Stern Review- submission by Dr Andrew Dlugolecki, Visiting Research Fellow, Climatic Research Unit, University of East Anglia

The Economics of Climate Change

1.Implications for energy demand and emissions of economic growth

The best view is given by the IEA projections in "World Energy Outlook", showing that emissions will grow to such levels by 2030, that dangerous climate change will be inevitable i.e. temperatures will rise by more than 2^{o}C this century. This is true under either of two scenarios - business as usual, and "economic" mitigation i.e. ignoring the eventual damages caused by climate change, and merely implementing measures that appear justified on the basis of current, short-term costs.

It can be argued that economic growth will be seriously retarded before 2030 however, due to damage and disruption caused by unlimited climate change (see below), and local air pollution (see example of Iran below). Such effects are ignored by IEA. To the extent that that happens, emissions will not grow so rapidly as IEA foresees, and certain energy forms, particularly coal and petrol, will be restricted in usage to reduce pollution.

2 Consequences of climate change

This section examines evidence for the impacts of climate change being worse than the prevailing view that they will be "tolerable" ie capable of being adapted to, and in any event costing less than it would to modify energy consumption technology and patterns of behaviour. I do not attempt to assess the cost of adaptation, but it can be readily imagined that for some of the aspects eg migration, shutdown of the Gulf Stream, adaptation would be very costly. First I look at trends and projections for extreme events, then irreversible events, followed briefly by air pollution, before considering the economic costs and adapatation measures.

2.1 Trends and projections of extreme events

It is instructive to consider the hurricane season of 2005, and its implications for insurers, before looking at broader aspects, and then the implications of a dynamic climate for systems of all kinds.

2.1.1 The experience of 2005

2005 is set to be the costliest yet in terms of economic losses from weather-related disasters, Preliminary figures from Munich Re state that natural disasters look set to cost the global economy $200 billion in 2005, up from $145 billion in 2004 – the previous most costly year (see Figure 1). However, I believe that the true cost is around $300 billion, because the secondary effects of Hurricane Katrina, including lengthy disruption to global energy supplies, and the prolonged effects on New Orleans itself, are not properly included. Of these losses, $70 billion are likely to be borne by the insurance sector, up from $45 billion in 2004.

Climate change certainly played a part. A major factor contributing to these losses was this year's hurricane season, which saw 26 tropical storms – five more than the previous record – and, in Hurricane Katrina, the costliest weather-related disaster ever, possibly up to $200 billion in economic losses ($125 billion according to Munich Re). Hurricane Wilma, which struck Mexico, was the strongest recorded hurricane; Hurricane Vince was the most eastern and northern hurricane yet, reaching Spain in October; and tropical storm Delta became the first to hit the Canary Islands.

Climate change has raised global temperatures by about 0.7 degrees C; Summer 2005 was the hottest ever observed in the Northern Hemisphere as a whole, and this pattern continued into October , so that 2005 will certainly be close to the hottest year recorded. . World sea surface temperature (SST) has risen by around 0.5 degrees C in the last 30 years[1], and that is a crucial factor in producing and intensifying hurricanes. At the same time, there has been a doubling in destructive potential of hurricanes[2]. In fact, SST is now well above the trend line in the Gulf of Mexico and the related hurricane-active areas[3]. If human induced climate change doubled the risk of a hurricane of Katrina's intensity occurring in Louisiana, it could be argued that $100bn, half of the cost of this hurricane, was due to climate change, as in the case of the European heatwave (Stott et al, 2004).

In the case of Katrina, a particularly intense hurricane occurred in a vulnerable location. This induced a "step" effect; if the intensity had been somewhat reduced due to lower SST, then the levees would not have

[1] Webster et al
[2] Emanuel 2005
[3] realclimate

broken and the damage would have been considerably lower, which reinforces the case that global warming contributed significantly to the loss. A further push to the step effect was given by the steady annual increase in sea-level due to climate change- making storm surges all the more dangerous.

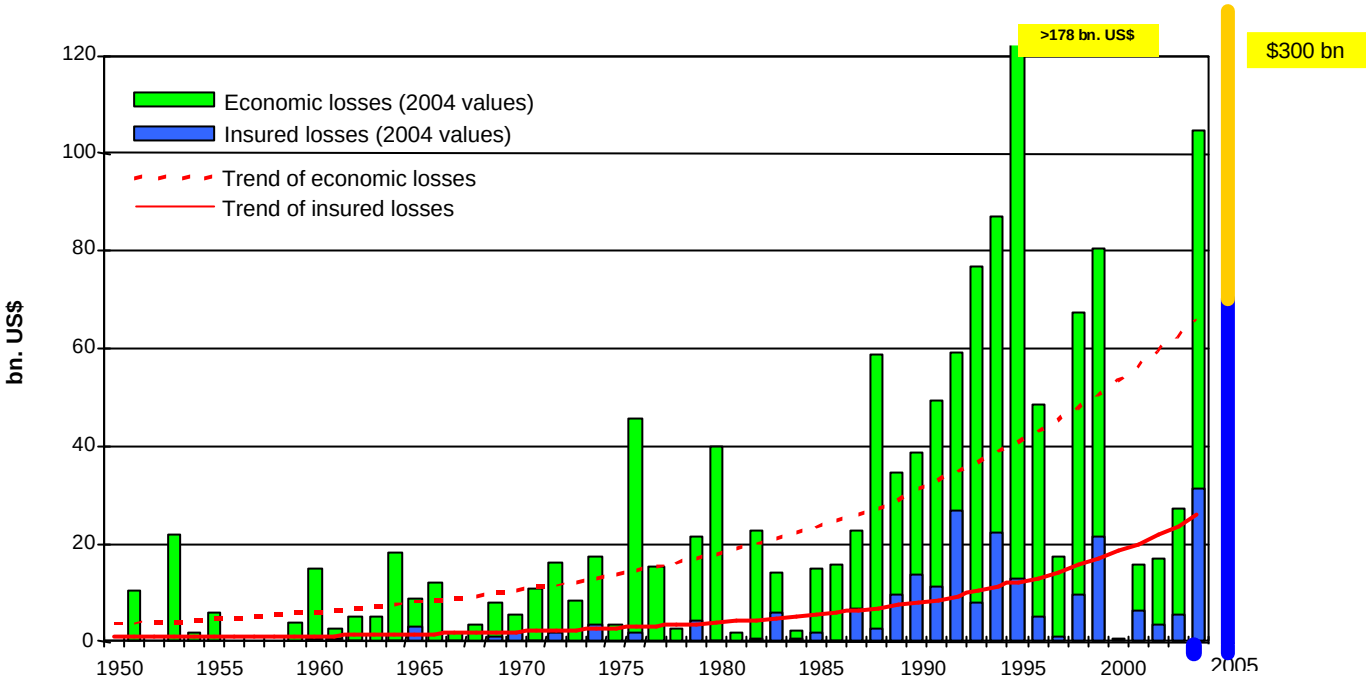


Figure 1 The cost of major natural disasters, globally 1950-2005
Source: Munich Re. 2005 estimated by A Dlugolecki. Trend lines fitted on 1950-2004 data.

100 days after Hurricane Katrina

Data are scarce, but there are enough indicators to illustrate what the residents of New Orleans are discovering upon their returns. To start with, the job market is significantly smaller. Fast-food chains may be passing out signing bonuses, but the metropolitan area has still lost more than 220,000 jobs. Vital public services are functioning selectively, which has a tremendous effect on what type of people can return. Before the storm, more than a quarter of residents relied on city bus lines; with only 10 percent of the fleet now in service, returnees need to have cars to get to jobs and shopping.

Fortunately, tourists may also be coming back. Numbers here are even scarcer, but we do know that nearl out of every two hotels and one out of every three restaurants have reopened. It is not clear how many pay customers are actually visiting, but the growing number of "open for business" placards have been a welcc sign for everyone in the bankrupt city.

In effect, New Orleans remains in a state of emergency more than three months after it was officially declared. While some people - particularly those with their own transportation and children in private schools - have been able to start remaking their homes and lives, most everyone else remains in a holding pattern. (extract, New York Times, December 7, 2005)

Whilst it is not certain that the intensity or location of Katrina, Rita or Wilma were a result of anthropogenic climate change, they do give an indication of what may happen in the future. Research predicts that the intensity and lifetime of hurricanes will increase, their location will change, and that an increase in intensity leads to a disproportionate increase in damage[4].

The “Katrina effect” of high intensity and local unpreparedness could strike other oil-producing regions: Brazil had its first-ever cyclone in 2004, Venezuela is on the fringe of the hurricane zone, and the Indian insurance industry had its largest single loss during the extreme 2005 monsoon[5], from oil-rig damage.

Even a wealthy country like USA is not immune. The estimated hurricane damage in 2005 represents 2% of USA’s current GDP. This compares to economists’ predictions that climate change will cause damage of 1.5% to 2% of gross world product by 2050-60. Apparently we are ahead of schedule.

[4] "Financial risk of climate change", Association of British Insurers (2005)
[5] Mumbai recorded 944 mm of rain in 24 hours, the heaviest precipitation ever recorded in India.

2.1.1.2 Implications for insurance industry

The global capital of the insurance industry available for catastrophe events is around $200 billion. Thus the profitability and balance sheet of reinsurers and insurers will be affected by Katrina. Lloyds' net loss is predicted to be $2.6bn, and the rating agencies have already downgraded several underwriters. If Rita had been as severe as initially predicted, some reinsurers might have faced major solvency difficulties. Future insurance for offshore energy assets will be very expensive, and claims could extend to the municipal bond guarantee market[6] .

More events of this kind are likely to lead to insurance contract exclusions, passing a further burden on society. Even sceptics of climate change believe that we are now in a phase of high hurricane intensity , which could last for 10- 40 years [7], so there is a consensus for a stormy outlook. This could lead to political pressure on insurers (e.g. in the interpretation of cover, because flood damage is often excluded[8]) and increased, retrospective legislation (e.g. in 2004, insurers were not permitted to apply deductibles to more than one loss on property damaged by sequential hurricanes in Florida). The initial reaction to Katrina was that commentators saw no difficulty in raising more capital in order to write catastrophe business at higher rates in 2006. On reflection, the points about global warming, hurricane cycles and politicians mean that insurers and investors in them should be very wary of hurricane risk.

Katrina and Rita show that economists' predictions of the impact of climate change are underestimates because damage will be highly variable, and bad years can have catastrophic, unpredictable and long-term repercussions due to the event intensity and poor disaster management. One particular issue is appropriate funding arrangements for catastrophe insurance. Catastrophe or equalisation reserves allow for the transfer to and from reserve of premiums when the actual claims differ significantly up or down from the expected norm. However, they are being phased out because of accounting harmonisation rules, since the mechanism "distorts" the reported profit. This shows a fundamental misunderstanding of the temporal pattern of catastrophes, and forces insurers to rely upon reinsurers.

2.1.2 Recent trends, future projections and key vulnerabilities relating to extreme events

Out of the vast literature I have selected a few examples to demonstrate how important extreme events could be. Evidence on floods is contradictory, because of opposing trends. Spring thaw floods are diminishing due to warmer winters, whereas intensive rainfall is becoming more extreme (Kundzewicz). Milly et al,2005 undertook a pooled study of great floods with return periods > 100 yrs on very large rivers. For 29 basins, the '100-year flood' was exceeded 21 times , with 16 of the flood events occurring after 1953 (the probability is only 1.3%). For the smaller extra-tropical subset of basins 7 out of 8 flood events were in the second half of the record: a probability of 3.5% under random occurrence.

Around the world the land-surface suffering from drought has risen from 15% to 30% in 30 years[9]. A severe summer drought occurred in Europe in 2003. It resulted from the interplay of scarce precipitation and record-high temperatures, exceeding 40^{0}C in several European countries. The heat wave in Southern Europe, accompanied by deficient precipitation, led to wild fires, problems in water supply and energy production, and crop failures. This may be a proxy of summers in a greenhouse climate, cf. Beniston (2004), Beniston and Diaz (2004), Schär *et al.* (2004), Schär and Jendritzky (2004). The event was the hottest summer for at least 500 years ,possibly 1000 or more, coming on the back of the ten hottest years since mid-19century.It is very likely that human interference has doubled the chance of such an event (Stott et al, 2004). The chance will increase 100 fold in the next 40 years. **ie an annual increase in risk of 12% !** The economic costs of 2003 are well summarised by Munich Re. – Property damage, especially in agriculture and as a result of forest fires: US$ 13bn. Other grave effects on the economy: Inland shipping (low water: cancellations and losses in cargo transportation and tourism) Industry, power plants (river water too warm, problems with cooling: production bottlenecks) Stark reduction in worker efficiency (resulting in an economic loss that is substantial but still very difficult to quantify in monetary terms). Even in sectors that usually profit from nice summers like open-air entertainment and tourist attractions, there was a shortfall in daytime receipts because it was just too hot.. The owners of cafés, ice parlours, garden restaurants, beer gardens, and swimming baths did a roaring trade though. Note that the death toll was revised to over 50,000 due to Italy's delayed assessment in 2005.

The probability of winter precipitation exceeding two standard deviations above normal will soar over large areas of Europe; over a five-fold increase is projected for parts of UK and the Baltic area, and even over

[6] Insurance Day
[7] Goldenberg et al, Science 293, 20 July 2001, The Recent Increase in Atlantic Hurricane Activity:Causes and Implications
[8] The State of Mississippi is prepapring a case against insurers, on the basis that it is unfair to consumers to exclude flood cover if it is consequent to a hurricane, which is covered under the policy
[9] A Dai, 2005/NCAR

seven-fold increase for parts of Russia. In general, many semi-arid regions are likely to suffer from decreased precipitation (e.g., Southern Africa, Australia, and the Mediterranean region). It is very likely that heavy precipitation events will increase over many areas of the globe, and it is likely that summer dryness will rise over most mid-latitude continental interiors (Cubasch *et al.*, 2001). The expected future increase of precipitation variability at the daily scale is not taken into account, so that **increases in flood frequencies are very likely to be underestimated.**

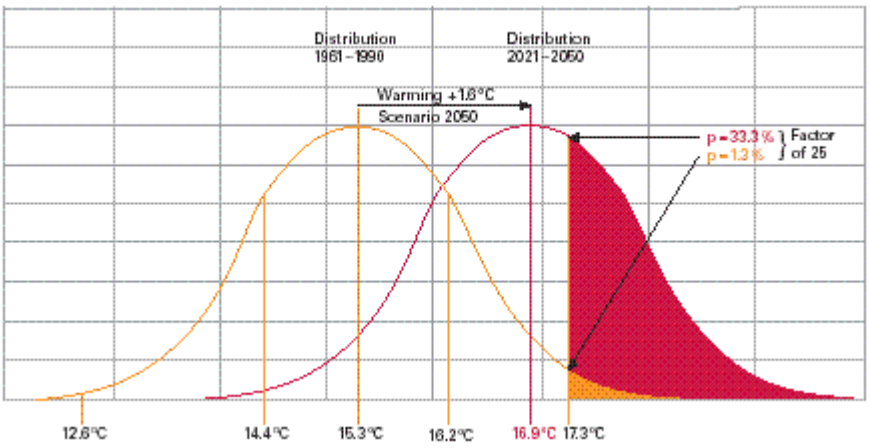
Deltas are highly sensitive to sea-level rise (SLR). Rates of SLR are double or more over the global average in many heavily populated deltaic areas, including the the Chao Phraya delta (Saito, 2001), Mississippi River delta (Burkett *et al*., 2003), and the Yangtze River delta (Liu, 2002; Waltham, 2002) because of human activities. Asia in particular has many deltaic mega-cities with over 10 million people. These deltas are all compacting under their own weight, but ground water withdrawal has exacerbated the potential for inundation of cities (e.g., New Orleans, Bangkok, and Shanghai). The construction of upstream dams and other water abstraction is now seriously depleting the supply of sediments to deltas with increased coastal erosion (Nicholls *et al.,*1999). The Changjiang sediment discharge will also be reduced by 50% after construction of the Three-Gorges Dam (Li *et al*., 2004b). For a 1 m rise in sea level, half a million square hectares of Red river delta and from 1.5 to 2 million square hectares of Mekong river delta is projected to be flooded.

In the Gambia, already there has been considerable damage to coastal infrastructure. A 1m sea level rise will result in the complete submergence of Banjul, the country's capital city, with land loss costs totalling about $217million (Gambia, 2003). The largest SLR flood danger to Los Angeles area property occurs if high tides, El Nino conditions, and storms were to coincide more frequently. By 2090, in the worst-case scenario, a 100-year flood could occur as frequently as every 3-4 years, and 500-year floods could be as frequent as every 50 years[10], putting dozens of the region's most significant infrastructure features at increased risk (Jacob *et al.*, 2001; Major and Goldberg, 2001).

2.1.3 The Implications of a Dynamic Climate

An attitude which comes up repeatedly is that recent extreme events are due to normal climatic variability. This is dangerous, because we are in a dynamic situation, which produces very rapid change in the likelihood of extreme events. Figure 2 shows the expected change in temperature distribution for UK summers due to climate change. A hot summer, like that of 1995, with a temperature of 17.3 ^{o}C was likely to occur about once in 75 years or 1.3% of the time on the climatic pattern of the period 1961-90, where the average was 15.3 ^{o}C. For the period 2021-2050, centred on 2036, the average temperature will be 16.9 ^{o}C. On that basis the chance of exceeding a temperature like 1995 will be 33.3% ie one year in three! This implies a 25-fold rise in frequency within 60 years, and the rate of change will be faster still for less frequent events. This process ids already under way, and there have been similar projections for the change in extreme precipitation. It is not possible to provide predictions for storms, but as noted earlier, we are currently in a period of high activity for the Allantic at least, so past averages are too low.

Figure 2 Change in distribution of UK summer temperatures: disjoint effect on extremes
(source Climate Change Impacts Review Group, 1991)



[10] **This means an escalation of 2.5 to 4 percent per year in the associated risk premium.**

Taking the midpoint of the two periods as representative, gives a time span of 60 years between the two patterns. To produce a 25-fold change within 60 years implies an annual rate of change of about 4.5% per year. Such a rapid change, if ignored, soon accumulates into a significant error. In five years, it means that return period calculations for the event would be 25% too low. The only reason it is not noticed soon is that the probability of the event is still quite low for the initial part of the transition time.
Nevertheless, what it means is that one can expect "surprises" to start occurring: there are many potential low probability events, so that some of them do start to occur " too often". (Of course the reverse happens at the other end of the distribution, where events do not happen as often as they should.)

The position is even more extreme, because we are dealing with a multi-dimensional, nonlinear system. The shifts can compound across factors to produce very unexpected costs - for example inland and marine flooding at the same time eg Hurricane Katrina. If events become more frequent, that will also increase the chance of coinciding with an uncorrelated event eg an earthquake, or an economic catastrophe, as happened in UK on October 17th 1987, when the 87J storm coincided with a global stockmarket crash.

Implications

- Risk assessment will be wrong, and safety margins greatly understated across a wide range of activity including flood defence, building design, water supply and health-care provision
- For insurers, given that historical data is used to set prices, the error might be in the region of 25%.
- Credit rating for vulnerable activities like energy, insurance, agriculture will be incorrect.

2.2 Irreversible events

Various "tipping points" for dangerous climate change accelerating have been proposed by Schellnhuber (see Kemp, Nature 437, 27 October), whereby a particular natural subsystem collapses, producing acclerated climate change. These all produce strong local region effects, as well as a major global effect. Perhaps the most critical for UK would be the weakening or shut down of the NATHC (North Atlantic thermohaline current ie Gulf Stream). Conventional scientific wisdom was that a slowdown of NATHC is likely during the 21st century, but subsequent behaviour is unclear. Impacts would likely occur on a global scale with a variety of consequences:at northern high latitudes relative cooling near Greenland and NW Europe, southern hemisphere high latitude warming, and tropical drying, all over limited areas (Vellinga and Wood 2002, Wood *et al*., 2003), changes in productivity of marine ecosystems (Schmittner, 2005), and of potential terrestrial vegetation (Higgins and Vellinga 2004), shifts in oceanic CO_2 uptake and oxygen concentrations (Matear and Hirst 2003; Sarmiento and Le Quéré 1996), as well as in fisheries with widespread impacts throughout Europe on precipitation, coastal flooding, agriculture and natural ecosystems (Vellinga and Wood, 2002; Wood *et al*., 2003). Other investigators have identified smaller consequences of disruption of the NATHC eg. slow warming rather than rapid cooling on the western/Northern margins of Europe and lower impacts than estimated elsewhere (Link and Tol, 2004). Even the likelihood of a collapse of the NATHC is contested (Alley *et al*., 2003; Arnell *et al*., 2005). One paper contended that the current salinity/ freshwater balance from ice melt in the Northern North Atlantic does not indicate a likely shutdown in the 21st century (Curry and Mauritzen, 2005). Most experts surveyed considered the likelihood of NATHC-type events even after 2100 to be less than 1% (Arnell *et al*., 2005). However, these sanguine views have been thrown into disarray by Bryden et al writing in Nature in December 2005: the NATHC appears to have weakened by about 30% between 1957 and 2004. This is quite unexpected , and as yet has not resulted in a perceptible brake on European temperature rise, (witness the record summer of 2003), but it does give rise to grave concern.

2.3 Air pollution

The case of the Asian Brown Haze, arising from energy combustion in India and China is well known, as is the recurrent problem of haze caused by forest fires in Indonesia during droughts related to El Nino. A recent example occurred in Tehran, Iran in December 2005, when public buildings including schools were shut for three working days and restricted -driving zones were extended, all to abate air pollution caused by road traffic primarily. In fact it is estimated that globally, the savings yielded from the clean air benefits of mitigation policies are equivalent to half the cost of meeting the Kyoto targets, because they avoid the need to implement expensive air pollution control measures. Similarly ozone inhibits plant growth perhaps amounting to six percent of crop value, or 21 billion euros per year for EU, US, and China alone. Such events are damaging to the economy in terms of lost production and ill health, but are usually ignored when assessing the cost of climate change.

2.4 Economic costs

Very little work has been done in this area. One of the major prob;lems is aggreagting costs across countries , where very different cultures and standards of living prevail. A second is of course the intergenerational problem. Is it fair to discount to zero effectively, the costs that will be borne by the next generation and their descendants, when they have no say in today's decisions, and we will not have to live with the outcomes? Changnon *et al,* 2001), in a study of U.S. national economic losses and gains due to weather variability between 1950 and 1997, found an annual average national loss value of $17.5 billion and an average gain value of US$5.8 billion (1997 dollars), about 0.2% of U.S. GDP. Energy use costs (US$4.7 billion per year) ranked highest followed by those due to hurricanes, floods, and crop losses due to temperature and rainfall extremes (not storms). A recent economic assessment using three climate scenarios for 2060 (temperature increases between 1.5°C and 5.0°C with precipitation increases of 0 to 15%) estimated a range of economic impacts from $36 billion in benefits to $19 billion in losses (Mendelsohn and Smith, 2002), about 0.1% of GDP [11]. The U.S. National Assessment in 2001 found somewhat smaller impacts (NAST (National Assessment Synthesis Team), 2001), but did not attach economic values to all identified impacts. In the light of Hurricane Katrina, which cost 1.7% of US GDP, these estimates must be seriously in question.

Results for 3 out of 4 scenarios for the UK imply an annual increase of 2 to 4% in the cost of flood damage, which will have a large impact on the medium and long-term planning of infrastructure Foresight Programme, 2004). One of the first attempts to calculate the future cost of climate-related insurance was made in 1991 (CCIRG, 1991). An update of this calculation indicated that future climate-related insurance claims in the United Kingdom might be two to three times higher than current levels by 2050 assuming no change government policy on climate adaptation (Dlugolecki, 2004) - see Table 1

Table 1. Preliminary estimates of future costs of weather insurance claims in UK
(£m, 2004 values. Source: Dlugolecki 2004, for Association of British Insurers).

	Today		**2050**	
	Annual average	**Extreme year**	**Annual average**	**Extreme year**
Subsidence	300	600	600	1,200
Storm	400	2,500	800	7,500
Inland flood	400	1,500	800	4,500
Coastal flood	-	5,000	-	40,000 (London affected)

One of the main uncertainties in this calculation is the future frequency and severity of extreme climate events because climate models do not yet provide a consistent estimation of future storm tracks and intensity. Regardless of this uncertainty, knowledge about extreme climate events is crucial for estimating future property damage. In the UK, the cost of a 1000-year extreme climate event is roughly two-and-a-half times larger than the cost of a 100-year event (Swiss Re 2002). In Germany, insurance claims increase as the cube of maximum wind speed (Klawa and Ulbrich, 2003), or a power relation of the fourth or fifth degree (Munich Re, 2002). Thus, if rare events become more common, future insurance costs will rise significantly. For example, the damage from a wind speed of 200 km/h is 0.2% of the value of insured property in Austria, to around 1.2% in Denmark (Munich Re, 2002). While insurers are able in principle to adapt quickly to new risks such as climate change, the uncertainty of future climate impacts has made it difficult for them to respond to this new threat.

The Association of British Insurers commissioned further work on economic costs (ABI,2005), which gave estimates of around +60% in the cost of tropical storms by late-century, due simply to climate change. Their estimate of a many-fold increase in flooding costs for Europe was not model-based, but by simple analogy with the Foresight Programme estimates for UK.

[11] **This seems much too low now- the 2005 hurricane season may cost two percent of US GDP, with international repercussions beyond that eg high winter fuel costs in UK.**

2.4.1 Potential social costs of climate change

Social unrest, migration and also disruption of the supply chain are not adequately modelled in climate change assessments.

more people will be harmed by climate change than benefit

In the short term, the rich north would benefit due to warmer winters, and the poor would get poorer. Thereafter even the wealthier nations would have difficulties if climate change gathers momentum, as shown in Table 2. It is a constant feature of weather disasters that the poor suffer more realtively speaking and are left in an even worse situation afterwards, because of their lack of a safety net beyond their localised extended families. A progressive increase in inequality could trigger criminal and civil disorder on a large scale.

Table 2 Macro-economic effect of climate change (source IPCC,2001)

Country type	Temperature rise	Effect
Developing	Any	Generally net economic loss , increasing as temperature rises
Developed	up to 2 oC rise	net economic gain
	from 2 to 3 oC rise	mixed or neutral
	Above 3 oC rise	net loss

For developing nations, the cost of natural disasters can be crippling, and it delays the whole process of economic development. The World Bank has inadvertently become the world's third largest reinsurer after Munich Re and Swiss Re, because it has to divert so much of its development funds into disaster relief.

A key issue might be migration. Climate-related disruptions of human populations and consequent migrations can be expected over coming decades. Such climate-induced movements can have effects in source areas, along migration routes and in the receiving areas, often well beyond national borders. Periods when precipitation shortfalls coincide with adverse economic conditions for farmers (such as low crop prices) would be those most likely to lead to sudden spikes in rural-to-urban migration levels that might lead to socio-political unrest in developing countries. Climatic changes would likely exacerbate land degradation, shortfalls in food production, rural poverty and urban unrest. Such changes would likely affect not only internal migration patterns, but also migration movements to western countries, particularly in the light of the growing minority populations resident there but with strong affinities to developing countries. Particularly important for UK, nearby regions like Africa and the Mediterranean might become sources of migrants.

By 2015, 22 mega-cities in the world, mainly in the Asia-Pacific region, will be impacted by weather-related coastal hazards that include erosion, storm and wind damage, flooding and salinisation of surface waters (Klein *et al*., 2002). One flood model estimates that in 1990 approximately 10 million people per year worldwide experienced coastal flooding arising from storm surges. By the 2080s, between 2 million and 50 million additional people per year will experience flooding, even if coastal flood defences were improved during this period (Nicholls, 2004).

An increasing proportion of industrial (and service) activity is located in developing countries, so that climate-related disruption there would affect the whole supply chain, but this has not been factored into the projections yet. The political emergency caused by the sudden restrictions on Chinese-manufactured clothing entering the EU in 2005 illustrates in a very mild way the potential for disruption.

2.5 Adaptation measures and cost of them

In this submission I do not have time to examine the cost of adaptation measures properly, other than climate insurance. Three points are worth making.

1) It is sometimes stated that greater economic growth will provide greater resources to deal with the associated increase in climate-related damages (Foresight Report, 2004). This has not been validated by an integrated sectoral level modelling exercise; one can readily envisage that growth would be in services, health, biotechnology etc, whereas adaptation might require resources from sectors in decline eg construction. It also begs the question of whether a growth-oriented society would readily switch resources to deal with future damages.
2) A recent estimate of the cost of hurricane-proofing New Orleans came to $32 billion (New York Times, November 29, 2005). It is unclear how much allowance was made for the possibility of more intense

hurricanes due to climate change (see earlier), but thi s demonstrates the enormous costs of maintaining current development patterns.

3) Social effects of climate change , like human migration and increased social divisions, will be very costly, and are presently not included in adaptation assessments.

2.5.1 Climate insurance

As the risks of economic damage rise, so the need for insurance also grows. However, there are very substantial problems in providing a viable private market solution.

- *Data availability- on hazards and exposures*

This is fundamental to risk assessment. Poor data means the risk or uncertainty is much higher, and the private market will be less able, or unable, to participate in risk-bearing. Geographical , economic and climate data tends to be much better for developed countries than for developing countries. In general data access and use requires a fee.

- *Funding*

The private sector has limited capital and needs to earn a reliable and adequate return for investors. They prefer a low volatility to permit steady payments of dividends, and erratic profits depress the share value. For that reason, reinsurance is heavily used. Alternatives like equalisation reserves are possible, but may require special accounting and taxation treatment, to counter the regulatory trend against profit-smoothing.

- *Risk management*

A crucial pre-requisite is that risk management is well embedded in the built environment and client behaviour, otherwise insurance will simply encourage risky behaviour and the system will collapse.

- *Products*

Novel financial risk transfer tools have appeared like weather derivatives and catastrophe bonds. The problem for traditional insurers is that these are not "insurance" products, and so they do not have the traditional in-house skills or corporate structure. They may require banking or commodity market techniques, and a different legal platform.

2.5.1.1 Developing countries

For developing countries the risk of climate change is enormous, because they are dependent on the agricultural sector, which is one of the most vulnerable to extreme events, and the local economies do not possess sufficient reserves to refinance the country after a disaster. The Kyoto Protocol recognises this specifically in Articles 4.8 and 4.9 which mention the possibility of using insurance as a risk management tool. In fact it may be better to take the arrangement out of the UNFCCC process for three reasons. Firstly, those Articles also raise the issue of compensating energy producers for loss of revenue due to emissions controls, secondly it is impossible to apportion damage to manmade climate change as opposed to natural variability, and thirdly there are non-climate disasters which could be handled under the same scheme.

In most cases, an insurance scheme in these regions would require to be subsidised by OECD countries in some way. The rationale for private insurers to assist in providing cover for climate risks under a public scheme is that it makes the local economy sustainable, which generates revenue for other financial services. Providing services to the scheme naturally generates some revenue also, provided the sevices are properly costed and do not endanger solvency of the provider. And ultimately, the public scheme may transmute into private insurance if the risks can be well-managed .

The design of an insurance scheme for climate risks is infinitely variable. Most public insurance schemes cover just property loss, but there is a case to include income protection, and health care and funeral costs. Other parameters to be addressed include the sector(s) of the economy to be included, the geographical scope, and the funding mechanism, since it will need to be subsidised. Because the private insurance sector has the technical skills to run such a system, and could often provide the service at a marginal cost, due to the presence of other lines of business, such schemes could be of interest to insurers and reinsurers. For risk-bearers however, the potential loss can be the whole of the capital provided, which may be equal to the annual turnover (see influencing factors). In general the main barriers to the private market lie in the function of risk financing. The other functions like risk assessment, risk management, risk transfer, product design, distribution (networks to access customers and suppliers), loss-handling, administration, and facilities management are technical rather than solve ncy-threatening.

The most efficient solution may be to have an international pool: the premiums can be substantially reduced by pooling the risks with other countries' risks in order to reduce the statistical volatility of losses. Also, if the customers are unable to pay the premiums, a pool allows consistency and convenience to channel subsidies. However, objective and consistent underwriting is key: if certain members believe there are

cross-subsidies to others, they will withdraw from the pool. Also, if there is slack practice, then claims will rapidly overtake the premiums, and the pool will collapse

2.5.1.2 Climate insurance in industrialising, medium-risk countries.
In these regions there is more disposable income, and more reliable business income, so insurance can be purchased privately. The key issues are whether insurers can make money, and whether customers want the product. The regulatory system has to permit a fair return on capital, and freedom to manage the underwriting process, and be geared towards risk prevention.

A private market requires customer demand as well as insurer supply. There are various demand-side barriers some of which the private sector may be able to overcome, while others may need public sector intervention.

- *Perception of risk* Often consumers have low risk awareness, particularly regarding low frequency-high impact events. The private market can play a useful role in awareness-raising, since it has a profit motive to increase market penetration
- *Price* Where the cost of the premium is relatively high, consumers will not insure. This may be a signal from the private market that the risk is very high (unsustainable), or that there is great uncertainty, or that the scale of operations is too small, or that alternative risk management options exist.
- *Efficiency* The insurance process must be efficient- recovery must be achieved in acceptable timescales. Here the existence of a private market will provide an incentive to attract customers by being more efficient than competitors.
- *Fairness* If consumers believe that others will benefit unduly from the system, or that they are paying more than their "fair share" to the insurance fund, they will not insure willingly. The private market will seek to segment customers, so eliminating cross-subsidies. However, this may be contrary to public policy in terms of solidarity.
- *Relevance* The insurance must cover the assets that matter to the customer. Here again the private sector seeks to meet customer needs in order to maximise penetration.

2.5.1.3 Climate insurance in OECD countries.
There are very few countries even in the OECD which have a complete and effective system of insurance against climate hazards in place- UK and Sweden have private market solutions, Spain has a public sector systems, while USA and France have mixed-market systems (storm is in the private sector). Germany in principle has a private market solution, but the penetration of partcularly flood insurance in West Germany is low. A recent attempt to develop a public-private market solution for Germany was unsuccessful, due to legal and political difficulties concerning the introduction of universal mandatory cover. All of these systems have some defects in operation, and it is likely that climate change will stress them quite strongly.

2.5.1.4 Implications
The need for insurance against climatic hazards will rise strongly in all types of countries in the coming decade and beyond. A concerted effort is required to review existing insurance systems , and introduce appropriate ones where they are lacking. Useful work has been done by the World Bank-sponsored Provention Consortium, but it needs new urgency and political commitment. This could be done in conjunction with ISDR or UNFCCC. The private sector would be a willing partner in such a review eg through the UNEP Finance Initiative Climate Change Working Group and Regional Task Forces.

2.5.1.5 Costs
The cost of a comprehensive insurance scheme to handle all climate-related costs would be enormous, and would be inefficient , because of transaction costs and moral hazard. However, the alternative of leaving the victims to cope , with erratic disaster relief is also not tenable. By introducing new sources of capital through non-conventional products (weather derivatives, cat bonds) and using new distribution channels (microinsurance) the scope can be broadened. Also, if due weight is given to the need for multi-year accounting , then risk-takers can price more efficiently, because the variance loading in price calculations can be reduced.

The question is not how much the scheme would cost, but rather, what is the best way to use the projected funds that will be consumed by disasters, and whether additional funds could be attracted to that purpose with appropriate policies and incentives.

3 Costs and benefits of actions to reduce emissions concentrations

This is not my area of expertise. The literature and my frequent discussions with experts indicates that there is no "magic bullet" - a mix of efficiency, conservation, fuel switching, action on other gases, and land

management is required. Half of future emissions could be saved by efficiency[12]. Technically, there are several potential energy technologies that would create less emissions than current ones. Hydrogen and CCS (carbon capture and storage) are glamorous projects, but need time and regulatory support. CCS might cost 40 euros per tonne CO_2 once it is perfected, so it is not cheap (see Box). Similarly, IGCC (integrated gas combined cycle) coal generation has high efficiency potential but is expensive at present, and is not essentially a "clean energy", simply a less-harmful process. However, given the enormous coal reserves in some countries, the capital already invested oin coal-based power generation, and the legth of time it will take to establish new energy technologies, CCS and IGCC seem essential.

Carbon capture and storage (CCS)

CCS for electricity generation from coal is in the research and development phase. Currenty it costs 40-75 euros per tonne of CO_2. This can reasonably be expected to come down to 20-40 euros by 2030. This is still a considerable cost penalty-CCS would increase the cost of electricity by 2-3 c/kwh at present (1-2c/kWh by 2030). The additional investment is up to 400 million euros per power station to include CCS. If successful, it could reduce total emissions by about 20%, and for coal-producing countries the continued use of coal would have clear benefits for security of supply and the balance of trade.

Source: International Energy Agency 2004

Nuclear is rather inflexible (eg it requires a reliable flow of cooling water, which the drought of 2003 showed is not a sound assumption, and it cannot meet rapid demand variations). More importantly it has environmental and security issues. The waste disposal costs are very high, and the possibility of a catastrophic accident means that the technology is essentially uninsurable.[13] The raw fuel still has to be imported, with the possibility of interruption. Finally, it would be inequitable to declare for nuclear ourselves as the best route to a carbon-free economy, while denying that route to other countries because they are not trustworthy. In the short term it is feasible to extend the lives of the current nuclear plant for many more years. That may be an appropriate compromise, on the basis that we commit to building no new plant.

To underline that there will be winners and losers, the Merrill Lynch/WRI report "Energy security and climate change" (2005) reviewed the coming clean car revolution. EU vehicle emission targets are scheduled to go from 165 gCO_2/km in 2002, to 140 (2008) to 120 in 2012, a 27% reduction for new vehicles in ten years. Similar measures are proposed in California, though in both cases the industry is resisting the move. In fact some manufacturers are much worse placed than others, and this guarantees a bitter opposition, despite the overall merits of the case (see Figure 3).

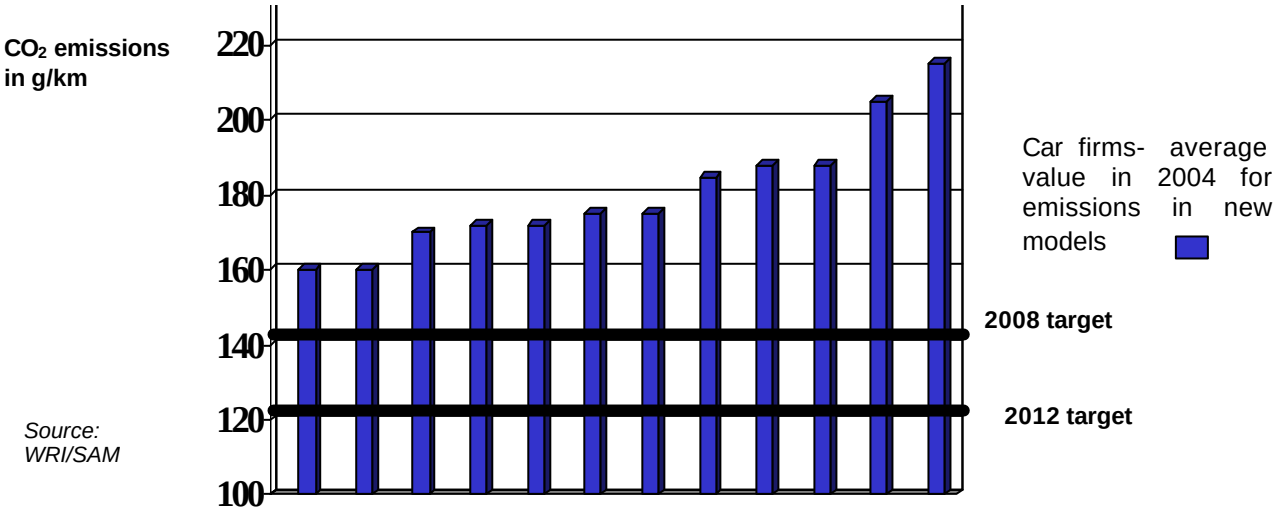


Figure 3 Car emissions for manufacturers new models (2004) versus targets

[12] for example the average thermal efficiency in power stations is about 30%, compared to best available technology of 45%. Thus the primary energy (coal mainly) is half again as large as it needs to be, and so are the emissions.

[13] I know, because I was invited to take the post of deputy head at the limited nuclear insurance facility in the London insurance market in 1998, which I declined to accept.

4 Impact and effectiveness of policies and arrangements to reduce emissions

The best scientific guidance is that a dramatic change is needed in the way we produce and consume energy if we are to avoid dangerous climate change. Figure 4 shows that, on a business-as-usual path , energy demand will rise by 60% by 2030, whereas we need to be on a trajectory of 60% less by 2050. This means a turn-round in energy trend of 100% in twenty-five years!

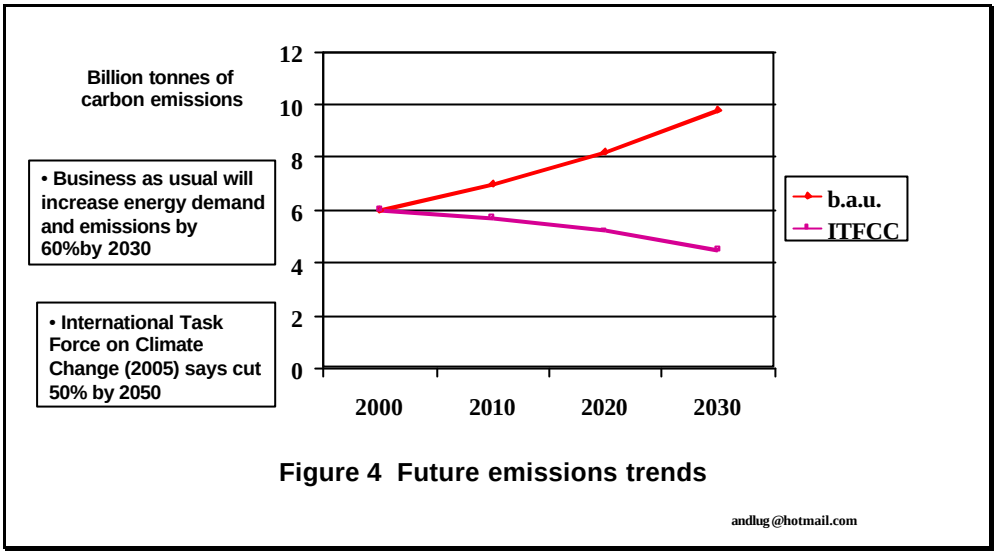


Figure 4 Future emissions trends

Twenty countries are responsible for 90% of ghg emissions (EU25 will comprise just 10% of global emissions by 2030)[14]. If just a small group that includes major developing nations could agree essential policies like emissions targets then climate change could be managed. The future adaptation benefits of reducing emissions will fall to the developing countries, so international action on emissions is in their interest. The cost of climate impacts could be between 80 and 140 euros per tonne of CO_2.

Three important reports provide a broader context for such action: the report of the ICCTF (International Climate Change Task Force)[15], the WBGU report "Kyoto and Beyond"[16], and the EU Commission briefing paper on Energy and Environment[17]. All support a target of a temperature rise of under two degrees C, and action now, with a strong focus on best available technology, support for developing countries, transport sector action, and increased R&D. The implication is a move away from energy solutions that are "cheapest, ignoring side-effects" to "most sustainable". This can be managed without economic disruption and with considerable co-benefits, but it requires good planning and communication and public acceptance.

International Climate Change Taskforce - Ten point action plan 25 January 2005.

1. The appropriate target for 2 degrees C is 500 ppmv cde. However it may have to overshoot, then return.
2. All countries must take differentiated equitable responsibilities , based on equal percapita rights to emissions.Developing countries could approach national emissions targets in phases.
3. G8 should adopt a target of at least 25% of electricity from renewable energy by 2025.
4. G8 should double R&D on clean energy by 2010, and deploy best available technology fast
5. A G8+ group incorporating major developing country emitters should be formed.
6. G8+ should shift agricultural subsidies to biofuels.
7. Developed nations should adopt "cap and trade" emissions policies, and link thes e markets globally.
8. Policies should support renewable energy and energy efficiency -no perverse subsidies/ supportive lending criteria for multilateral banks and ECA's/ new funds for clean energy development /disclosure of relevant information/ investor duties to include attention to environmental objectives
9. Adaptation funds and mechanisms for developing countries should be properly resourced.
10. Governments should make the public aware of the issues and solutions.

[14] EU staff paper2005
[15] the report of the International Climate Change Task Force, 2005
[16] WBGU report "Kyoto and Beyond" 2004
[17] EU Commission briefing paper on Energy and Environment

The WBGU report emphasises the importance of an ultimate goal that is sustainable, looking to an economy that is based entirely on solar energy by 2100. In the medium term, it advocates a mix of efficiency, low-carbon sources, sequestration, and conservation of natural carbon, and engaging developing countries through technology diffusion, "Contraction and Convergence" and emissions trading. Alternatively, Socolow's "wedges" are a pragmatic way forward[18]. He notes that 15 key climate-friendly technologies or policies are available now, and that any seven of them would be sufficient to stabilise emissions by 2050. Four are efficiency-based (vehicle design, transport mode, building and power plant design), three are storage-based (extracting carbon at power plant, hydrogen plant, or coal conversion plant), six are low-carbon fuels (gas-for-coal, nuclear, wind, photovoltaic, renewable-generated hydrogen and biofuel), and two are agricultural practices (forestry and crops). This is not the final word; eg other gases, wave, combined heating and power, and industrial process efficiency could be effective by 2050. He does not take account of cost-effects: eg sequestration would equate to setting a price of 40-80 euros per tonne of CO2, a very substantial premium compared to the price in the EU-ETS.

The EU Climate Change Plan is now pursuing such policies: ETS, renewable energy, co-generation, biofuels, building design, and end-user efficiency, supplemented by action on fluorinated gases, ETS, and energy R&D. ETS is likely to extend into other sectors like marine and aviation, and land use. This could bring important benefits for industry and consumers through cost-effective energy conservation and cheaper renewable energy.

Among the many implementation issues are the need to engage positively with small-scale innovators, and the difficulty of retrofitting old building stock to higher standards. Decision-making often involves several parties (see section on asset management), and can take place at several levels in the political system, so this can create blockages. However, this layered decision-making can also give some freedom; individual states and cities are leading the way in USA while the federal administration hangs back. Lack of information to make decisions is also a problem; Australia has introduced mandatory energy audits and reporting for corporates, while investors have formed their own initiative to seek information on climate risk, the Carbon Disclosure Project.

A final area of policy is how to engage the international community in solving climate change in a way that is fair and financially effective. There are many alternative proposals- what the finance sector would like to see is goals for emissions reductions beyond 2012. For energy equipment and plant, a horizon of 15 years would be desirable, on a rolling basis[19], so that new projects always benefit from the same planning timescale. Secondly, the system must involve developing countries in a way that capitalises on emissions trading. this means the CDM must be able to cope with high-volume activity, a process which has begun in earnest at COP11. Thirdly, of course everyone would like to see the "missing" Annex 1 countries engaged- the key reasons given for non-participation are cost of mitigation measures and fear of being disadvantaged in the international economy.

4.1 The Finance Sector and Mitigation

Such uncertainties at policy level mean that the finance sector is timid about committing resources. To bring the sector on board , policy needs to be " loud, long, and legal" ie clear and simple, with long-term milestones, and with definite penalties for non-compliance. It is common to think of the sector as being concerned with venture capital, project finance and corporate finance through the medium of the baking industry. However, in addition to those activities, secondary investment markets are also very important because of their potential influence on publicly quoted companies, which in fact they own through their shareholdings. In the past they have left corporate managements to run the companies, but recent scandals in corporate governance and a growing concern for social and environmental issues is leading to more active involvement in corporate strategy. Climate change has become the test area, with several investor initiatives now pursuing active agendas (Institutional Investors Group on Climate Change, Carbon Disclosure Project, Investor Network on Climate Risk etc). Insurance underwriting is also important for new technologies, and has been dealt with at length in a report I co-authored for UNEP in 2004 "Financial Risk Management Instruments for Renewable Energy Projects", so I shall not go into that further here. A number of publications also deal with banks, so here I shall focus on institutional investors. They are involved in equities, property, and to a lesser extent private equity.

[18] S Pacala & R Socolow, Science 305, 13 August 2004

[19] UNEPFI CEO Briefing on Renewables , 2004

4.1.1Equities

With equities, investors face on the one hand the eventual decline of carbon-intensive sectors and passive or even obstructive companies, and on the other the growth of clean energy firms and proactive or open management. This issue has been studied elsewhere eg the Allianz/WWF report published in June 2005 considered in detail the potential risks for different sectors, and the latest sell-side broker views on company and sectoral prospects, particularly relating to the EU ETS, but also Oil & Gas, Pharmaceuticals, Automobiles and Aviation. The point was made that sector is not the right level to base decisions upon, because individual companies face very different regulatory risk, and reputation risk (cf Esso), and this can be quantified as a very significant drag on corporate earnings in some cases.

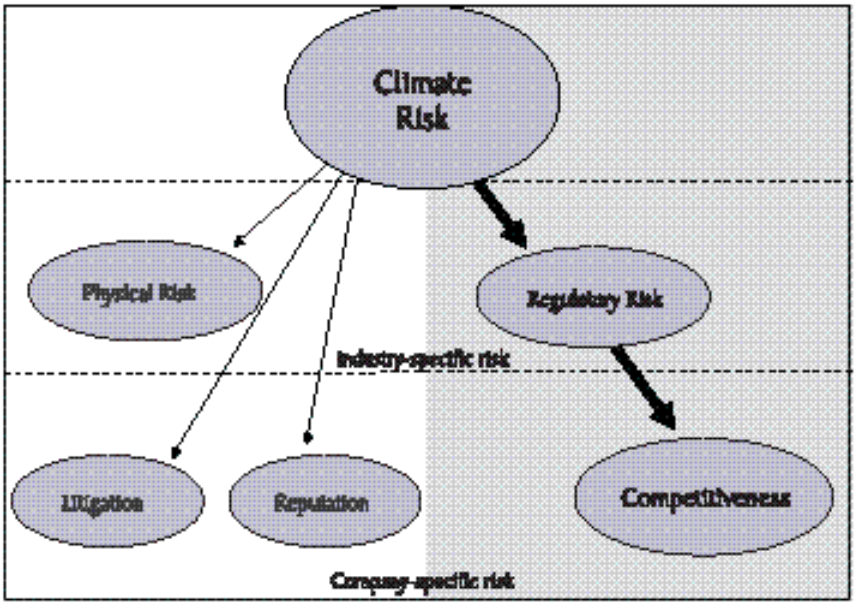


Figure 5 Climate Change Risk and Corporate Value

Source WRI capital Markets Research in "Framing Climate Risk in Portfolio Management" CERES/WRI 2005

Figure 5 demonstrates this; risk can stem from a number of sources, particularly physical risk (changing weather patterns and rising sea-level) and regulation at industry level. Even for physical risk, there are strong company-level effects eg after Hurricane Katrina, many oil companies and insurers were not directly affected by the damage. But climate change is an issue that in general really bites at company level, because of the many differences between firms in terms of markets, product lines, location and management. For example currently, New York power utilities face action by the State Attorney General to mitigate their greenhouse gas emissions. The strongest influence however, is from formal regulation, either in force, or impending- as many US companies face from State actions, and the aviation industry faces in EU. The issue is particularly perplexing in USA, but owing to its potentially large effect (eg see Innovest's sensitivity analyses in the CDP3 report), it must be addressed now.

A recent analysis of brand value and climate change by the Carbon Trust in UK threw up some surprising conclusions for investors to consider. Although they are relatively light in carbon-intensity, their sheer size and dependence on brand means that there may be as much as 20 billion euros of investor value at risk in the food and drink and bank sectors. This has not been assimilated into corporate thinking yet.

Moreover, these risks or opportunities are not independent- there is a portfolio-level risk. The market value at risk could range from 150 billion euros to 680 billion[20]. The wide range reflects uncertainty about growth, and innovation in the most affected sectors of automobile manufacturers, energy, healthcare and utilities. The reverse side of this is that institutional investors can take a broad view as "universal investors". They can offset declines against gains elsewhere, or even a sectoral decline against a general benefit, so that shifts in asset values due to climate change in one area need not be detrimental if they are foreseen and balanced with gains elsewhere.

[20] Carbonomics- WestLB, 2003

There are significant barriers to asset managers giving more attention to social, environmental and ethical issues (SEE). For example, when investing a pension fund, the wishes of individual members of a pension fund are not available, and the trustees are not experts, so instead the key actors use "hard" financial measures as a yardstick, with the emphasis on quarterly performance (see Table 3) . Advisors and analysts are deal-focussed. Fund managers work on a 3-12 month cycle, revolving around their principal's views, which rarely go out even as much as five years. With mainstream sentiment still being sceptical of socially responsible investment (SRI), there is no client pressure to address SEE, including climate change. This is reinforced by the fact that 70% of trades in equities now come from hedge funds according to ABP.

Table 3 Principal actors in the investment of pensions (adapted from Tyndall Centre Technical Report 20)

Main actor	Appointed by	Motivation	Influenced by
Trustee	Stakeholder (including sponsoring company)	Duty as guardian of beneficiaries' funds	1 Beneficiaries (rare) 2 Consultants 3 Stakeholders 4 Media
Actuarial Consultant	Trustee or sponsoring company	Statutory responsibility and client satisfaction	1 Legislation 2 Stakeholders 3 Professional guidance 4 Standard practice
Fund Manager	Trustee with guidance from actuary	Reward for short-term performance of fund	1 In-house analysts 2 Sell-side brokers 3 "The market" 4 Media 5 Consultants

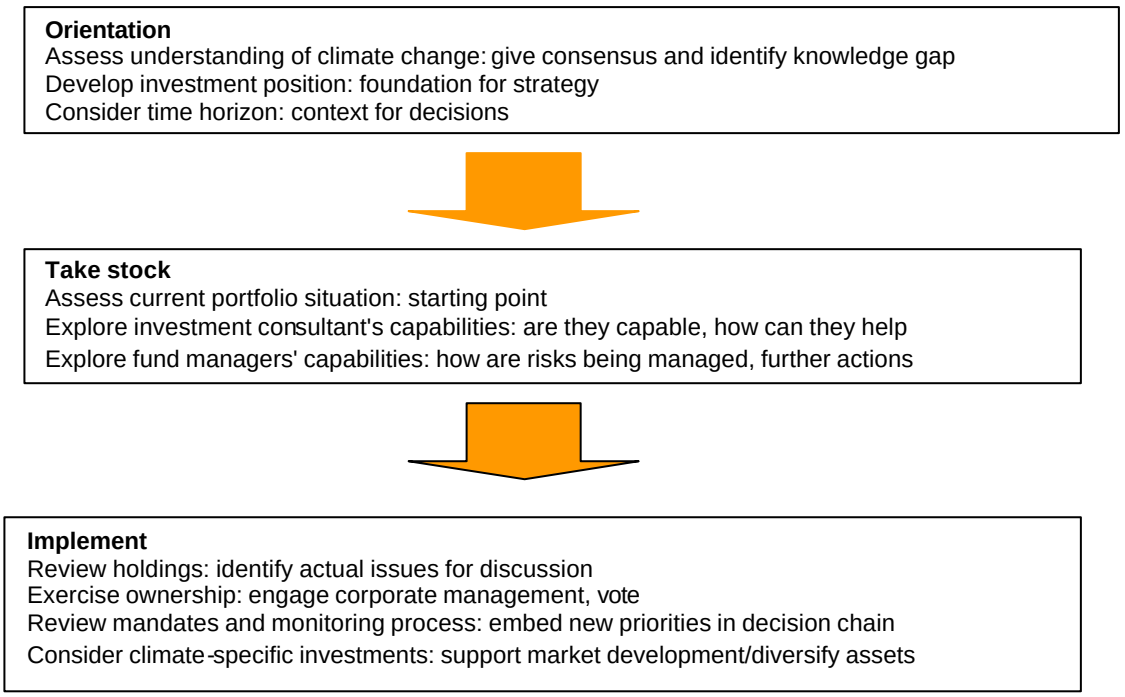
The market is even less aware of environmental issues outside Anglo-Saxon/North European circles. Moves have begun to rectify this situation. The EU has introduced an Accounts Modernisation Directive - appearing in UK as the Operating and Financial Review (OFR)- to make companies give a comprehensive picture of relevant non-financial information, but it lacks rigour because there is too much discretion in regard to key performance indicators[21]. In fact, the Chancellor has just announced that he will relax the planned guidelines! The Morris Report in UK missed an opportunity to set standards for actuaries on SEE issues, and the UK Government is unsure how to improve standards of knowledge for trustees.

IIGCC is working with The Carbon Trust to develop an education package about climate change for pension fund trustees[22] (see Figure 6). As well as laying out a process, the IIGCC/Carbon Trust package indicates where difficulties in the process may arise, and the sort of practical obstacles that will arise eg time for debate, funding for research. The package also includes a Powerpoint template for trainers. The main problem is that with no funding for rolling out the trustee training, this excellent package will not be used.

Further investment guidelines eg from OECD, national governments on SRI, collaboration, corporate governance, pension fund disclosure could influence consultants and investors to pay more attention to SEE issues (Ambachtsheer, 2005).

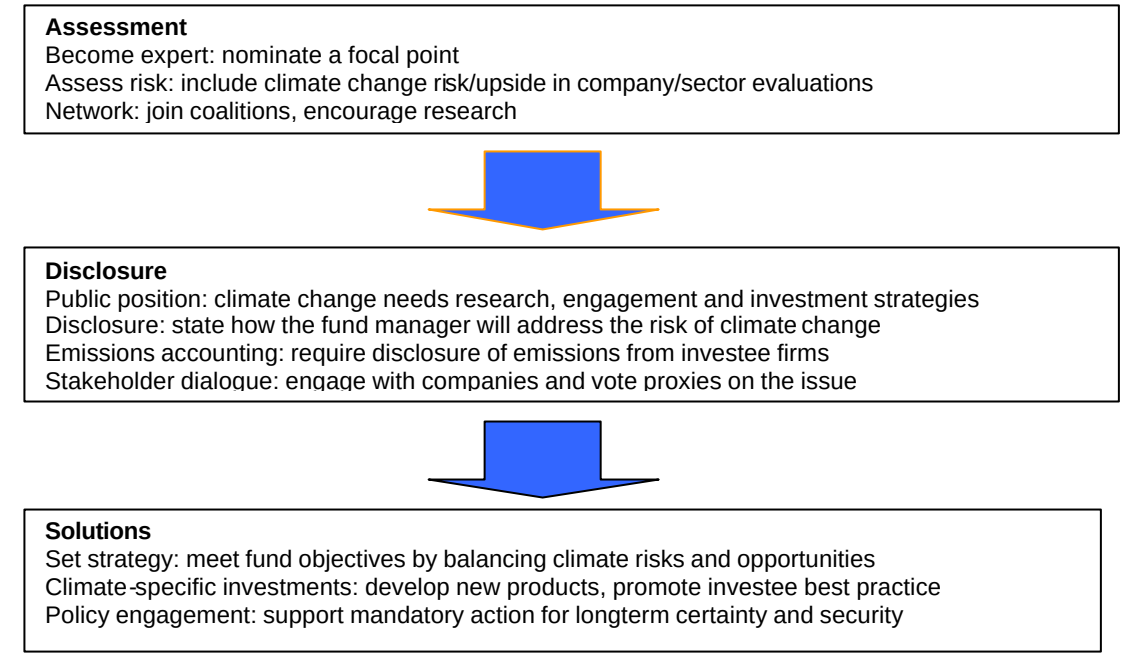
[21] N McIndoe Environmental Finance April 2005
[22] *A climate for change: A trustee's guide to understanding and addressing climate risk* Carbon Trust, 2005

Figure 6 IIGCC/Carbon Trust trainee training package model (a summary)



The CERES "Investor Guide to Climate Risk" proposes an action plan that covers not just the trustees "plan sponsors", but also fund managers and investee companies. Summarised below in Figure 7 , the fund manager action plan provides the basis for progressive fund management.(A particular aspect of this in USA is the lodging of potentially hostile resolutions at company AGM's, but this is not a feature of EU corporate conduct).

Figure 7 CERES Investor Guide to Climate Risk model (fund managers module)



4.1.1.1 The SRI debate and climate change

Traditionally institutional investors have been passive, relying upon even less-engaged advisors to propose strategy and implement it. They have ignored social, ethical and environmental (SEE) issues like global warming, or pigeon-holed them as SRI, for minority interest clients, but of no relevance to mainstream, conventional asset management. The indications are that this status is changing as investors have realised the dangers of trusting others too far (eg Worldcom, Shell, Enron). Increasingly there is good evidence that

shows that in the short-term SRI returns are just as good as non-SRI. In the longer run this should be reinforced because firms that exercise good governance should produce less volatile performance, and therefore better credit/financial ratings, due to better risk management.[23]

It has become clear that when corporate managements focus on short-term profit that carries real risks for investors. Governments are requiring companies to adopt corporate social responsibility, through measures like Sarbanes-Oxley in USA, and investors are being prompted too by regulations on pensions funds to reveal how they address SEE issues[24]. This trend is particularly relevant in a world where corporate assets are often intangible (brand, network), and is one that should foster attention to climate change risk.

Jane Ambachtsheer of Mercers believes that SRI has progressed from its screening/ethical beginnings through a stage where it was seen as revenue-neutral, justifying the development of new indices eg FTSE4Good(2001) and Dow Jones Sustainability Index (1999), to now being perceived as a source of alpha[25]. This reflects a large body of research that has been carried out on performance of SRI- rated funds. The most recent article[26] to attack the anti-fiduciary argument shows that the incremental benefits of SRI can be substantial. Based on analysis using Innovest's eco-efficiency scores for US companies, the findings were that SRI added over 3 percent mean annual return over 8 years between worst and best companies (best versus average will be about half that). This was robust over a variety of adjustments. It cannot be attributed to market risk, investment style (eg large-cap v small, growth v cashcow), or industry-specific components. Thus it appears that CSR reflects quality management strategy, and any portfolio dilution through restricting the universe of stocks is imaginary. It appears that the market does not price this factor, particularly in "non-sensitive" sectors.

This conviction seems to be growing in the market too. Mercer's Fearless Forecast 2005 survey of fund managers suggests that SRI practices will become more widespread over the coming decade. The survey does give a misleading impression overall, as the weighting is not representative; there too many positive fund managers, and not enough in USA, where opinion is less favourable. To get a realistic picture globally, would require taking the straight average of EU and USA managers as shown in the Table. However, the true message is that there will be a two-speed SRI market for some time. Mainstream US managers will remain distrustful, while other markets will adopt SRI.

	EU		US		World (50/50)	
Factor	5 years	10 years	5years	10 years	5 years	10 years
Active ownership	77	94	63	72	70	83
Screening	52	69	11	34	31	51
Use of social and environmental factors	63	84	11	37	37	60

Table 4 Mainstreaming SRI tools for asset management (source: Mercers,2005)

A universal investor wants codes of corporate governance and looks for general economic and social welfare , implemented by engagement overlay and active ownership. This fits with the new view of SRI as it shares essential elements of asset assessment.The most effective SRI approach appears to be engagement with companies on SEE, rather than screening or avoiding the issues: it requires more resource, but the return on effort is better.

A contrary view is that climate change is an issue that will gradually evolve out of the political and scientific haze, with relatively few sectors facing significant impacts (insurance being one of those), and with policy likewise affecting relatively few sectors seriously (mainly energy and heavy industry) in the near future. In many cases costs will simply be passed along the supply chain, these investors believe. In these circumstances, they think it would be wrong to try to second-guess policy. Coherent policy should come first, based on firm knowledge. Lobbying is inappropriate at this time, and indeed does not add anything to

[23] ABI 2001;ABI 2003; Murphy 2002; Derwall et al, 2005;Goldman Sachs , 2005.
[24] ABI, 2001; ABI 2003
[25] (Benefits and Compensation International 35(1), July / August 2005)
[26] "The Eco-Efficiency Premium Puzzle" J Derwall et al Financial Analysts Journal 61(2) March/April 2005

the ability to assess and evaluate investment risk. Even creating metrics like carbon intensity for investors to report on the climate change performance of their portfolios , as CDP asks, and as Prudential does for its property portfolio, may be misguided the argument goes. A heavier CO_2 profile is not necessarily bad, if it reflects a shift in structure, or stronger engagement with emitters. Indeed, Hendersons has observed ruefully that the sectors which have soared in recent months have been coal and oil, on views of future demand and current supply problems.

These points are not valid, but they do require answers.

1. *There is time to wait*. No, the recent hurricane seasons show that even wealthy countries are vulnerable to extreme weather. Likewise, analysis shows that it takes companies years to prepare for a carbon-constrained future.
2. *Lobbying is inappropriate.* No, every other stakeholder is lobbying. While the detail of climate mitigation may be best left to technical experts, the overall direction is relevant for all stakeholders. Investors have a large financial stake, and indeed might even be held liable by other stakeholders as being asset owners/managers who are negligent of their duties eg if investee companies lobby against mitigating global warming.
3. *Carbon intensity is pointless* No, it just has to be used with common sense, like any simple metric.
4. *Carbon is profitable* Yes, but..In the short term that appears so, but what is the exit strategy? And the reputational damage from actively supporting a harmful product could be large, unless there is a mitigation strategy eg support for "clean coal".

Accepting that an SRI approach to climate change is necessary and practical, how to implement it? As KLD Research & Analysis Inc, Boston observes, the problem with climate change as a pure play is volatility, due to the small size of the companies involved. On the other hand large cap companies dilute the focus and may even be harmful environmentally. On balance, they must be included if they are leaders in technology- even if some products are environmentally harmful, or not relevant eg GE, BP, Toyota, Lennar Corporation (homes). A new benchmark is required, which could even serve as the basis for a fund. KLD is attempting to construct a Global Climate 100 Index, on firms in renewables, energy efficiency, and future fuels eg hydrogen). So far 86 firms have been identified, and back-testing gives promising results that it is a sector that could generate "alpha" ie consistent added value. Although this could be a valuable tool, nevertheless it is clear that it will not in itself deal with global warming, because the issue permeates every sector through energy use, technology, and climate impacts; a broad-based SRI approach is necessary.

4.1.1.2 Investor collaboration

Investors are generally reluctant to enter the environmental policy debate[27], preferring to react to hard information, and being wary of the reliability of scientific knowledge[28]. The fact that there is still uncertainty over many aspects reinforces this conservatism. What investors do want is better information on corporate performance and prospects, and a clear policy framework[29]. Given the immense size of the financial markets, there is a limit to what a single investor can achieve in terms of changing the way business is done. Any attempt to introduce additional analysis risks being undermined by competitors taking a less rigorous approach. At present therefore there is considerable attention to improving data through focussed exercises like Carbon Disclosure Project, with a few more active investors involved in broader campaigns .

The most noteworthy investor initiative on climate change is the Carbon Disclosure Project. The third CDP report in September 2005 was undersigned by 143 investors with 15 trillion euros under management. It shows that awareness of climate change continues to grow, even in the USA where the political mood is not supportive. However, though 90% of responding firms identified climate change as a significant corporate issue for them, just 51% have implemented emissions reduction plans, and only 35% have ghg reduction targets. Disclosure of emissions was less than half of the companies in some high -impact sectors like Oil & Gas, Aerospace & Defence, Conglomerates, and Surface Transport. Also, some non-respondents had significant CDP shareholder stakes, notably Boeing at 20% of shares held by CDP supporters.

Innovest's analysis of shadow prices gives a useful insight into the relative vulnerability of the different companies to future carbon restrictions. However their method of assigning climate leadership status is not so suited to sectors that are less carbon-intensive. Detailed analysis also revealed that the data is difficult to use (eg across years), inconsistent, and incomplete, which means there is considerable scope for

[27] It was notable that at the time of the debate on EU National Allocation Plans, when heavy industry was prominent in the discussion, the finance sector was absent from the debate.

[28] Some compare it to food science: at one time a particular product was definitely good, but then studies showed that it could cause health problems, and now no-one knows the truth.

[29] Tyndall Centre workshop, 2004

improvement, and of course it needs to be integrated with other corporate data- no investor ever based decisions solely on the basis of climate change positioning.

4.2 Private equity

Policy changes are creating a perception of greater risk for investors in the energy sector due to increased uncertainty about fossil fuel economics. This can be countered to some extent by reducing the uncertainty in renewables (see Figure 8 below), but in such a dynamic situation it seems inevitable that investors will have less appetite to participate in the energy sector until policies have crystallised and new business models have emerged and stabilised. Possibly the pause will be short, given current oil prices, and new government R&D in new technologies (eg Asia Pacific Rim Climate Change and Technology Pact, 2005).

Figure 8 Financial risk in the energy sector (with acknowledgements to Justin Mundy, Deutsche Bank)

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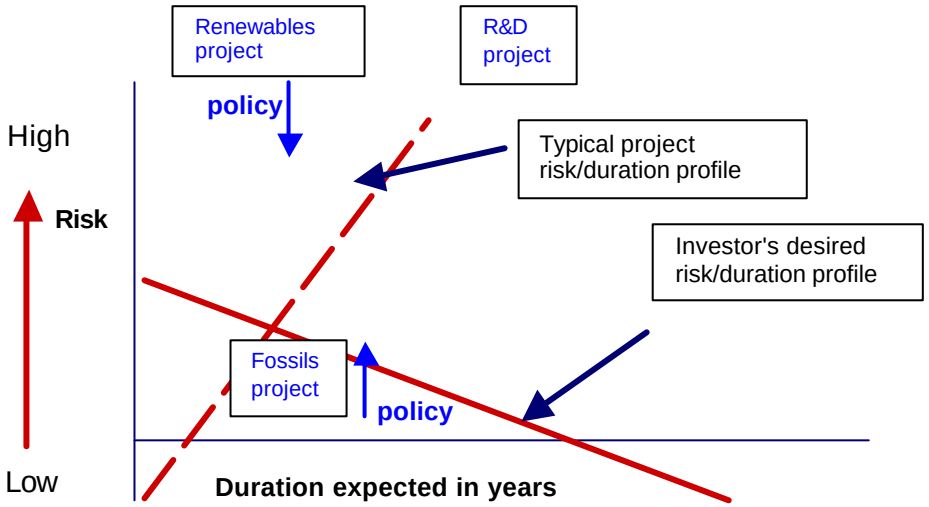


A second area of concern for the private sector is the so-called "valley of death" for innovators (see Figure 9). To get from pure research to the marketplace, innovations have to pass through a number of stages, from basic R&D to demonstration, to niche market and then full commercial production. Governments are often prepared to support the initial phases of innovation, but are reluctant to "pick winners" ie to support manufacturers in the wind-up to full-scale production and marketing, between the demonstration to niche market phases of development. Since this is a "cash-burn" situation, when the costs are still high and the revenue is insignificant, it is unattractive for investors.[30]

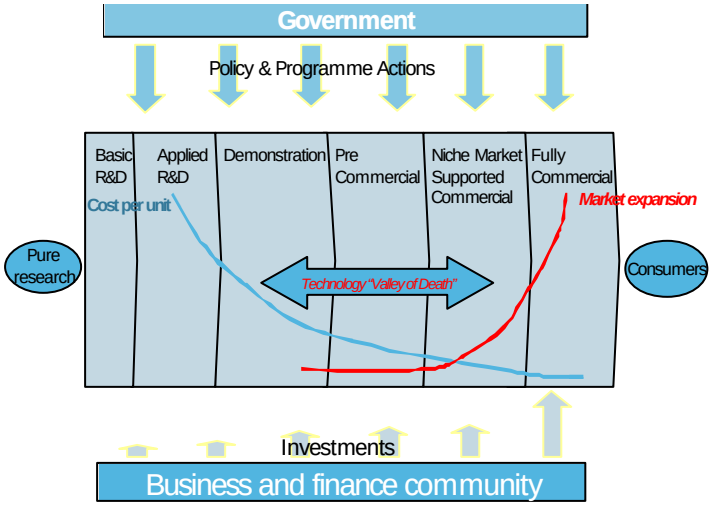


Figure 9 The Technology Innovation Process (Source Grubb, EEMR 2005)

[30] Grubb, EEMR 2005

This whole area is dynamic as stakeholders and policymakers realise the enormity of the problem, and the urgency of the task. Policy is bound to evolve in more efficient directions, and so the implementation cost of any given emissions target will reduce greatly.

Traditionally institutional investors have not entered this field, leaving it to other branches of the sector like corporates, private foundations, and banks, because the scale of activity is too small, and the failure rate of projects at around 40% is too risky, despite the high net return on investment, including failures, of around 30%[31]. Jupiter Asset Management has declared it will not enter VC/.PE because of the high volatitility. However, as returns have dropped in traditional asset classes, and volatility has also worsened there, investors have begun to diversify. Private equity, carefully managed, does provide good opportunities for fund managers and high net worth individuals.

The energy sector in particular has suffered from inconsistent government policy eg subsideis for fossil fuels. Now however, with the Kyoto Protocol coming into force, and the science of climate change becoming more alarming, the prospects are improving. One survey found that investment in renewables and clean energy technology rose 150% between 2000 to 2004, across a wide range of applications (efficiency, windpower, fuel cells, etc).

In USA the two largest pension funds, CalPERS and CalSTRS, both based in California, are channelling more assets into alternative assets to maintain higher returns and diversify risk. About 12% of CalSTERS is invested in private equity: venture capital , buyouts, mezzanine debt, and distressed equity, with a net return on capital (roc) of 18% in 2004, 700 basis points ahead of public equity.In March 2004 CalPERS decided to direct $200 million into clean technology (water, energy, air, materials, transitional infrastructure). The reasoning was that besides a good prospective roc, these projects are good for innovation, jobs and a cleaner world future.The endeavour is time-hungry:200 opportunities were vetted to identify five real prospects.It needs expert external input to perform due diligence, technology appraisal, and environmental impact analysis, and provide private equity expertise. This combination of traditional investment analysis with new environmental screening tools is organised by means of a new advisory board. CalPERS feel it will take two years plus to deploy the funds: 30/40% as venture capital,30/40% as buyout/corporate finance, and 20/40% as project finance/infrastructure funding.

The story is similar for CalSTRS- they have only managed a 7% return on alternative assets, which are a smaller proportion (5%) of their portfolio.They are now targetting $250 million into clean technology with a focus on those energy technologies and services where California has an advantage: advanced materials, efficiency, nanotechnology, and IT-related.CalSTRS aims to advance commercialisation by targetting gaps in the early finance cycle: pre-VC and tested, market-ready projects/products.They will use their convening power to boost leadership, and add partners to give leverage, but most importantly they will use expert advisors to avoid expensive mistakes. This process is growing. At the International Investor Summit on Climate Risk 2005 hosted by UN in New York, investors announced they had allocated $1 billion to direct investment in clean energy.

4.3 Carbon funds

So-called "carbon funds" that pool investor resources to invest in mission reduction credits from a portfolio of JI/CDM or related projects are growing rapidly. Over $1.5 billion is currently invested in 15 carbon pools worldwide, and at least four new funds have been announced during the first half of 2005 (Innovest, CDP3 report, Appendix C). Often they are managed by public banks (eg the World Bank), because they have an interest in the underlying policy objective of sustainable development. However, other FI's have begun to recognise the potential eg the 60 million euro European Carbon Fund led by the French institution CDC IXIS. The two motives for these new private sector entrants are corporate compliance clients, and speculative hedge funds that gamble on carbon as a volatile commodity. Dexia however notes various difficulties: industrial clients don't believe that energy efficiency matters enough, a local presence is needed, the "product" can't be standardised because of different jursidictions, the EU is a big territory, with diverse client cultures, languages etc. Finally the value of carbon credits is unsure- therefore the underlying project must be commercially viable, contrary to CDM rules. EBRD is willing to partner, with minority stakes, provided the due diligence is reliable, and there is a robust legal regime, but projects are relatively small scale, the price of fossil is too low, and investor expectations are very high. For these reasons, in the near future the bulk of business may well be government to government.

Pension funds are unlikely to enter the carbon markets: they are already committed in the industrial sectors as equity owners; SRI is seen a low-return approach; the underlying assets and the credits themselves are

[31] M Liebrich and B Aydinoglu Env Fin Apr 2005 A bright future or bust in the making

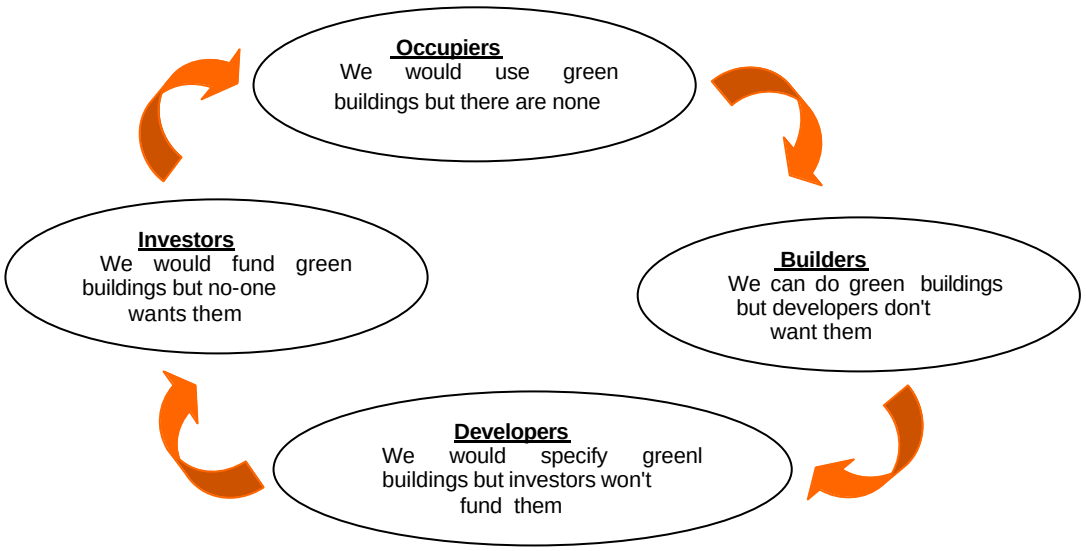
not liquid; and the longterm future of carbon is uncertain anyway, until a global framework that involves the USA is functional. It may be possible to create a premium product by strict due diligence, and so get a premium price for credits, with a guaranteed revenue stream, but this is a niche area with a high development cost.

4.4 Property

Property investment portfolios differ of course, but typically over 50% of value is in retail (shops and warehouses), 25 % in offices, and about 20% in industrial and miscellaneous. Domestic property is a minor feature. Half the non-residential property in UK is owned by institutional investors[32]. Investors are therefore exposed to changes in emissions regulation such as the Energy Performance of Building Directive. The barriers to action are similar to those already seen on equity investment. The involvement of various actors eg tenants, agents, consultants, construction professions with their own particular objectives (see Figure 10) makes it difficult to get a coherent strategy. Tenants want low rentals, and think about energy bills later.

However, since property is an illiquid asset with an inbuilt obsolescence, it is more important to embed sustainability. The need for periodic refurbishments provides opportunities even for existing stock. The critical argument is that sustainability is becoming a fiduciary argument, not only a moral one, due to the increasing importance of eg energy performance. Prudential plc now tracks the carbon intensity of its property portfolio. The average efficiency of buildings in terms of energy consumed per square metre is about three times worse than best available technology so there is huge scope to improve[33]. (Put another way, investors have not acted in advance of the Directive, leaving themselves vulnerable to loss of value in obsolescent stock.)

Figure 10 The blame circle (source Bill Bordass, Usable Buildings Trust)



The EU Energy Performance of Buildings Directive (EPBD) is expected to have a major effect on property management[34]. EU hopes to achieve one-fifth of its Kyoto target through the savings that EPBD will generate as property accounts for 40% of all ghg emissions. Already the construction industry is researching how best to adapt to climate change, and accommodate these new standards; passive insulation, night-time cooling, and reducing solar exposure are all avenues. London and the southeast will be much harder hit than, say, Manchester or Edinburgh (Hacker and Holmes, 2004). Climate risk can also impact property through damage and serviceability. Potentially insurance cover could be restricted at some point during a long lease if insurers decide the risk of damage from extreme weather or sea-level rise has deteriorated. In USA, each year $530 million of property value is lost due to coastal erosion for example (Heinz Center).

Apart from dealing with the likely effects of changes in patterns of extreme weather, the construction industry will need to find ways of tackling comfort temperature, humidity, and air quality, and more insidious effects like UV radiation, acid rain, pests, weeds and micro-organisms. (UKCIP,2003; CIBSE 2004). At the

[32] Bordass 2002
[33] Lowe 2000
[34] The essential feature is the introduction of minimum standards of energy performance forlarge buildings (ie over 1000 m^2)

same time, planners need to anticipate changes in building usage eg telecentre operations, hot-desking, home-working, intensive community access to public premises etc.

Climate change has to be seen as part of the wider sustainability movement, embracing other issues like water usage, waste management, air pollution, transport policy and biodiversity. This and the increasing attention to corporate governance, which has been considered by numerous reports and reviews, means that global warming will become a mainstream issue for property investment (Cadman, 2004). Currently Kingston University is addressing the issue through the Sustainable Property Appraisal Project, which seeks to incorporate sustainability criteria into conventional valuation techniques. A pilot exercise produced a decrease of over 7% in value for a shopping centre when sustainability was introduced (Sayce,2004).

Besides regulation and energy costs, two other factors can help to drive improvements in building efficiency: education of stakeholders and professional pride within the construction industry. For that reason, concerned professionals have set up voluntary standards like the USGBC Green Buildings Code in USA . However, regulation is probably the best way to improve building efficiency, until environmental costs are internalised through higher energy costs, because education and professional pride cannot be relied on.

4. 5 Miscellaneous

insurance for clean technology projects does pose problems- even when available it may amount to 11% odf operating costs, and business interruption periods are generally too short. Weather derivatives could be worth exploring in more detail.See the UNEP study of financial risk transfer and renewables cited earlier.

Microfinance is proving to be a key channel for diffusing wealth and technologies to the underprivileged in developing countries, particularly in rural areas, where access to financial services is poor. There are many excellent works on this area, and the subject was given a 12-page spread by "The Economist" in November 2005. Clearly funding the diffusion of energy appliances to the disadvantaged could be a major purpose. The related issue of micro-insurance is also beginning to emerge, and would benefit from some form of reinsurance arrangements to provide a safety net for climate disasters.

5 Implementing a low carbon economy: timescales for action, and policies and institutions.

5.1 Implementing longterm thinking in institutional investors

ABP, europe's largest pension fund, believes there are four key questions:
1 Is there a positive link between SRI and corporate financial performance?
-we have answered that- yes.Therefore , it is no longer acceptable for investment practice to ignore SRI.
2 How can reward structures be reconciled with longterm aims? The Enhanced analytics Initiative (EAI) is a partial answer, but it is voluntary, ignores fund manager mandates, and 95% of the broker commission stream is unaffected
- a more radical approach is needed eg with longterm contracts, and deferred bonuses.
3 Can regulations be improved to encourage longterm thinking?- regulations can never cover all the desirable features of behaviour in detail for every circumstance.
- For climate change , the important thing is transparency- therefore it should be made best practice that corporate reporting includes the information that is required by CDP.
4 How can extra-financial information be used in the assessment and selection process?
- for climate change there are now satisfactory methods eg Innovest's carbon beta©- via shadow pricing and simple scenarios, or the staggered approach suggested by WRI/CERES (see below).

Figure 11 shows how WRI/CERES recommends building climate change into asset valuation and assessment, by refining the analysis as policy certainty improves. They recommend always working at company level, not sector, because of large inter-company differences in the key factors. They also emphasise that it needs to go beyond pure regulatory risk on in-process emissions, to consider the whole value chain eg petrol consumed during driving is 75% of lifetime emissions associated with a vehicle. Customer reaction to carbon constraints is another vital factor, and finally corporate strategy eg product range, brand, emissions trading, substitution, sourcing etc. The focus is on cash flow, but this writer believes there may be "start-up" effects due to one-off shifts in asset values also. WRI recommend not using a "terminal value" but making longterm cash projections in the sensitive areas, using shadow prices, or "certainty equivalents". The alternative is to adjust the discount rate, which may be fine for relative assessment eg at sectoral level, but is not sensitive to company level issues, and assumes the same relative effect through time.

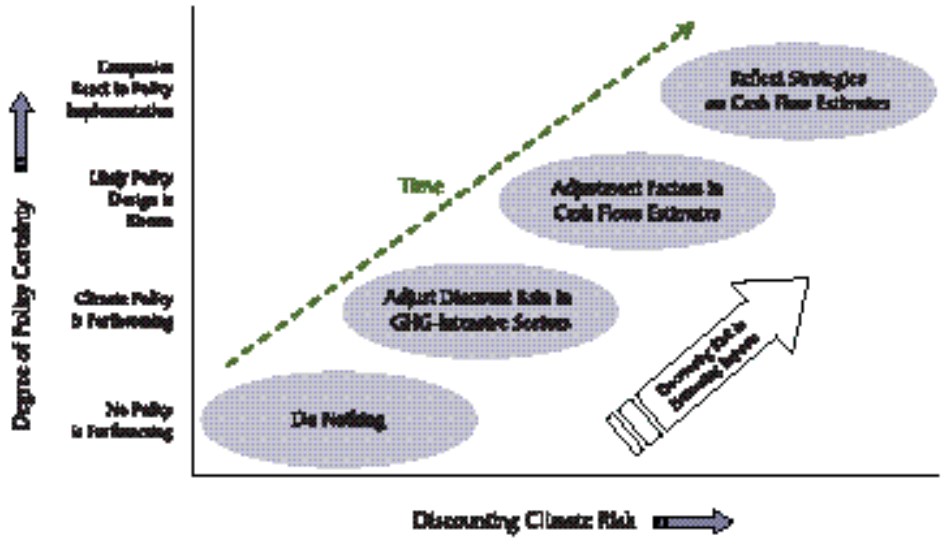


Figure 11 Reflecting climate change in DCF Analysis
source WRI capital Markets Research in "Framing Climate Risk in Portfolio Management" CERES/WRI 2005

5.2 Public Policy

The critical ingredient is government policy. Private companies do not have the remit to set aside basic economic cost/benefit analysis in making strategic choices, nor can they hope that major expenditure undertaken speculatively in anticipation of government decisions will be rewarded. The market will down-grade their share price and credit rating because of the immediate drain on earnings. For business, policies that reduce emissions need not be a threat. Sulfur dioxide emissions at power plants in the USA were reduced by 35% in twenty years while electricity sales grew by 50% in the same period[35]. Indeed, energy efficiency measures may pay for themselves within three years.

The earlier discussion on institutional investors indicates that:

- Climate change is an issue that has to be considered at company level, rooted in weather impacts, regulation and reputation.
- Investment professional are not adequately informed about climate change.
- Pressure and evidence to adopt SRI techniques is growing at least in Europe.
- Even actively adopting SRI will not be sufficient to tackle climate change- more focus is needed.
- Current business practices eg terms of trade are hindering action on climate change by emphasising short-term performance.
- Some issues require collective action eg effective government policy, collaboration among investors. It is understandable that the private sector and governemt wish to minimise regulation, but in that case more emphasis must be given to promoting best practice, and shaming those who do not adopt it.

The role of local authorities eg cities and solar power, or the regulatory framework and economics of grid interconnection for renewables are other important issues that need to be addressed. Both would help to decentralise deciion-making and accelerate deployment of new technologies.

A review of EU power infrastructure prospects is essential as a starting point for planning and discussion in order to avoid having stranded assets at a later date. Much of the infrastructure is reaching the end of its economic life and a major replacement programme will occur in the next decade.

5.3 How does the finance sector in Europe compare?

CDP gives detailed information on the top 500 public companies globally. I examined the detailed returns for the finance sector to get the following picture, using a 20-point scoring system (see Table 5). Apart from US companies, which are rather poor, the average score is just over 10, ie **currently financial companies are NOT doing well on climate change, which indicates a real opportunity for UK to outshine**. This is

[35] Australian Climate Group, 2004

underlined by the fact that many US and Asian firms did not even reply. However, it is evident from the responses, that **leading US companies like JP Morgan, AIG and State Street intend to push climate change up their priorities very soon**.

Table 5 Climate change ranking (20 points maximum)	
Banks and diversified financials	**Insurance**
18 Westpac	
17 ABN Amro, HBOS	
16 Credit Suisse, HSBC, HVB	16 Swiss Re
15 ANZ, Banco Santander, CIBC	15 Axa, Millea, Mitsui Sumitomo
14 Barclays, BNP Paribas, Fortis, Mitsubishi Tokyo, Mitsui	
13 Credit Agricole, San Paolo	13 Allianz, Aviva, Munich Re
12 Citigroup	12 AIG
11 Standard Chartered, JP Morgan, Scotiabank	11 ACE, AGF

5.4 Timetable for international action

I proposed the following timetable for building an international climate policy regime beyond 2012, which was adopted by the UNEP Finance Initiative and presented at COP11.

2006 - amend the Clean Development Mechanism (which awards emission reduction credits to projects in developing countries that reduce GHG emissions) to make it "more commercially viable".
- agree on the long-term basis for emissions targets (eg to limit the average increase in global temperatures to 2degreesC above pre-industrial levels.

2007 - guarantee that CDM credits will continue to have value beyond 2012.
- launch pilot adaptation schemes with public/private partnerships.

2008 - define the rules for linking non-Kyoto emissions trading schemes.
- outline the post-Kyoto framework for 2013-2024.

2009 - decide on a detailed framework for 2013-2024.

The full briefing paper recommends a staged approach, to allow for a variety of commitments on emission reductions by different countries according to the stage of their economic development. It notes that around 80% of global greenhouse gas (GHG) emissions come from just 25 countries and that these include both industrialised and developing nations. It is therefore desirable that any post-2012 multilateral agreement should include as many of these as possible.

The paper adds, however, that "the Kyoto Protocol structure must be retained to build investor confidence in the continuity of the emerging carbon markets, in energy efficiency and renewable energy projects." It stresses that, for financial institutions, "it is vital that any differences between the first Kyoto period [2008-2012] and a second commitment period beyond 2012 … should be agreed upon soon to permit a smooth transition."

A 10-year commitment period would be preferred by the financial sector, the report says, and the rules should be set five years before it starts.

5.5 Improvements to CDM

The announcements at COP11 on increased funding by means of a levy on projects, and also backdating some credits are welcome.

Major issues still be resolved include a decision on whether CCS should be eligible for CDM credits and also the definition of 'additionality' – that is, the assessment of whether a project leads to reductions of GHGs that are additional to those which would have taken place without the revenue from its carbon credits. It is vital that these reviews deliver commercially sensible answers, without compromising the basic principle of mitigation of course, and it is to be hoped that HMG will give appropriate attention and consult fully with the large UK finance sector during the process.

5.6 The international dimension

The following two boxes provide an insight into what non-UK financial houses think, with some pointers for policy. They are based on an unpublished survey of UNEP FI members in June 2005

UNEPFI Regional Task Force Member Survey on Climate Change Policy - June 2005

- **Political will** and education and of course viable markets are the key triggers for change
  -national commitments in developing countries, tougher targets for Annex 1, clarity about post- 2012 regime, a positive USA attitude: all these would positively help.
  -strong carbon prices/market liquidity
  -better awareness of risks/opportunities (50% of even active institutions have not seen UNEPFI Briefings on Climate Change)

UNEPFI Regional Task Force Member Survey on Climate Change Policy - June 2005

- **Financial Institutions do not engage on climate change**
  -In developing countries the involvement is minor, except public sector banks on CDM. There is no emissions trading activity because there are no greenhouse gas limits.
  -Elsewhere the general attitude to emissions trading is "too risky"- avoid such projects, do not include value of emissions credits
  -Interest begins in the carbon-heavy sectors- energy, utilities, mining; or due to other regulations - energy efficiency, clean air

- **Emerging market companies also ignore climate change**
  -A survey of East European listed companies showed that 26% of all companies, and just 14% of financial institutions believe climate change is a relevant issue
  -Only 15% of those who believe it is important, actually take it into account

- **Public/private collaboration**- there is scope in the following areas:
  -Support for small-scale REEE projects to overcome transaction costs and entry barriers
  -Technology transfer
  -Risk-sharing (long-term credit from public sector)
  -Insurance for credit delivery (public sector could carry "uninsurable" risks)
  -Business-friendly framework regulations for REEE inc CDM
  -Dialogue on policy and implementation
  -Adaptation eg flood risk management
  -Non-Kyoto emissions trading shemes
  -Promotion of SRI concept to establish climate change as a factor in asset management
  -Government price support for credits post 2012 (to overcome "Kyoto cliff")

6. Approaches to adaptation

Defra is carrying out reviews of adaptation currently, so I merely note a few thoughts here.

More stringent control of building development eg Environment Agency recommendations aimed at reducing risk from flooding are often over-ruled.

There is no formal way of projecting local flood frequency from climate models, nor formal standards for different building/development purposes.

Storm damage reveals that building practice in Scotland is more resilient, due to the use of a roof lining. This should be adopted in the rest of UK.

Globally, insurers find that damage is generally much worse than expected, because of poor quality construction, resulting in defective or sub-standard buildings. Care should be taken not to weaken building inspection resources.

Globally, the use of permanent mobile home/trailer park has mushroomed, for reasons of "economy". In fact this is false economy: in extreme conditions they are death traps, and are readily damaged or destroyed. This type of development should be limited, not encouraged.

Dr Andrew Dlugolecki - CV

Education B Sc (Hons) in Pure Mathematics at Edinburgh(1970), MA in Operational Research at Lancaster(1971), and a Ph D in Technological Economics at Stirling (1978).

Professional qualifications Fellow of Chartered Insurance Institute (1990), Fellow of Royal Meteorological Society (1992)

Work I joined General Accident insurance company as a statistical analyst in 1973 . Early projects for the company included the effect of weather on motor and property claims. I developed the first ever multi-regression model of motor insurance claims, incorporating the effects of weather on claim frequency, which the company used in its calculations for motor insurance premiums, and later devised an internal catastrophe reinsurance programme to underpin internal profit-sharing schemes.

In my career with General Accident, I became head of Statistical and Marketing Services in 1980, providing actuarial advice on pricing and claims reserving for all lines of UK non-life business with a team of 30 professionals. After a spell as Commercial Underwriting Manager (UK) (1985-91), I then became Chief Manager for Branch Operations in UK, responsible for servicing all UK customers (approximately 2.5million) and intermediaries, with a staff of 3,500 in 60 branches around the UK . I was promoted to head of International Division in 1997 (Brazil, Caribbean, Middle East, South Africa, and India), with additional responsibility for best practice in general insurance globally. Following the formation of CGU in 1998 I became Director of General Insurance Development, responsible for reinsurance, actuarial issues, and best practice in general insurance worldwide.

I took early retirement from CGNU in December 2000, following the merger of CGU with Norwich Union, and the company's desire to focus on Europe, and life business. I am now a private consultant, focussing on insurance and climate change, and a Visiting Research Fellow at the Climate Research Unit, University of East Anglia

Climate Change As a member of the British Insurance Association Research Panel, I began to work with UK and other scientists on the issue of global warming from 1988 onwards. I was lead author on the effect of climate change on financial services for works by the Department of the Environment (UK 1991 and 1996), EU (2000), and the IPCC (1995), and editor of that section of the 2001 IPCC assessment. I chaired two major studies by the Society of Fellows of the Chartered Insurance Institute (1994 and 2001). My contribution in 1991 on climate change in the UK broke new ground, by estimating the insurance costs from the future changes in various UK hazards.

In 2001, I co-authored with Mark Mansley, the paper "Climate Change -a Risk Management Challenge for Institutional Investors", sponsored by the Universities Superannuation Scheme, which has provoked a major shift in the investment world, with similar reports in USA. Other projects include managing a major study of Climate Change and financial markets for the UNEP Financial Institutions Initiative (UNEPFI)- the report was a major contribution from UNEPFI at the recent Climate Summit (COP 8 in Delhi, October 2002).

Committee Work
I was a committee member of the UNEP Insurance Industry Initiative from its inception in 1995 until 1998, and played a key role in drafting their policy on climate change, and also the general principles of membership. I continue to be the adviser on Climate Change to the UNEP Finance Initiative (UNEPFI), which amalgamated the banking and insurance associations. In addition, I am a board member of the following bodies:
NERC's Funding Committee for Coupled Ocean -Atmosphere Processes and European Climate (COAPEC)
The Advisory Board to the Tyndall Centre for Climate Change Research
The Advisory Board of the Carbon Disclosure Project

Recent Projects (a selection)
I am frequently called on to facilitate projects or assist communication on climate change and the finance sector. For example I co-ordinated the stakeholder participation for a 2-day EU-funded workshop on climate impacts (MICE= Measuring the Impact of Climate Extremes) in Florence in October 2004. I identified 20 stakeholders from 6 sectors (Energy, Insurance, Forestry, Agriculture, Tourism, Water) representing 6 countries and designed the format and content of the workshop. Also in 2004, I carried out a major study for Association of British Insurers on climate change, which involved estimating the future cost of UK impacts, assessing current awareness (25 interviews) and preparing a report and extensive appendices. I represented DEFRA at the 5-day UNFCCC workshop on insurance within the Kyoto Protocol. I advised World Bank on a major report in 2003 on possible mechanisms for financing disaster recovery in India. I organised a workshop on climate change and asset management for the Tyndall Centre, reported in their Technical Report #20. This involved 24 interviews before the meeting, preparing a briefing paper (8 pages) and designing and organising the workshop itself. I am currently advising Tata Energy and Resources Institute on a study of climate change and the insurance industry in India.Linked to this, I am representing the Tyndall Centre on a multi-institute task force which presented a paper on "Climate Insurance" at COP11 on December 5th. My largest recent project is a study of climate change and the finance sector, published by Allianz Group in June London. It involved extensive desk research and 40+ interviews, and assimilating the comments of 10 expert reviewers, and was over 50 pages long, with a further internal-only report of similar size identifying strengths, weaknesses, opportunities and threats for Allianz Group. Finally, as an adviser to UNEPFI, I am constantly involved in updating and communicating their strategy on climate change- most recently a CEO Briefing "The Future of Climate Policy" presented at COP11 on December 5th .

Recent Publications (* as lead author, others as sole author)

Tyndall Briefing Paper #6 "The Carbon Disclosure Project" 2003 (Tyndall Centre website)
"Climate Change and the Financial Services Sector" in Geneva Papers on Risk and Insurance 28.3 July 2003*
"CEO Briefing on Renewable Energy", Climate Change Working Group, UNEP Finance Initiative, Geneva, June 2004
"A Changing Climate for Insurance", Association of British Insurers, London, June 2004
"Climate Change and Asset Management" Tyndall Centre Technical Report #20, February 2005*
"Climate Change and the Insurance Sector" in "The Business of Climate Change" ed K Begg et al, Greenleaf Publishing 2005*
"Climate change – agenda for action: the financial sector's perspective" Allianz Group and WWF, Munich June 2005 *

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Literature/References for this submission

A full detailed listing can be provided if required.