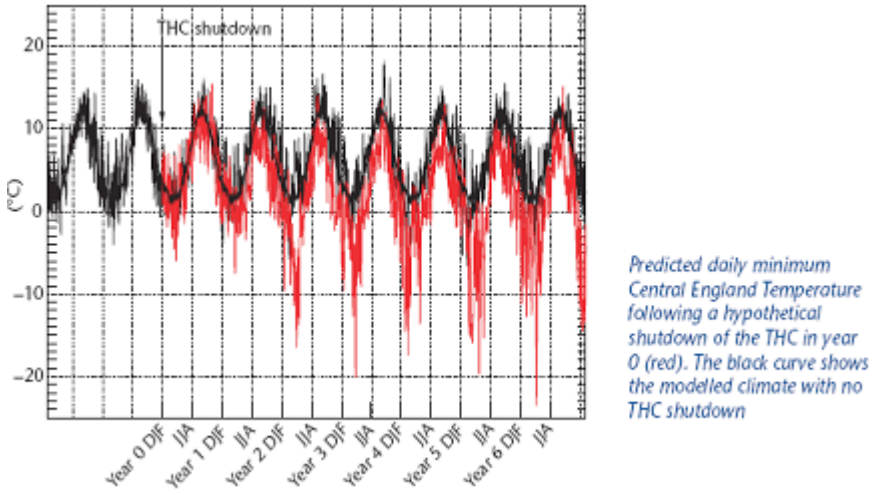
Europe could cool rapidly if global ocean circulation is affected by conversion of ice into ocean water

The impact of melting ice on sea levels would pale in comparison to the secondary effects that the conversion of ice into ocean water causes. The addition of fresh water makes oceans less salty. That could alter large-scale ocean currents that now transport heat. This global current system is called Thermohaline circulation. It is termed thermohaline because it is driven by changes in temperature and salinity. For instance, in the North Atlantic, the ocean surface water is cooled by cold winds and is replaced on the surface by the warmer water – the Gulf Stream – flowing from the Gulf of Mexico. An increase in fresh water could switch off this Gulf Stream. Ocean currents will then no longer be able to transport heat to Europe.

[20] Source: Hadley Centre for Climate Prediction and Research
[21] Source: BBC news report dated February 2, 2005 quoting British Antarctic Survey
[22] Source: BBC news report dated March 9 2006 quotes a study in the Journal of Glaciology
[23] Source: IPCC's 1998 report
[24] Source: IPCC's 1998 report
[25] Source: A Reuters report dated March 30 2006 quoting a World Bank report

Temperatures in Northern Europe would fall dramatically. For instance, in **Central England daily minimum temperatures could fall below –10 degrees Celsius. It is important to remember that the UK is the same latitude as Alaska, and it is the Gulf Stream that accounts for the vast difference in climate**. The Gulf Stream has switched off before, about 13,000 years ago. Europe then cooled by several degrees within a couple of decades.[26]

Figure 12: Changes to the Gulf Stream

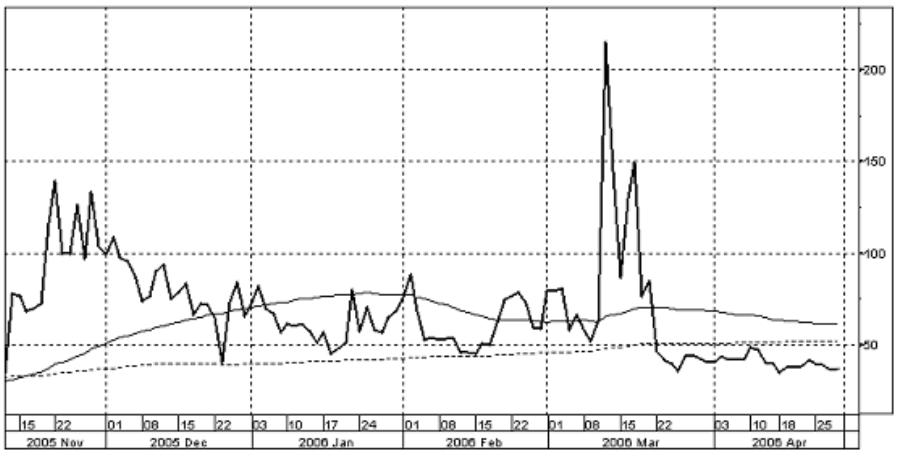


Source: Hadley Centre for Climate Prediction and Research

Biting cold winters in Europe would boost demand for power and gas prices would soar

European winters have already been getting colder in recent years causing a rise in the consumption of power during the colder months. For instance, the colder than usual winter in Europe in 2005/2006 caused gas prices to spike disrupting businesses and the economy, negatively impacting consumer confidence.

Figure 135: UK Natural Gas Hit $44.00 / MMBtu in March 2006



Source: Bloomberg

The weather impact from a disruption to the ocean currents will not be restricted to just Northern Europe. Much of the Northern Hemisphere would be cooler.[27] Cooling is most

[26] Source: Hadley Centre for Climate Prediction and Research
[27] Source: Abrupt Climate Change Scenario – a report prepared for the US based advocacy group, Environmental Defense

pronounced during the winter. Conditions in the Southern Hemisphere could also change significantly, possibly offsetting the cooler North.

The sudden and precipitous change in the temperature of ocean currents will also have a dramatic impact on precipitation and rainfall in almost all parts of the globe. Agriculture would be affected. Vast farming districts the world over could experience droughts.

Abrupt climate change could produce events that stress key regions simultaneously. Supply of food, water, and energy could come under severe pressure globally.

Hurricanes – Increase in frequency and intensity

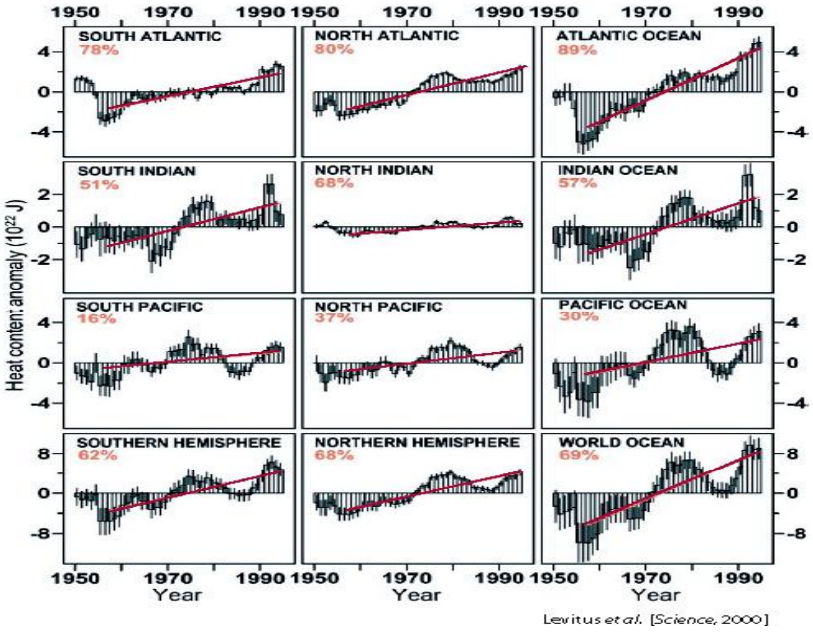
Scientist now firmly believe that there is a strong relationship between increased hurricane intensity and global warming

The Earth today is experiencing increasing frequency of hurricane activity. These storms have also become more intense in nature. Scientists now firmly believe that intensifying hurricanes is an outcome of the increased temperature of sea surface waters, which in turn is an outcome of global warming.

Short-term effects like El Nino, air circulation patterns, and changes in winds at various elevations can also affect the strength of hurricanes. Sea surface temperatures, which have shown a steady upward trend in every ocean over the past 34-year period[28], are however seen as the primary cause.

In the latter half of the 20th century, ocean temperatures have been rising as they have absorbed approximately 30 times more heat than the atmosphere has since 1955.

Figure 14: Temperature increase in oceans across the globe



Source: Woods Hole Oceanographic Institution presentation

The number of hurricanes to hit the Atlantic basin since 1995 increased to 7.7 compared to 5 between 1970-1994

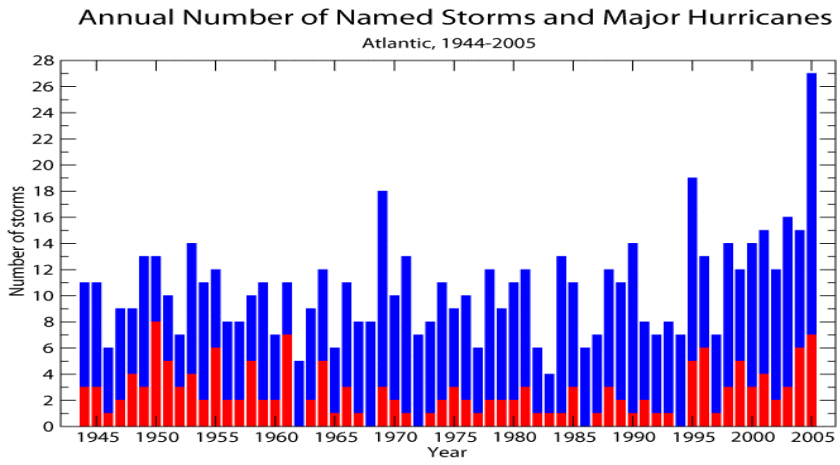
As shown in the figure below, tropical cyclone activity in the Atlantic basin has been above normal since 1995. This is primarily attributed to the active phase of the multi-decadal signal. Multi-decadal signals are characterized by warmer sea surface temperatures in the tropical Atlantic region and other factors that are conducive to increased storm intensity.

[28] Source: BusinessWeek Online

The average number of named storms since 1995 has been 13, compared to 8.6 during the preceding 25 years during which time the multi-decadal signal was in an inactive phase. The number of hurricanes to hit the Atlantic basin since 1995 increased to 7.7 compared to 5 that occurred between 1970-1994.

Recent studies also reinforce the impact of global warming on the increased intensity of hurricanes. These have indicated that in addition to the multi-decadal oscillation, increased intensity of hurricanes since the mid-1970s was noticed after the rapid increase in global ocean and land temperatures began.

Figure 15: Increase in number of hurricanes across the Atlantic



Source: National Climate Data Centre

Forecasts indicate that the 2006 Atlantic hurricane season will be much more active than the average 1950-2000 season

The year 2005 saw a record number of named tropical storms, hurricanes and category-5 hurricanes.[29] According to Swiss Re, a reinsurance company, the cost of natural disasters exceeded US$225 billion in 2005, compared to US$118 billion in 2004. Scientists across the globe are of the view that tropical storm frequency and intensity is expected to increase with the rise in global temperatures. In just the last month, an insurance crisis has developed in some US coastal regions. Several major insurers are withdrawing coverage leaving home and business owners unprotected. Governments are likely to have no choice but to pick up the tab as the insurer of last resort. This could be another catalyst to break the housing bubble, as it is extremely difficult and expensive to get a mortgage without insurance.

Forecasts by the tropical Meteorology Project at Colorado State University indicate that the 2006 Atlantic hurricane season will be much more active than the average 1950-2000 season. The university researchers have forecast that 17 named tropical storms and hurricanes will form in this season, which usually lasts from June to December. In an average year, the Atlantic basin experiences approximately 10 storms.

Impact of Hurricanes

Human lives as well as crops in the path of hurricanes suffer immense damage and destruction. For example, Cyclone Larry damaged farms in Australia when it lashed Northern Queensland in March 2006. The storm, which had winds reaching a speed of 290 km/h, caused widespread damage to banana production and almost wiped out

[29] Category-5 hurricane is defined as storm with wind speed of more than 155 mph

approximately 80% of Australia's crop, worth approximately 300 million Australian dollars. The storm also destroyed approximately 15 million Australian dollars worth of avocados.

Oil & Gas Industry – hard hit by hurricanes

Due to hurricanes Katrina and Rita, approximately 7.6% of US oil production that was produced in the Gulf of Mexico had to be shut down

The increase in frequency and intensity of hurricanes will cause significant disruptions in coastal refineries. For instance, hurricanes Katrina and Rita that struck the Gulf of Mexico in August and September 2005 caused major damage to oil and gas production. Nearly 1.6 million barrels per day (mbpd) of crude oil, equivalent to 7.6% of US oil production that was being produced in the Gulf of Mexico before the storm struck[30], had to be completely stopped. Production facilities were evacuated and wells had to be shut down. The storms destroyed 111 production platforms and 52 were seriously damaged. In addition, a number of drilling rigs were destroyed. This is likely to limit future production from new wells that are yet to be completed. A full four months after the disaster, production is yet to return to normal. Currently production levels remain approximately 24% lower than pre-Katrina levels.[31] Going forward, as the frequency of hurricanes is expected to increase due to global warming, there will be many more such disruptions causing annual oil production to decline globally. This weather-induced decline in production will exacerbate the problem of peaking global oil production. (For more on the challenges facing the oil and gas industry see http://www.sprott.com/peakoil.php)

[30] Source: Congressional Research Service (CRS) report
[31] Source: BusinessWeek Online

GLOBAL WARMING–IMPACT ON COMMODITIES PRODUCTION

As global warming induces climate change it can have a dramatic impact on agricultural productivity. In addition, increased levels of carbon dioxide emissions, which are the major contributing factors towards global warming, can have a detrimental impact on crop yields.

Argentina is one of the first countries to experience the detrimental effects of climate change on agriculture

Argentina, the world's third-largest exporter of beef, corn, and soybeans, is one of the first countries to experience the detrimental effects of climate change on agriculture. Global warming is responsible for flooding in some areas and drying up of rivers in others, according to Vicente Barros, a climatology professor at the University of Buenos Aires. Warmer weather is evaporating water from rivers in northern Argentina at a faster pace than in previous years, curbing hydroelectric power and cutting the water supply to crops, Barros said. It also is bringing more rain to the central provinces of Cordoba, Santa Fe and Buenos Aires, flooding fields of soybeans, wheat and corn, he said.

IPCC Assessment

According to Intergovernmental Panel on Climate Change (IPCC), the poorest countries could be hardest hit as a result of a decrease in crop yields, due to water shortage and changes in pest incidence. In Africa and Latin America many rain fed crops are near their maximum temperature tolerance. A small change in temperature could trigger a sharp fall in yields. It is projected that due to the climate change phenomenon, agricultural productivity may decline up to 30% over the 21st century.[32]

Other Studies

According to Rosenzweig and Hillel, who authored *Climate Change and Extreme Weather Events; Implications for Food Production, Plant Diseases, and Pests*, global food supply may be affected by an increase in extreme weather events and climate variability associated with global warming. Altered weather patterns can increase crop vulnerabilities to infection, pest infestations, and choking weeds. This will not only decrease yields of crops, but also force farmers to apply harmful and expensive pesticides and herbicides.

Grain Production – Shortages imminent

In 2002, India and the US suffered a sharp decline in harvests because of record temperatures and drought

Grain production averaged approximately 1.8 billion tons per year between the years 1996 and 2003. Between the year 2000 and 2003, grain stocks had been declining, culminating in a consumption shortage of 93 million tons in the year 2003. Earth's average temperature has been rising since the late 1970s, with the three warmest years on record coming in the last five years (2000-2005). In 2002, India and the US suffered a sharp decline in harvests because of record temperatures and drought. In the year 2003 Europe suffered very low rainfall throughout the spring and summer, and a record level of heat damaged most crops from the UK and France in Western Europe through Ukraine in the East. The UN scientists had warned in 2005 that one in every six countries in the world faced food shortages that year because of severe droughts that could become semi-permanent under climate change. Wulf Kilman, chairman of the UN food and agriculture organization's climate change group, stated that droughts that have damaged crops across Africa, Central America and south-east Asia in 2004 are part of an emerging pattern. The food and agriculture organization and the US government, both of which monitor global food shortages, agree that 34 countries are now experiencing droughts and food shortages and others could join them.

[32] 2001 Intergovernmental Panel on Climate Change - Third Assessment Report

Drying Aquifers – Water, water everywhere, not a drop to drink

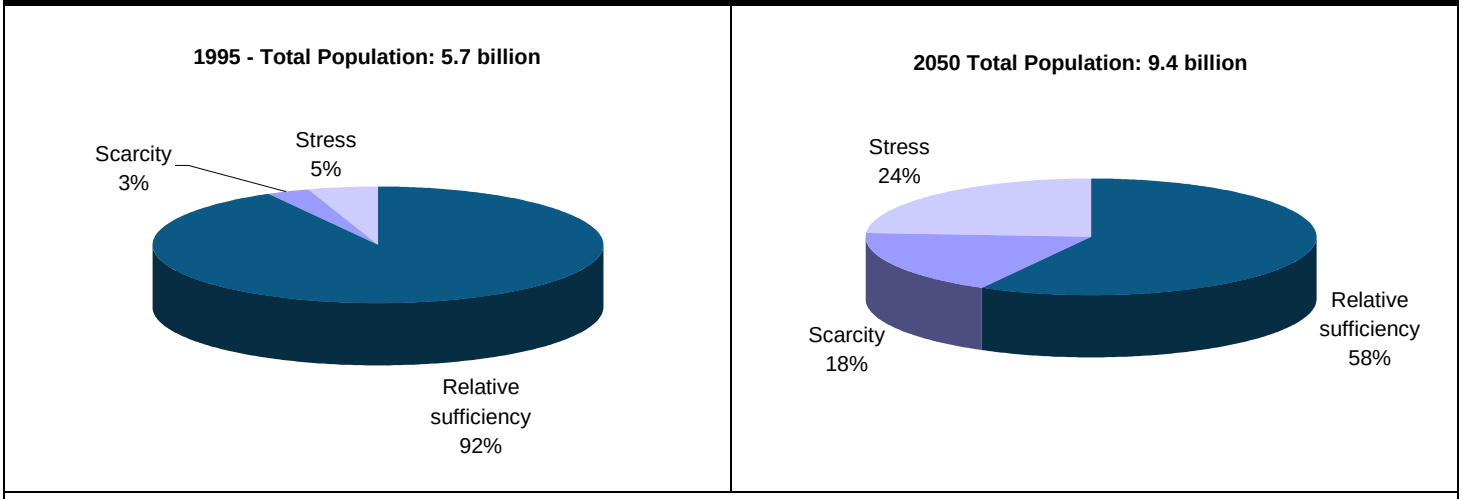
Seawater encroachments threaten aquifers that are a source of drinking water

The beauty of our planet is that close to many of the coasts that emerge from large salty oceans lie freshwater resources. These fresh water resources such as those in the USA or in the Middle East are a source of water, aqua culture and marine foods. They also act as a buffer against floods and protect the quality of ground water. Global warming now threatens the symbiotic existence of people living along the coasts.

Rising sea levels, and storm surges that a higher sea level will allow, will increase the salinity of estuaries and freshwater aquifers. In the USA, water availability in places such as New Jersey, New York, Philadelphia, and California's Central Valley along with coastal states such as Florida, Louisiana, and Maryland could be affected.

The largest aquifer in the world – the Ogallala aquifer in the US – is drying because the glaciers that created the aquifer are receding. Aquifers in India and China are rain-fed. Low precipitation due to global warming would dry them too. Fresh water is in short supply for one-third of the world's population already. Global warming will only make water shortages a more global phenomenon.[33] We are already witnessing restrictions being placed on mining companies the world over due to water shortages and aquifer depletion.

Figure 16: Water scarcity to become more global: World population in water scarcity areas



Source: As cited in IPCC's report on Climate Change; T.Garner-Outlaw and R.Engelman

Demand for desalination plants to go up

Desalination plants (facilities that remove salt from salt water) are likely to be viewed as an answer to some of the problems. Desalination plants, however, have their own drawbacks. They consume a large amount of energy and will further stress the power grid.

Notwithstanding, desalination plants are already being planned throughout the United States. California, New Mexico and Florida have embarked upon implementing such plants. Developing countries are expected to join the bandwagon. Companies such as GE now view developing countries as the major market for water desalination plants.[34]

Droughts, Dying Flora and Fauna – Global warming unleashed

A quarter of all plant and animal species may be extinct by 2050

The impact of global warming will vary considerably depending on location. Eastern Africa could be plagued by persistent drought while the southern states of the USA become dry.

[33] Source: IPCC's Simplified guide to climate change
[34] Source: A Wall Street Journal report dated March 2005 on General Electric

Mega droughts could envelope Southern China and Northern Europe too[35]. The proportion of the Earth's surface suffering from drought may have doubled since the 1970s.[36] Global warming will lead to increased drying over most land areas during summers, and this drying may have already begun.[37]

Flora and fauna will be drastically impacted. As much as a quarter of the world's plant and vertebrate animal species could be extinct by 2050.[38] A doubling of carbon dioxide to 550 ppm could lead to elimination of 56,000 plant and 37,000 animal species in the top 25 hot spots such as South Africa's Cape Floristic Region, the Caribbean Basin, and the tropical regions of the Andes Mountains. Species living in these hot spots are particularly vulnerable to climate change. In Costa Rica, 110 species of Harlequin Frogs have become extinct in the past 30 years. Penguin populations in parts of Antarctica may have already shrunk by 33%.

Melting Permafrost – The real tipping point

The tipping point for climate change was thought to be as high as 550 parts per million of carbon dioxide in the atmosphere.[39] A greater understanding of feedback loops and other processes behind climate change has forced a reassessment and the need to aim for a threshold of 450 ppm for CO_2.[40] However, melting may emerge as the force that tips the climate beyond a point of no return.

Thawing frozen ground could add to emissions as it houses a massive amount of greenhouse gases

Approximately 20% of the Earth's land mass is covered by permafrost or glacial ice which can be up to 650 meters thick in some locations. Within this perennially frozen soil is sequestered significant quantities of greenhouse gases; namely, carbon dioxide and methane. As the frozen ground thaws it will spew these gases into the atmosphere. Carbon frozen inside permafrost could amount to 800 gigatons, which is massive compared to the annual human carbon output of 7 gigatons.[41] One area in West Siberia alone is said to hold 70 billions tonnes of methane[42] which is said to be four times more destructive than carbon dioxide with respect to global warming.

In Western Siberia, an area of permafrost spanning a million square kilometres is melting for the first time since it formed 11,000 years ago. Methane hotspots have been found in Eastern Siberia, and the permafrost in Alaska is melting as well. It is feared that this process will have even more of an effect on global warming than recent human emissions.[43] The melting permafrost is already injecting massive amounts of greenhouse gases into the atmosphere. If permafrost thawing continues, global warming could tip beyond our control.[44]

Solutions to Global Warming

With rising populations and increasing urbanization in the developing world, more space and energy will be required if we continue with the status quo. Continued deforestation is a likely outcome to satisfy our need for space. On the other hand, the need for energy will result in an increased rate of fossil fuel burning, which in turn will release more CO_2 into the atmosphere. That in turn will accelerate the process of global warming.

[35] Source: A report on abrupt climate change prepared for the advocacy group, Environmental Defense
[36] Source: A study by scientists of National Center for Atmospheric Research in 2005
[37] Source: Aiguo Dai, Lead author of the study by scientists of National Center for Atmospheric Research
[38] Source: A National Geographic news item dated April 12 2006 quoting a study in April edition of the journal conservation biology
[39] Source: Jonathan Overpeck, University of Arizona
[40] Source: David King, Chief Scientific Adviser, UK
[41] Source: A Time Magazine article dated March 23 2006 quoting David Lawrence of National Center for Atmospheric Research
[42] Source: A Guardian news article dated August 11 2005
[43] Source: A Guardian news article dated August 11 2005
[44] Tony Juniper, Director, Friends of Earth

Conservation
Conservation is one of the simplest methods to control carbon dioxide emission. According to the US Environmental Protection Agency (USEPA), each gallon of gasoline releases 8.64 kg of CO_2 into the atmosphere. Each kilowatt of electricity generated by a coal-fired plant produces about 1.4 kg of CO_2. It's likely that our governments will have no choice but to implement regulations and financial incentives to force conservation on a scale necessary to lower carbon emissions sufficiently. The USEPA estimates that energy-saving appliance standards in the US reduced national electricity consumption by 3% as of the year 2000. This reduction will offset the need for 31 large power plants. A 625 MW coal-fired plant, which can serve approximately 425,000 homes, emits 1 million tons of carbon each year.

Nuclear energy
Nuclear power is touted as the most efficient alternative to producing electricity, which will emit lower carbon emissions compared to fossil based fuels. According to research studies, while nuclear plants emit 0.025 kg CO_2/Kwh, natural gas and coal plants emit 0.58 and 1.04 kg CO_2/Kwh, respectively.

Renewable Energy
Another means of reducing carbon emissions is the development of new technologies, such as renewable energy. The four most popular renewable energy methods are

- Solar
- Wind
- Water
- Biomass

There have been initiatives undertaken by the government to boost the development of renewable energy technologies. For example, a program by the Japanese government to put solar panels on the roofs of a million homes has made Japan a world leader in that technology. Denmark has become the leader in wind power, supported by its government.

Renewable energy prevents far more greenhouse gas emissions than it causes. For example, a wind turbine typically produces about 50 times as much energy over its lifetime as is consumed by its construction and installation. Generally, electricity generated via renewable energy causes a fraction of carbon emissions compared to that generated by fossil based fuel.

Carbon sequestration
One of the methods to reduce green house gases is to employ carbon sequestration techniques. This process involves the capturing of carbon, separating the same, and subsequently storing it or reusing it in a gainful manner. Germany is among the leading countries that are trying to develop carbon sequestration and carbon storage technologies.

Technological Advances in Transportation

Greenhouse gas emissions across the world are rising faster in transportation than in any other sector. This is primarily due to the fact that more cars and trucks are being used. The number of private vehicles is increasing in almost all developing countries. Higher usage of transport requires increased consumption of petroleum, which translates into higher carbon emissions.

Advancement in technologies is resulting in improvements in fuel economy and also a gradual shift from internal combustion engines to electric-drive propulsion technology. This has resulted in the increased use of electric cars (and hybrids), and hydrogen cars in certain countries. The use of electric-drive systems — fuel cells, batteries, and hybrid electric systems — is likely to improve energy efficiencies by 50% or more and is also likely to lead to less pollution.[45] In the interim, there are other technologies that can act as a stopgap as we transition from internal combustion to the next generation, such as the injection of hydrogen into the engine to reduce emissions and improve fuel economy.

[45] Source: Transportation in Developing Countries – An overview of greenhouse gas reduction strategies – by Daniel Sperling and Deborah Salon, University of California, Davis

INVESTMENT OPPORTUNITIES

It is undoubtedly callous to discuss the investment opportunities that an abrupt climate change will spawn, considering the unspeakable horrors that life on our planet is facing. Unfortunately, we have no choice but to face reality and deal with the consequences that stem from our analysis of the global macro environment. It should be apparent after reading the first half of this report that global warming will likely be the single most important event of the next century. It is likely that every sector of the economy will be impacted profoundly. It is our aim to not only help our fund holders be protected and prosper but also help them invest in potential solutions to global warming. As the masses come to realize the potential scenarios that lay before us, the choice will be clear. Pay more for climate friendly energy production now or run the risk of realizing the full impacts of an abrupt climate change. Government regulation will be driven by an emerging consensus that the risks of continuing on our current path are too great.

Traditional industries could come under pressure as compliance costs increase. The option of carbon taxation is already arriving on the policy table the world over. Given the overwhelming evidence that the steep rise in carbon dioxide levels is already seriously impacting the environment, this policy option may become reality in short order.

Figure 17: Examples of sector risks

Sectors	Analysis
Automobiles	Among top auto manufacturers, there is a 25% difference in average fuel efficiency for the line of passenger cars sold in 2004.
Banks	Certain banks have upwards of 50% of their commercial loan portfolio directed towards "high risk" sectors with exposure to both the regulatory and weather risks of climate change.
Chemicals	Assuming a price of $50 per tonne of carbon, a 20% emissions constraint and a 7-year compliance period, the most exposed company in the chemicals sector could face annual compliance costs of nearly 4% of net income. Conversely, given the same assumptions, the least exposed firm faces less than 1.5 %.
Electric Utilities – International	Assuming a price of €40 ($50) per tonne of carbon, a 20% emissions constraint and a 7-year compliance period, the most exposed company in the Electric Utilities - International sector could face annual compliance costs of nearly 8% of their net income. Conversely, given their same assumptions, the least exposed firm faces less than 1%. Some large emitters could see financial windfalls from carbon pricing.
Electric Utilities - North America	Assuming a price of $50 per tonne of carbon, a 20% emissions constraint and a 7-year compliance period, the most exposed company in Electric Utilities - North America sector could face annual compliance costs of over 20% of net income. Conversely, given the same assumptions, the least exposed firm faces less than 1%.
Metals & Mining	Assuming a price of $50 per tonne of carbon, a 20% emissions constraint and a 7-year compliance period, the most exposed Metals & Mining company could face annual compliance costs of nearly 22% of net income. Conversely, given the same assumptions, the least exposed firm faces approximately 2%.
Oil & Gas	Assuming a price of $50 per tonne of carbon, a 20% emissions constraint and a 7-year compliance period, the most exposed Oil & Gas company could face annual compliance costs in excess of 2% of net income. Conversely, given the same assumptions, the least exposed firm faces less than 0.5%.

Source: Carbon Disclosure Project September 2005

Some of the more obvious sectors that what will be benefactors will be the nuclear power industry, renewable energy, and advanced transportation. Alternative ways of using coal, as well as technologies to capture and utilize carbon dioxide, will be in high demand. Even more so would be the companies that are able to cleanly produce hydrogen.

The energy sector, and in particular the nuclear energy sector, would be the most watched. This is because energy is the biggest culprit in terms of greenhouse gas emission. This is the sector that needs to be dealt with at the earliest. There would therefore be intense pressure to identify alternative sources of energy that are at the same time carbon friendly. Newer technologies of power generation that are safe and cheap may come into the

marketplace. We anticipate a massive build-up of nuclear power capacity the likes of which the world has never seen. At this time, there seems to be no other practical alternative that can be taken that can have nearly the same impact in as short a time. Nuclear energy is highly reliable and cost effective. As our use of nuclear energy expands, technological advancements will continue to make nuclear energy more reliable and more effective.

ENERGY SECTOR

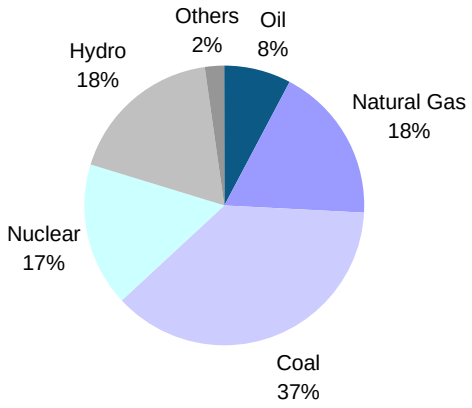
Global electricity demand is projected to double by 2030 to 31,500 bln kWh from 15,391 bln kWh

Supply side – Nuclear energy to play a vital role

To meet the projected energy demands over the period up to 2025, massive investment will be made in new capacities as well as in extensive expansion of installed generating capacity, i.e. the hourly level of production when the power plant is operating at full capacity.[46] Global installed electricital capacity is expected to grow from 3,315 gigawatts (Gw) in 2002 to 5,495 Gw in 2025.

The key issue of course is the mix of various fuels. The mix of fuels used for production of electricity has changed over the decades.

Figure 18: Global Electricity generation by fuel source (2005)



Source: EIA

Going forward, the world will be forced to move towards a common solution for the reduction of greenhouse gases and the adoption of sustainable development as a policy. In such a scenario, we believe the importance of nuclear power in the generation of electricity would increase due to its cost effectiveness compared to other sources, and its potential for lesser emissions of CO_2 compared to other fuels. The proportion of nuclear energy in total power produced could increase to as much 60% of global electricity generation in the next century.

Nuclear is one of the cheapest sources of electrical generation

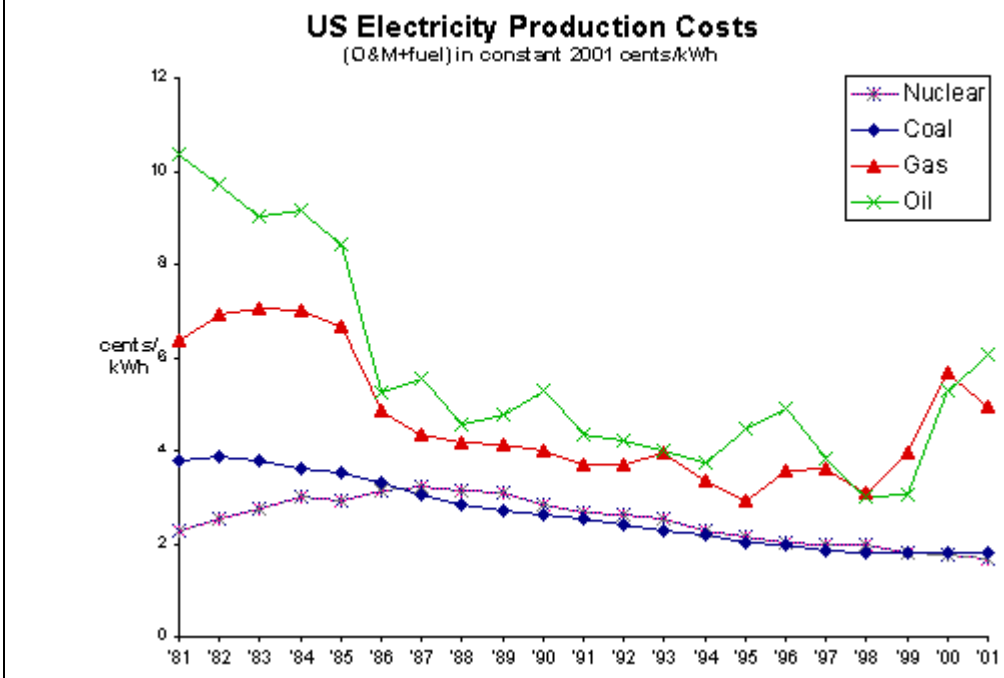
Depending on the location of the coal, gas, or nuclear plant, the cost of generating electricity varies considerably. In countries like China, Australia, and the US, the cost of producing electricity through coal is cheaper due to abundant domestic coal resources. If you add in the cost of CO_2 capture, then nuclear power takes the lead. Until recently, gas was also considered to be a cheap source of power generation, but a recent surge in the price has made natural gas extremely expensive during high demand periods. Gas prices have almost doubled over the past three years and are now close to $7/MMBtu (a Million British Thermal Units). Nuclear, on the other hand, is still competitive with other fossil fuels for electricity generation despite the high capital costs involved. When we factor in other qualitative factors, such as its impact on social, health, and environmental benefits, nuclear energy's advantages far outweigh those of the other sources.

[46] Source: International Energy Outlook 2005

With relatively few new nuclear plants constructed in the past decade, the amount of information on the costs of building modern nuclear plants is inevitably somewhat limited. However, various recent studies have concluded that nuclear plants are cheaper compared to other sources of energy. It should be noted that in these studies, the gas price assumption in most cases was below $3.5/MMBtu.

Generally, the competitiveness of nuclear power depends mostly on the cost of capital. If the cost of capital were around 8% then capital costs of nuclear power would be below $1,400 per Kw, thereby making nuclear power highly competitive.[47]

Figure 19: Electricity Production Cost in the US[48]



Source: US Utility Data Inst. (pre 1995), Resource Data International (1995)

Low fuel cost percentage makes Nuclear attractive

On average, fuel cost comprises less than 10% of the total cost of nuclear power. Interestingly, around two-thirds of the cost associated with Uranium is related to its fabrication and enrichment so as to make it usable for electricity generation. Even after taking into account allowances made for the management of the radioactive spent fuel and the ultimate disposal of that spent fuel, nuclear is still attractive.

[47] Source: 'The New Economics of Nuclear Power'- World Nuclear Association Report

[48] Note that the above data refer to fuel plus operation and maintenance costs only, they exclude capital, since this varies greatly among utilities and states, as well as with the age of the plant. On the basis of the OECD projections opposite, capital costs in USA are 55% of total for nuclear, 45% of total for coal and 16% of total for gas. Grossing these up on this basis for 2001 gives 3.73 c/kWh for nuclear, 3.27 c/kWh for coal and 5.87 c/kWh for gas.

Uranium prices have risen from under $10/lb to over $40/lb today. It is remarkable how little impact there is on the cost of generating nuclear power even with such a large price increase. We calculate that the raw uranium cost only makes up 0.23 cents per kilowatt-hour of the nuclear power price.

Figure 20: Fuel cost of getting 1 kg of Uranium as UO_2 reactor fuel

Input/Process	Kg/Price*	Total (US$)
U_3O_8	8 kg x $90.20	722
Conversion	7 kg U x $12	85
Enrichment	4.8 SWU x $122	586
Fuel fabrication	Per kg	240
Total (approximately)	US$1,633	
Thermal Power Yield		3,400 GJ
Total Fuel Cost		0.52 cents/kWh
Uranium Cost		**0.23 cents/kWh**
*Mid April 2006 prices		

Source: Economics of Nuclear Power, with Sprott Asset Management Estimates Added

Total fuel costs of a nuclear power plant in the OECD are typically about a third of those for a coal-fired plant

When compared with the other fuels, the total fuel costs of a nuclear power plant in the OECD are typically about a third of those for a coal-fired plant, and between a quarter and a fifth of those for a gas combined-cycle plant. Furthermore, the fuel cost is steadily declining due to increased efficiency over the years. For instance, due to improvements in the enrichment levels and in burn up, nuclear electricity cost were reduced by 29% over 1995-2001 in Spain. The enrichment brought about a reduction of around 40% in fuel costs.[49]

Fuel costs are typically a major cost in overall electricity generation. In the case of coal and gas, fuel costs account for nearly 35% and 73% (at a 10% discount rate) of total costs, respectively. For nuclear, fuel costs are merely 4.5% of total costs, even with uranium at $40 per lb. **If uranium rises to $100 per lb (a further 150% increase) the cost of nuclear power would only rise by approximately 6.75%.**

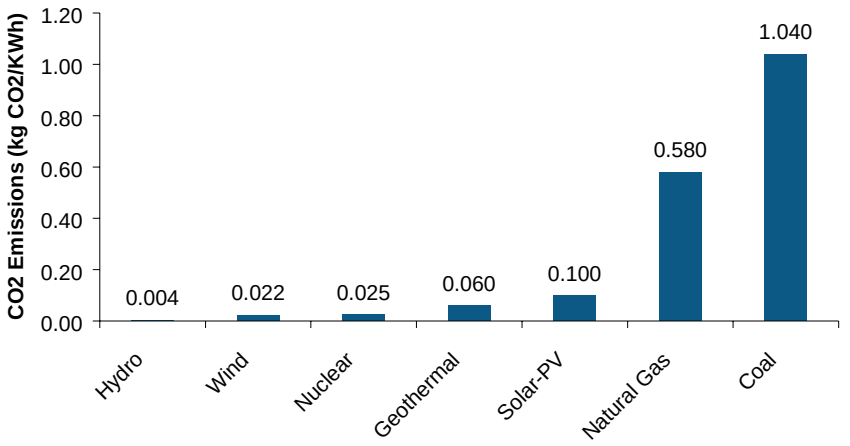
[49] Source: The Economics of Nuclear Power

Emission of CO_2 by Nuclear power plants is one of the lowest

Nuclear plants emit 0.025 kg CO_2/Kwh, natural gas and coal plants emit 0.58 and 1.04 kg CO_2/Kwh, respectively

Nuclear power is not only cheap, it is also environmentally friendly. The emissions rate of CO_2 is the lowest for nuclear plants compared to competing sources such as conventional coal and gas plants. While nuclear plants emit 0.025 kg CO_2/Kwh, natural gas and coal plants emit 0.58 and 1.04 kg CO_2/Kwh, respectively.[50]

Figure 21: Carbon Dioxide Emissions by different sources (KG CO_2/KwH)

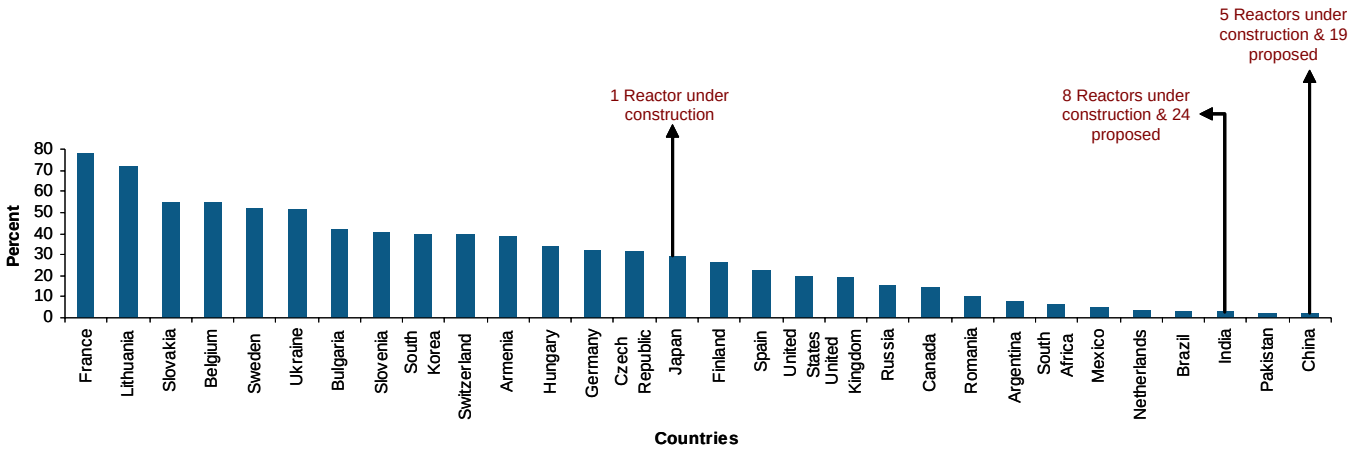


Source: J. Davidson (2000)

Currently there are 441 nuclear power reactors in operation and another 27 under construction

We expect that the world will look to countries such as France, where nuclear power accounts for almost 78% of total electricity generation. In 2003, only 19 countries were dependent on nuclear power for at least 20% of their electricity requirements.[51] Globally, at the end of March 2005, there were 441 nuclear power reactors in operation and another 27 under construction[52], which will be commissioned in the next 5-10 years.

Figure 22: Nuclear Share of National Electricity Generation (2004) and Proposed Nuclear Reactors



Source: EIA

[50] Source: J. Davidson (2000)
[51] Source: EIA
[52] Source: same as above

Nuclear Power – the Future is promising

We believe the implementation of the Kyoto Protocol, the income from carbon trading, and higher gas and oil prices, will drive the growth in demand for nuclear energy. Today 56 countries operate civil research reactors, and 30 have 440 commercial nuclear power reactors with a total installed capacity of over 360,000 MWe. Some 27 further power reactors are under construction, equivalent to 6% of existing capacity, while another 38 are firmly planned, equivalent to 10% of present capacity. Another 113 nuclear reactors are currently proposed and the list has been growing at an accelerated pace.

Nuclear Capacity to increase six fold by 2030?

Recently, Patrick Moore (a founding member of Greenpeace) stated in a Washington Post article that the world's power mix should be "reversed so that only 20 percent of our electricity is generated from coal and 60 percent from nuclear. This would go a long way toward cleaning the air and reducing greenhouse gas emissions. Every responsible environmentalist should support a move in that direction." But, in order to raise nuclear power's contribution to 60% of global electricity production (compared with 17% currently) and satisfy the estimates of power demand in the year 2030, a more than six fold increase in nuclear reactors will be required.

Figure 23: Reactors required by 2030 to satisfy 60% of estimated power demand

Current Scenario	
Current Electricity Generation through Nuclear Power	368 Gw
Current Number of Nuclear Reactors operating	441
% of Existing Reactors to be dismantled by 2030	80%
Future Nuclear Power Capacity Required	
Global Energy Demand by 2030	31,500 Twh
Expected Share of Nuclear Power in total electricity generation	60%
Expected Nuclear Energy Production Required	18,900 Twh
Total Giga Watt Required - A	**2,158 Gw**
Number of Reactors Required	
Capacity Utilization of each Nuclear Reactors - B	80%
Total Capacity Required - (A/B)	2,697 Gw
Capacity of each Reactor	1 Gw
Number of Nuclear reactors required by 2030	**2,697**

Source: World Nuclear Association, with Sprott Asset Management Estimates Added

Uranium – The Bull run to continue…

Prices of Uranium have moved up sharply from an average level of US$7-7.50 per pound in 2000 to the current level of around US$40 per pound

The price of Uranium in the last couple of years has moved up sharply from an average level of US$7-7.50 per pound in 2000 to a current level of around US$40 per pound. Given the burgeoning demand for new nuclear plants, uranium prices have the potential to rise substantially as the nuclear power market is not uranium price sensitive.

Demand to be driven by new nuclear reactors

A six fold increase in nuclear reactors to around 2,700 reactors would require around 1.3 billion lbs per annum of uranium compared to current mine production of approximately 100 million lbs per annum. It is difficult to imagine that this is realistically attainable, but

given the urgency to reduce CO_2 emissions, we believe that in the coming decades the world will make every effort to attempt to build as many reactors as possible. The supply of uranium may well be the most limiting factor. Much higher uranium prices will be required to attract enough investment capital to meet the growth in demand. Marginal mines will become the price setters. Large low cost producers may be able to reap Middle East-like oil profits for decades.

Supply would lag behind demand

Australia, Kazakhstan and Canada account for around 70% of global uranium resources

Uranium is a relatively common metal with traces of it being found in seawater and in rocks. Uranium's average abundance in the Earth's crust is 2.7 parts per million (ppm), which is comparable to other metals such as tin and tungsten.

Substantial amounts of global uranium reserves are found in Australia (34%), followed by Kazakhstan (20%) and Canada (14%). The US accounts for only about 3% of global uranium reserves.

According to the authoritative "Red Book" produced jointly by the OECD's Nuclear Energy Agency and the UN's International Atomic Energy Agency, the world's present known economic resources of uranium, exploitable at below US$80 per kilogram of uranium ($36/lb), are some 3.5 million tonnes. This amount is enough to last for 50 years at today's rate of usage – a figure higher than for many widely used metals. It is also estimated that there is an additional 9.75 million tonnes of uranium available[53] to be discovered that will be extractable at this is price. Moreover, uranium is easily removed from its host minerals. Economically extractable concentrations of uranium also occur in more than a dozen different deposit types in a wide range of geological formations. This diversity is, for example, far greater than that for oil. It means that discoveries need not be confined to a few geological settings to create a high probability that known economic resources will be replenished.[54] Even if new discoveries were made, due to high lead-times (often a decade or more) between discovery and commencement of production, supply constraints over the next 25 years would still exist. As a result, in order to meet demand uranium prices will need to rise and be sustained at high levels to encourage the investment necessary to find additional resources and make lower grade deposits economically viable.

New mining technologies have improved the supply of Uranium

The increase in uranium reserves to 3.5 million tonnes today from the level of 2.1 million tonnes a decade ago was partly due to the discovery of new fields in new countries. More importantly, it was also due to the development of improved techniques of exploitation, in particular In Situ Leaching (ISL) which permits low cost mining of resources viewed previously as unviable due to high cost. Furthermore, the advancement of technology such as breeder reactors offer the prospect of increasing the uranium resources by almost 50 times. Although these reactors are not yet economically viable, they are becoming an integral part of the energy plans for Russia, Japan, and India.

[53] Source: Greenhouse Emissions from Nuclear Energy by Ian Hore-Lacy in 'Australian Science' magazine
[54] Source: "Can Uranium Supplies Sustain the Global Nuclear Renaissance"? - WNA Position statement

ALTERNATIVE USES OF COAL

Coal used in Power Plants

Burning coal results in significant carbon emissions in the atmosphere and is one of the leading causes of global warming

Coal is the primary fuel used in power plants worldwide to generate electricity. However, the burning of coal results in significant carbon emissions into the atmosphere and is one of the leading causes of global warming. Coal is said to have greater environmental impacts than any other energy resource.

A coal plant having a 500-megawatt capacity produces 3.5 billion kilowatt-hours per year of power. Such plants are large enough to provide electricity to a city of about 140,000 people. However, in the process of generating electricity the typical plant burns 1,430,000 tons of coal, uses 2.2 billion gallons of water, and 146,000 tons of limestone.[55] The following table highlights the key pollutants emitted by a coal plant and the adverse impact it has on the health of humans.

Figure 24: Side effects of a coal plant

Pollutant	Quantity released (tons)	Adverse Impact to health/environment
Carbon Dioxide	3.7 million	Carbon dioxide is the main greenhouse gas and is the leading cause of global warming
Carbon monoxide	720	Also contributes to global warming
Sulfur dioxide	10,000	It is the main cause of acid rain which damages forests, lakes and buildings
Nitrogen oxide	10,200	Causes acid rain
Small particles	500	Causes lung damage
Hydrocarbons	220	Causes smog in the atmosphere when fossil fuels which contain hydrocarbons are not burnt completely and are released into the air

Source: Union of Concerned Scientists

Though coal is a substantial pollutant, its reserves are greater than those of oil and gas reserves combined. Because it is one of the cheapest resources for producing electricity, research efforts continue to experiment with ways to process coal using alternative technologies. Coal can be processed to produce hydrogen as well as liquid fuels.

Coal can also be used to produce hydrogen

Alternative uses of coal

As well as being used as a fuel to generate electricity, **coal can also be utilized to produce hydrogen and cleaner burning diesel.** However, the carbon emissions associated with producing hydrogen from coal must be dealt with. With emerging carbon capture technologies, energy can be extracted from coal in various forms while preventing significant pollution of the atmosphere.

[55] Source: Union of Concerned Scientists

Gasification – A Clean Coal Technology

Integrated gasification combined cycle (IGCC) process is one of the better gasification technologies that aim for higher efficiencies and lower emissions

Gasification, an alternative technology to manufacture hydrogen from coal, is one of the most efficient and cleanest available technologies. The integrated gasification combined cycle (IGCC) process is one of the better gasification technologies that aim for higher efficiencies and lower emissions. Gasification technology is an alternative to the combustion process used in conventional coal-fired power plants. Gasification technology involves processing the coal and converting it into a synthesized gas, which can then be used to produce electricity, hydrogen, or liquid fuels.

Although gasification with CO_2 sequestration remains an expensive proposition compared to alternative ways of producing electricity, fears of global warming and government regulation will drive the adoption of this technology. The Kyoto Protocol is likely just the first small step on the path of increasing regulation. If CO_2 sequestration is mandated through regulation, then a coal gasification plant will produce electricity at a cost that is 20% lower than a conventional coal-powered plant modified with carbon capture technologies.[58] It is evident that gasification, if used with carbon capture technologies, can result in lowering the cost of producing electricity and at the same time can result in reduced carbon emissions. As this technology continues to evolve it may prove to be one of the cheapest and most effective ways of fueling a hydrogen economy in years to come.

Carbon Capture Technologies

Carbon capture technologies can result in a 65-95% reduction in power plant emissions

Carbon capture technologies, also known as carbon sequestration, can be used to capture carbon dioxide produced from the combustion of fossil fuels in power plants and can result in reduction of electricity plant emissions of between 65 to 95%.[56] This process involves the capturing of carbon dioxide by separating it from a gas stream and subsequently storing it. Germany is among the leading countries that are trying to develop carbon sequestrations and carbon storage technologies.

However, the carbon capture technology faces certain challenges, which need to be overcome for it to be deployed on a global scale. The technology is still very expensive and the costs need to be brought down to an affordable level for its mass use. In addition, carbon dioxide storage faces certain technical and regulatory issues associated with ensuring safe operations.[57]

Coal-to-Liquids (CTL)

Coal-to-liquids is a technology which is used to convert coal to liquid fuels. There are two primary methods to convert coal into transportation fuels and liquids. The first method is known as Indirect Coal Liquefaction (ICL). This method converts coal to produce syngas, which contains carbon monoxide and hydrogen. This syngas is then processed chemically to produce a variety of different fuels. The second method is Direct Coal Liquefaction (DCL). It is the process of breaking coal into smaller components, which in turn react with hydrogen under high temperature and pressure to produce a syncrude that can be further refined to produce clean liquid fuels. The conversion efficiency of DCL is greater than that of ICL and requires higher quality coal. China's first two CTL plants, which will use the DCL process, are expected to be built at a cost of US$2.5 - US$3 billion each and are expected to produce 70,000 – 80,000 barrels of fuel per day.[58]

[56] Source: Australian Bureau of Agricultural and Resource Economics (ABARE), a professionally independent government economic research agency
[57] Source: Tomorrow's Energy – A perspective on Energy Trends, Greenhouse Gas Emissions and Future Energy Options, ExxonMobil
[58] Source: Article from fin24.co.za by Justin Brown

CTL is economically competitive with an oil price in the low to mid-$40 per barrel range and a coal cost in the $1 to $2 per million Btu range, depending on coal quality and location[5]. Given the economies of scale required, 30,000 barrels per day is regarded as a minimum plant size[5]. Coal reserves of approximately 2 to 4 billion tons are required to support a commercial CTL plant with a capacity of 70,000 to 80,000 barrels per day over its useful life[5]. Capital expenses are estimated to be in the range of $50,000 to $70,000 per barrel of daily capacity.[59]

Alan Goldman, a professor of Chemistry at Rutgers University, has recently discovered that you can produce diesel from coal using chemicals alone. This new technology may lead to a significant increase in the efficiency of converting coal to diesel as more of the coal hydrocarbons can be converted. Goldman stated, "This is not your grandfathers diesel. These don't produce that sooty nasty matter. It is cleaner and you get 30 percent more miles per gallon."[60] Investment in harnessing coal energy in climate friendly ways is on the rise, ensuring that coal will continue to play a large role in the global energy mix of the future.

[59] Source: Energy outlook 2006, EIA/DOE (World Fuels Today, December 22 2004)
[60] Source: KFDX News - Diesel From Coal (April 30, 2006)

HYDROGEN – A CLEAN FUEL BUT NOT AN ENERGY SOURCE

Hydrogen is considered to be a promising energy carrier, having the potential to make vehicles fuel-efficient as well as emission-free

Hydrogen is considered to be a promising energy carrier. It has the potential to make vehicles fuel-efficient as well as emission-free. Using fuel-cell technologies, hydrogen can be used to power any electrical equipment including electrical motors, consumer electronics and electrical equipment in homes. It can even be stored to be used later, a benefit which electricity does not provide. Besides these benefits, hydrogen can be produced from multiple energy sources. As Hoffman writes in his book, *Tomorrow's Energy: Hydrogen, Fuel Cells and the Prospects for a Cleaner Planet* (MIT Press), hydrogen can "propel airplanes, cars, trains and ships, run plants, and heat homes, offices, hospitals and schools…. As a gas, hydrogen can transport energy over long distances, in pipelines, as cheaply as electricity (under some circumstances, perhaps even more efficiently), driving fuel cells or other power-generating machinery at the consumer end to make electricity and water. As a chemical fuel, hydrogen can be used in a much wider range of energy applications than electricity."

Though hydrogen is found everywhere on earth it does not occur naturally in a pure form and hence needs to be produced from water or hydrocarbons. Currently, nearly half of the hydrogen produced in the world is derived from natural gas by way of a steam reforming process[61]. The process involves the reaction of steam with natural gas in a catalytic converter that splits the hydrogen atoms away leaving carbon dioxide as the byproduct[7]. Hydrogen can also be produced via the coal gasification process but this process is usually more expensive than using natural gas[7]. Hydrogen can also be processed from gasoline or methanol but again the carbon dioxide emission remains a big disadvantage[7].

Hydrogen enjoys the following advantages:

- Hydrogen has the highest energy content per unit of weight compared to other known fuels.
- It produces effectively zero emissions when it is burned in an engine. When powering a fuel cell its only waste is water.
- Hydrogen can be produced from abundant domestic resources including natural gas, coal, biomass, and even water.

Limitations

Hydrogen can be thought of like electricity and as such requires a primary energy source in its production. Hydrogen does not occur naturally in a pure form and hence needs to be produced first from water or hydrocarbons. This requires the use of energy generated from primary sources such as oil, gas, coal, nuclear or renewables[62]. This would mean that any evaluation of hydrogen to be used as a transportation fuel, needs to be analyzed in terms of cost and the greenhouse gas (GHG) emissions involved in its production and distribution as well its consumption.

On a per km basis, the cost of production and distribution of hydrogen results in a fuel cost which is higher than gasoline

On a per kilometre basis, the cost of production and distribution of hydrogen results in a fuel cost that is higher than gasoline. According to an analysis by the National Academy of Engineering (NAE), the cost of fueling a hydrogen vehicle is between 1.9 and 15 times greater than a gasoline hybrid, depending on how the hydrogen is produced.[63] Going forward, it remains to be seen whether R&D can succeed in lowering these costs to a competitive level.

[61] Source: The Hydrogen Economy: The Creation of the Worldwide Energy Web and the Redistribution of Power on Earth, by Jeremy Rifkin
[62] Source: Tomorrow's Energy: A Perspective on Energy Trends, Greenhouse Gas Emissions and Future Energy Options
[63] Source: The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs, The National Academies Press, 2004

With respect to carbon dioxide emissions, a number of studies have concluded that hydrogen-run vehicles result in an 11-35% reduction in CO_2 emissions compared with hybrid technology.[64] This reduction is on top of the estimated 29% CO_2 improvement that hybrid cars offer compared to conventional combustion engines.[65]

There is also increasing interest in using renewable energy to make hydrogen, as this is the only option that would result in "zero emissions" transportation systems[6]. However, there are limitations with prohibitively high costs when hydrogen is produced from renewable energy. The NAE estimates that hydrogen is five times more expensive than gasoline when produced from wind and 15 times more expensive when produced from solar energy.[66]

The technologies available to produce hydrogen, though commercially viable, remain expensive. Hydrogen production in substantial quantities is unlikely before 2030 in the absence of a cheaper technological medium to produce it.[67] At this time it appears that coal and nuclear are the leading candidates for hydrogen fuel production.

[64] Source: General Motors/Argonne National Laboratory: Well-to-Wheel Study, June 2001; General Motors/LBST: Well-to-Wheel Study, September 2002; Concawe/EUCAR, EU joint Research Centre, December 2003
[65] Source: Merrill Lynch: Energy Security & Climate Change, Investing in the Clean Car Revolution, June 2005
[66] Source: The Hydrogen Economy: Opportunities, Costs, Barriers and R&D Needs, The National Academies Press, 2004
[67] Source: Energy outlook 2006, EIA/DOE

RENEWABLE ENERGY

As the world faces concerns over the increased emissions of greenhouse gases and the eventual peaking of world oil production, greater focus will be directed to the areas of renewable energy resources. Renewable energy is produced cleanly from natural sources. Apart from the fact that they are non-depletable, renewable energy resources used in generating electricity will also result in little or no greenhouse gas emissions compared to fossil fuels. It is worth noting that in 2004 approximately US$30 billion was invested in the renewable energy sector which contributes only 160 gigawatts (GW), or approximately 4%, of global power capacity.[68] There are four primary sources of renewable energy – solar, wind, hydropower, and biomass.

Solar Energy

Solar energy, or power from the sun, is a clean, efficient and sustainable form of energy. It is a renewable resource and is found in abundance almost everywhere. This form of energy can be used in both a direct and indirect manner. Plants store the sun's energy when they grow. This energy is released in the form of heat when the plants are burned and is an example of the indirect use of solar energy. The direct form of solar energy is the one used by humans. This form involves converting the sun's rays into an energy source, which in turn becomes electricity. This conversion from solar power to electricity is achieved through the use of "solar panels". There are two main ways in which solar power can be converted into energy. The first method involves using the energy of the sun to directly heat air or liquid and is known as a "solar thermal application." The second method is known as a "photoelectric application," and involves the use of photovoltaic cells to convert solar energy directly to electricity.

Figure 25: Advantages and Disadvantages of using solar energy

Advantages	Disadvantages
Solar energy is free - it needs no fuel and produces no waste or pollution	Does not work at night
In sunny countries, solar power can be used where there is no easy way to get electricity to a remote place	Expensive to build
Can prove to be an effective source of energy when the power required is low, such as solar powered garden lights and battery chargers	Can be unreliable unless the location is very sunny

Source: home.clara.net

Solar Energy remains an expensive source of energy except in limited applications.[69] Currently, the solar photovoltaic technology is significantly more expensive compared to conventional electricity generation. As such, it is estimated that grid-connected solar generation will remain less than 0.1% of total generation capacity through 2030.[70]

[68] Source: The REN21 Global Status Report
[69] Source: Tomorrow's Energy – A perspective on Energy Trends, Greenhouse Gas Emissions and Future Energy Options, ExxonMobil
[70] Energy Information Administration / Annual Energy Outlook 2006

Hydropower

Hydroelectric power is currently the largest source of renewable electricity in the world and in the US. Hydroelectricity is generated by harnessing falling water to spin turbines. Hydropower can play an important role in a future powered by renewable energy. According to a United Nations estimate, there is potential to generate significantly more hydropower in areas such as Russia, South Asia, and South America.

Figure 26: Advantages and Disadvantages of using Hydropower

Advantages	Disadvantages
Hydroelectricity comes almost free of cost once the dam is built	Expensive to build
The energy is generated without any pollution or waste	Building a large dam will flood a very large area upstream, causing problems for animals that live there
Hydroelectricity is more reliable than wind or solar power	Finding a suitable site can be difficult - the impact on residents and the environment may be unacceptable
Water can be stored above the dam ready to cope with peaks in demand	Water quality and quantity downstream can be affected, which can have an impact on aquatic plant life
Hydro-electric power stations can increase to full power very quickly, unlike other power stations	
Electricity can be generated constantly	

Source: home.clara.net

Hydropower provides 20% of the world's electricity, second only to fossil fuels

Hydropower provides close to 20% of the world's electricity, which is second only to fossil fuels[71]. Worldwide capacity is 650,000 megawatts (MW), with 14% of this in the United States, 10% in Canada, and 9% in the former Soviet Union[93]. China's Three Gorges Dam, currently under construction, will move China into fourth place, ahead of Brazil. Its hydro capacity has more than doubled since 1970.[93]

In addition, it is to be noted that small hydro projects worldwide have great growth prospects. Currently there are approximately 23,000 megawatts of small hydro capacity and more such projects are in the works in over 100 countries over the next few years[93]. China accounts for approximately 40% of the current small hydro projects and the country has a goal to generate approximately 23,000 MW of electricity by the end of the century.[93]

The case for low-impact hydropower

Large hydroelectric facilities have historically caused significant environmental damage including reservoir flooding, sedimentation, destruction of fish and wildlife habitats and greenhouse gas emissions. Small-scale hydroelectric development requires comparatively little physical space while only occasionally causing more local ecosystem damage than natural flooding, drought, and erosion that were present before the plant was built.

Biomass - Biofuels

Biomass supplies approximately 30 times more energy in the US than that provided by wind and solar power

Biomass refers to plant materials and animal wastes used for energy; specifically, forest products, agricultural residues like straw and manure, and organic matter of vegetable or animal origin. This type of energy supplies approximately 30 times more energy in the US compared to that provided by wind and solar power[93]. The primary advantage which biomass enjoys over other renewable energy sources such as wind and solar is that it can be easily stored and used when needed. In addition, it can provide a steady and uninterrupted supply of electricity and heating.

[71] Source: Union of Concerned Scientists

Figure 27: Sources of biomass and their energy products

Supply sector	Type	Examples	Energy product [a]
Forestry	Forestry by-products & wood industry	Fuel wood, sawdust, bark, black liquor from pulping operations	H, P, CHP
Agriculture	Lignocelluloses agricultural residues	Straw, stalks, and milling residues from corn and oat processing	H, CHP
	Lignocelluloses energy crops	Switch grass, reed canary grass, short rotation forestry	H, CHP
	Livestock manure	Liquid swine and dairy manure	H, P, CHP
	Oilseeds and starch energy crops	Corn, winter wheat, barley, oats, canola and soybeans	H, T
Urban organic wastes	Residues from food industry	Shells, husks, pulp, used frying oil	H, P, CHP, T
	Waste wood	Construction wood, demolition wood	H, P, CHP
	Biodegradable municipal waste	Kitchen and garden waste (KGW), organic municipal waste	H, P, CHP
	Biodegradable landfill waste	Landfill gas	P
	Sewage sludge	Sewage gas	H, P, CHP

Source: Smart Generation – David Suzuki Foundation
Note: H=heat, p=power (electricity), CHP=combined heat and power, T=transport fuel (ethanol, biodiesel)

Figure 28: Advantages and Disadvantages of Biomass

Advantages	Disadvantages
It is an inexhaustible source of energy	Can become a contributor to pollution and global warming if energy is generated using direct combustion
The environmental impact is minimum if energy is generated via fermentation, pyrolysis, etc. and not through direct combustion	In terms of cost, biomass is an expensive proposition both in terms of producing and converting it into alcohol
Alcohols and other fuels produced by biomass are efficient, viable, and relatively clean-burning	Energy from biomass is a viable proposition only if it is done on a large scale. On a small scale there is a higher probability of a net loss of energy.
Availability of biomass does not pose any problem	
Electricity can be generated constantly	

Source: home.clara.net

The countries in the world that lead the production of biomass are Finland and Sweden. Biomass accounts for approximately 19% of Finland's total primary energy supply, while in Sweden it accounts for approximately 15%. Energy generated through biomass can also be used to heat up homes in some countries. Currently, biomass contributes approximately 2% of total electricity generation while it accounts for approximately 1% of liquid fuels used in cars and trucks.[72]

Biofuels

Biofuel is defined as fuel derived from biomass and is a renewable energy source compared to other natural resources such as petroleum, coal, and nuclear fuels. Besides being a renewable resource, biofuels emit much lower carbon dioxide levels compared to gasoline. Currently ethanol and biodiesel, liquid fuels derived from organic matter, are used as biofuels to improve the supplies of gasoline and diesel fuel.

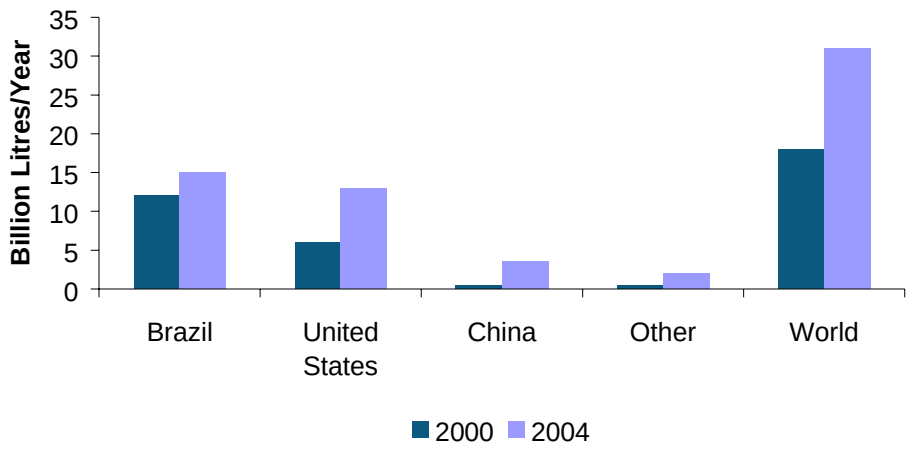
[72] Source: Union of Concerned Scientists

Ethanol is the most common biofuel and accounts for more than 90% of total biofuel usage

Ethanol is the most common biofuel and accounts for more than 90% of total biofuel usage[73]. It is usually used in low-concentration blends with petroleum gasoline. In the US ethanol is produced primarily from corn, a technology that continues to evolve. Currently the technology to produce biofuels suffers from one big disadvantage. The current technology can process only a small portion of the corn plant[74]. Going forward, ethanol from cellulose could hold great promise in terms of utilizing a much larger portion of the biomass used as input[8].

The global ethanol industry is primarily in Brazil and the US. Brazil, which uses sugar as the biosource, is the leader in ethanol production with approximately 15 billion litres produced annually. The US is second to Brazil with annual production of approximately 14 billion litres, up from approximately 4 billion litres in 1996.[7]

Figure 29: Ethanol Fuel Production, 2000 and 2004



Source: Renewable Energy 2005 – Global Status Report

Ethanol – Net energy benefit is debatable

There are opposing views regarding the net energy benefit of using ethanol as a biofuel depending on the type of crop that the fuel is derived from. A section of the researchers are of the view that it takes as much or more fossil fuel energy to create an equivalent amount of ethanol energy under some circumstances. In other words, the energy needed to run the tractors, produce the fertilizer, process the ethanol, and the energy associated with the wear and tear of the equipment used in the process may be more than the energy derived from burning ethanol. In short, the net energy benefit is negative. According to a new Cornell University and University of California-Berkeley study, turning plants such as corn, soybeans and sunflowers into fuel uses much more energy than the energy generated by the resulting ethanol or biodiesel. In these cases, using plant biomass for liquid fuel does not result in any energy benefit and therefore there is a consensus that such strategies are not sustainable[75].

[73] Source: Renewable 2005 – Global Status Report
[74] Source: Tomorrow's Energy – A perspective on Energy Trends, Greenhouse Gas Emissions and Future Energy Options, ExxonMobil
[75] Source: David Pimentel, professor of ecology and agriculture at Cornell

According to one study, turning plants such as corn, soybeans and sunflowers into fuel uses more energy than the energy generated by the resulting ethanol or biodiesel

Pimentel and Tad W. Patzek, professors of civil and environmental engineering at Berkeley, conducted a detailed analysis of the energy input-yield ratios of producing ethanol from corn, switch grass, and wood biomass as well as for producing biodiesel from soybean and sunflower plants.

Comparing the energy output with the energy input for ethanol production, the study found that:

- Corn requires 29% more fossil energy than the fuel produced;
- Switch grass requires 45% more fossil energy than the fuel produced; and
- Wood biomass requires 57% more fossil energy than the fuel produced.

Comparing the energy output with the energy input for biodiesel production, the study found that:

- Soybean plants require 27% more fossil energy than the fuel produced, and
- Sunflower plants require 118% more fossil energy than the fuel produced.

In assessing inputs, the researchers considered such factors as the energy used in producing the crop (including production of pesticides and fertilizer, running farm machinery and irrigating, grinding and transporting the crop) and in fermenting/distilling the ethanol from the water mix.

There is another view that the net energy created in using ethanol is greater than the energy used to produce it

Other forms of ethanol production such as sugarcane and palm oil are viewed as being net energy positive[76] and as a result, these forms of biofuel production are experiencing huge growth. However, the net energy equates to between 0.7-1.5 units of ethanol per unit of fossil fuel energy consumed.[9] For comparison sake, if the same one unit of fossil fuel is invested in oil and gas extraction it will yield 15 units of gasoline.[77] The point of this analysis is to highlight the relatively insignificant amount of net energy that is created by the ethanol industry, even in the best cases.

Biofuels leading to destruction of rain forests

As oil prices surge the incentive to produce energy from vegetable oils heightens. This in turn is likely to result in the increased cultivation of plants like palm and soybeans, used to make biofuels, which will cause widespread destruction of rainforests. From the orang-utan reserves of Borneo to the Brazilian Amazon, virgin forest is being razed to grow palm oil and soybeans to fuel cars and power stations in Europe and North America[78].

Rising demand for biofuels, which are also known as green energy, has resulted in an increase in the international price of palm oil. The increase in palm oil prices has lured farmers to increase the palm oil plantations with potentially serious repercussions. Palm oil is considered to be detrimental to the environment and it is believed that the expansion of palm oil production is one of the leading causes of rainforest destruction in Southeast Asia[79]. Soybean oil is considered to be a primary alternative to palm oil, but unfortunately, Soya has been the single largest cause of rainforest destruction in the Brazilian Amazon[12].

[76] Source: Study conducted by Hosein Shapouri, James A. Duffield, and Michael S. Graboski. U.S. Department of Agriculture,
[77] Source: Net Energy from the extraction of oil and gas in the United States by Cutler J. Cleveland
[78] Source: Issue 2526 of New Scientist magazine, 22 November 2005, page 19
[79] Source: Simon Counsell, director of the UK-based Rainforest Foundation

Governments the world over seem to be unknowingly encouraging the destruction of rainforests to meet the increased demand for 'green energy'. In July 2005, the Indonesian government announced the development of the biggest palm oil plantation in the world which will clear the "Heart of Borneo", the vast areas of tropical rainforests in Kalimantan.[80]

Finally, when we take into consideration the potential shortages of food crops that may result from an abrupt climate change, it is likely that governments will soon be facing a choice between feeding people and feeding SUV's.

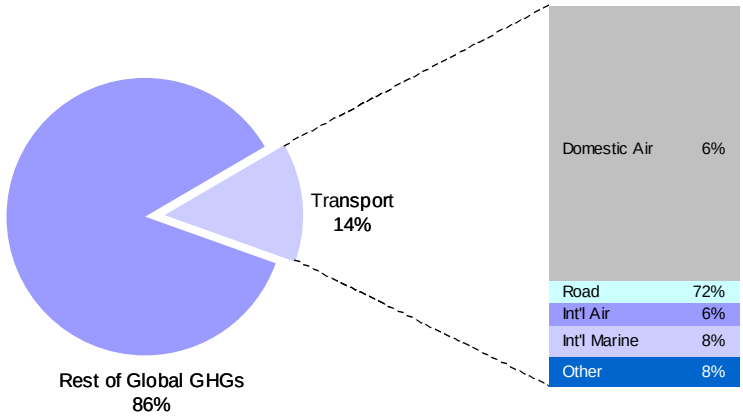
[80] Source: Climate Conundrum as Biofuel threatens rainforests, Forests.org

TRANSPORTATION

Transportation is one of the primary contributors to greenhouse gas emissions, accounting for 14% globally

Transportation is one of the primary contributors to greenhouse gas (GHG) emission accounting for approximately 14% of global GHG emissions. Within the transportation sector, road transport accounts for approximately 72% of sector emissions and approximately 10% of global GHG emissions.

Figure 30: Greenhouse gas emissions from Transportation



Source: International Administration Energy (IEA)

By 2020, the IEA expects global transport emissions to increase by 50%. Increases of about 30% are projected in developed countries (Figure 55). Much higher increases are projected in developing countries, including China (143%), India (92%), Indonesia (122%), Mexico (71%), and the Middle East (68%).

Figure 31: Forecast of CO_2 emissions from transportation

		% Change	
Country	**% of World 2002**	**1990–2002**	**Projected 2002–2020***
United States	35.5	24	30
EU-25	18.3	23	31
Japan	5.1	20	–
China	4.8	101	143
Russia	3.7	-29	49
Canada	3.0	21	–
Brazil	2.6	60	77
Mexico	2.1	21	71
South Korea	1.9	120	–
India	1.9	15	92
Australia	1.5	23	29
Indonesia	1.4	109	122
World	**100.0**	**40**	**50**

Source: IEA

*Note: CO_2 from international bunker fuels is not included. Growth rates for Russia are from 1992 (not 1990). *Projections are drawn from IEA (2004c). The projected figure for the U.S. includes Canada; Australia includes New Zealand. "–" Signifies no data.*

Hybrid Vehicles

Electric cars run solely on batteries and, compared to conventional vehicles, are expensive and suffer from limitations. The answer therefore lies in hybrids, also known as hybrid electric vehicles (HEVs), which combine an internal combustion engine with an electric motor and batteries. This combination reduces fuel consumption and emissions, providing a 90% reduction in smog pollution[81]. Though HEVs cost approximately 30-40% more than conventional vehicles, they also provide better mileage, smoother acceleration at lower speeds, and a superior driving experience when compared to conventional vehicles. In the long run these vehicles can be more economical as they provide significant maintenance and fuel savings. On the mileage front, a conventional gasoline car consumes 1 litre of fuel to run 15 kilometres, whereas the new generation HEVs can run 36 kilometres on the same amount of fuel. Another key feature of an HEV is its regenerative braking. This technique involves capturing the energy lost during braking and returning it to the battery, thereby eliminating the need for frequent charging.

The hybrid car market is accelerating and in the past five years, US hybrid sales have increased from 9,500 in 2000 to 200,000 in 2005, an increase of more than 21 times

The hybrid car market is accelerating and in the past five years US hybrid sales have increased from 9,500 in 2000 to 200,000 in 2005, an increase of more than 21 times[82]. However, this sales number still represents only 1.2% of the 17 million new cars sold in the US in 2005.[105] Going forward, the sales of hybrid cars are expected to continue doubling every year for the next few years. This could result in US hybrid car sales reaching the million mark in 2007 or 2008.[105] Again, if we compare this against the over 700 million vehicles worldwide[105], it seems that it will take decades to upgrade the global auto fleet.

Hydrogen Powered Vehicles

In December 2005, the International Energy Agency (IEA) made a forecast that, even under the most favorable conditions, hydrogen vehicles would represent only 30% of the global fleet by 2050.[105] Much like hybrid vehicles, hydrogen powered transportation will require significant time and investment to roll out in a meaningful way. In the case of hydrogen vehicles, we will need to build out the entire hydrogen production and distribution system as well as the actual vehicles themselves. Still, we feel this area remains promising and needs to be monitored for emerging investment opportunities.

Cleaner Burning Diesel

The EU has recently backed a move to use cleaner burning diesel, which can be produced from natural gas (GTL) or coal (CTL). While this is cleaner, it is not a perfect solution. Fortunately, a significant impact on emissions can be realized due to the quickness with which this initiative can be implemented. It is believed that we can quickly switch over public transportation to use 'clean diesel' in order to reduce CO_2 emissions and city smog.

[81] Source: Electric and Hybrid Vehicles in Asia Pacific, by Frost and Sullivan

[82] Source: The Top Ten Hybrid Myths by Bradley Berman– BusinessWeek Online published in February 2006

INFLATIONARY ENVIRONMENT

Costs of avoiding or dealing with abrupt change will be inflationary.

If abrupt climate change were to occur, it would impose large destabilizing costs on the world economy. Governments will be forced to engage in massive deficit spending to fund prevention, while struggling to deal with real time consequences. Areas of concern include agriculture, forestry, rising sea levels, health, water resources, energy systems and human settlements. It is clear the magnitude of change and its consequential fallout will be severe. Nothing, including famines, water wars, water refugees or catastrophic disasters can be ruled out. In such a scenario, the most serious threat to livelihood and investments would be inflation. Inflation could spiral out of control as severe resource scarcity becomes commonplace. **Central bank funded deficit spending on commodity intensive infrastructure projects may combine with a litany of supply disruptions to push us into a hyperinflationary environment.**

In a commentary on East Asian economies, the World Bank has noted that climate change will significantly affect the GDP of countries in the region. The fact that the region's mega cities are located on the coast is cited as the prime reason for their vulnerability to a rise in sea levels and weather related disasters. The loss of livelihood, not to mention loss of life in the millions, could threaten these economies[83]. Since Asian governments are the world's largest holders of US dollar reserves, we can expect that they will seek to spend these reserves in an effort to combat the negative effects of global warming. We are already witnessing a growing number of governments planning strategic stockpiles of various commodities. In May of 2006 the Chinese government announced their intent to build up strategic reserves of uranium, copper, aluminum, and other commodities. The disgorging of US dollar reserves to build stockpiles of 'real things' by central governments could trigger a mass exodus out of low yielding bonds the world over. If the past is any indication, every fiat currency in the history of the world has ended up being destroyed by hyperinflation at one time or other.

Dealing with abrupt change

Stress on the carrying capacity of economic and ecological systems could spawn large-scale violence and disruptions

Stresses created by abrupt changes in climate could increase the level of violence and disruption in the global economy[84]. This scenario assumes that resource constraints and environmental challenges will lead to inter-state conflict. Violence levels will likely be exacerbated well beyond what we have experienced during past commodity shortages due to the fact that the capacity of the global ecosystem to support the current human population will be challenged under an abrupt climate change scenario.

There are many reasons why such a scenario could unfold. One is that there are only six key grain-growing countries in the world. Grain production, however, will come under severe pressure as a result of climate change. Rising populations would also reduce per capita availability of food as higher temperatures reduce agricultural yields. The result would be soaring grain prices.

Climate change would also increase the proportion of regions that suffer from water scarcity. That would lead to increased government expenditures globally on sourcing and supplying drinking water.

Energy demand would soar as a result of regional cooling, for example in Europe. In addition, the use of energy by developing countries would rise as urbanization takes effect. The supply of energy to meet the soaring demand would be scarce. Just this past winter, there have been countries that export natural gas in Europe cutting shipments to satisfy their own needs. These export dependent countries, literally frozen in the cold, faced loss of life and economic hardship as energy prices soared and power was interrupted.

[83] Source: Reuters report dated March 30, 2006 quoting World Bank
[84] Source: Environmental Defense, an advocacy group and a report on abrupt climate change scenario envisaged by Peter Schwartz and Doug Randell for the Pentagon

Finally, the human population will have to deal with more catastrophic events such as hurricanes, excess rainfall, flooding, and drought. The costs of such catastrophes will rise significantly. The replacement of capital stock lost in such weather events and the relocation of people affected will impose severe costs on governments and taxpayers.

Return of accelerating inflation

With food, water, and energy supplies put under severe stress, the political climate will worsen. Regional migration due to extreme weather events could create internal security problems. Refugees from across the border could threaten national security. Preservation of national sovereignty would take priority leading to an increase in defense expenditures. Soaring grain prices, increased investments for water and energy, and a higher outlay to deal with catastrophes and defense expenditures would put the budgets of governments under intense strain.

There would also be the problem of private debt. A substantial proportion of borrowers from the private sector – households and corporations alike – might be forced to default. Governments would then be forced to intervene to ensure banks and insurance companies do not sink. In turn, budget deficits, which now threaten even developed countries, could become larger and larger. Deficit financing would haunt the global economy with greater force. Central banks would likely be forced to flood the money system with increasing amounts of liquidity.

Gold, in particular, will be in demand as faith in currencies such as the dollar, euro, and yen decline. For thousands of years people have viewed gold as money. We believe gold is destined to resume its monetary role as fiat currencies face the destruction of their purchasing power. (Please see http://www.sprott.com/metal.php for insights into our precious metals outlook.)

Clearly, the threat of crossing the "point of no return" looms large. Ignoring the global consensus on emission restrictions, and the emerging evidence of how climate has already changed in some regions, make it necessary to plan for the worst. As a Swiss Re executive stated it in a report, "Global warming has accelerated from a problem that might affect our grandchildren, to one that could significantly disturb the social and economic conditions of our lifetime."[85]

[85] Source: A March 2006 CERES report, 'Corporate Governance & Climate Change: Making the connection' quoting Richard Murray, Chief Claims Strategist, Swiss Re

GLOBAL WARMING – THE BOTTOM LINE

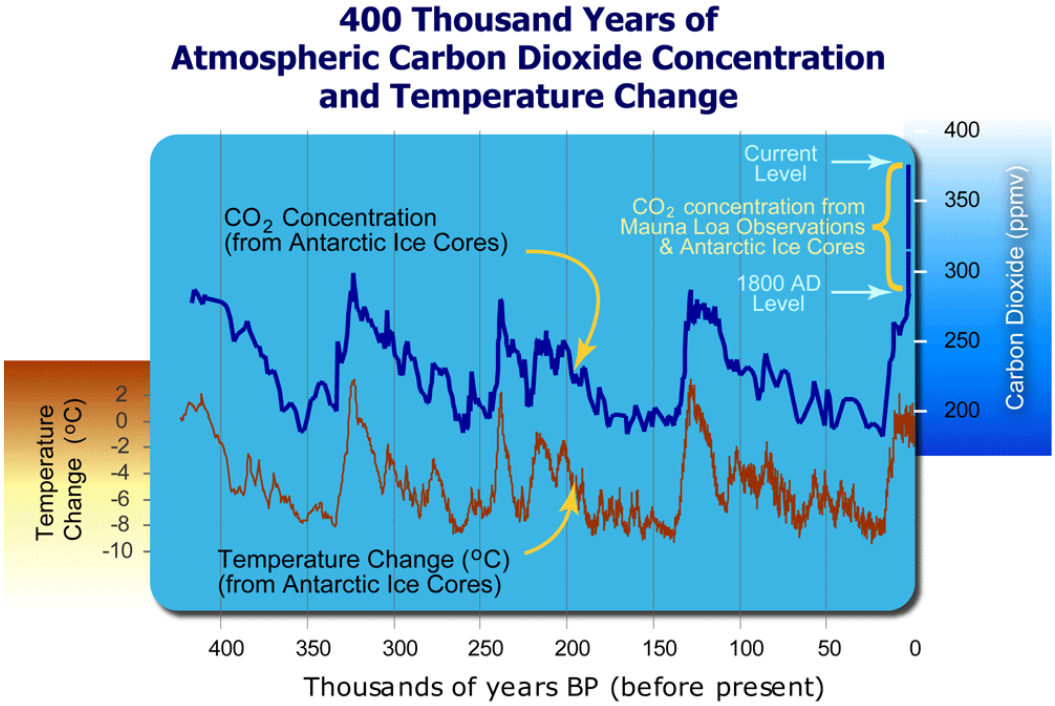
In 1975, Sir James Lovelock outlined his vision of Earth as an ultra-stable system operated automatically and unconsciously by the living organisms constituting its biosphere. This self-organizing behaviour would be manifested in the form of stable global temperatures and chemical compositions. Such a self-organizing system, consisting of the Earth and its biosphere, atmosphere, oceans and soil, was collectively referred to as Gaia.

Lovelock's arguments were based on constant global temperatures and constant ocean salinity that was in evidence then. Comforting as this vision may be, it does not represent reality now. Lovelock himself has taken up the cudgels against global warming. Global warming, in his view, is the response of our outraged planet. We are effectively at war with the Earth.[86]

Lovelock also frets that only a catastrophe would prompt the world to tackle the threat of climate change. Catastrophic climate change can no longer be deemed an alarmist point of view. With each passing year, the carbon dioxide dumped into the atmosphere sets a new record for greenhouse gas levels. Extreme weather events are now providing a glimpse of what it would be like to live in a world enveloped by a carbon-rich atmosphere. The acceleration in global warming in 2004 and 2005 has enhanced the probability of abrupt climate change. There is not one aspect of human life that will be left untouched by sudden changes in climate.

Just as a pot of water placed on a stove takes time to react to the heat from the element, a lag time was to be expected as the vast waters of the ocean take time to warm. Greenhouse gas levels have already been pushed to levels that ensure further planetary warming as well as serious environmental consequences that are as yet not fully understood. Hence, we are playing with fire as we push greenhouse gas levels up to well beyond the range of the last 400,000 years.

Figure 35: Intricate link between greenhouse gases concentration and temperature established



Source: NOAA, Michael Ernst, The Woods Hole Research Center,

[86] Source: BBC report dated June 3, 2004

To put in perspective the time span of the 400,000 years covered by the above chart, consider that humans have only been farming for 10,000 years. Further consider that the majority of anthropologists believe that our species, Homosapiens, originated in the African savanna 250,000 years ago. We colonized Europe 40,000 years ago and colonized the Americas a mere 10,000 years ago.[87] Currently, CO_2 and methane levels are respectively 30% and 130% higher than at any time in the past 650,000 years. Since industrialization, they have been increasing 200 times faster then ever before.[88]

Already, the detrimental effects of an accelerated warming trend are everywhere. For those that still have doubt, consider that a "Science Magazine survey of all peer-reviewed studies on climate change showed that of the 928 independent studies done to date, (those not paid for by industry) all concluded that global warming is a real and growing threat. There are no independent studies saying otherwise. Yet stories sampled from newspapers, television and magazines, show that 53 percent suggest global warming is unproven."[89]

If we truly are at the dawn of abrupt climate change, the prognosis is dire for almost all traditional asset classes. But there are also investment opportunities and the potential to add significant returns. Individual weather events are impossible to predict, and many of the more devastating effects of climate change will only be felt over the years and decades to come. But factual awareness is clearly on the rise as global warming concerns get thrust from the periphery to the mainstream of capital markets. The global warming theme will need to be factored into investment decisions going forward.

We encourage the reading of the quotes and articles listed in the *Appendix: Articles of Interest* section.

[87] Source: Wikipedia, Templeton, Alan (2002). "Out of Africa again and again" Nature 416: 45 - 51
[88] Source: BBC News, Black, Richard (Nov 2005). "CO2 'highest for 650,000 years"
[89] Source: Bloomberg, Carlson, Margaret (May, 2006). "Here's to Al Gore and `An Inconvenient Truth'

APPENDIX – ARTICLES OF INTEREST

Date	Title	Publication	Quote	Link
16-May-06	Global warming turns pristine coral into rubble	The Independent	Scientists said the findings showed that rising global sea temperatures could have a more devastating impact on the world's tropical corals than previously thought. "Some of the reefs have collapsed to almost mobile beds of rubble. They are no longer solid structures and some have been overgrown with fleshy green mats of algae,"	http://news.independent.co.uk/environment/article485006.ece
16-May-06	Saudi Arabia's Entry into Nuclear Will Accelerate the Uranium Renaissance	Stock Interveiw.com	In Japan, ten desalination facilities are linked to pressurized water reactors producing electricity. The International Atomic Energy Agency is working closely with about 20 countries to implement dual-use nuclear reactors, which would also desalinate water.	http://www.stockinterview.com/journal.html
16-May-06	Over 60 per cent of winter wheat is lost to drought in parts of China, UN says	UN News Center	A prolonged drought has left hundreds of reservoirs dry and tens of thousands of wells with little or no water in western and northern China, wiping out nearly two thirds of the winter wheat in the worst-hit areas and reducing spring planting, the United Nations Food and Agricultural Organization of the (FAO) said in a new alert.	http://www.un.org/apps/news/story.asp?NewsID=18497&Cr=china&Cr1=
15-May-06	Seafloor methane and runaway global warming	Planet Save	Human are emitting CO2 up to a hundred times faster than the volcanic eruptions that likely triggered past runaway global warming episodes (and 30 times faster than what triggered the end-Permian, which resulted in the death of most life because of oxygen deprived ocean depths).	http://planetsave.com/ps_mambo/index.php?option=com_content&task=view&id=7161&Itemid=69
15-May-06	West's failure over climate change 'will kill 182m Africans'	The Independent	It estimates that a "staggering" 182 million people in sub-Saharan Africa could die of disease directly attributable to climate change by 2100. Many millions more face death and devastation from climate-induced floods, famine, drought and conflict.	http://news.independent.co.uk/environment/article484097.ece
10-May-06	Corn fields fuelling U.S. quest for energy	The Globe and Mail	Alternative fuels burn more energy than they produce, researchers said at Cornell University and University of California-Berkeley last summer. The study found it takes 29 per cent more fossil-fuel energy to turn corn into ethanol than the amount of fuel the process produces. And the millions in government subsidies that support bio-fuel production mask the true cost, researchers said.	http://www.theglobeandmail.com/servlet/story/LAC.20060510.IBETHANOL10/TPStory/?query=ethanol
10-May-06	Salmon stocks dive as 'climate change bites'	The National Website of Wales	Rob Evans, from the Environment Agency fisheries, said the main reason for the worrying decline of salmon stocks across Central and Northern Wales was climate change in the north-eastern Atlantic.	http://icwales.icnetwork.co.uk/0100news/0200wales/tm_objectid=17055089&method=full&siteid=50082&headline=salmon-stocks-dive-as--climate-change-bites---name_page.html
10-May-06	Witnessing climate change in Russia's Far East	Pandra.org	Winter was beginning a full two months later. He said that while the winter frosts had previously begun in September, they were now really only taking hold in November. Magtagin, and many other survey participants, also noted the frequent occurrence of weather phenomena that either did not occur previously, or occurred only very rarely.	http://www.panda.org/news_facts/newsroom/index.cfm?uNewsID=67580
2-May-06	Climate change causes Tibet's glaciers to melt faster	Science News	Global warming is causing Tibet's glaciers to melt faster than expected at a rate of 7 % annually, triggering droughts, expanding desertification and increasing sandstorms in China	http://science.monstersandcritics.com/news/printer_1160152.php
2-May-06	Climate change science stands up to scrutiny, says Fitzsimons	The New Zealand Herald	"There are some very entrenched vested interests that don't want to change ... they're just not credible any longer," she said. "Supposing the skeptics were right, what would we have lost by trying to prepare to reduce our greenhouse emissions?"	http://www.nzherald.co.nz/category/story.cfm?c_id=39&objectid=10379856
2-May-06	The Global Warming Denial Lobby	The Tyee.ca	APCO specialty is supporting rogue scientists who are financed by industry and purport to challenge established scientific thinking.	http://thetyee.ca/Mediacheck/2006/05/02/PaidtoDenyGlobalWarming/
1-May-06	Drought in China affects 10 million	The Hindu	China is suffering sustained drought as over 10 million people have been facing drinking water shortage since mid-April	http://www.hindu.com/2006/05/01/stories/2006050100311500.htm
30-Apr-06	Diesel From Coal	KFDX	For years, coal has been turned into diesel fuel, but there is a large part of that you can't use and it is usually burned. Alan has found a way to salvage that and turn it into clean diesel fuel.	http://www.kfdx.com/news/default.asp?mode=shownews&id=11713

27-Apr-06	10 states sue EPA over global warming	The Mercury News	Ten states fired a new legal salvo at the federal government Thursday in a long-running court battle over global warming and pollution from power plants. The states,...sued the Environmental Protection Agency over its decision not to regulate carbon dioxide pollution as a contributor to global warming.	http://www.mercurynews.com/mld/mercurynews/news/politics/14445933.htm
26-Apr-06	Strapped insurers flee coastal areas	USA Today	With the 2006 hurricane season starting in just five weeks, many home insurers from Texas to Florida to New York are canceling policies along the coast or refusing to sell new ones out of fear of another catastrophic storm.	http://www.usatoday.com/weather/news/2006-04-25-hurricane-usat_x.htm
25-Apr-06	Global warming behind record 2005 storms: experts	Reuters UK	The record Atlantic hurricane season last year can be attributed to global warming, several top experts, including a leading U.S. government storm researcher	http://today.reuters.co.uk/news/NewsArticle.aspx?type=scienceNews&storyID=2006-04-25T025301Z_01_N24341281_RTRIDST_0_SCIENCE-ENVIRONMENT-HURRICANES-DC.XML
24-Apr-06	Bush Faces Dissent From Republicans on Climate Change	Bloomberg	``Resistance to action on climate change is crumbling,'' says Reid Detchon, an Energy Department official under former President George H.W. Bush who is now head of energy and climate at the United Nations Foundation	http://www.bloomberg.com/apps/news?pid=10000100&sid=atNDDfPMAanE&refer=germany
24-Apr-06	Cyclone Monica could be largest hurricane hitting Australia: expert	China View	A category five cyclone which is expected to hit Northern Territory of Australia later Monday could be the most intense one Australia has ever seen, according to meteorologists.	http://news.xinhuanet.com/english/2006-04/24/content_4467773.htm
17-Apr-06	While Washington Slept	Vanity Fair	If global warming isn't halted, rising sea levels could submerge coastal cities by 2100. So how did this virtual certainty get labeled a "liberal hoax"?	http://www.vanityfair.com/features/general/articles/060417fege07
16-Apr-06	Going Nuclear: A Green makes the case	Washington Post	Nuclear energy is the only large-scale, cost-effective energy source that can reduce these emissions while continuing to satisfy a growing demand for power. And these days it can do so safely.	http://www.washingtonpost.com/wp-dyn/content/article/2006/04/14/AR2006041401209_pf.html
11-Apr-06	Wheat Prices Rise as Drought in U.S. Great Plains May Cut Crop	Bloomberg	Wheat prices in Kansas City extended a 41-month high on speculation spring rains will not be able to reverse damage to crops after five months of unusually warm, dry weather in U.S. Southern Great Plains.	http://www.bloomberg.com/apps/news?pid=10000081&sid=akGZ7NK6.pUM&refer=australia
10-Apr-06	James Lovelock's Latest Book Rejects Renewables, Endorses Nuclear Energy as the Only Viable Energy Source	Stock Interview.com	"There is no sensible alternative to nuclear power if we are to sustain civilization." - James Lovelock, preeminent world leader in the development of environmental consciousness	http://www.stockinterview.com/journal.html
6-Apr-06	Drought delays spring plowing, planting	Shanghai Daily	A widespread drought, lasting several months, has hit 13.87 million hectares of farmland, delaying spring plowing and sowing.	http://www.shanghaidaily.com/art/2006/04/06/259222/Drought_delays_spring_plowing__planting.htm
6-Apr	Winter Sea Ice Fails to Recover, Down to Record Low	Physorg.com	Scientists at NSIDC announced that March 2006 shows the lowest Arctic winter sea ice extent since the beginning of the satellite record in 1979	http://www.physorg.com/printnews.php?newsid=63552889
6-Apr	Scientists detect massive rivers under Antarctica	Physorg.com	British scientists have discovered rivers the size of the Thames in London flowing hundreds of miles under the Antarctica ice shelf	http://www.physorg.com/printnews.php?newsid=64754411
5-Apr-06	Climate change leaves adverse impact on wheat produce	Hindustan Times	An Unexpected change in climate has adversely affected the yield of wheat crop here in the entire eastern Uttar Pradesh this year. Agricultural scientists believe that the total yield would fall around 25 to 30 % than expected this year.	http://forests.org/articles/reader.asp?linkid=54872
4-Apr-06	Colorado State issues updated 2006 hurricane forecast	USA Today	Today's report states that "information obtained through March 2006 continues to indicate that the 2006 Atlantic hurricane season will be much more active than the average 1950-2000 season."	http://blogs.usatoday.com/weather/2006/04/colorado_state_.html
3-Apr-06	Water crisis predicted on the Prairie	Globe and mail	Canada's Prairies will face an unprecedented water crisis in coming years due to declining river flows and growing water usage - especially in processing Alberta's vast oil sands, says a new study.	http://www.theglobeandmail.com/servlet/story/RTGAM.20060403.wwater0403/BNStory/National/home
2-Apr-06	Winter Weather Review: Temps above normal with significant fluctuations	Cattle Network	An extremely dry winter across the central and southern Plains and Southwest contrasted with persistent cold-season storminess in the North-west	http://www.cattlenetwork.com/content.asp?contentid=26944
30-Mar-06	Climate change big threat to East Asia - World Bank	Reuters Alertnet	Climate change is likely to significantly affect economies in the Asia-Pacific region, threatening the increasingly industrialized coastal belt and hurting the region's poor	http://www.alertnet.org/thenews/newsdesk/SP315128.htm
30-Mar-06	RWE plans 1 bln euro carbon-free coal power plant	Reuters	RWE plans to invest 1 billion euros in a new coal-fired power plant that will not emit carbon dioxide	http://today.reuters.com/business/newsArticle.aspx?type=naturalResources&storyID=nL30324499

24-Mar-06	Glacial Earthquakes warn of global warming	The Independent	Scientists have recorded a significant and unexpected increase in the number of "glacial earthquakes" caused by the sudden movement of Manhattan-sized blocks of ice in Greenland.	http://news.independent.co.uk/environment/article353302.ece
23-Mar-06	Glimpse to past adds weight to global warming forecasts	EurekAlert	Impact of last interglaciation shows shape of things to come	http://www.eurekalert.org/pub_releases/2006-03/uoc-gtp032206.php
23-Mar-06	Scott Pelley And Catherine Herrick On Global Warming Coverage	PublicEye Blog	He says his team tried hard to find a respected scientist who contradicted the prevailing opinion in the scientific community, but there was no one out there who fit that description.	http://www.cbsnews.com/blogs/2006/03/22/publiceye/entry1431768.shtml
23-Mar-06	Devastating floods seen from global warming	Globe and mail	If current temperature trends continue to the end of the century, Earth's climate will be warm enough to cause a massive melting of Greenland's ice sheet and a partial collapse of the Antarctic ice sheet, resulting in a global sea level rise of six metres from the torrent of melt water, according to two new research papers.	http://www.theglobeandmail.com/servlet/story/RTGAM.20060323.wenvi0323/BNStory/Science/home
23-Mar-06	Global Warming Heats Up	TIME	The climate is crashing, and global warming is to blame.	http://www.time.com/time/archive/preview/0,10987,1176980,00.html
22-Mar-06	Stronger Hurricanes tied to global warming	Discovery Channel	A 34-year trend of intensifying hurricanes has now been tied to warmer sea surface waters, which, in turn, is being caused by global warming, say scientists.	http://dsc.discovery.com/news/briefs/20060320/hurricanes_pla.html
22-Mar-06	Climate change to create African 'water refugees' - scientists	Reuters Alertnet	Climate change is expected to shrink many African rivers dramatically, triggering massive refugee movements and even war, according to scientists at the Africa Earth Observatory Network.	http://www.alertnet.org/thefacts/reliefresources/114303555233.htm
21-Mar-06	Climate Change Threatens Poor Nations	The Associated Press	Regions including Africa and South Asia - home to most of the 1.1 billion people who live without clean water - will be among the hardest hit by changing weather patterns, experts at the 4th World Water Forum said.	http://news.tbo.com/news/nationworld/MGB28K0R1LE.html
21-Mar-06	Global warming could melt your portfolio	CNN Money	Long-term investors take heed: Global warming will have a significant impact on the financial performance of companies in your portfolio.	http://money.cnn.com/2006/03/21/news/international/pluggedin_fortune/
21-Mar-06	Argentina's Floating Icebergs Worry Farmers Who Fear Flooding	Bloomberg	For scientists, the icebergs' migration underscored how global warming is disrupting weather patterns and threatening agriculture.	http://www.bloomberg.com/apps/news?pid=10000086&sid=aEnJGKhyXBkI&refer=latin_america
19-Mar-06	Rewriting the Science	CBS News	Hansen says man has just 10 years to reduce greenhouse gases before global warming reaches what he calls a tipping point and becomes unstoppable. He says the White House is blocking that message.	http://www.cbsnews.com/stories/2006/03/17/60minutes/main1415985.shtml
14-Mar-06	Gas Warning: not enough to meet demand	The Guardian	Cold weather provokes supply crisis	http://business.guardian.co.uk/story/0,1730310,00.html
14-Mar-06	Sharp rise in CO2 levels recorded	BBC News	CO2 levels now stand at 100ppm above the pre-industrial average.	http://news.bbc.co.uk/2/hi/science/nature/4803460.stm
27-Feb-06	Is America facing yet another dust bowl?	Morris Daily Herald	The exceptionally warm Atlantic waters are weakening and changing the course of a low-level jet stream that normally channels moisture into the Great Plains.	http://www.morrisdailyherald.com/main.asp?SectionID=1&SubSectionID=58&ArticleID=17343&TM=57545.85
6-Feb-06	World's largest aquifer going dry	US Water News Online	Because of heavy usage, some water experts have pronounced it one of the fastest-disappearing aquifers in the world.	http://www.uswaternews.com/archives/arcsupply/6worllarg2.html
25-Apr-05	The Climate of Man	New Yorker	Disappearing islands, thawing permafrost, melting polar ice. How the earth is changing	http://www.wesjones.com/climate1.htm

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