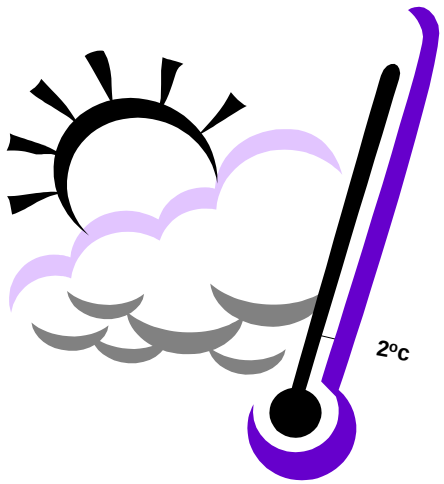
Tomorrow's Climate Beyond Peak Carbon

A discussion paper from Tomorrow's Company



tomorrow's company

Contents

Foreword Sir Richard Branson, President, Virgin Group

Introduction

7 **Summary**

12 **Part 1** **Peak Carbon – The scale of the Copenhagen challenge**

Question 1 – Does the business world understand the true scale of what is likely to happen post-Copenhagen?

20 **Part 2** **The climate crunch – the potential for a post-Copenhagen crisis**

Question 2: Should the policy-making system be strengthened perhaps with business input?

28 **Part 3** **The green opportunity – creating value in a carbon-constrained world**

Question 3: What policies should business most support?

42 **Part 4** **European carbon pricing - modelling the costs of carbon trading**

Question 4: Can we use carbon price projections to plan, or should we simply strive for maximum efficiency and decarbonisation?

50 **Part 5** **Conclusion**

54 **Post-script** – Tony Manwaring, Chief Executive, Tomorrow's Company

58 **Appendix - Green Investment Frameworks**

Foreword

By Sir Richard Branson, President, Virgin Group

First, I would like to thank Tomorrow's Company for inviting me to share my thoughts in this important publication.

Over the next few months, we are choosing our destiny. Either we work together across borders and interests to tackle climate change – or we choose a future with huge environmental and economic risks and uncertainty.

We are locking the planet onto a course as we speak with huge investments going into roads, buildings, grids, cables and power stations. So the decision is now. What destiny do we choose?

As a business leader, such a question must start with my own businesses. Creating a low carbon aviation business is one of the biggest challenges the Virgin Group faces. But it is a challenge we must and will meet. Aviation connects the world and enables economic and social development by providing links for trade, tourism and work-force mobility.

Virgin Atlantic is working with other airlines to accelerate the use of sustainable bio-fuels. But we also need public policy. It is vital that we have a bespoke emission trading scheme designed around the needs of aviation and we are working with other airlines to help policy makers understand the opportunities such an approach would offer.

In 2008 I called for the creation of a Carbon War Room. The Carbon War Room is a global initiative founded to harness the unique influence, resources and spirit of entrepreneurs to fill the gaps in the war on climate change. Many of the solutions are already out there, the War Room will help leverage further resources to support partners in speeding and scaling these solutions.

In a similar way, this report also identifies the need for more powerful central co-ordination of the effort to overcome global warming.

It is also now time to consider the importance of rainforests. Nick Stern once said:

'The next five years of carbon emissions from burning rainforests will be greater than all the emissions from air travel since the time of the Wright Brothers to at least 2025'.

Rainforests are one of the greatest machines we have in helping combat climate change but – and this is the deepest irony – their current rate of destruction makes them one of the greatest sources of greenhouse gas emissions. There is loads of complexity in the rainforest debate but one thing is true, as The Prince of Wales says – the rainforests needs to be worth more alive than dead. I am proud to serve on his Rainforest Project.

Two years I launched the Virgin Earth Challenge – a $25 million prize to find a commercially viable technology to remove CO_2 from the atmosphere.

It is vital that the UNFCCC Copenhagen process is successful. We must seek to build trust between the developed and developing nations. The developed world must show its commitment to bold action in cutting its greenhouse gas emissions

drastically. The developing world must show its commitment to following a pathway to energy efficiency and a low carbon future.

To sum up, I'm very much on the glass half full side of the debate. The challenges are massive and at times, the outlook seems black. None of us can sit on the sidelines. Otherwise our own way of life is at risk and we could see millions of people dying of starvation or in extreme weather conditions. But this is what provides us with the impetus to act and to act now. No one group can solve these issues, which is why I call for all of us to work together, whether as individuals, businesses, Government or NGOs to reach creative, pragmatic but bold decisions that will create tipping points for the challenges we face.

In a matter of a few decades, our children will ask us: What did you do, when you realized how bad things were? Did you act? Did you think about us?

These are the fundamental questions that business leaders must try to confront.

I sincerely believe that business is the force of change. Business is essential to solving the climate crisis, because this is what business is best at: Innovating, changing, addressing risks, searching for opportunities.

There is no more vital task.

Sir Richard Branson
President
Virgin Group

May 2009

Introduction

> *The survival and success of tomorrow's global company is bound up with the health of a complex global system made up of three interdependent sub-systems - the natural environment, the social and political system and the global economy. Global companies play a role in all and they need all three to flourish."*
> Tomorrow's Global Company: challenges and choices. 2007 [1]

This report takes a broad look at the big issues raised by climate change and how companies relate to them. This approach follows two principles that have been set out in Tomorrow's Company's work over the past few years. The first of these is that the fortunes of companies are linked to the economic, social and environmental context in which they work.

We have defined a 'sustainable company' as: *"one that pursues long term success, understanding that it depends upon - and therefore must contribute to - the health of the economy, the environment and society."*

In terms of the environment, companies depend on eco-systems in several ways. They use natural resource feedstocks. They suffer if there are floods, crop failures, extreme weather events or other impacts of climate change. An environmental catastrophe is an economic catastrophe. Its prospect leads to pressure from customers, employees, investors and NGOs.

The environment also exemplifies a second principle – market forces, while powerful drivers for progress and growth, need to be directed by frameworks of legislation and regulation if they are also to lead to sustainable ends. Many current frameworks are weak and are leading to unsustainable outcomes – a clear example being the continued burning of fossil fuels and mass deforestation.

Such thinking may seem a luxury at a time of global recession, but climate change is not only an issue for the long term. Actions taken in the next ten years will determine whether we leave a habitable planet to future generations. In addition, many political leaders are making the environment an economic issue. Those who support the injection of public funds into the economy to restore growth and create jobs recognise that 'green' investments are among the most attractive. There is an unprecedented synergy between economy and ecology.

The business opportunities inherent to climate change arise mainly as politicians act to reward low-carbon activity and penalize emissions. But the two major actors – government and business – need to work closely together to shape a green market, with governments as the architects and businesses as the builders. The synergy of the economy and ecology can only be fully exploited through a corresponding synergy between government and business.

This report asks key questions about how business might help to create that synergy. Can companies and their leaders do more to prepare for the scale of the task that they face over the next decade? Can they do more to help policy-makers create a more stable context for investment, rather than one whose parameters are constantly shifting? Can they do more to identify priorities for policy?

In Tomorrow's Company's view, companies need to take on more of a leadership role in engaging with stakeholders at all levels, with carbon reductions and energy efficiency as primary aims - not only within business but among all its stakeholders. The concept of 'partnerships', working together at all levels of society, is now of paramount importance for meeting the challenges ahead. Businesses not only need to engage with other stakeholders but provide much more of a leadership role in this partnership approach. This report sets out its recommendations in that context, not just for 'tomorrow's companies', but as a matter of some urgency for all businesses today.

Acknowledgements

In drafting this report we have spoken to many people involved in the scientific, political and business dimensions of climate change and are grateful for their time, input, scrutiny and comment. We have taken many of their comments and challenges on board in the final report, modifying it as a result, while standing by our underlying perceptions and conclusions. The views expressed are our own and we take responsibility for them.

Among those to whom we owe particular thanks for input and comment are: Kevin Parker and Michael Mainelli of the Z/Yen Group for their modelling of carbon dioxide-related costs for business; Vanessa Havard-Williams, Partner and Global Head of Environment at Linklaters LLP; David Wasdell, Director of the Meridian Programme; Nick Robins, Head of the Climate Change Centre of Excellence at HSBC; Patrick Bader, Sylvain Augoyard and others at BNP Paribas; and Robert Nash, Capital Accountability Policy Officer at WWF.

NOTE: This is a final pre-publication draft being distributed on a private basis. Some formal permissions have yet to be obtained in respect of material used herein.

Summary

> *"Over the bleached bones and jumbled residue of numerous civilizations are written the pathetic words: 'Too late.' "*
> Martin Luther King [2]

This report reviews the current state of science, policy and business approaches to climate change. It was initiated because although climate change is widely acknowledged as a major threat – often the greatest threat - to human civilisation, we perceived a dangerous disconnect between the declining priority accorded to the issue in the business world and the increasing urgency with which it is being treated in the scientific and policy-making communities.

Climate change is slipping down the agenda for business leaders. For example, the proportion of CEOs citing it as a concern in the annual PricewaterhouseCoopers Global CEO Survey has declined from 40% in 2007 to 34% in 2008 and 26% in 2009. [3] [4]

This might be expected given the current global economic turndown. Yet in the latest survey, global warming was seen as a lesser risk, not only than the recession, but than issues such as inflation, skill shortages and protectionism. Given that background, in this report we cover four topics and pose four questions.

Topic 1 – The scale of the Copenhagen challenge

In the first chapter of this report we set out why we believe climate change should be given a higher priority. It's not because business leaders should be concerned about the issue on environmental or ethical grounds. It's not even because they should be worried about the potential physical impacts of climate change on their companies' assets and business activities in years to come. In our analysis there are more pressing, short-term, reasons for prioritising climate change:

First, scientific evidence, as presented to policy-makers by the Intergovernmental Panel on Climate Change (IPCC), has been leading to ever tougher targets and tighter deadlines. Whereas in 2001, debate revolved around the target of stabilising carbon dioxide (CO_2) emissions at around 500-550 parts per million[5], now many support a target level of 400ppm – just 20ppm above today's level. And whereas in 2001, debate tended to centre on bringing emissions to a peak around 2025, today the IPCC is saying that to prevent the rise in temperatures on pre-industrial times exceeding 2°C, emissions need to peak by 2015. Such targets and timescales represent a massive transformation of the economy, particularly its energy base. Greenhouse gas (GHG) emissions are currently rising at around one billion tonnes a year, and accelerating. Bringing them to a peak in the next decade means reversing the upwards trend of the last 200 years at a time when energy needs are growing as a result of the rapid industrialisation of China, India and other emerging economies. In most economies, GHG emissions need to be cut much more in the next 10 years than they have been in the past 20. In the UK for example, emissions of CO_2 have been cut by 13% since 1990 (on the most generous reading of the data), [6] yet the government has just increased its 2020 target to a cut of 34% on 1990 levels and a goal of 42% is possible if there is a global agreement. [7]

Second, the projected cost of decarbonising the economy is vast – though best estimates suggest it will be manageable if properly planned and started soon.

In ballpark terms, the estimates for necessary investment in energy efficiency and low-carbon technology from authoritative sources such as the International Energy Agency (IEA) are around $10 trillion from now to 2030, or around $500 billion a year.[8]

Third, politicians are showing a new readiness to pursue these tough targets. Several governments are already pursuing aggressive GHG reduction policies, the Obama administration being a game-changing addition to the list. But currently these policies are being introduced unilaterally, without an overarching global framework other than the soon-to-expire and relatively modest Kyoto Protocol. A much more ambitious global agreement is in prospect at the 2009 Copenhagen climate summit. We expect the international effort to combat climate change to shift gear decisively after that point. Many countries will have demanding targets for 2020, if not 2015, and businesses can expect to see a 10 year programme for change unfold, with a series of new challenges, opportunities, costs and incentives. This leads us to the first of our four questions for discussion.

Question 1 – Does the business world understand the true scale of what is likely to happen, post-Copenhagen?

Topic 2: The climate crunch – the potential for a post-Copenhagen crisis

The second chapter of this report asks whether the prospective Copenhagen deal will actually be enough to deal with the problem. Will it set in train the necessary decarbonisation of the economy, or will it be followed by a further ramping up of scientific evidence, targets and deadlines?

The danger is that the pattern of ever-toughening targets and ever-tightening timescales may not be over. The ratchet effect comes from a system whereby science is only gradually translated into policy. Because of the nature of the system, today's policies are based on yesterday's science, and the science is constantly evolving. In 1995, for example, the IPCC could only say the 'balance of evidence' suggested humans were influencing the climate. The relatively modest Kyoto Treaty was a proportionate response to such a muted concern and one that left room for widespread scepticism. But by 2007 the IPCC expressed 'very high confidence' – or over 90% likelihood – of human impacts. Hence, the much tougher policies and proposals being put forward now.

However, the focus of science is now shifting. Instead of looking mainly at the impact of greenhouse gases on the climate, it is increasingly looking at the impacts of the impacts – in other words the 'feedbacks' or 'tipping points' whereby one impact leads to another. For example, science has revealed much about the potential melting of Arctic ice and its effect on sea levels. We know less about the process whereby the loss of reflectivity or 'albedo' in thinning ice may accelerate the melting. Another related feedback mechanism is the way that warming of permafrost may release trapped methane. Increasing understanding of such factors could drive a new scientific consensus and create pressure for yet tougher targets and policies. Already, James Hansen, Director of NASA's Goddard Space Science Laboratories, whose testimony before the US Congress in 1988 played a major part in alerting the world to global warming, believes it is not enough simply to stop emissions rising. Instead he says it is necessary to take carbon out of the atmosphere and reduce the concentration of CO_2 to 350ppm in order to preserve the Arctic's sea ice and prevent catastrophic flooding. [9]

Copenhagen will be a political response to the IPCC's 2007 report, itself based on research from the preceding decade. But many scientists are saying that politicians need to factor in more recent findings. Arguably they should be seeking to get ahead of the curve by creating policies that address serious risks as well as near-proven science.

As John Maynard Keynes said, it is better to be roughly right than precisely wrong. That statement has been invoked by the UK Chancellor and others to justify the rapid and sometimes rough-hewn response to the financial crisis. Should a similarly pragmatic approach not be applied to climate change?

Businesses are seeking a stable context for investment – with clarity on policies for the next decade or so as a basis for planning and calculating returns. But this is impossible when targets keep moving. The IPCC, which advises world leaders on climate science, and the UN Framework Convention on Climate Change (UNFCCC), which runs the negotiations and administers international mechanisms for addressing global warming, have done outstanding work. But the two organisations together operate on around $30m a year,[10] or roughly what GE spends on R&D in a week.[11] We ask whether the world's effort to secure its own survival should be co-ordinated by institutions with the financial firepower of a moderate sized SME. Our question is whether they could be usefully supplemented by a 'rapid response' function dedicated to assessing science and advising policy-makers of risks on a continual basis.

This then leads to questioning the wider institutional architecture by which the world seeks to cope with global warming. As well as assessing science more rapidly, should there not be extra capacity to co-ordinate the action taken in response? For example should there be a UN-backed centre to collate data on emissions, policies and good practice?. If the world was a business, would its board be content with the way it is managing its greatest risk? Indeed, could business assist this strengthening of capacity in some way, through funds, secondees, advice or other channels? With only a modest injection of new resources, the effort could be taken to a new level, commensurate with the urgency of the situation as well as with the potential of the corporate sector to assist. This takes us to a further question:

Questions 2: Should the policy-making system be strengthened, perhaps with business input?

Topic 3: The green opportunity – creating value in a carbon-constrained world

Once targets are set and decisions taken to aim for particular targets to mitigate GHG emissions, politicians have a kaleidoscope of technology and policy options to choose from. The emission reduction tool-box has three broad compartments – 'save', 'switch' and 'sow'. In the 'save' compartment are energy efficiency measures through which emissions are avoided by using less fuel and power. In the 'switch' category emissions are avoided by replacing high carbon energy with low carbon energy, whether from renewables, nuclear power, biofuels or deployment of carbon capture and storage. The 'sow' option involves stopping deforestation, which is responsible for around a fifth of all GHG emissions[12], comparable to all the damage caused by cars.

The policy portfolio to drive such reductions includes direct government investment, emissions trading, taxation, regulation, subsidies, price guarantees ('feed-in tariffs') and mandates or quotas that require certain proportions of energy

to come from low-carbon sources. Some policies, such as emissions trading and quotas, involve little public spending, but create markets in carbon emissions allowances or renewable energy, placing costs on businesses and thus on their customers. Other policies, such as subsidies and direct government capital spending, involve taxpayers' money. Ultimately the citizen pays, whether through taxes, personal investment in clean products, or through price increases resulting from higher business costs.

For businesses, climate change represents both risks and opportunities, depending on the nature of the company's work. There are clear winners, such as wind power companies or businesses making energy efficient industrial plant. And there are losers, for example companies in high emissions sectors such as oil and gas, cement and steel. However such companies can turn the problem on its head and create an opportunity by being a first mover in the lower-carbon world. If a sprint event is replaced by a hurdle race, the runner who has already trained for the new event will have the advantage. All companies have the opportunity to save energy and thus save costs and emissions – though arguably this should be part of good business regardless of climate change. But business cannot achieve the necessary emissions reductions unilaterally – by 'doing its bit'. Climate change can only be resolved by governments, business and public working together.

The more complex questions for business relate to the blend of policies, investing patterns and business activities that will result in the most efficient means of reducing emissions. The recession has changed the dynamics in this area as several governments have opened their coffers to an unprecedented degree to fight the downturn triggered by the banking crisis of 2008. Some have chosen to include in their spending programmes large green components that simultaneously address unemployment, climate change, energy security and the threat of 'peak oil'. President Obama's green spending package has grabbed headlines but China is also pumping billions into recession-beating environmental measures including an aggressive build-out of renewables. However there is no universal consensus that 'green is good', as the lack of internationally co-ordinated fiscal action has shown.

Neither is there a clear consensus from the business world on the specific policy tools that should be adopted – whether trading or tax, mandates or market mechanisms, regulation or R&D spend. And what are the outcomes that should be prioritised, electric cars or biofuels, nuclear power or carbon capture, increasing efficiency or preventing deforestation? The answer tends to be "These are not alternatives – we need to use every tool". But that avoids the question of priorities. Where does the first dollar, pound or Euro go? As climate policy starts to have a more severe impact on business, we believe clearer calls from business for particular actions will be helpful. We do not attempt to come up with specific answers to the question below, but we do try to sift the options to bring out more of an order of priorities. Our suggested list is headed by energy efficiency (stimulated by emissions trading, but with sharper measures as used in California as a back-up), carbon capture and storage (CCS) (a must, whether funded by industry, government or, more likely, both), wind power (incentivised by feed-in tariffs) plus more R&D on solar and other renewables, opportunities to help halt deforestation, and green bonds to unlock private capital. Others will come to other conclusions. The key is for the business community to be engaged at this level of debate as well as issuing high level exhortations.

Question 3: What specific policies should business most support?

Topic 4: European carbon pricing - modelling the costs of carbon trading

The final topic covered in this report is a more specific one. While recognising the significant opportunities that many companies enjoy as a result of their particular business activities, we wanted to get a greater insight into the orders of magnitude by which business costs might increase as a result of actions taken by governments. How much might the impacts vary if differing courses are pursued?

Costs are difficult to forecast because policies are still developing. However one area where a fairly specific course has been charted is the EU's emissions trading scheme (ETS) in which provisional emissions caps have been set up to 2020 as part of a framework to achieve a 20% reduction in GHG emissions. We therefore worked with the economic consultancy Z/Yen to understand how costs might develop in the ETS under different scenarios. We looked the 'business-as-usual-scenario in which a 20% cut in overall EU GHG emissions is the goal. We then examined what would happen if the target was raised to 30% as the EU has pledged in the event of a global deal. Then bearing in mind the possibility of a further tightening of policy following more disturbing scientific findings, we looked at what an effort to cut emissions 40% by 2020 might entail. In each case, we also looked at the impacts on the carbon price of different levels of price elasticity and differing rates of progress in reducing carbon footprints.

The good news is that with reasonable progress in efficiency and technology, the costs of all scenarios, even the most demanding, appear manageable. The projected costs of carbon dioxide allowances under the scenarios of 30% or 40% reductions by 2020 ranged from €25 to €35 in 2015 and €19 to €29 in 2020. The downside is that with poor progress in efficiency and technology the model projected CO_2 costs rising as high as €65 in 2015 and €114 in 2020. The wide range reflects uncertainties on how much progress will be made in energy efficiency and low-carbon technologies. The actual costs borne by companies, as opposed to the costs of carbon dioxide, are set to increase substantially, whatever happens, because as the scheme develops, fewer allowances are being given away and more auctioned, meaning that companies and their customers will need to pay for greater shares of their emissions. Also, although the ETS by itself may drive a significant switch towards a lower-carbon economy, other costs are likely to affect companies. Fuel prices may be influenced by biofuel mandates. Investments may be necessitated by building regulations. And any 'green stimulus' in public spending may increase taxation. Hence our final question:

Question 4: Can we use carbon price projections to plan, or should we simply strive for maximum efficiency and decarbonisation?

Part 1:

Peak carbon – the scale of the Copenhagen challenge

"What is needed is nothing short of an energy revolution… Preventing catastrophic and irreversible damage to the global climate ultimately requires a major decarbonisation of the world's energy sources." World Energy Outlook, International Energy Agency, 2008 [13]

'Peak Carbon' is a mountain that has to be conquered by 2020. The scientists who advise governments not only tell us that greenhouse gas (GHG) emissions must be halved by 2050, but that they need to peak and start falling in the next 10 years. That is a major challenge when emissions have been rising for 200 years and are accelerating. We believe today's political leaders are serious about taking on this challenge. The question is whether the business world is ready too.

A relatively low priority for business leaders

This report begins from the observation that despite all the debate, analysis and activity of the past few years, including major programmes in companies themselves, climate change is not at this moment a major priority for business leaders.

For example, among over 1,000 business leaders interviewed for the 2009 PriceWaterhouseCoopers Global CEO survey, 74% were either 'not at all concerned' or 'not very concerned' about climate change. Only 7% were 'extremely concerned', compared to 42% who were 'extremely concerned' about the economic downturn. Climate change ranks 11th in the list of CEO concerns, below such issues as skills, inflation and protectionism. The proportion of CEOs citing climate change as a concern has declined from 40% in 2007 to 26% in 2009. [14] [15]

A survey by the Prince of Wales's May Day Network showed that over half of UK businesses had not considered modifying their processes in response to climate change.[16]

This 'climate fatigue' is understandable, but it needs to be overcome. The need for business to take climate change seriously is not a moral or ethical obligation. It is simply a matter of risk management. It is not only about managing the relatively long-term risks of floods, storms, water shortages and other physical impacts of climate change. It is about the much more immediate, short-term, regulatory risk that arises from three factors:

- ever tougher targets and tighter deadlines for emissions reduction being presented to policy-makers by the Intergovernmental Panel on Climate Change (IPCC);
- the significant potential costs of transforming economies into lower-carbon ones, with associated opportunities for companies that can take advantage of the shift;
- increasing preparedness among policy-makers to take radical action to address the issue.

How have targets moved?

The moving targets of the past decade can be traced by reference to four key metrics.

The temperature target: the maximum that the average global temperature be allowed to rise over that of pre-industrial times in order to avoid catastrophic climate change.

The stabilisation target: the level at which greenhouse gases, principally carbon dioxide, need to be stabilised in order to stay within the temperature target. The Earth is surrounded by a natural blanket of GHGs which prevent temperatures dropping to sub-zero levels. Before the Industrial Revolution, indeed for all of human history, the level of CO_2 had been under 300 parts per million (ppm).[17] In the last 200 years the concentration of CO_2 has risen to around 386 ppm[18] as a result of the burning of huge volumes of coal, oil and gas and the destruction of vast areas of forests. The question now is at what level the GHG concentration should be stabilised and prevented from increasing further.

The emissions target: the amount by which we need to cut annual GHG emissions by a given date to keep the blanket of GHGs to the targeted thickness? Human-generated emissions of CO_2, resulting from energy consumption, deforestation and agriculture, currently amount to around 36 billion tonnes a year. Total GHG emissions are over 50 billion tonnes a year.[19]

The peak-year target: the date by which emissions need to stop rising and start falling. Given that emissions are currently rising and will inevitably continue to rise until policies bite hard, the peak year is a key determinant and indicator of the intended trajectory of emissions reductions towards the date at which the emissions reduction target is to be reached.

The least contentious and most stable of these targets is the temperature. It has been widely believed for some time that 2-2.5°C is the maximum that the global mean temperature should rise on pre-industrial levels. The EU, for example, has said that limiting warming to 2°C is needed to avoid “massive and irreversible disruption of the global climate system”.[20]

The other targets have been moving rapidly over the past decade, as can be seen by examining the stabilization and peak-year goals.

Between 2001 and 2005 a commonly discussed scenario was that of stabilising carbon dioxide levels at around 500-550 parts per million (ppm), with emissions peaking by 2025. [21]

Then in 2006, when Lord Stern produced his report for the UK Government, he raised the stakes, recommending action to stabilise CO_2 between 400 and 490ppm[22] (which equates to 450-550ppm of all greenhouse gases in ‘CO_2 equivalent’ terms). Stern calculated that 400ppm was likely to be unachievable and that stabilising GHG levels at the upper end of the range would require emissions to peak within 10 to 20 years - ie by 2026 at the latest. [23]

However in 2007, the IPCC, in its Fourth Assessment Report, said that CO_2 levels should be stabilised at or below 400ppm to have a chance of keeping the temperature rise to 2-2.4°C – and that emissions should peak as soon as 2015.[24]

In terms of the emissions target, the IPCC said that human-made CO_2 emissions should be cut by 50 to 85% globally by 2050 in order eventually to stabilise the concentration level at 400ppm or below.[25] Cuts will need to be heaviest in advanced economies such as the US and Europe – in the order of 80-95% by 2050 and 25-40% by 2020.[26]

So whereas in 2001 debate centred on bringing emissions to a peak in around 25 years' time, today the IPCC says we have just six years in which to reverse the upward trend of the last two centuries. Instead of aiming to stabilise CO_2 some 100ppm higher than the current level – as was being discussed less than ten years ago, the IPCC is indicating that CO_2 needs to be stabilised at just 15ppm above the level it stands at today.

What do the likely targets mean?

The implications of the IPCC's findings are daunting. Today, annual GHG emissions are not simply rising, but accelerating fast Emissions rose at around half a billion tonnes a year from 1970 to the mid-1990s, but in the last decade they have been rising at nearly twice that rate.[27] The level of GHGs in the atmosphere is increasing by about 2ppm every year, so is due to reach 400ppm around 2015.[28] So if the 400ppm stabilisation target is ultimately achieved, it is likely to be after some initial overshooting.

The International Energy Agency (IEA) calculates that if trends continue as today, then there will be a 70% increase in oil demand by 2050 and a 130% rise in carbon dioxide emissions –projected to lead to a 6°C rise in temperature and *"significant change in all aspects of life and irreversible change in the natural environment".*[29]

Another way to look at the issue is to calculate 'carbon budgets' - the total of GHGs that a country, region or the world can afford to emit. One recent study by Oxford University[30] estimated that the world can emit one trillion tonnes of carbon – equivalent to 3,670 billion tonnes of CO_2 - if the temperature rise is to be kept to around 2°C. Half a trillion tonnes has already been burned, leaving another half to be consumed. The study estimated this total would be reached in 40 years at current rates. The UK government has adopted a carbon budget approach – with a budget of around 600 million tonnes a year of GHGs up to 2012.[31]

One of the major problems is that – notwithstanding the current downturn – the underlying economic trend is one of growth in energy consumption, driven by the rapid industrialisation of China, India and other countries.

According to the US Energy Information Administration, China's CO_2 emissions from fossil fuels have risen from 1.5 billion tonnes in 1980 to 6 billion in 2006. Over the same period US CO_2 emissions from fossil fuels rose from 4.8 billion to 5.9 billion tonnes while those of Europe, including central and eastern European countries, remained relatively flat at around 4.7 billion.[32] Emissions of GHGs in the western EU's EU15 countries were actually reduced by 2% from 1990 levels by 2005[33].

However, many of the significant cuts had been in the 1990s when the liberalisation of the EU gas market prompted a switch from high-carbon coal to lower carbon gas – the so-called 'dash for gas'.[34] In other words a lot of the 'low-hanging fruit' has gone.

In the UK, emissions of CO_2 have been cut by 13% since 1990, on the most generous reading of the data which takes into account emissions allowances purchased from other countries. Yet the government has just increased its 2020

target to a cut of 34% on 1990 levels and its advisers on the Committee on Climate Change propose raising the target further to 42% in the event of a global deal at Copenhagen.[35] If that happens, then we are only a quarter of the way to the reductions needed between 1990 and 2020, with two thirds of the time elapsed. And the UK is one of the world's leaders in cutting emissions.

The challenge was well articulated by the Slovenian government when it had the EU Presidency. After a scenario-building exercise it concluded that given current economic systems and their dependence on hydrocarbons, *"the momentum that acts against innovation cannot be under-estimated".* [36]

What are the costs of change?

The disruptive transformation involved in turning a high carbon world into a low-carbon one task will inevitably have a major price. Quantifying the cost is fraught with difficulty as the tools of economic analysis tend to depend on numerous assumptions and cannot factor in every variable. Technology developments may lower costs unexpectedly. On the minus side, unforeseen social costs could arise, for example as a result of mass migration when people move away from flooded or arid land.

Caveats aside, several estimates of the costs of the required energy efficiency, low-carbon energy and reforestation suggest a need for investments of around $500 billion a year.

The IEA, for example, estimates that stabilising greenhouse gases at 400ppm of CO_2 or below will require investments of roughly $9 trillion between 2010 and 2030.[37] The World Economic Forum and New Energy Finance say that more than $10 trillion, or $515bn a year, should be invested in clean technology between now and 2030.[38] This compares for example with around $150 billion of private sector 'CleanTech' investment in 2008.[39] The yearly spend is also less than the US government alone has spent on rescuing banks in the past year.

And while the absolute numbers are large, they represent small proportions of world GDP – typically 1-3% of future annual GDP according to leading projections. The IPCC says that keeping the temperature within 2.4°C of pre-industrial times would cost the global economy less than 3.0 % of its GDP by 2030, or a loss of around 0.12 % of growth per annum.

The positive dimension of all these numbers is that the cost of mitigating climate change is estimated to be far less than the cost of letting it happen. Lord Stern said that the dangers of unabated climate change would be equivalent to at least 5% of GDP each year, while the annual costs of stabilising at around 490ppm were likely to be around 1% of global GDP by 2050.[40] But of course 490ppm is over 100ppm away from today's level, whereas 400ppm is just 15ppm away and Stern suggested that such a rapid decarbonisation would have higher costs. Stern has subsequently revised his view to suggest targeting a level around 450ppm, saying this would cost around 2% of GDP.[41]

Even 1-3% of world GDP is a sizable amount – around $600-1800 billion[42]. And macro-economic projections of proportions of GDP many years hence mask the way costs break down between short and long term, different sectors and different countries. For a heavy emitter in an advanced economy short-term costs could be very onerous. Dr Fatih Birol, Chief Economist of the IEA, said of the 2015 peak scenario: *"Exceptionally quick and vigorous policy action by all countries, and unprecedented technological advances, entailing substantial costs, would be needed to make this case a reality".* [43]

Will politicians respond to the science?

Given the scale of the emissions reduction challenge, the potential costs and the current economic recession, politicians might be expected to shy away from taking decisive action on climate change. However many political leaders have endorsed the aim of cutting emissions 50% or more by 2050, including the G8 group of industrialised countries.[44] Those with an eye to their legacy may recognise that this is the last chance to take advantage of a window of opportunity in which what is seen as necessary by scientists overlaps with what is deemed possible by politicians.

At the same time the recession has provided an opportunity to make the green investments that have been politically problematic in the past. These simultaneously address unemployment, climate change, energy security and the threat of 'peak oil'. Over $60bn of the US's $787 recovery package is being directed towards energy efficiency, low-carbon energy, green transport and environmental remediation [45] President Obama wants to create 3.5 million new jobs, many of which will be 'green-collar jobs' in areas such as solar, wind and energy efficiency. [46] He is also pressing ahead with plans to bring cap-and-trade to the US.

China is also pumping billions into recession-beating environmental measures including an aggressive build-out of renewables. Indeed, while discussions take place among the G8 or G20 group of large economies, much of the task devolves on the effective 'G2' of the US and China which are together responsible for nearly 40% of the world's energy-related carbon dioxide emissions. [47]

The UN Environmental Programme and others are advocating that the fiscal stimulus model be expanded to create a 'global green new deal' with investment of $750bn, accounting for one third of the total spend.[48] Lord Stern and colleagues at The Grantham Research Institute on Climate Change in February 2009 published a case for a 'green stimulus' for the entire global economy, calling for governments to make around $400bn of investments in energy efficiency and low-carbon technologies over a year or so. [49] However environmentalists were disappointed by the G20 meeting in London in spring 2009, where there was scant mention of climate change and no formal commitments to any co-ordinated green stimulus package.[50]

In terms of the global framework agreement, with the G8 having endorsed a 50% GHG reduction target for 2050 and the IPCC advising it is the very least needed to avert a rise of 2-2.4C, politicians will find it hard not to accept the goal.

What is less often mentioned is the more demanding goal of a peak in emissions by 2015. Whether or not 2015 is specifically mentioned, if a target of halving emissions by 2050 is set, there will be pressure to target a particular peak year and to set interim goals, particularly for 2020, in order to create a trajectory for early cuts rather than leaving the effort until decades to come.

Assuming there is an agreement on halving emissions by 2050, a major issue will be how the burden is shared between developed and emerging economies. The issue cannot be tackled without very deep cuts in the emerging world because since 2004, non-OECD emissions of carbon dioxide have been greater than those of the OECD countries, and the gap is widening.[51] The IPCC's 2007 report put forward an approach in which developed countries would aim to reduce emissions by 25-40% by 2020 and by 50-85% by 2050 on 1990 levels while there should be *"substantial deviation from the baseline"* in Asia, Latin America and the Middle East by 2020 and worldwide by 2050.[52]

The EU has a goal of a 20% cut by 2020 on 1990 levels and has pledged to raise it to 30% if there is a global agreement, with corresponding commitments from other industrialised countries.[53] The US is simply aiming to bring 2020 emissions back to the 1990 level.[54] Japan may struggle to do the same. [55] So, of these major players, only the EU is within the IPCC's vision of a cut of 25-40% in advanced economies.

Meanwhile, emissions in China, India and other growing economies continue to soar. One way to partly square the circle is to allow developed countries to make cuts in the developing world and count them against their target. The Kyoto Treaty created the 'clean development mechanism' (CDM) which provides for developed countries and their businesses to gain credit for emissions reductions that they have financed in emerging and developing economies. It also created 'joint implementation' (JI) projects designed to achieve similar ends in the transition economies of central and eastern Europe.[56]

The CDM – though not without its flaws - has proved itself to be the unexpected success story of Kyoto, growing into a market of around $32bn in 2008.[57] In time, though not necessarily at Copenhagen, we can expect the existing CDM to be transformed into a much more powerful conduit for action.

If it raises its emissions reduction target from 20% to 30% on 1990 levels, the EU is expected to look for the extra 10% to come from the purchase of emissions reductions from developing countries as it will be hard pressed to achieve even 20% reductions through behavioural and structural change.

The focus of much of the pre-Copenhagen work is on the mechanisms whereby funds will be transferred from OECD countries to developing economies. Several different approaches are being considered, with debate focusing on the mix between public finance and market mechanisms. Key issues include intellectual property rights, sectoral agreements in energy intensive areas such as steel and cement, and the potential for carbon markets to become more robust and credible. The EU is looking for the more prosperous developing countries to adopt hard-edged reduction targets for the long term, and in the shorter term national plans to reduce emissions compared to 'business-as-usual'.

In general whether one looks at the required emissions reductions, the pace of change, the costs, or the political and financial mechanisms, the scale of what is being contemplated for the next 10 years is immensely challenging. This leads to our first, simple, question:

Question: Do business leaders understand the true scale of what is likely to happen, post-Copenhagen?

Part 2:

The climate crunch – the potential for a post-Copenhagen crisis

"After climbing a great hill, one only finds that there are many more hills to climb" Nelson Mandela

Copenhagen is likely to set the world a giant challenge in terms of logistics, cost and policy co-ordination. But will it be the end of the matter? The experience of the last few years does not inspire confidence. It has been a story of constantly shifting targets and there is a clear risk that the ground will continue to move after Copenhagen. So can society find a way not only to stabilise the climate, but to stabilise its response to global warming? And can business do more to help?

Why do targets move?

In the last 10 years, a cyclical pattern has emerged. A major report comes out – such as an IPCC assessment report, or the UK's Stern Review – putting forward a set of targets and deadlines. Governments, business organisations and others rally around that position. Typically they stress the urgency of the situation but also set out what appears to a path for an affordable and orderly transition to a low carbon world. An immense amount of analysis is then carried out on the detail of achieving the targets in question. It takes longer still for governments to adapt legislation to respond.

In the meantime, the next big report comes along and sets out a more advanced position. The detailed analysis of the earlier position is shelved and a period of adjustment follows while the conventional wisdom is updated and the flock catches up with the new consensus.

This creates anything but stability in national policy. For example, in 2008, the UK government moved to reflect the IPCC's 2007 report by revising its 2050 goal for cutting emissions from 60% on 1990 levels to 80%.[58] Its target for 2020 also shifted. No sooner had the UK government introduced a Climate Change Act in November 2008, with a target to cut CO_2 emissions 26% on 1990 levels by 2020 than its own Climate Change Committee recommended increasing the target to 34%.[59] This was duly accepted in early 2009.[60] The Committee recommends that if a global deal is agreed, the target should be revised again to 42%.[61] The UK therefore faces the prospect of its 2020 target being changed twice within a year.

In the EU, much work and analysis has gone into the 20-20-20 programme which sets targets for 2020 to reduce GHG emissions 20% on 1990 levels, increase the share of renewable energy in the economy to 20% and increase energy efficiency by 20%. Yet the EU has pledged to increase it to 30% if there is a global agreement.[62]

The main driver for this ratchet effect is the process whereby the IPCC assesses scientific research and presents its implications to politicians in its 'assessment reports'. These reports typically take six or more years in gestation. So far there have been four: Assessment Report (AR)1 in 1990, AR2 in 1995, AR3 in 2001 and AR4 in 2007. They draw on a vast amount of relevant research, particularly that conducted since the last report. For example, the 2007 AR4 draws heavily on research from the 2001-2005 period. IPCC reports are then used as the basis for a period of negotiations on policy, and then, eventually, the policy is implemented. So the process has four stages: primary research; IPCC report; policy-making; and policy implementation.

The AR4 report is informing a phase of policy-making that is due to culminate in the December 2009 Copenhagen Summit and designed to provide a new policy framework to succeed the Kyoto Treaty from 2012.[63] So in terms of the formal global level mechanism for change, scientific findings from say, 2002, will not inform action on the ground until a decade later.

This pattern would not matter if we were dealing with a field in which time itself was not critical. However, the danger is that by the time a given generation of science has been reflected in action it has been succeeded by new research which shows a need for more urgent action still. There is a systematic disconnect between science, policy and the business response. Scientists whose research demands a rapid response from politics and business are part of a system that makes such a rapid response impossible.

How has science progressed?

In the past 20 years, the IPCC's reports have gradually progressed in certainty regarding the fundamental science of climate change. In its first report in 1990, the IPCC said unequivocal detection of global warming was unlikely to be possible for a decade. In 1995, it said the "balance of evidence" suggested that there was a human influence on the climate. In 2001 it said human involvement was 'likely'. In 2007 the IPCC said warming was "unequivocal" and it had "very high confidence" (over 90% in IPCC-speak) that human activity was responsible.[64]

There was a particular step-change between the IPCC's 2001 and 2007 reports. For example whereas in 2001 there was a 'wide range of uncertainty' about what level of GHGs would lead to given temperature increases, by 2007, the scenarios were presented much more starkly, with the clear indication that keeping the temperature rise to 2°C meant stabilising at 350-400ppm.[65]

Whereas in 2001, the IPCC said that climate change 'can' affect human health, depending on local circumstances, by 2007 it was saying that millions were projected to be affected through conditions such as malnutrition, diarrhoea, cardio-respiratory and infectious diseases.[66]

But just as the world is adjusting to these messages, so science may be on the brink of another step-change and another set of uncertainties.

How is science now changing?

The science on which policy is currently based largely focuses on one dimension of the climate system - the impact of increasing greenhouse gas concentrations on the world's heat generation and thus its temperatures. However the system is much more complex and contains many potential 'feedbacks' whereby one impact of climate change triggers another. The 'feedback school' argue that greenhouse gases simply initiate the process of global warming.[67] Once it is under way the process itself triggers chain reactions that lead to runaway global warming.

For example, as ice melts, it loses its reflective quality, or 'albedo'. It instead absorbs more heat and melts faster, a process called the 'albedo-flip'. There is already evidence of this happening. Peter Wadhams, Professor of Ocean Physics at Cambridge University, has shown how Arctic sea-ice is not only shrinking faster than projections expected – but faster than the most pessimistic case put forward in those projections - the lower limit of the 'standard deviation' or 'plus-or-minus' factor used by statisticians. The extent of Arctic sea-ice as measured each September has nearly halved since 1950.[68]

In another feedback cycle, as tundra melts, for example in Siberia, there is a risk that vast quantities of methane, a much more powerful GHG than CO_2, will be released. [69]

The potential mother of all feedbacks is that the Earth's warming will accelerate as the 'thermal inertia' of the planet is overcome. The Earth, as a vast sphere of matter, takes some time to respond to the application of extra heat. But once it starts to respond, its heating accelerates. It gets hotter quicker.

David Wasdell, of the UK-based Meridian programme and one of the most radical exponents of the feedback school, says that the key target should not be temperature but heat - the level of heating of the planet, known scientifically as 'radiative forcing', the equivalent of the gas burner under a pan. Wasdell argues that this heat engine needs to be turned down to zero from its current level of around two watts per square metre. In his analysis, allowing the global temperature to rise by 2°C – widely regarded as the tolerable threshold - would be disastrous because such a rise would result from a near doubling of the power of the heat engine. If heating rises that much, Wasdell argues, this would push the climate across a range of dangerous 'tipping points' including a major sea level rise. [70]

While the effects of reaching tipping point may not occur for centuries, many scientists believe several decisive points could be reached this century. For example the melting of the Greenland ice sheet could take 300 years, but the process that triggers it could happen in the next 50. [71]

It is important to note that scientists highlighting the risks of feedbacks are not contradicting the IPCC or forming a separate school of thought. The last IPCC report flagged up the risks of feedbacks while stating that there are many uncertainties surrounding them. In what may prove a prescient footnote to its most critical findings on the emissions cuts needed to achieve particular concentration targets, the IPCC says: *"The emission reductions to meet a particular stabilisation level reported in the mitigation studies assessed here might be underestimated due to missing carbon cycle feedbacks."* [72] In other words, more understanding of feedbacks could make emissions targets even tougher.

A key reason for targeting a 2°C limit to the temperature rise on pre-industrial times is the danger of runaway warming if that threshold is passed. Indeed President Obama's Science Advisor John Holdren authored a UN report saying that increases beyond that point *"will entail sharply rising risks of crossing a climate 'tipping point' that could lead to intolerable impacts on human wellbeing."* [73]

What could be the implications of emerging science?

Feedback science introduces a new urgency into the climate debate because while devastating effects of climate change have not yet been seen, it suggests we are close to tipping points at which such impacts become inevitable.

For example, although widespread melting of the Greenland ice sheet might take several centuries, some scientists believe that it could become inevitable this century if temperatures rise to around 4 degrees above pre-industrial levels[74] - and the action needed to avert that outcome needs to be initiated soon.

Possible evidence of the acceleration in warming is now appearing. Eleven of the 12 years up to 2006 were among the 12 hottest years on record[75] and since 2007; scientific reports have revealed new findings that go beyond the evidence presented in the 2007 IPCC report. In late 2008, for example, WWF produced a report, *Climate Change: Faster, stronger, sooner,* reviewing a range of studies which suggest global warming is accelerating beyond the IPCC's forecasts.[76]

Among the studies covered were those showing that the Arctic Ocean is losing sea ice up to 30 years ahead of IPCC predictions. It is now predicted that the summer sea ice could completely disappear between 2013 and 2040 – for the first time in more than a million years.

The ultimate risk presented by feedback science is that it is becomes the consensus, but only after such a time lag that GHG levels are by that time well above what it demands they should be. In 2001 the optimum peak year for emissions being discussed was 2025. In 2007, it was 2015. If the trend were to continue at the same rate, then by the time of the next IPCC report, the AR5, due in 2014, scientists could be saying emissions should have peaked in 2005.

Indeed, James Hansen, Director of NASA's Goddard Space Science Laboratories and the academic whose 1988 testimony to the US Congress played a major part in alerting the world to global warming, now believes it is necessary to take carbon out of the atmosphere. He says the concentration of CO_2 needs to be reduced to 350ppm from its current 387ppm in order to preserve the Arctic's sea ice and prevent catastrophic flooding. He has also argued that the temperature target should be a rise of just 1.7°C on pre-industrial times if the world is to avoid major loss of polar ice, widespread flooding and large-scale species extinction.[77]

Could there be a 'climate crunch'?

The risk for business is that the past Copenhagen era will see a further shift in targets or even a full-blown crisis on the scale of the current financial crisis.

The potential elements of such a crisis are already visible – increasing physical signs of climate change, developing feedback science and inertia affecting efforts to reduce emissions. Imagine for example that around 2013 or 2014 dramatic crop failures hit Africa around the same time as floods affect millions in Bangladesh. Millions are made homeless and call on the West for help, arguing that the developed world bears responsibility. Around the same time, Arctic ice melt accelerates dramatically, with the ocean even becoming ice free in summer. Stranded polar bears become an iconic image of the Earth's plight. The physical impacts increase interest in new science showing that global warming is accelerating everywhere as a result of feedbacks such as the albedo-flip and methane releases. At the same time progress on emissions reduction is proving

tough, because emissions from recently built coal power capacity are cancelling out gains in efficiency and low-carbon power. Such a series of events would bring home the realities of climate change in a new way. People would see that their children and grandchildren face a risky future in an unstable world. Eventual human extinction – today only discussed on the margins of debate by thinkers such as James Lovelock - would be more widely seen as a real possibility. The reaction might include crash programmes to cut emissions, throwing business activity into disruption, as well as costly public projects to take carbon out of the air through 'geo-engineering'.

We are by no means saying that this will happen, simply that it is a plausible risk given the trends already visible today. We believe this cluster of factors is sufficient for the prudent business to at least ask "What would we do in such a crisis? How would it affect us and how would we come through it?"

As the PricewaterhouseCoopers 2009 Global CEO Survey notes: "*The financial crisis is a global, systemic event. Climate change may prove to be bigger."* [78]

Can we reduce uncertainty and create a stable framework?

The prudent business might also be somewhat frustrated by the large amount of uncertainty that surrounds the climate issue. We therefore believe a key question for business leaders to consider is whether and how the uncertainties can be reduced. There are two approaches:

- either there can be an attempt to reduce scientific uncertainties by accelerating the process of research and assessment so that there is more understanding of the likely impacts and progress in mitigating them; or
- policy can be made more stable if policy-makers decide to act not only on the basis of hard facts but significant, though unproven risks, aiming to develop 'future-proof' policies that cover potential as well as actual threats.

We suggest it is worth business organisations considering both these routes to a more stable policy framework.

1. Accelerating research assessment

First, in seeking greater certainty, is it not possible to develop a more rapid response to emerging science? Could the IPCC not be usefully supplemented by a 'rapid response' function dedicated to assessing science and advising policy-makers of risks on a continual basis – with the necessary caveats to indicate the provisional nature of the advice?

Going further, is there not also scope to upgrade the international community's central co-ordination of the response to climate change? For example could there be a formal, UN-backed, centre to collate data on emissions, policies and good practice – to act as a very visible 'dashboard' to indicate progress – to communicate with the public and maintain high levels of attention on the subject? Indeed, could business assist this capacity strengthening in some way, through funds, secondees, advice or other channels? With only a modest injection of new resources, the effort could be taken to a new level, commensurate with the urgency of the situation as well as with the potential of the corporate sector to assist.

The IPCC, which advises world leaders on climate science, and the UN Framework Convention on Climate Change (UNFCCC), which runs the negotiations and administers international mechanisms for addressing global warming, have done outstanding work on a limited budget. However they together operate on around $30m a year[79], roughly what GE spends on R&D in a week.[80] It is time to consider whether the world's effort to secure its own survival should be co-ordinated by institutions with the financial firepower of a moderate sized SME.

2. A risk-based approach

The second route to a more stable investment framework that reduces the threat of a crisis is to take more of a risk based approach to policy-making. Currently we have a fact-based approach. We operate on the basis of what we can calibrate, rather than real but hard-to-quantify risk factors. The IPCC deals in observed phenomena and clusters of studies which reinforce each other. This is understandable when for most of its existence it has faced hostile scrutiny from vocal sceptics of global warming.

However the IPCC itself says: *"Understanding of low-probability/high-impact events and the cumulative impacts of sequences of smaller events, which is required for risk-based approaches to decision-making, is generally limited."* [81]

In other words, there is another way to make decisions, but it lies in unfamiliar territory – the world of what *could* happen, rather than what exhaustive research has indicated *will* happen.

However we are at a point in history when policy-makers should be challenging the conventional, empirical, lengthy approach to planning. We are now suffering the effects of an unpredicted, unexpected credit crunch which became a banking crisis and then a full-scale downturn. The experience underlines the need to stress test critical assumptions and business models, and allow for asymmetric business outcomes

The whole system has been based on establishing facts and acting on the basis of them. But there is no overwhelming logic for taking this approach. Where risk is more palpable, policy-makers base their decisions on it. In making defence policy, governments guard against potential threats, not only proven ones. Businesses prepare for major catastrophes by drawing up contingency plans for war, IT failure or a pandemic. In buying insurance policies, individuals and businesses protect themselves against a range of possible risks, not all of which can be precisely foreseen. In many ways, every day, organisations guard against the unknown.

So we might ask why, when the future of the very planet is at stake, world leaders have chosen to act only on the basis of near unambiguous scientific fact – and even then up to 10 years after those facts are established.

The global financial crisis has discredited analysts who failed to see it coming and lent credence to those who anticipated it by applying unconventional analysis, such as the author of *The Black Swan*, Nassim Nicholas Taleb. He questions the logic of basing decisions on what is believed to be known and suggests that where there are major unknowns, decisions should be based instead on the risks that these pose.[82]

As John Maynard Keynes said, it is better to be roughly right than precisely wrong – a statement that has been invoked by the UK Chancellor and others to justify the rapid and sometimes rough-hewn response to the financial crisis. We believe that the same pragmatic approach now needs to be applied to climate change.

This is a relevant point at which to acknowledge the continuing presence in the debate of those who question the consensus view of climate change. For example, Nigel Lawson, former UK Chancellor of the Exchequer, describes the IPCC as *"something like a politically correct alarmist pressure group".*[83]

The debate between supporters of the consensus IPCC view and sceptics has recently revolved around the claim that global warming is the result of natural climate variability rather than increasing levels of GHGs. However, experts such as Sir John Houghton, former Chief Executive of the UK Meteorological Office, have countered that Paleoclimate, or historical / geological, information suggests that the warmth of the last half century is unusual in at least the previous 1300 years.[84]

When 650 sceptical scientists authored a 231 page US Senate minority report in late 2008, they said they outnumbered the 52 scientists who authored the IPCC's Summary for Policymakers.[85] But the IPCC report draws on the work of thousands. And there has been no sign of a mass revolt.

From a pragmatic, business-focused point of view, it doesn't matter whether one agrees with the science. The debate is effectively over among policy-makers and the consensus view has prevailed. That is the reality that the most sceptical business leader has to live with.

Nicholas Taleb, author of *The Black Swan*, says that even if he believed the consensus was based on shoddy science and that its supporters were probably wrong he would still take a cautious approach on the *"very remote possibility that they might be right."* [86]

So businesses face a future post-Copenhagen in which targets for addressing climate change may continue to shift as a result of the slow process whereby science feeds into policy. There is also the risk of a crisis that provokes a sudden lurch in policy. But are these risks material?

If so, can they be mitigated by renewing the process whereby science is assessed and policy developed? And if businesses really want to see a more stable environment – physical and economic – how might they help in practical ways to create a more responsive system? If the world was a business, would its board be content with the way it is managing its greatest risk?

For debating purposes we boil these issues down to one key question:

Question 2: Should the policy-making system be strengthened, perhaps with business input?

Part 3:

The green opportunity – creating value in a carbon-constrained world

"Sustainability is the single biggest business opportunity of the 21st century, and will be the next source of competitive advantage"
H. Lee Scott, President and Chief Executive Officer, Walmart.[87]

A constant theme in the business world is that the shift to a lower carbon society brings great opportunities to companies. But those opportunities are inextricably linked to government policies. So should businesses be forming clearer views on the detail of policy? And if so, what should be the top priorities?

Lord Stern has likened the green economy to the revolution caused by the arrival of the railway, motor car and IT.[88] The 'low-carbon and environmental goods and services economy' was recently estimated by the UK Government to be worth £3 trillion globally and to account for over 800,000 jobs in the UK.[89]

However, the opportunity, while real, is not a straightforward one. The £3 trillion 'low-carbon economy', for example, includes established, profitable businesses such as water supply, publicly-funded services such as waste disposal and businesses dependent on policy support such as wind power. The ambition of business and government must be to create businesses that make a profit – unsubsidized - through activities which directly reduce emissions. So far, that is true of relatively few companies. Key emissions-reducing technologies such as wind, solar, carbon capture and biofuels are still at a stage where they are dependent on government support for their viability.

Market forces alone will not create a green economy. In fact they have created the unsustainable economy we have now. The unavoidable reality is that sustainability comes at a price. Recent US estimates, for example, indicate that unsubsidized wind power costs around 8-12 cents and solar 20-30 cents per kilowatt hour [90] [91], while coal and gas typically lie in the 4-8 cents range.[92] A coal-fired power station using carbon capture is estimated to cost over $5000 per kilowatt of capacity compared to only $3000 for conventional coal power.[93] Energy saving measures – ranging from LED light-bulbs to advanced industrial plant – ultimately save both money and emissions, but only after the initial capital investment is recouped.

However, if governments act to re-direct market forces to sustainable ends – whether by capping emissions and creating carbon markets or by offering incentives for emissions-reducing activity – policy-led business opportunities are created. And in time, green business will become profitable business, without policy support.

The interaction of policy, technology, funding mechanisms and business strategies is complex but critical. It requires detailed discussion between business and governments. The business community has been assertive in speaking out in favour of general principles. Letters signed by scores of CEOs calling for a stable investment framework have become a staple of climate summitry. So have statements saying there is 'no magic bullet'. True, but where does the first dollar or Euro go? What are the priorities? At this stage of the debate we believe business organisations need to take views on priorities and make them known to policy-makers.

The process is beginning, for example through the Taskforce on Low Carbon Economic Prosperity established by the World Economic Forum[94] o work with governments and UN offices to develop practical projects and policy proposals that attract investment, stimulate technology and create jobs.

The debate on practical steps needs to take place across the business world. We offer the following analysis as a sample thought process to reach a set of priorities. Others will follow different processes and arrive at different priorities. That is positive because it creates a debate from which preferences will emerge. The key is for business to engage with government at the level of detail as well as the level of rhetoric.

In this analysis we seek to identify policy priorities by examining the options through four lenses – emissions, politics, business and investment.

- What are the potential big wins in emissions reduction?
- What policies are available to incentivise the big wins?
- Which emissions-reducing business projects require new policies?
- What will attract investors into green energy and clean technology?

This helps us to identify the pathways that are most promising from all angles.

What are the potential big wins in emissions reduction?

Broadly, emissions can be reduced in three ways – using less energy, using clean energy or restoring carbon sinks – 'save', 'switch' or 'sow'. Using less energy is a straightforward way to cut both emissions and costs. Clean energy involves replacing fossil fuels with renewables, using nuclear power, or deploying carbon capture technology to eliminate emissions from coal or gas. Restoring carbon sinks means halting deforestation, planting trees and changing agricultural practices.

Where emissions come from

A key consideration in assessing the options is where the emissions come from – the targets. Despite the frequent focus on 'gas-guzzling' cars and aviation, the largest source of direct emissions worldwide is electricity generation. Energy supply accounts for around a quarter of all human-generated emissions while transport only makes up around 13%. Industry produces 19% and buildings 8%. Deforestation accounts for nearly 20% and other agricultural practices for over 10%.[95]

Within the power sector, coal is the major source of GHGs. Emissions from burning coal account for around 40% of all energy-related emissions and 70% of those from the power sector.[96] Coal provides a half of the US's power[97]and in China it's been estimated that at least one coal plant starts operating every week. James Hansen's view is that "Coal fired power plants are factories of death." [98] The future depends on whether policy-makers can stop the high and rising emissions from coal-fired power.

Transport is a fast-growing source of emissions which cannot be ignored. However cars last for around 14 years[99] and their environmental performance is constantly being improved, while a power plant lasts for 40-50 years.[100]

Reduction options

Options for reducing emissions start with using less energy. **Energy efficiency** has been calculated to be able to account for roughly a third of the necessary GHG reductions. The size of the prize is clear. Efficiency measures cut costs as well as emissions, once the initial investment has been made. The nature of the task is also reasonably clear. It means bringing large volumes of buildings and vehicles up the standards already set by the best. California, for example, has shown what can be done through aggressive efficiency standards – such as a tiered electricity tariff that rewards low consumption but penalises heavy energy use. Over the last 35 years, California has reduced its per capita energy demand to 40% below the national average and, according to the state's Energy Commission, saved more than $56 billion in electricity and natural gas costs. [101] [102]

Studies have shown huge scope for extending efficiency, using new methods and a variety of policies. For example, a recent paper by the Peterson Institute suggested that spending $10bn to insulate US homes and federal buildings could create and sustain up to 100,000 jobs between 2009 and 2011, while saving the economy $1.4bn to $3.1bn a year between 2012 and 2020.[103]

Efficiency reduces energy demand which in time will lead to less capacity being needed. But it is a gradual process that needs to be supplemented by more radical 'top-down' measures if rapid reductions are to be made.

The importance of coal as a target means that any means of reducing coal use is potentially a big win. Simply switching coal generation to gas can create significant reductions, as gas emits roughly half as much CO_2 as coal, unit for unit.[104] Larger wins can be gained by switching to renewables or nuclear or by using carbon capture and storage (CCS).

Renewable forms of energy could reduce emissions substantially, but their current scale is small. Non-hydro renewables account for only 2-3% of all power generation[105]. However costs have fallen significantly over the past 20 years and further cost reductions can be achieved by technology breakthroughs and economies of scale. Wind is growing particularly strongly, with 120GW of capacity installed by the end of 2008[106] (though out of a world total power capacity of over 4,000GW).[107] Solar capacity, in contrast, totalled under 3GW. Solar remains generally uncompetitive, but has huge potential and there are many R&D projects to improve solar cell efficiency and create cells from new materials.

Nuclear power currently accounts for around 15% of power generation and is widely accepted in countries such as France and the US.[108] It is expensive in capital terms and still prone to political controversy over safety and waste. While opponents remain, such as the Scottish Government which refuses to choose nuclear, some environmentalists believe safety concerns have been overcome by new designs such as the integral fast reactor. The UK government has given the go-ahead for a new generation of nuclear power stations and several companies have been involved in consortia bidding to build them, including EDF, RWE, E.ON, Iberdrola, Scottish & Southern Electricity and GDF Suez.[109]

CCS is particularly attractive as it allows coal to continue to be used but draws its environmental sting by eliminating up to 90% of the emissions. While CCS has been widely used to capture CO_2 from oil and gas production projects, with the CO_2 often being used to force oil or gas out of mature, low-pressure fields, it has not been used at commercial scale in power plants. However CCS has been projected by the IPCC to have the potential to deliver up to 55% of *all* reductions needed this century.[110] CCS is also estimated to save money in the long term. According to the European Commission, the costs of meeting a reduction of

around of 30% in emissions in 2030 in the EU could be up to 40% higher without CCS than with it.[111] The gap between progress and potential is a wide one. President Obama has said: "*We figured out how to put a man on the moon in 10 years. You can't tell me we can't figure out how to burn coal that we mine right here in the United States of America and make it work."* [112]

In transport, many options remove emissions from the tailpipe only to create them elsewhere. The key measure for any technology or fuel is how much emissions are cut on a 'well-to-wheels' basis, calculated over the full life cycle of the fuel and its components. Hydrogen fuel cells have been demonstrated in cars and buses, but bring with them the problem of creating a whole new fuelling infrastructure as well as safe storage and distribution. Electric cars are not carbon-free as they cause emissions upstream at power plants, but some studies have indicated that these may only amount to half those of a conventional engine.[113] Biofuels do not require new fuelling stations but have proved highly controversial. Concerns include the displacement of food crops by those grown for fuel and the deforestation and destruction of habitats in Asia where large palm oil plantations are being developed. The focus for many companies now is to develop new generations of advanced biofuels that avoid the problems associated with the current portfolio, including high-energy fuels from non-edible 'ligno-cellulosic' or woody crops such as miscanthus and switchgrass. These new biofuels, when commercially viable, could deliver significant well-to-wheels emissions reductions.

Preventing deforestation is emerging as a strongly favoured route towards emissions reduction. Scientists say one day's deforestation is equivalent to the carbon footprint of eight million people flying to New York[114]. At the same time the EU calculates that deforestation could be halved by 2020 if up to 25 billion Euros a year were invested in rewarding developing country governments.[115] This is a relatively modest investment for a major reduction in emissions. The UNFCCC describes the process as 'Reducing emissions from deforestation and forest degradation in developing countries' (REDD) and has called it *"the mitigation option with the largest and most immediate carbon stock impact in the short term..."*[116] The opportunities for business are not yet clear but may include the chance to buy forest carbon credits which could be set against their emissions limits.

There are **other 'outsiders' in the field** such as geo-engineering to remove carbon from the atmosphere. Potential technologies include placing sulphur aerosols into the atmosphere, fertilising oceans with iron to increase absorption, or using orbital mirrors to bounce sunlight back into space. Costs are currently very hard to predict although some technologists have suggested they might be relatively inexpensive compared to the costs of decarbonising the energy industry at speed.

Concentrated solar thermal power is a potentially large-scale form of renewable energy in which vast arrays of panels or towers could generate electricity in large volumes in sunny areas such as the Mediterranean and North Africa. It's been calculated that covering an area of the Sahara the size of Wales with solar thermal equipment – capturing less than 1% of the sunlight falling on the desert - could provide all Europe's power. [117]

So looking through the technology lens, a rough order of priorities might be: 1) maximise efficiency 2) make CCS happen 3) scale up wind 4) use nuclear if politically acceptable 5) invest in solar R&D 6) invest in advanced biofuels R&D 7) look for opportunities in forestry 8) keep abreast of 'outsider' options 9) promote 'climate-friendly' activity.

Immediately this highlights the fact that there is particular catching up to do on CCS. Energy efficiency has been a business priority for many years. Nuclear is a very mature technology and wind a fast maturing and growing one. CCS – at least at power plants - is not. If CCS is also a 'must-do' for now, as many experts believe, it should not be still at the start of its demonstration phase. This anomaly arguably makes CCS the top priority because its progress is so far behind its potential.

What policies are available to incentivise the big wins?

The policy architecture needed to get these building blocks into place comprises an overarching global agreement to set targets for individual governments, and the national policies and plans whereby these goals are pursued.

Global framework

In terms of the global framework, countries negotiate over climate change in the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC was agreed at the Rio 'Earth Summit' in 1992 and has now been ratified by 184 countries[118]. Its secretariat runs the global negotiations.

The only global agreement to be signed thus far has been the Kyoto treaty – negotiated in 1997 and signed by over 150 countries. Under Kyoto, industrialised countries agreed to cut emissions by around 5% on 1990 levels by 2008-2012, but there was no overall global target. The Treaty also created mechanisms for countries to help each other cut emissions – ensuring that one country's efforts to cut emissions in another would count towards its own targets. The 'Clean Development Mechanism' (CDM) provides for developed countries and their businesses to gain credit for emissions reductions that they have financed in emerging and developing economies. 'Joint implementation' (JI) projects designed to achieve similar ends in the transition economies of central and eastern Europe.[119]

Kyoto was the right shape but the wrong scale. Its reach was too short, its targets too modest, its market mechanisms too complex and its enforcement practically non-existent. Emissions have soared among those not obliged to reduce them, notably China and India, and many OECD countries, such as Japan, will struggle to meet their targets.

The focus is now on Copenhagen and the prospect of a successor treaty to Kyoto that has fit-for-purpose targets, timescales - and teeth. The framework has five elements - a shared global vision for long-term action, agreements on cutting emissions and adapting to climate change, development and transfer of technology and finance mechanisms. Chapter 1 of this report outlines the scale of the agreement needed to respond adequately to the demands of the problem as mapped out by scientists.

National / regional policies

While a global framework sets targets, national and regional policies are needed to achieve them. These come in several forms and work in combination, involving a blend of public and private funding. The main categories of policy are:

- **market mechanisms –** policies that create markets, including emissions trading systems where companies buy and sell allowances to emit CO_2; and mandates or quota systems for renewable energy in which they buy and sell credits created by generation of clean energy;
- **fiscal and regulatory mechanisms** – including carbon taxes, feed-in tariffs, subsidies, grants, R&D spend, building and vehicle regulations and policies to stimulate green investment.

Many businesses and governments have seen emissions trading as the central engine for emissions reduction although there has been increasing recognition of the need for it to be supplemented by other measures. This analysis starts by looking at the strengths and weaknesses of trading – and then asking what measures are needed to supplement it.

Emissions trading

Emissions trading has long been viewed as the main means of bringing the power of market forces into emissions reduction. 'Cap-and-trade' systems set an overall ceiling on emissions from a group of emitters, issuing participants with emissions allowances that add up to the total. Participants who want to emit more than their limit have to buy allowances from those who do not need them so that the overall cap is not exceeded. This drives participants to cut emissions and creates a market in which carbon dioxide has a price. Over time, the cap can be lowered to reduce emissions.

The EU Emissions Trading Scheme (EU ETS) has been running in the EU since 2005, covering thousands of industrial sites and accounting for around 45% of the region's emissions. In the US, where small-scale trading systems already exist, President Obama is committed to cap-and-trade and Democrats have introduced a bill in Congress to create a federal trading system.

The UK is introducing an emissions trading system for smaller businesses – the Carbon Reduction Commitment (CRC) - in which allowances will be auctioned, initially for £12 per tonne of CO_2, proceeds being placed in a fund from which payments are recycled to participants according to their success in reducing emissions.[120] Systems are also being introduced in Australia [121] and New Zealand.[122]

Emissions trading has proved its worth in reducing the US's emissions of sulphur dioxide, the chemical responsible for 'acid rain'. Electric utilities reduced their SO_2 emissions from 17.5 million tonnes to around 10 million between 1990 and 2007 as a result of a trading system that featured clear targets, annual decreases in caps and clear rules on monitoring and reporting.

The vision of the UNFCCC is for CO_2 trading systems to build into a single global emissions trading network. However the architecture for such a confluence of systems is not yet in place and the task of standardising GHG accounting systems is a complex one. The IPCC has published guidelines for national GHG inventories[123], while the World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) have developed a GHG protocol for use at company and project levels.[124]

However more needs to be done in emerging and developing economies to build the capacity to measure and report on GHG emissions in a way that can underpin a rigorous global marketplace.

In theory, emissions trading – with caps set stringently enough – should be all that is needed to prompt a clean energy revolution. But in practice, the caps decline gradually and if the volume of emissions that a plant can produce is reduced by relatively small amounts each year, this tends to encourage correspondingly incremental measures. Companies first reduce waste. Then they invest in more efficient plant or source some of their power from renewables. In schemes such as the ETS, they can also invest in projects in emerging economies such as China or India to gain tradable credits without making cuts in their own emissions. Ultimately they can continue to make incremental reductions by closing production or changing to less carbon intensive business models. In other words emissions trading is excellent at prompting energy saving, but cannot be relied upon to drive a switch to clean energy.

Further difficulties have emerged as the ETS has been implemented. The first phase allowed caps to be set very leniently with Emissions Unit Allowances (EUAs) being given away to companies. Many plants emitted less than their caps. This led to very low prices and an increase, rather than a decrease, in emissions.[125] Under the second, 2008-2012, phase of the scheme, caps are being more stringently set and more emissions allowances are being auctioned – so the prospect for genuine reductions is greater. In 2008, plants taking part in the ETS collectively reduced emissions by 3%, a reduction also influenced by very low economic growth of 0.8% at a time of global recession.[126] But with EUAs reduced by 6.5%, many large emitters were nevertheless 'short' on allowances, having emitted over their limits.[127] Still, in early 2009, prices plummeted as participants sold off allowances, believed by many to be a way of raising cash because they could borrow allowances from the next year's allocation. At the time of writing carbon prices had recovered somewhat although remaining well below the level of around €30 reached at their peak. The future of the ETS is uncertain. Will recession depress production so that companies do not need their allowances and the price collapses? Or will economic activity be robust and companies keep borrowing from their future allocations, prompting a crunch in 2012 when there are no more allowances to bring forward? The big question is whether participants will be able to cut emissions, or buy sufficient allowances, to meet their limits. If they can't, then the system will bust and fail.

Looking further ahead, one of the main problems inherent in emissions trading is that a market-based system by its nature leads to a fluctuating and unpredictable price. Yet if companies are to make major investments in low-carbon energy – for example in carbon capture and storage (CCS) technology at power stations - they need to be reasonably confident that such investments will pay off. Given the long lead times of such investments, this depends on the future price of carbon being likely to be sufficiently high to make the low-carbon investment profitable. For example, analysis by BNP Paribas suggests that the investment required in CCS at a coal-fired plant will be offset if CO_2 prices reach around €45-50.[128] Yet our analysis (see following sections and appendix), like those of others, suggests that future ETS CO_2 prices are hard to predict and could well be below that level.

So if governments want to ensure CCS investment takes place, as well as improvements in efficiency, they either need to contribute significantly to its funding in the early stages or develop some mechanism to underwrite the carbon price and provide an acceptable rate of return should the market not deliver one. A more drastic option is to force companies to use CCS, but this runs the risk of deterring investment in capacity.

From the EU's particular perspective, it is arguable that while the region may be able to cut emissions by up to 30% on 1990 levels by 2020 mainly through efficiency, failure to invest in CCS will mean failing to acquire intellectual property in a technology that is destined to become one of the world's most widely used tools in overcoming climate change.

Mandates and forestry credits

So if trading is to be supplemented, what are the options? Some other policies also aim to release market forces, such as mandates. Many countries have introduced quotas that mandate a certain proportion of power or fuel to come from renewable or low-carbon sources. Examples are the Renewable Portfolio Standards operating in many US states and the UK's Renewables Obligation that places a requirement on power suppliers to source a proportion of their electricity from renewable sources – roughly 10% by 2010, 15% by 2015 and 20% by 2020.[129] It has been calculated that this will add around 6% or £1bn in total to power bills by 2010.[130] When generating companies create energy from renewable sources, they are issued with Renewable Obligation Certificates (ROCs) for each MWh of electricity generated which can be sold to suppliers to fulfil their obligation. Suppliers can either present enough certificates to cover the required percentage of their output, or they can pay a 'buyout' price for any shortfall. The UK's Renewable Transport Fuel Obligation requires certain proportions of vehicle fuel to come from renewable sources – the current mandate being for 5% by 2010-11.[131]

An alternative to mandates / quotas is the 'feed-in tariff' whereby power suppliers are required to pay an above market price for a particular form of renewable energy such as wind or solar – say 40 cents per kilowatt hour instead of 10 cents. This incentivises companies to produce renewable energy. The tariff is then reduced over time and phased out when the renewable energy form reaches a certain market penetration. Feed-in tariffs have helped to make Germany a world leader in solar and wind power with renewables providing nearly 10% of the all the country's energy.[132]

Avoiding deforestation has rapidly moved up the agenda as a major potential source of emissions cuts in the short term. And this has led to plans for market-based policies. The UNFCCC and others are now working on the methodology of achieving, measuring and verifying emissions reductions from avoided deforestation. For example the EU has proposed a Global Forest Carbon Mechanism whereby some proceeds from auctioned ETS permits would be handed to developing world governments as a reward for action to reduce deforestation. If it were to work this system might be extended to include creating avoided deforestation 'credits' which companies could buy to offset their own emissions. In other words companies would effectively pay for avoided emissions in the developing world instead of cutting their own emissions. But the European Commission does not want to introduce such a system until processes are in place to ensure that claimed emissions reductions are actually achieved.[133] So there may be no clear business opportunity in this area for some time.

Fiscal and regulatory mechanisms

Taxation is used in several countries to discourage emissions, including in a relatively small way in the UK where the climate change levy is a tax on energy such as electricity and gas delivered to non-domestic users. However, tax has two drawbacks which have elicited business opposition. First, it fails to bring the power of the market to bear in stimulating efficiency and innovation.

Second, it fails to provide guaranteed reduction in emissions. The danger is that consumers and businesses will simply accept the tax burden and carry on emitting, in the same way that motorists have done as gasoline and diesel taxes have risen over the years. Trading – in theory and if properly enforced – provides a definite limit on emissions. Tax only provides a deterrent and no certainty of hitting any particular limit.

On the other side of the fiscal equation is government spending on efficiency and low-carbon energy. Companies have argued for many years that they need incentives such as subsidies to invest in new technologies in order to bring them to a point where they can compete in a market context. And governments have signalled agreement by introducing such policies, albeit in a limited manner.

However there is now a widespread belief that increased public spending is needed to overcome recession and this has given governments the political space to launch public spending programmes with larger low-carbon and energy efficiency components. These simultaneously address unemployment, climate change, energy security and the threat of 'peak oil'. President Obama's ambitious environmental plans have now effectively become part of his economic programme. Over $60bn of the US's $787 recovery package is being directed towards energy efficiency, low-carbon energy, green transport and environmental remediation.[134] Obama wants to create 3.5 million new jobs, many of which will be 'green-collar jobs' in areas such as solar, wind and energy efficiency.[135] China is also pumping an estimated $200 billion plus into recession-beating environmental measures including an aggressive build-out of renewables. [136] A report by HSBC has identified commitments of around $430 billion in 'green' stimulus spending taking place worldwide.[137]

The UN Environmental Programme has called for a 'global green new deal' with investment of $750bn, accounting for one third of the total worldwide spend.[138] Lord Stern has suggested governments make around $400bn of investments in energy efficiency and low-carbon technologies over a year or so.[139]

Regulation can drive reductions in emissions by setting standards for energy efficiency or low-carbon energy. Among EU measures, for example, are the Energy Performance of Buildings Directive[140] and new vehicle emissions limits. In the UK, power generators are given targets for energy reduction among their consumers through the Carbon Emissions Reduction Target (CERT).[141]

Which emissions-reducing business projects require new policies?

Moving to the business lens, companies have shown themselves willing to take varying degrees of unilateral action to cut their own emissions or develop low-carbon products and services. But more far-reaching developments have to be supported by policy.

The table opposite, on Page 39, follows a model being increasingly being used by Tomorrow's Company to demonstrate ways in which businesses can act to bring about social or environmental benefits. The horizontal axis indicates scale. Small scale projects can be undertaken unilaterally by responsible companies without being mandated by policy. Larger scale deployments (middle column) take place when existing policy frameworks enable them. But very large deployments require new and stronger policies, probably in the context of a global framework. The vertical axis represents the nature of the product, service or project. 'Climate friendly' initiatives are those whose primary aim is not climate-related, but one of

whose benefits is to reduce emissions. 'Eco-efficiency' refers to measures that reduce emissions by saving energy, thereby saving both emissions and costs. Low-carbon' projects are those that substitute low-carbon energy for high-carbon energy.

21st century value matrix	Small-scale pilot in business	Scaled for market under existing frameworks	New frameworks required
Climate friendly	Virtual offices staffed by tele-workers with shared facilities online	Audio-conferencing services	Large-scale public transport systems in mega-cities.
Eco-efficient	Passive homes	Eco-efficiency driven by emissions trading	Universal uptake of best practice in buildings insulation
Low-carbon	Demonstration plants for ligno-cellulosic biofuels	Wind power in US, China, Denmark; solar power in Germany and Spain	Deployment of carbon capture and storage in major coal consuming countries

So for example, in the area of low-carbon energy, companies wanting to be ahead of the game will themselves fund demonstration plants for advanced biofuels. Other companies, who would not unilaterally bear the costs of wind power deployment, have done so when governments have provided mandates, feed-in tariffs or subsidies – or a mix of all three as in the US. However as yet there has been neither a business case nor sufficient policy support for the deployment of carbon capture and storage in major coal consuming countries.

As the low-carbon landscape takes shape, as we have seen, there will be a net cost running into hundreds of billions of dollars a year. There will be winners – for example those who supply clean energy or energy-saving materials – and losers – such as those whose businesses depend on high carbon activity. There will also be losers-turned-winners in the shape of those companies in adversely affected sectors which adapt most cost-effectively and rapidly to the new context and lose least as a result. For example, a report by the Carbon Trust in 2008 indicated that well positioned companies in the building insulation business might gain 80% in value, while badly prepared ones in automotive or aluminium sectors risked losing 65% of value. The report identified four effects of climate change policy which apply to different sectors: increasing demand, as in insulation products; decreasing demand, as in oil and gas; offering the opportunity to transform, as in the automotive and aluminium sectors; and creating volatility as in the beer industry.[142]

What will attract investors into green energy and clean technology?

A final and vital lens through which to examine the issue is that of the investor. Until the credit crunch, investors were increasingly supporting green energy and efficiency projects where there was a payback – especially when some payback was guaranteed by government policy. However 'cleantech' funds have dried up with the credit crunch. According to New Energy Finance, investment in clean technology only rose by around 5% last year, compared to over 50% in the previous three years.[143] To invest in clean energy today, investors need to see that it can still make a competitive return – that governments remained committed to it – and that sufficiently attractive means of investing are available.

What are the policy priorities?

So having looked at the issues from different perspectives, what points emerge as drivers of policy priorities? From an emissions-reduction lens, efficiency, CCS, nuclear, wind and possibly forestry are key targets – ones where the potential for dial-turning reductions is clear today. From a policy perspective, experience shows how some of these can be incentivised. The business and investor perspectives reinforce the need for large-scale developments that cannot be contemplated without new policies and mechanisms to unlock private capital.

Emissions trading, given the benefit of early doubts, looks to be effective at driving efficiency savings. With efficiency topping the list of 'big wins', its benefits need to be seized. If major efficiency gains are not demonstrably made within a few years, there may be a need to investigate more direct ways to achieve them. One option is the Californian example of tiered electricity tariffs that penalise high consumption. Another is to institute a separate trading system in energy efficiency itself, as has been proposed by developers and experts in Australia specifically rewarding emissions avoided through energy saving in non-residential buildings.[144]

However, efficiency aside, there is no certainty that trading alone will stimulate major step change investments in areas such as carbon capture and storage (CCS) or wind power. These are big, game-changing technologies that deliver major cuts in emissions, but they are capital-hungry and expensive in their running costs.

CCS emerges as a particular priority because it is urgently needed, yet still in its infancy as a technology. In the EU and US there was a long impasse in deciding whether CCS – which can double the cost of a power plant - should be funded by governments, central funds or industry. The European Commission had been pressing industry and member states to fund the initial rollout of up to 12 demonstration plants. However in 2008 ministers agreed that 300 million centrally held ETS allowances would be used to subsidize the programme, provided there is substantial co-funding by the operator.[145] The allowances can be sold on the market to those who need to emit carbon – which means that the clean technology of CCS is effectively funded from the price of pollution.

In the UK, Climate Secretary Ed Miliband has announced plans for four demonstration projects and said that no new coal-fired power station will get government consent without being able to capture 25% of its emissions immediately and 100% by 2025.[146] Funding details are unclear as we write, but ultimately it's expected that consumers will pay the extra generation costs of CCS through a levy amounting to around 2% on electricity bills by 2020.[147] Critics have pointed out that the proposals still leaves coal power plants able to emit 75% of the previous total, but the move has been hailed as a step in the right direction by NGOs and environmentalists.[148]

As well as deciding whether the UK's move is sufficient, there is now a need to explore how CCS can be implemented in other parts of the world, particularly China, India and the US, and in industrial plants other than coal power stations – such as gas plants, cement and steel factories. The technology has been held up by a protracted 'haggle' between governments and industry over who bears the major financial burden. In the EU and UK the deadlock is being broken with solutions that – logically enough - share the costs. The priority now is to find ways to settle this debate worldwide and get the capacity built. In the end it is the public that pays, either through power bills or taxes – so a lengthy wrangle between public and private sectors is irrelevant to the outcome.

In terms of wind, the US has shown how a combination of policies can galvanise the market. Many states have Renewable Portfolio Standards which mandate a proportion of energy to come from renewable sources[149], plus a federal Production Tax Credit which rewards each unit of production.[150] In California, the mandate is for 20% of power from renewables by 2010 and 33% by 2020.[151] And this is about to be supplemented by a feed-in tariff. The results of this blend of policies across the US have been dramatic. In 1999, the US Energy Information Administration projected that the country would have under 4GW of wind power in 2008 and 20GW by 2020 – in a 'high case' scenario. [152] In fact by the end of the 2008, the total capacity was already 25GW and it grew by 2.8GW in the first three months of 2009.[153]

Feed-in tariffs have also driven up renewable deployment in Spain and Germany and are now being proposed by the UK government to assist small projects.[154] Some would argue that Britain should go the distance and replace its Renewable Obligation mandate with a feed-in tariff, given the latter's success in countries such as Germany. Unlike mandates, the feed-in tariff does not discourage production above the goal set by the quota. It provides certainty of returns to producers and gives confidence to investors. Encouraged by feed-in tariffs, Germany now generates some 15% of its power from renewable sources[155] compared to little over 5% in the UK.[156]

For the low-carbon economy to take shape, private capital has to be deployed alongside public funds. Many investors have funds to allocate for the long term, as clean energy or forestry projects require, but are looking for stable returns. If the right mechanisms can be created, private capital can act as a powerful supplement to public spending, encouraging companies to enter the green industrial sectors. One possible mechanism is the 'green bond', issued by a government or bank with an agreed rate of return, such as 3% per annum, and earmarked for investment in a carbon reducing industry. If these are used in tandem with policies that push up the costs of high carbon energy and lower the costs of low-carbon energy, issuers can be confident that they can pay back investors.

Green bonds have already been issued by the US Government, the European Investment Bank and the World Bank, which issued $350m of six-year green bonds in January 2009, paying 3.5%.[157]

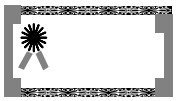
Finally, forestry has belatedly climbed the agenda as a leading route towards emissions reductions. The business opportunity here is still taking shape but may become significant. There is scope for forestry companies to carry out afforestation (new forest), reforestation and avoided deforestation projects which create tradable forest carbon credits. These may be funded by investors or by heavy emitters looking to offset emissions elsewhere. There will be opportunities for agents to organise such links and a need for professionals such as auditors, and consultants to ensure the process is rigorous and verifiable.

So after looking at the areas with major potential for emissions cuts, at policies to encourage them and at the positions of businesses and investors, we come down to a fairly simple list of priorities:

- **Efficiency** is potentially the biggest, earliest win. Therefore there should be a major drive to maximise efficiency, particularly in buildings, as part of the post-Copenhagen effort. Emissions trading may need to be supplemented by California-style policies or other innovations to accelerate efficiency.

- **CCS** is vital to make coal clean. The pressing need now is for funding mechanisms to be agreed. Once they have been agreed it may be possible to replicate the funding model elsewhere to avoid further lengthy debate.

- **The renewable energies**, of wind, solar, wave and geothermal power still represent less than 1% of all energy supply, a tiny proportion given the attention paid to them. Wind power is a mature technology and its deployment needs to be scaled up. The examples of the US, Germany, Denmark and Spain show that strong policies can push up scale rapidly. Feed-in tariffs appear to be the most effective solution but a mix of quotas and subsidy has also been successful. Other renewables, particularly solar, need more R&D support.



- As well as diverting public funds into a ‘green stimulus’, policy-makers need to access the large pool of private capital that is available. **‘Green bonds’** may prove the best vehicle.

- As deforestation accounts for around a fifth of emissions, **REDD (**Reducing emissions from deforestation and forest degradation in developing countries**)** can deliver major benefits. The task for policy-makers is to develop mechanisms such as forest carbon credits that create the necessary markets, with some companies investing to offset emissions and others managing, organising, verifying and facilitating projects.

Some countries will add **nuclear power** to the list, depending on whether they are prepared to bear the financial costs and overcome political obstacles.

This list emerges from our analysis and approach. Other will take different approaches and come up with different priorities. The key is that business should engage in a detailed conversation about priorities rather than limiting itself to more generalised calls for action.

Question: What policies should business most support?

See the Appendix for details of pioneering policy frameworks.

Part 4:

European carbon pricing – modelling the costs of carbon trading

Different policy frameworks will have different impacts on business. To what extent can we predict those impacts? If we take the European Union's Emissions Trading Scheme as a leading example, how might different approaches affect the costs of some typical companies?

The objective of this paper is to generate debate over the key questions relating to business and climate change, rather than to make predictions. The situation is very uncertain and we would treat any forecasts with caution – whether prices, targets, emissions reductions or any other measures.

However we can use existing data to look at how different policy approaches might lead to different outcomes in terms of costs. One of the key observations of this report, discussed in Chapter 1, is that targets for GHG reductions tend to keep moving as a result of developments in science and we were interested to see what these changes might mean in terms of actual costs for businesses.

Projecting costs is difficult when there are many unknowns. But in one area – the EU Emissions Trading Scheme (EU ETS) – we have some numbers to work with because the European Commission has set out a set of emissions caps for the decade ahead.

Using these numbers as a base, we can make some indicative projections for the costs of emissions among large emitters and the costs of power for non-ETS participants whose power bills reflect the pricing of CO_2.

We therefore worked with the economic consultants Z/Yen to model the power-related costs that might accrue for businesses as a result of the EU ETS over the next decade.

Targets and scenarios

Our starting point was the 'business-as usual' scenario, based on the EU's current target to reduce emissions by 20% on 1990 levels by 2020'. We called this 'Scenario Red', reflecting the fact that it is lower target than the 25-40% which the IPCC says developed countries should achieve to be on track for a global halving of emissions by 2050, consistent with keeping the rise in temperature on pre-industrial times to around 2°C.

However the EU has pledged to increase its 2020 target to a 30% cut on 1990 GHG emissions in the event of a global deal at Copenhagen. So we looked at a 'Scenario Orange' based on this trajectory.

Our analysis suggests that it is possible – though by no means definite – that there may be a further ratcheting of targets in the 2010-2015 period as a result of new scientific evidence, possibly based on feedback effects and the risk of climate 'tipping points' being breached. So we added a 'Scenario Green', asking what might happen if this led to a further tightening of the targets to a 40% cut on 1990 emissions. This is not an unreasonable concept given that it is at the top end of the range of emissions cuts that the IPCC puts forward for the developed world? Indeed the UK's Climate Change Committee has recommended that in the event of a global deal Britain should raise its national target to 42%.

Scenario Red *the worst for the environment*	Scenario Orange *the aim endorsed by the G8 and business groups*	Scenario Green *The feedback crisis-dramatic but possibly necessary for the environment*
No agreement at Copenhagen and the EU simply continues with its current target to cut emissions by 20% on 1990 levels by 2020.	An agreement to target a 50-85% cut in emissions by 2050 – or indeed a more modest agreement – but at least a deal of some kind. The EU would then raise its target to 30%.	A deal at Copenhagen is followed by new science and new evidence of global warming triggering a greater effort to reduce emissions – in which case we assume the EU targets a cut of 40% by 2020.

Scenario details

So what might these scenarios mean for companies participating in – or affected by - the ETS?

Scenario Red

Current plans are designed to help achieve the goal of a 20% cut in emissions by 2020. The ETS is now in its second phase, due to last until December 2012. The total of the caps for the plants covered is 2.08 billion tonnes for each year of the scheme – a 6.5% reduction compared to 2005 emissions from the same group of emitters.[158] Plans are being drawn up for Phase III of the scheme, due to start in 2013.

The caps for these two phases are calculated on the basis that an overall 20% EU-wide cut in emissions is equivalent to a 14% reduction compared to 2005. However as it is cheaper to reduce emissions among the large emitters in the plants covered by the scheme, the ETS sector as a whole is required to cut emissions by 21% compared to 2005. This leads to a design in which the caps for 2013-2020 reduce by 1.74% each year from 1.97 billion tonnes in 2013 to 1.72 billion tonnes in 2020. We have designed our model accordingly, with an annual reduction rate of around 2% each year.[159]

Scenario Orange

In the event of a global deal, the EU target may be raised to 30% for the region as a whole. The EC currently has no guidance on how the ETS caps would be amended as this is still subject to political discussions. So we have assumed that if a 20% cut by 2020 means a 14% EU wide cut on 2005 levels and a 21% cut for the EU ETS sector, then a 30% cut by 2030 means a 24% overall cut on 2005 and a 36% cut for the EU ETS sector – around 5% a year.

Scenario Green

Our ‘Scenario Green’ is based on the EU deciding around 2013 that it needs to go further and cut emissions 40% on 1990 levels by 2020. We have assumed that if a 20% cut by 2020 means a 14% EU wide cut on 2005 levels and a 21% cut for the EU ETS sector, then a 40% cut by 2030 means a 34% overall cut on 2005 and a 51% cut for the EU ETS sector. But this effort will not begin until 2013 and so a rapid reduction will need to be made between 2013 and 2020 – estimated at around 8% a year.

Coverage

The cost burden for companies depends on the proportion of their power-related emissions that are caught by the scheme. Today – because emissions allowances are reasonably generous and largely given away by governments - companies pay for only a relatively small proportion of their emissions. But as the scheme develops and more allowances are auctioned, companies will have to pay for more of their emissions. In 2007, UK ETS participants emitted 20% more than their cap allowed, thus needing to buy allowances to cover roughly 16% (ie 20/120) of their companies' emissions.[160] We have assumed this proportion is likely to roughly double in the second phase of the ETS and so have assumed that companies whose direct emissions are covered by the ETS are now paying the prevailing CO_2 price for 30% of those emissions. Our projections assumed that all companies will pay for 30% of their emissions in 2010 but 90% in 2015 and 2020. We used 90% rather than 100% on the basis that skilful buying at auction will enable companies to buy their allowances at a discount to the eventual prevailing CO_2 price. We applied these estimates to small companies which are not ETS participants on the grounds that their power suppliers will pass on their costs.

Elasticity and decarbonisation

Variables were also applied to flex prices according to two factors.

- **The elasticity factor** – the degree to which the price of carbon dioxide allowances rises as the number of allowances is reduced. If consumers are able to reduce consumption or find low-carbon alternatives fairly easily, then they will use those alternatives and the price of carbon allowances does not rise that much. But if they have few other options and there is greater competition for the available allowances then the price goes up more. If a reduction in supply leads to a greater proportionate increase in price – for example a 5% cut in supply driving prices up 10%, prices are said to be inelastic. If the reduction in supply leads to a lower increase in price – for example a 5% cut in supply leading to a price rise of only 3% - prices are said to be elastic. If the price rise is the same as the supply contraction – for example a 5% cut in supply leading to a 5% rise in price, the price is said to be 'unit elastic'.
- **The decarbonisation factor** – the extent to which the carbon footprint decreases and costs fall through progress in technology and know-how in areas such as development and deployment of energy efficiency technologies, renewables, carbon capture and nuclear power.

These two factors are related because the extent to which society succeeds or fails in developing new low-carbon energy options helps to determine whether consumers can change behaviour and lower their use of higher carbon energy.

We tested prices under three scenarios of elasticity and decarbonisation:

- **Good progress** – with an elasticity factor of 1.0 in which a 10% reduction in CO_2 allowances will increase the price by 10%, and a carbon footprint reduction of 2.0% per year;
- **Average progress** – with an elasticity factor of 0.8 in which a 10% reduction in CO_2 allowances will increase the price by 12%, and a carbon footprint reduction of 1.75% per year;
- **Poor progress** - with an elasticity factor of 0.4 in which a 10% reduction in CO_2 allowances will increase the price by 25%, and a carbon footprint reduction of 1.0% per year.

Price projections

We started our projections with a baseline price of €10 in 2009 – the price when the estimates were made - and €26 in 2010. The latter may seem high but we believe this baseline price remains realistic as the developments of the next year, particularly the Copenhagen summit, will make businesses more aware of the need to conserve allowances and the fact that they have to make provision to cut - or cover - their emissions by 2012.

Our projections are summarised in the following table:

Estimated carbon dioxide prices in EU ETS (€ per tonne of CO_2)	**2009**	**2015**	**2020**
Scenario red: EU cuts emissions 20% by 2020			
Good progress on low-carbon technology - very elastic CO_2 price	10	21	10
Average progress on low-carbon technology - averagely elastic CO_2 price	10	22	12
Poor progress on low-carbon technology - inelastic CO_2 price	10	28	24
Scenario orange: EU cuts emissions 30% by 2020			
Good progress on low-carbon technology - very elastic CO_2 price	10	25	15
Average progress on low-carbon technology - averagely elastic CO_2 price	10	28	19
Poor progress on low-carbon technology - inelastic CO_2 price	10	43	53
Scenario green: EU cuts emissions 40% by 2020			
Good progress on low-carbon technology - very elastic CO_2 price	10	30	21
Average progress on low-carbon technology - averagely elastic CO_2 price	10	35	29
Poor progress on low-carbon technology - inelastic CO_2 price	10	65	114

Under **Scenario Red** the projections indicated that:

- With good progress in efficiency and technology - prices could be as low as €21 in 2015 and €10 in 2020.
- But with poor progress in these areas they could be as high as €28 in 2015 and €24 in 2020. We project that this could lead to power costs increasing by between 10% and 24% in 2020.

Under **Scenario Orange** the projections indicated that:

- With good progress in efficiency and technology - prices could be as low as €25 in 2015 and €15 in 2020.
- But with poor progress in these areas they could be as high as €43 in 2015 and €53 in 2020. We project that this could lead to power costs increasing by between 8% and 29% in 2020.

Under **Scenario Green** the projections indicated that:

- With good progress in efficiency and technology - prices could be as low as €30 in 2015 and €21 in 2020 – showing how progress in these areas might mitigate prices even in a demanding situation.
- However with poor progress in these areas prices could be as high as €65 in 2015 and a huge €114 in 2020. We project that this could lead to power costs increasing by between 11% and 63% in 2020.

Cost projections

We then applied these prices to the emissions profiles of a series of indicative companies, loosely based on typical representatives of their sectors.

Company A is a large power generator with emissions of 7MT of CO_2 a year and a commitment to cut emissions by 12% by 2020. Our projections showed that the costs of carbon dioxide might move from around €21m today to between €139m and €429m in 2015 and between €62m and €707m in 2020. By comparison, the company pays around €2.5bn for its commodity feedstock, €1.1bn for transmission and metering and €430m in operating costs. In 2008 its operating profit was around €2.2bn. In the extreme scenario – Green - where the EU targets 40% emissions reductions by 2020, costs could nonetheless be contained to €130m in 2020 with good progress in efficiency and technology, but with poor progress, the company's cost of carbon could rise over 30 fold to €707m. This analysis simply looks at the potential 'wholesale' costs for Company A. If they are passed on, then large costs will be spread out between the millions of businesses and households which ultimately receive the power generated by Company A.

Company B is the European arm of a global services company with indirect emissions through power usage of 120,000 tonnes a year. Company B has a strong reputation for environmental responsibility and has succeeded in becoming 'carbon neutral' by reducing energy consumption, buying renewable energy where possible and offsetting the rest of its emissions by investing in projects such as hydroelectricity and energy efficient industrial plant that reduce emissions by equivalent volumes. Its annual spending on offsets for the European business currently totals around €800,000 or around €5 per tonne. It aims to cut emissions by around 2% of the current total each year and we assume it succeeds. The company's total European operating expenses are around €6 billion. Our projections showed that the costs of carbon dioxide for this company might move from around €920,000 today to between €2.2m and €6.8m in 2015 and between €1m and €11m in 2020. In Scenario Green, costs could be contained to €2m in 2020 with good progress in efficiency and technology, but with poor progress, the company's cost of carbon could rise over 20 fold to €11m. However for a services company, this only represents around 0.2% of total operating expenses.

Company C is a utility with indirect emissions of 180,000 tonnes of CO_2 a year, mainly resulting from around 300GWH of annual electricity consumption a year. It has a power bill of around £22m (€25m), just over a tenth of a total cost base of around £200m. It has a commitment to cut emissions 10% by 2020. The projections showed that the costs of carbon dioxide for Company C might move from around €500,000 today to between €3.6m and €11.1m in 2015 and between €1.6m and €18m in 2020. In Scenario Green costs could be contained to €3.7m in 2020 with good progress in efficiency and technology, but with poor progress, the company's cost of carbon could increase almost 40 fold to €18m. This would mean it was paying almost as much for its emissions as it is today for the power that creates them. However this would only represent a rise of 10% on today's total cost base.

For Company D is a small company with 2,000 tonnes a year of indirect emissions and no plans to reduce them. Our projections showed that the costs of carbon dioxide might move from around €6,000 today to between €42,000 and €130,000 in 2015 and between €20,000 and €230,000 in 2020. In Scenario Green costs could be contained to €42,000 in 2020 with good progress in efficiency and technology, but with poor progress, the company's cost of carbon could also increase around 40 fold.

Company E is a major heavy industry operator with 13MT of emissions from its EU based operations. It is making good progress in reducing emissions, with a target of cutting them by 25% on 1990 levels by 2015. As of 2009 it is halfway to that target, having cut emissions by around 12% on 1990 levels. We assume that it achieves the 2015 target – cutting emissions to around 11MT by then – and goes onto cut them to 9MT by 2020. The company had around €4bn of profit worldwide in 2007. Our projections suggested that this company's carbon costs could move from €40m to between €230m and €715m in 2015 and between €190m and over €1bn in 2020. In Scenario Green costs could be contained to €190m in 2020 with good progress in efficiency and technology, but with poor progress, the company's cost of carbon could increase around 25 fold to represent around a quarter of today's global profits.

The analysis focused on power costs as they are the ones that can most simply be modelled given the ETS's relatively clear parameters. But many companies have emissions that mostly arise from transport. Once carbon prices start to bite there will be pressure to find ways to cost these in a similar way to those from power. Hence, we also looked at **Company F with 50,000 tonnes of power related emissions but 1MT of transport related emissions.** Today, under the ETS, Company F only pays for its 15,000 tonnes of indirect power-related emissions – costing around €150,000. But if transport emissions gradually came to be priced in the same way as those from power – assuming 50% of the transport emissions are priced in 2015 and 100% in 2020 - its 1MT of emissions from its buses and trains would incur costs of between €11m and €35m in 2015 and €11m and €120m in 2020, depending on targets, prices, price elasticity and progress on technology. However we recognise that as the company is providing public transport there will also be pressure to alleviate those costs as they are incurred in avoiding journeys made in private vehicles. The projections are summarised in the table on Page 50

Conclusions

The bottom line of this analysis is that, looking only at costs arising from the ETS, the impacts of even the most severe clampdown on emissions look bearable except in the extreme scenarios. A second observation is that prices vary widely according to different levels of price elasticity and success in reducing carbon footprints. Whatever the actual outcomes, it pays to look at all options for increasing efficiency and decarbonising business activity.

Companies with major direct emissions, such as power generating companies and heavy industry, face material cost increases, threatening to dent profits by up to a quarter on today's levels. But companies in the service sector escape lightly, given that energy costs are only a small proportion of their overall spending. Other companies face a rise of 50% or more in power costs in the more radical projections, but the increases are manageable unless power accounts for a very large share of their overall cost base. The wild card is that other costs occasioned by the effort to beat global warming might eclipse ETS-related ones, for example if huge public spending leads to big rises in company tax.

Progressive businesses are already acting on the key message that emerges, which is that companies need to carry out or commission their own modelling in order to understand potential impacts on their own circumstances. Carbon price prediction is a very inexact science and attempts to make precise predictions are unwise. We believe that companies need to prepare for a wide range of possible prices in the next decade. Responses should be broad-brush in nature, testing the company's exposure under a range of scenarios. The question we are left with after this brief analysis is this:

Question: Can we use carbon price projections to plan, or should we simply strive for maximum efficiency and decarbonisation?

EU Emissions Trading Scheme Cost Estimates

R = Red Scenario: no global agreement on cutting emissions – EU targets 20% reduction in GHG emissions by 2020 on 1990 level (business-as-usual)

O = Orange Scenario: global agreement on cutting emissions leads EU to raise target for 2020 to 30% cut in GHG emissions on 1990 level – as currently pledged if other developed countries also take similar action

G = Green Scenario: global agreement followed by new scientific evidence leading EU to increase in 2020 target to 40% cut in GHG emissions on 1990 level – as envisaged by Tomorrow's Company

o = optimistic view on technology costs coming down and prices being elastic
a = average view on technology costs coming down and prices being elastic
p = pessimistic view on technology costs coming down and prices being elastic

Estimates assume companies pay ETS-linked CO_2 price for 30% of emissions in 2010 and 90% in 2015 and 2020 – also variations for particular companies' emissions reduction efforts.

	Estimated price of allowances €/tCO_2	**Company A** *major power generator*	**Company B** *European arm of global services company*	**Company C** *medium sized utility*	**Company D** *small company*	**Company E** *European operations of global heavy industry company*	**Company F** *transport company*
Emissions paid for under ETS		2009 - 2.1MT 2015 - 6.6MT 2020 - 6.2MT	2009- 36KT under ETS + 84K offsets at €5 a tonne 2015 - 105KT 2020 - 96KT	2009 - 54K 2015 - 170KT 2020 - 160KT	2009 - 600T 2015 - 2KT 2020- 2KT	2009 - 4MT 2015 - 11MT 2020 - 9MT	2009 - 15KT 2015 - 540KT 2020 - 1.05MT (assuming ETS covers transport from 2015)
	€/t CO_2	**€**	**€**	**€**	**€**	**€**	**€**
2009	10	21m	920000	540000	6000	40m	150000
2015							
Ro	21	139m	2.2m	3.6m	42000	231m	11.3m
Ra	22	145m	2.3m	3.7m	44000	242m	11.9m
Rp	28	185m	2.9m	4.8m	56000	308m	15.1m
Oo	25	165m	2.6m	4.3m	50000	275m	13.5m
Oa	28	185m	2.9m	4.8m	56000	308m	15.1m
Op	43	284m	4.5m	7.3m	86000	473m	23.2m
Go	30	198m	3.2m	5.1m	60000	330m	16.2m
Ga	35	231m	3.7m	6.0m	70000	385m	18.9m
Gp	65	429m	6.8m	11.1m	130000	715m	35.1m
2020							
Ro	10	62m	960000	1.6m	20000	190m	10.5m
Ra	12	74m	1.2m	1.9m	24000	108m	12.6m
Rp	24	149m	2.3m	3.8m	48000	216m	25.2m
Oo	15	93m	1.4m	2.4m	30000	135m	15.8m
Oa	19	118m	1.8m	3.0m	38000	171m	20.0m
Op	53	329m	5.1m	8.5m	106000	477m	55.7m
Go	21	130m	2.0m	3.7m	42000	189m	22.1m
Ga	29	180m	2.8m	4.6m	58000	261m	30.0m
Gp	114	707m	10.9m	18.2m	228000	1026m	120.0m

Part 5: Conclusion

"Problems cannot be solved at the same level of consciousness that created them." Albert Einstein

The range of cost projections with which we end the main body of this report highlights how much remains uncertain for businesses in relation to global warming. Some uncertainties cannot be resolved – How fast will Arctic ice melt? Will there be a breakthrough in solar power? But others can. They result from gaps in understanding, communication or process. Our report has identified three such gaps:

- If a majority of CEOs are 'not concerned' about climate change, as surveys show, then presumably they must not understand the scale of what is being proposed – the massive effort to cut emissions between 2010 and 2020. The same is true of the public. A recent US survey showed that only a third of Americans believe global warming is a very serious problem[161]. There is a **gap in understanding** between the reality as perceived by those grappling with it and the level of knowledge among the public and in business.

- While the science relating to feedbacks and the risk of runaway climate change is still developing, it clearly presents a set of major risks, as the IPCC has acknowledged. Yet policy is being made on the basis of earlier science that does not take these risks into account. There is a **gap in policy-making**, a systemic disconnect which leads to a lengthy time-lag between climate science and the action it demands.

- The business world is awash with discussion of the 'opportunities' arising from climate change. Yet emissions are still rising and such opportunities as exist depend heavily on how policy-makers act. What remains missing from the debate is a very simple, widely agreed agenda for action from business. In other words, while politicians and business people are constantly in contact, there is in this critical sense a **gap in communication** between business people and the political class.

These gaps can all be filled and arguably they are for politicians to fill. But for example, confronting the public with the stark reality of what has to be achieved in the next 10 years may not seem the smartest move for a political leader facing re-election soon. A warmer, 'lets-all-do-our-bit' message is much more attractive.

So can or should business act to fill in these gaps? That is for businesses to decide themselves. This report simply invites them to consider whether they agree that these gaps exist and whether the business community should do more to intervene. One argument for action is that the mounting urgency may lead to disruptive lurches in policy if these issues are not addressed.

The **understanding gap** is fundamental to the process. The UK Energy and Climate Change Secretary Ed Miliband acknowledged this when he told The Guardian newspaper in December 2008: *"When you think about all the big historic movements, from the suffragettes to anti-apartheid to sexual equality in the 1960s, all the big political movements had popular mobilisation. 'Make Poverty History' was a mass movement that was necessary to get the agreement. In terms of climate change, it's even more difficult."* [162] However a popular campaign for action on climate change can only happen if there is an increase in public understanding of the potential consequences of global warming. It's particularly important for citizens of the US and northern Europe to recognise that while they or their children may not personally experience drastic physical impacts, this century may see crop failures, floods, water shortages, disease and mass migration in the developing

world – for which the developed world will be blamed, leading to increased tensions and instability. Many have said that climate change requires mobilisation of resources on a scale analogous to a war. The challenge has been to summon up the necessary urgency without a traumatic event such as a terrorist attack or the assault on Pearl Harbour. However, if the public can be persuaded of the need for change, and the cost of change, then there would be less tension over whether those costs are channelled through public or private sectors. The process becomes more of a common effort to address a common problem. Should they choose, business could play a decisive role in this. Today, progressive businesses engage their customers by promoting sustainable goods or providing carbon footprint calculators. But more could be done. For example consumer-facing companies such as supermarkets could give customers information at the point of sale. It would be a new and different step to ask customers to join in a campaign aimed at politicians. But it would not be 'political' in a partisan sense and might be seen – especially in retrospect – as a badge of leadership.

The **policy-making gap** is also one that business – should it chose to do so – could highlight and help to fill. If we were starting afresh in the battle against global arming, what capabilities would we put in place? Are those capabilities present in the system that has evolved today? For example, the six or seven-yearly IPCC Assessment Reports might be supplemented by a 'rapid response' function to receive, filter and present scientific findings to governments, flagged for risk levels, on a regular basis. There is also scope for a central, global database and analysis centre for climate-related information. This might cover the physical impacts of climate change; GHG emissions country-by-country; progress towards targets; R&D projects; best practice in policy, technology and energy efficiency. Currently these areas are covered by different bodies as a result of evolving custom and practice rather than by high-profile, well-funded UN or international structures.

The **communication gap** is more complex. Businesses undoubtedly do engage with politicians, particularly through umbrella groups. And business is not primarily there to talk but to do. When they turn to advocacy, business groups have tended to communicate either in very general or very detailed terms. High level communiqués calling for deep cuts in emissions and a consistent policy framework have been issued for many years in advance of UNFCCC meetings and G8 summits[163]. At the other extreme some groups have set out panoramic and highly detailed proposals for action, such as the US Climate Action partnership's *Blueprint for Change*[164] or the UK Confederation of British Industry's *Low-Carbon Economy Roadmap*. But political action often arises from a simple agenda being widely trailed among legislators, opinion formers and the media – the ground being prepared, in the way it was for the plans on cap-and-trade in the US or CCS in the UK. If one were to ask the typical European Parliamentarian or US Congress member what two things business most wants on climate change, how consistent would the answers be? What appears to be missing is a simple agenda of priorities which is clearly communicated not only to political decision-makers but those who influence them. Furthermore, while there are channels for contact between politicians and business leaders, is there scope for a more regular, systematic meeting in which ideas from both business and policy-makers can be discussed?

All of these gaps are manifestations of the lack of a common approach across government, business, NGOs and public, between different countries and cultures. The journey towards sustainability has been mainly delayed by protracted negotiations at border crossings – between public and private sectors, between government, business and NGOs, between scientists and policy-makers, between developed and developing worlds. Why has 'partnership' become a buzz-word in the lexicon of sustainability? Should it not be a given? Or is it highlighted because it is so far from a norm of reluctant interaction between separate power centres.

This is more accentuated in the Western political tradition with its clear dichotomy between ‘private’ and ‘public’ sectors. The Asian political culture often takes a more integrated approach. But for real progress to be made worldwide, these borders need to be broken down. This is a demanding, many-sided challenge, bearing out Einstein’s observation that problems are not solved at the level of thinking at which they were created.

To move to a new level, we suggest that there needs to be a widespread mobilisation of understanding and support for change, a thorough review of the international machinery for action and a clearer, deeper and more trusting engagement between the worlds of politics and business.

Postscript

Business in the Age of Sustainability: the post-carbon paradigm shift

By Tony Manwaring, Chief Executive, Tomorrow's Company

> *That's why I want to construct a global 'green new deal' that will pave the way for a low carbon recovery and help us build tomorrow's green economy today*.
> Gordon Brown - at the UK Carbon Industrial Summit - launching the Low Carbon Industrial Strategy. [165]

> *The state of our economy calls for action: bold and swift. And we will act not only to create new jobs but to lay a new foundation for growth. We will build the roads and bridges, the electric grids and digital lines that feed our commerce and bind us together. We will restore science to its rightful place and wield technology's wonders to raise health care's quality and lower its costs. We will harness the sun and the winds and the soil to fuel our cars and run our factories. And we will transform our schools and colleges and universities to meet the demands of a new age. All this we can do. All this we will do.*
> President Barack Obama, Inaugural Address, 20 January 2009 [166]

Discussions about how to tackle climate change are framed by the paradigm of industrialisation which has shaped the world for the last 200 years of more – economic development that has been based on making use of natural resources, in particular coal and oil.

If we burn all the world's coal, CO_2 levels are projected to go well beyond the dangerous 'peak carbon' threshold of 400ppm.[167] If we phase out coal and burn all the oil and gas the climate consequences will not be so severe, but the critical issue is of course that we will have then reached or gone beyond 'peak oil'.

The policy debate around climate change is a bit like constructing one giant, zero-sum, see-saw: carbon on the one side, pricing, fiscal policies, regulation and behaviour change to reduce the use of carbon on the other. This framing is rooted, not surprisingly, in the current paradigm; it does not look to the future, and build stepping stones back from that future to guide present action.

Our argument is that we need to re-frame the discussion. We need to recognise the power of the insight of economists such as Kondratiev that 'waves' of economic development begin, peak and end; and that our current 'meta-wave', rooted in the inherent exploitation of natural resources, has come to an end. Each wave is characterised by different kinds of value creation, and different business models. Not to recognise this is to throw good money after bad, using policy tools and business models which are no longer fit for purpose.

As things fall apart, the green shoots of the future break through: the 'Age of Sustainability' has begun, but we have not come to terms with it yet. This age will be driven by the need to enable nine billion people to live on our one planet on a basis of equity and justice, which will require new business models able to generate sustainable value, producing energy in very different ways.

We have earlier described our '21st century value matrix', and the importance of creating the right enabling frameworks so that low-carbon, eco-efficient and climate friendly products and processes are encouraged. What this means is that we need to re-frame the debate, away from carbon. We need to recognise that sustainable value in the future will be about green innovation, green talent, green jobs, green savings on energy costs and green finance. This new agenda is well articulated by the Climate Prosperity Project helping to shape not only the policies of the Obama administration, but also now spreading state wide, across political boundaries, uniting business and government – with detailed strategies emerging for Silicon Valley, Delaware and elsewhere.[168]

We speculate on the future shape of the economy and society, and their relationship to the environment, at our peril. H.G. Wells's visions through the lens of his time machine remind us of limits of looking in the crystal ball. That said, as Bill Becker (of the Presidential Climate Action Plan) has advocated, models of the future powerfully shape economic development for generations to come: Becker cites Futurama, the exhibit created by General Motors at the New York World's Fair in 1939, a vision of cars and freeways, of urbanisation and driving, made possible by unending supplies of oil.[169]

In thinking low-carbon, we need to come to understand what the world will look like post-carbon: and in so doing, we will start to recognise that the debate is not about what we won't have and be able to do, but what will be possible. In so doing we will recognise why this will be so exciting, the ground will shift, and together we will seek to create this new future, to actively bring it into being.

We will re-frame the growth/no-growth debate in a way which comes to terms that some industries will indeed decline and eventually come to an end, as many do over time – from typewriters to tobacco – as others rise: and that this will all add up to new ways of working, living and being.

We need to recognise that the Age of Sustainability must also be an age of equity, recognising that developing countries will demand a standard of material prosperity which matches that long enjoyed by developed countries – and that the challenge for the developed world will be to become models of sustainable excellence, demonstrating that tomorrow's green economy offers a practical way forward to combine prosperity with sustainable and increasingly non-material growth (such as education and entertainment).

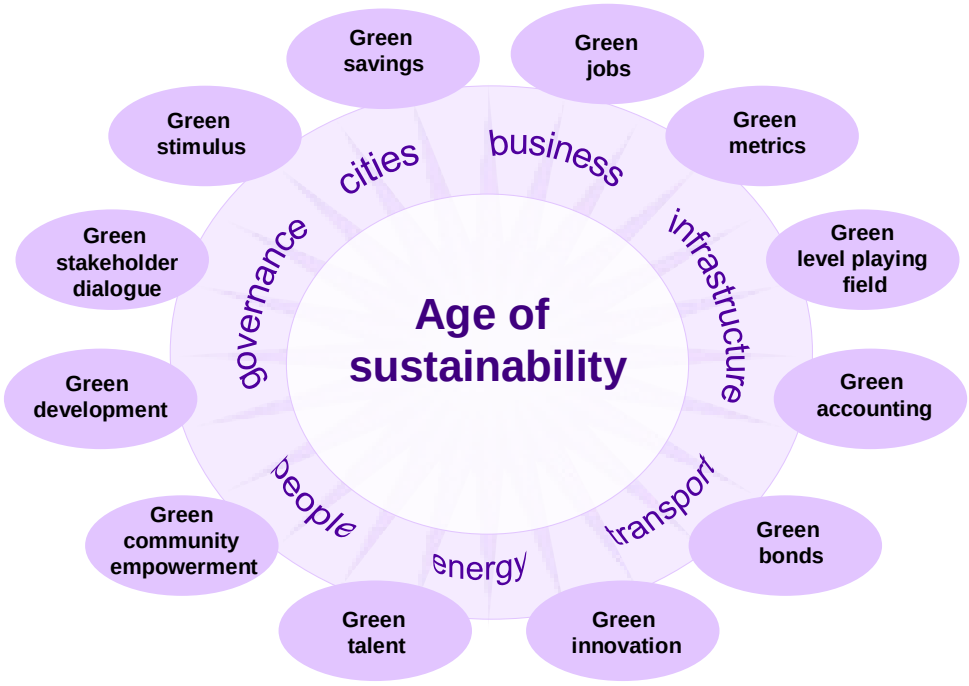
The precise form – in terms of the products and processes - this will take is arguably less important than the principles, culture and behaviours which will provide the 'DNA' of tomorrow's green economy. Some of these are starting to take shape. Here are *12 operating principles for tomorrow's green economy* – a paradigm shift in the DNA which frames our carbon based economy of the last 200 years:

1. ***Green savings*** *– recognising the scale and scope for massive efficiency gains, and therefore cost savings.* The first wave of savings can be achieved through taking advantage of the low hanging fruit of eco-efficiency; the real gains are to made through process re-engineering. (Witness the pioneering work of Ray Anderson and Interface).[170]
2. ***Green jobs*** *– the evidence is clear that more jobs will be created through green programmes.* For example, a $100 billion 2 year 'green' investment will generate four times the number of jobs than the same investment in the oil industry.[171]; $1 billion invested in 'green' strategies will generate 5,000 more job years than if invested in road building, and 23,000 more than if invested in tax cuts. [172]

3. ***Green metrics*** *– there is growing evidence that taking account of environmental, social and governance criteria as well as financial metrics, provides far more reliable indicators of creating sustainable value.* This should come as no surprise, these criteria are a powerful proxy for managing complexity, coping with uncertainty and meeting stakeholder needs. [173]
4. ***Green level playing field*** *- bringing to end the massive subsidies globally for fossil fuels* – estimated by UNEP to be in the order of $300bn annually[174]– which means that green-tech is not competing on a level playing field. As the Presidential Climate Action Programme evidenced, the green economy will re-task and make demand of many of the components, such as ball-bearings, of the present.[175]
5. ***Green accounting*** *- Internalising the externalities through green accounting.* This has most comprehensively been developed and demonstrated by the Green Indian States Trust in India – so that biodiversity and human/social capital impacts are reflected on the balance sheets of corporations, impacting on investor behaviour and the decisions of key stakeholders. [176]
6. ***Green bonds and other financial instruments*** – building on the pre credit crunch growth in funding of clean-tech, particularly in the USA, through pension funds, private equity and venture capital. Green finance needs to be creatively tied to public policy and public funding instruments. The payback period for green tech requires underwriting or financing, recognising the confidence of payback in the medium to long-term, but the poor returns in the short-term.
7. ***Green innovation –*** *recognising that the 'cool' and iconic jobs of the future* are not going to be rooted in the celebrity world of 'cool Britannia' or financial services, but are going to be about engineering and related disciplines, to redesign the products, processes and infrastructure which shape how we live, work, and travel
8. ***Green talent*** *– the Age of Sustainability reframes the agenda for talent.* What it is, who has it, where it is, how we harness it. We have developed this argument in *Tomorrow's Global Talent.* And if we are right, it means a new agenda for tomorrow's global leaders, and a new curriculum for business schools.
9. ***Green development*** *– promoting microfinance and social business, recognising the central role of women, building the capacity of local communities.* We develop this argument with others in the *Ubuntu Declaration for a Just and Sustainable World Economy.*[177]
10. ***Green community empowerment*** *– enabling individuals and communities to come together, create and fund their own energy and infrastructure solutions.* Smart grids will enable an energy revolution, but the biggest change won't be the technology, it will be people being enabled to produce their own energy. Cities and local government have a transformative role to play.
11. ***Green stimulus*** *– stimulus packages geared to promote recovery need to build the economy of the future.* For example, UNEP argues that a quarter, or £750bn, of current stimulus packages should be so focussed.[178] HSBC calculate that the UK for example has geared 7% of stimulus to green outcomes. [179]
12. ***Green stakeholder dialogue*** *– we need to transform the relationship between business, civil society and government*. We live in a zero-sum, adversarial world. The contribution of business is limited by the lack of enabling frameworks and the fear of condemnation by NGOs; government waits for voters to demand change; the vision of a new way of living and creating value that business and NGOs together could create, with government, remains unfulfilled.

These operating principles will shape new ways of living and working, of doing business and designing the cities most of us live in, the energy we use, and future patterns of transport and infrastructure: the change will be cumulative, creating a tipping point of transformation, giving practical shape to tomorrow's economy, society and environment, both driven and enabled by a step-change in relationships between business, civil society and government.

Achieving this paradigm shift will not be all or nothing. Given the scale and nature of the challenge we have to overcome we need to use every available instrument, and find out what will work under what circumstances. Carbon pricing and other mechanisms are an essential element of our armoury. But we need a compelling vision of tomorrow's green economy, and the drivers and dynamics of sustainable value creation, to harness the capabilities and commitment of all the key forces and institutions that we need to create the Age of Sustainability.



Appendix

Green Investment Frameworks

This briefing describes some of the frameworks that have been established in various countries to support the transition to green, low-carbon economies. Whilst each have followed their own path the importance of governments and business working together to establish effective frameworks is shared, as are the positive returns both economically and environmentally that are being generated. This is not intended to be a comprehensive briefing - rather it provides indicative examples.

There is widespread agreement that global carbon emissions must be drastically reduced to prevent irreversible climate damage. This needs to be achieved despite the predicted doubling of world energy demand by 2030. Currently, just 30% of the total world energy supply comes from renewable sources. It is therefore plain to see that there is an urgent need to set some clear policy frameworks which will drive progress in support of renewable energy, energy efficiency, and research into new technologies such as CO_2 Capture and Storage (CCS).

Examples of Success:

Sweden: Heating
A national energy efficiency plan, promoting an increasing share of combined heat and power production from waste has led to a dramatic change in the fuel mix. In 1970, oil was the main fuel but today, oil accounts for only a few percent today, 62 per cent of district heating fuel today is biomass.

Portugal: Renewable Energy Generation
Portugal owns Europe's largest onshore wind farm, the world's first commercial wave power plant, and is constructing the world's largest solar photovoltaic farm. The government has supported the clean-tech transition with measures such as feed-in tariffs for clean energy, tendering procedures for wind and biomass installations, and investment subsidies.

China: Green Investment
Policies and guidelines (such as a tax on SUVs, and a fuel efficiency standard for cars 40 percent higher than the United States) have encouraged a new consumer market for green technology. China is the market leader on electric bikes (ebikes).

Republic of Korea: Green New Deal
This year the Korean government announced a $36 billion "Green New Deal" strategy. The investment includes restoring four major rivers, constructing a 3,000km bike path, and setting targets to increase the use LED illumination and the number of environmentally-friendly vehicles.

A complete transition to a low-carbon, green economy is required on a demanding timescale set by climate change and fossil fuel depletion. The case studies on the following pages illustrate how green investment has been successfully promoted under various government frameworks and resulted in economic and environmental rewards.

Sweden

A European Low-Carbon Leader

Sweden has one of the lowest carbon dioxide emissions per person in Europe and is an example of a country which has succeeded in combining economic growth with a sustainable environmental policy. Since 1990, the Swedish economy has grown by 44 per cent, while its emissions of greenhouse gases have diminished by 9 per cent.[180]

A key reason for this is the near 0% dependency on fossil fuels for its electricity generation. Approximately half of Sweden's electricity is generated by hydro power and the remainder from nuclear power. Despite rising industrial output, the use of oil has fallen from more than 75 per cent of the total energy supply in 1970 to 32 per cent today. Renewable resources supply 40 per cent of the country's energy – the highest proportion in the EU. [181]

Through the introduction of a carbon dioxide tax in 1991 Sweden put a high price on CO_2 emissions. The taxation policy was aimed at improving energy efficiency and encouraging the use of bio fuels creating incentives for companies to reduce their environmental impact.[182] One example of its success is in the heating sector. Sweden has a district heating sector which accounts for about 40 per cent of the heating market. A national energy efficiency plan, promoting an increasing share of combined heat and power production from waste has led to a dramatic change in the fuel mix. In 1970, oil was the main fuel but today, oil accounts for only a few percent today 62 per cent of district heating fuel today is biomass. [183]

In 2003, a market based green electricity certificate system was introduced. The aim is to promote cost effective electricity production based on renewable sources such as bio energy, wind power and hydropower. It creates a competition between different renewable energy sources and it gives consumers the most renewable energy for their money. The principle is that there is a seller and a buyer of electricity certificates and that trading takes place between them. Electricity suppliers are obliged to purchase electricity certificates from approved producers of renewable electricity who receive one electricity certificate for each megawatt-hour of electricity from central government. Demand for electricity certificates is consequently created, and producers of renewable electricity gain an extra source of revenue.[184]

Portugal

A Commercial Cleantech Pioneer

Portugal is a country heavily dependent on fossil fuels. However, the government has made a commitment to be a leading force in Europe's clean-tech revolution, setting itself some of the most ambitious targets and timetables for renewable energy adoption.[185] Today, Portugal owns the largest onshore wind farm in Europe, the first commercial wave power plant, and is in the process of constructing a solar photovoltaic farm twice the size of any other in the world.

The wind farm consists of 120 windmills across one of Portugal's poorest regions and provides power for up to a million people. The Portuguese government expects that by 2010 they will have 5,000MW of wind energy installed, a tenfold increase in five years.[186]

The first stage of the world's first commercial wave power plant went live off the coast of Portugal last year. The project was supported by legislature in Portugal which pays a feed-in-tariff of about 18 pence per kilowatt hour generated. Once at full capacity, the plant will generate enough electricity to power 15,000 Portuguese homes.[187]

Portugal is also home to the world's largest solar photovoltaic farm near the southern town of Moura. The infrastructure consists of 2520 solar trackers, each set at a 45 degree angle, which are able to rotate 240 degrees throughout the day in order to gain the maximum solar exposure. The 48 MW facility will provide power to over 30,000 Portuguese households, producing 93 million kWh of electricity annually and avoiding over 89,000 tonnes of carbon dioxide emissions.[188]

It is Portugal's mixture of government enthusiasm, subsidies and special tariffs that has turned it into one of the focal points of renewables development in Europe over the past five years. Key measures undertaken include; feed-in tariffs for clean energy, tendering procedures for wind and biomass installations, investment subsidies, and a new building code which introduced the obligation to install solar thermal systems in certain cases.[189]

China

A Developing Economy Encouraging Green Investment

The carbon emissions resulting from China's rapid economic growth have been a primary concern for a number of years. China has overtaken the United States as the world's leading emitter of carbon dioxide. However, China's per capita emissions are actually only a quarter of that of North America. It is estimated that if the Chinese citizens were to have a carbon footprint the size of the citizens of America, China's emissions would be approximately equal to the current emissions of the entire planet.[190]

Due to its status as a developing country, despite signing the Kyoto protocol, China has not been set any targets regarding the "greening" of its economy. However, the Chinese government are well aware of their current and potential future impact and, as a result, have set their own national targets for moving towards a low carbon economy which are on a par with most of the developed nations worldwide. In fact, the Chinese government's target to reduce energy intensity by 20 percent between 2006 and 2010 is one of the most ambitious in the world.[191]

China's installed renewable capacity, at 152 gigawatts, is the largest in the world.[192] The renewable sector in China is currently worth $17 billion and employs approximately one million people. China plans to almost double the proportion of renewable energy it uses from eight percent in 2006 to 15 percent in 2020. [193]

The policies and guidelines that the government is putting place are encouraging private investment in low-carbon markets, and through funding projects, such as the Renewable Energy Development Project (REDP), encouraging research and development in these fields.[194] China's six biggest solar companies currently have a value of over $15 billion and China is expected to become the leading exporter of wind turbines this year. A fuel efficiency standard for cars 40 percent higher than the United States has encouraged investment in an area of land half the size of the U.K. for biofuel production.[195] A tax on SUVs has helped facilitate growth in alternative transport markets such as electric bikes (ebikes), of which the Giant Bike Co sold over 250,000 electric bikes in 2007. [196]

China has assigned $140 billion of its $586 billion economic stimulus package to green investments - the equivalent of two per cent of national GDP and is quietly laying the foundations for a cleaner, greener economy.[197] However, without evidence that the developed nations of the world are making similar investments, long term success is still uncertain.

The Republic of Korea

Making a Substantial Economic Commitment to a Green New Deal for 2009

On January 6th 2009, the Korean government announced its $36 billion "Green New Deal". The investment, which is equivalent to 3% of total GDP, composes nine core projects and 27 related sub-projects.

Of the proposed schemes, the highest priority is restoring four major rivers which, when completed, will prevent disasters from flood and drought, secure water resources, enhance water purity and expand the number of environmentally-friendly locations. This scheme alone will create 280,000 additional jobs.

Another major project being undertaken is the "Green Transportation Network". The government aim, by 2018, to have constructed a 3,000km bike path to connect the entire coastal area of the southern peninsula.

Other plans include that by 2012 20 per cent of public facilities will use LED illumination, and the number of environmentally-friendly vehicles, including hybrid cars, low-pollution automobiles and natural gas buses, will rise to 68,000. In total, the "Green New Deal" is expected to create 960,000 new jobs.[198]

Europe

Investing in CO_2 Capture and Storage (CCS)

CCS is a package of technologies which separate and compress the carbon dioxide from traditional power plants, this is then injected deep underground at a suitable location where it is then trapped within the rock in liquid form.[199]

In March 2007, EU leaders signed up to support the construction of 10-12 large-scale CCS demonstration plants. In November 2008, the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP) presented its proposal to bring forward the large-scale deployment of CCS by ten years, stating that by 2020, all new coal-fired plants should include CCS technology and existing plants should be 'retrofitted'. This major technology initiative will integrate all aspects of CO_2 capture, transport and storage – including technology, infrastructure, the environment, health and safety, legal and regulatory issues, funding mechanisms, public communication, and international collaboration.[200]

However, estimates suggest that ten moderately-sized commercial CCS projects will together carry incremental costs of €6 -10 billion - or even more - compared to conventional power plants without CCS and, although these technologies have been proven at the experimental level, they have not yet been deployed together in practice at commercial scale. Therefore, questions regarding the integration of project components, scale-up of technology, policy and regulation, public acceptance, cross-border issues and cost are all yet to be answered.[201]

Sources and Notes

[1] Tomorrow's Global Company: challenges and choices. Tomorrow's Company, 2007

[2] Martin Luther King, Riverside Church, New York City, 4 April, 1967
http://www.hartford-hwp.com/archives/45a/058.html

[3] PricewaterhouseCoopers 11th Annual Global CEO Survey, 2008
http://www.pwc.com/ceosurvey/pdfs/11th_ceo_survey.pdf

[4] PricewaterhouseCoopers 12th Annual Global CEO Survey, 2009
http://www.pwc.com/ceosurvey/pdfs/doca.pdf

[5] For example, speech by Robert Watson, IPCC Chair, 19 July 2001
http://www.ipcc.ch/graphics/speeches/robert-watson-july-2001.pdf

[6] Department for Energy and Climate Change, final greenhouse gas emissions figures for 2007
http://www.defra.gov.uk/environment/statistics/globatmos/download/ghg_ns_20090203.pdf

Department for Energy and Climate Change, provisional greenhouse gas emissions figures for 2008
http://www.defra.gov.uk/ENVIRONMENT/statistics/globatmos/download/ghg_ns_20090326.pdf

[7] Department for Energy and Climate Change, 2007 greenhouse gas emissions final figures
http://www.defra.gov.uk/environment/statistics/globatmos/download/ghg_ns_20090203.pdf

Provisional figures for 2008
http://www.defra.gov.uk/ENVIRONMENT/statistics/globatmos/download/ghg_ns_20090326.pdf

[8] International Energy Agency (IEA) World Energy Outlook, 2008
http://www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=275

[9] Target Atmospheric CO2 – Where should humanity aim?, James Hansen and others, 2008, http://arxiv.org/abs/0804.1126

[10] United Nations Framework Convention on Climate Change (UNFCCC) budget proposals 2008-2009 http://unfccc.int/files/meetings/cop_13/application/pdf/cp_budg_eigh_ni.pdf

Intergovernmental Panel on Climate Change (IPCC) Programme and Budget, 2008
http://www.ipcc.ch/meetings/session29/doc3.pdf

[11] GE website, $3bn invested in R&D in 2007 – approximately $8m per day
http://www.ge.com/citizenship/performance_areas/products_services_rd.jsp

[12] IPCC Fourth Assessment Report, 2007 (IPCC AR4)

[13] International Energy Agency, World Energy Outlook, 2008

http://www.worldenergyoutlook.org/docs/weo2008/WEO2008_es_english.pdf

[14] PricewaterhouseCoopers 11th Annual Global CEO Survey, 2008
http://www.pwc.com/ceosurvey/pdfs/11th_ceo_survey.pdf

[15] PricewaterhouseCoopers 12th Annual Global CEO Survey, 2009
http://www.pwc.com/ceosurvey/pdfs/doca.pdf

[16] Business in the Community Press Release 1 May 2009-05-18
http://www.bitc.org.uk/media_centre/press_releases/crc.html

[17] Figures collated by NOAA at
http://www.ncdc.noaa.gov/paleo/icecore/antarctica/vostok/vostok_co2.html

[18] US National Oceanic and Atmospheric Administration (NOAA) press release, 21 April 2009 http://www.noaanews.noaa.gov/stories2009/20090421_carbon.html

[19] IPCC AR4

[20] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/16

[21] For example, speech by Robert Watson, IPCC Chair, 19 July 2001
http://www.ipcc.ch/graphics/speeches/robert-watson-july-2001.pdf

[22] UK HM Treasury, The Stern Review, October 2006 Press release
http://www.hm-treasury.gov.uk/press_stern_06.htm

[23] UK HM Treasury, The Stern Review, October 2006
http://www.hm-treasury.gov.uk/d/Chapter_8_The_Challenge_of_Stabilisation.pdf

[24] IPCC AR4 SPM http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

[25] IPCC AR4 SPM http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

[26] IPCC AR4 Box 13.7
http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter13.pdf

[27] IPCC AR4
http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_topic2.pdf

[28] NOAA Trends in Atmospheric Carbon Dioxide
http://www.esrl.noaa.gov/gmd/ccgg/trends/

[29] IEA, Energy Technology Perspectives 2008
http://www.iea.org/Textbase/techno/etp/ETP_2008_Exec_Sum_English.pdf

[30] http://www.ox.ac.uk/media/news_stories/2009/090430_2.html

[31] UK Department for Energy and Climate Change press release 22 April 2009
http://www.decc.gov.uk/en/content/cms/news/pn047/pn047.aspx

[32] US Energy Information administration (EIA) 2008,
http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls

[33] EU greenhouse gas emissions decrease in 2005
http://www.eea.europa.eu/pressroom/newsreleases/eu-greenhouse-gas-emissions-decrease-in-2005

[34] http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls

[35] Department for Energy and Climate Change, 2007 greenhouse gas emissions final figures
http://www.defra.gov.uk/environment/statistics/globatmos/download/ghg_ns_20090203.pdf

Provisional figures for 2008
http://www.defra.gov.uk/ENVIRONMENT/statistics/globatmos/download/ghg_ns_20090326.pdf

[36] Oxford Analytica article, Climate scenarios outline framework, Jan 6 2009
http://www.oxan.com/display.aspx?ItemID=DB148106

[37] International Energy Authority (IEA) World Energy Outlook, 2008
http://www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=275

[38] World Economic Forum (WEF) and New Energy Finance (NEF), Green Investing report, 2009
http://www.weforum.org/en/media/Latest%20Press%20Releases/GreenReportPR

[39] New Energy Finance press release 2 April 2009
http://www.newenergymatters.com/download.php?n=20090402_PR_Q1_Investment_Figures.pdf&f=pdffile&t=pressreleases

[40] HM Treasury, UK, Stern Review Press Notice
http://www.hm-treasury.gov.uk/press_stern_06.htm

[41] The Guardian, 26 June 2008
http://www.guardian.co.uk/environment/2008/jun/26/climatechange.scienceofclimatechange

[42] CIA World Factbook https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html

[43] Article for Climate Action, http://www.climateactionprogramme.org/features/article/world_energy_outlook_2007_china_and_india_insights/

[44] BBC report of G8 meeting, 8 July 2008 http://news.bbc.co.uk/1/hi/sci/tech/7494891.stm

[45] White House website http://www.whitehouse.gov/issues/energy_and_environment/

[46] White House website http://www.whitehouse.gov/issues/economy/

[47] US Energy Information Administration data: http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls

[48] UNEP press release 16 February 2009 http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=562&ArticleID=6079&l=en

[49] London School of Economics press release http://www2.lse.ac.uk/ERD/pressAndInformationOffice/newsAndEvents/archives/2009/greenstimulus.aspx

[50] London Summit, Leaders' Statement http://www.g20.org/Documents/g20_communique_020409.pdf

[51] EIA International Energy Outlook, 2008 http://www.eia.doe.gov/oiaf/ieo/emissions.html

[52] IPCC AR4 http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter13.pdf

[53] EUROPA – Summary of EU Climate and Energy package http://ec.europa.eu/climateaction/docs/climate-energy_summary_en.pdf

[54] White House press briefing 18 April 2009 http://www.whitehouse.gov/the_press_office/Press-Briefing-By-Senior-Administration-Officials-On-The-Second-And-Third-Plenary/

[55] Guardian report 18 November 2008 http://www.guardian.co.uk/environment/2008/nov/18/greenhousegas-poznan

[56] UNFCCC, http://unfccc.int/kyoto_protocol/items/2830.php

[57] US Carbon Report http://uscarbonreport.com/global-carbon-market-up-massive-83-on-previous-year/

[58] BBC, 16 October 2008 http://news.bbc.co.uk/1/hi/uk_politics/7673748.stm

[59] Committee on Climate Change Report, December 2008

[60] UK Department for Energy and Climate Change press release 22 April 2009 http://www.decc.gov.uk/en/content/cms/news/pn047/pn047.aspx

[61] Committee on Climate Change Report, December 2008

[62] EUROPA – Summary of EU Climate and Energy package http://ec.europa.eu/climateaction/docs/climate-energy_summary_en.pdf

[63] UNFCCC Press Release http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/20090804_closing_pr_bonn.pdf

[64] IPCC presentation at

http://www.ipcc.ch/pdf/presentations/pre-cop-warsaw-2-10-2008/pres-warsaw-role-climate-global-protection-christ.pdf

[65] IPCC AR3 and AR4

[66] IPCC AR3 and AR4

[67] For example, Potsdam Institute for Climate Impact Research http://www.pik-potsdam.de/news/press-releases/future-tipping-points-in-the-climate-could-be-unveiled

[68] Planet Earth: We Have a Problem, Proceedings of briefing given to UK All Party Parliamentary Climate Change Group, November 2007

[69] Science Daily, 18 December 2008 http://www.sciencedaily.com/releases/2008/12/081217203407.htm

[70] Meridian Programme http://www.meridian.org.uk/FeedbackDynamics.htm

[71] University of East Anglia press release 7 February 2008 http://www.uea.ac.uk/env/events/tipping

[72] IPCC AR4

[73] UN Foundation Report February 2007 – Confronting Climate Change http://www.globalproblems-globalsolutions-files.org/unf_website/PDF/climate%20_change_avoid_unmanagable_manage_unavoidable.pdf

[74] Paleoclimatic Evidence for Future Ice Sheet Instability and Rapid Sea Level Rise, Overpeck et al, reported at http://uanews.org/printview/12116

[75] IPCC AR4

[76] WWF report - *Climate Change: Faster, stronger, sooner* http://assets.panda.org/downloads/wwf_science_paper_october_2008.pdf

[77] Target Atmospheric CO2 – Where should humanity aim?, James Hansen and others, 2008, http://arxiv.org/abs/0804.1126

[78] PricewaterhouseCoopers 12th Annual Global CEO Survey, 2009 http://www.pwc.com/ceosurvey/pdfs/doca.pdf

[79] United Nations Framework Convention on Climate Change (UNFCCC) budget proposals 2008-2009 http://unfccc.int/files/meetings/cop_13/application/pdf/cp_budg_eigh_ni.pdf

Intergovernmental Panel on Climate Change (IPCC) Programme and Budget, 2008 http://www.ipcc.ch/meetings/session29/doc3.pdf

[80] GE website, $3bn invested in R&D in 2007 – approximately $8m per day http://www.ge.com/citizenship/performance_areas/products_services_rd.jsp

[81] IPCC AR4

[82] The Black Swan: The Impact of the Highly Improbable Nassim Nicholas Taleb, Allen Lane. May 2007 Reviewed by Wall Street Journal at http://www.opinionjournal.com/la/?id=110009979

[83] Daily Telegraph 7 April 2008 http://www.telegraph.co.uk/earth/earthnews/3338632/Lord-Lawson-claims-climate-change-hysteria-heralds-a-new-age-of-unreason.html

[84] Critique of TV programme The Great Global Warming Swindle by Sir John Houghton http://www.jri.org.uk/news/Critique_Channel4_Global_Warming_Swindle.pdf

[85] US Senate Minority Report http://epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=83947f5d-d84a-4a84-ad5d-6e2d71db52d9

[86] Article on Edge Foundation website http://www.edge.org/3rd_culture/taleb08/taleb08.1_index.html

[87] H Lee Scott, President, Walmart, quoted by Jonathon Porrit at: http://www.pwc.com/extweb/pwcpublications.nsf/dfeb71994ed9bd4d802571490030862f/0b7a3627f0f9087780257404006109bc/$file/jonathon%20porritt%20presentation%20slides.pdf

[88] Comments by Lord Stern quoted at: http://www.pwc.com/extweb/ncpressrelease.nsf/docid/4E7CA24AF8CBB2D08525758A0064CBB0

[89] Department for Business, Enterprise and Regulatory Reform (BERR) report - Low Carbon and Environmental Goods and Services: An industry analysis http://www.berr.gov.uk/files/file50254.pdf

[90] Jay Apt and others, Carnegie Mellon University, http://www.issues.org/25.1/apt.html

[91] Solarbuzz Newsletter at http://www.solarbuzz.com/index.asp and http://www.solarbuzz.com/StatsCosts.htm

[92] Various reports including: http://www.tennesseeanytime.org/energy/node/1611; and http://www.recycled-energy.com/_documents/articles/tc_energy_mgmt_%205-08.pdf; http://www.scientificamerican.com/article.cfm?id=a-solar-grand-plan

[93] Various estimates compiled at http://sourcewatch.org/index.php?title=Comparative_electrical_generation_costs#_note-2#_note-2

[94] World Economic Forum website at http://www.weforum.org/en/initiatives/ghg/index.htm

[95] IPCC AR4

[96] IEA World Energy Outlook 2007

[97] US Energy Information Administration (EIA) http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html

[98] Observer article 15 February 2009 http://www.guardian.co.uk/commentisfree/2009/feb/15/james-hansen-power-plants-coal

[99] UK Commission for Integrated Transport http://www.cfit.gov.uk/docs/2001/scot0122/scot0122/02.htm

[100] IEA Clean Coal Centre http://www.cleancoalcentre.org/publishor/system/component_view.asp?logdocid=81405

[101] Energy Efficiency, Innovation and Job Creation in California, David Roland-Holst, UC Berkeley http://www.next10.org/pdf/report_eijc/75_01-2%20ClimateAction_Report%2004B_online.pdf

[102] California Energy Commission http://www.energy.ca.gov/title24/

[103] Trevor Houser, Peterson Institute for International Economics - Testimony before the Select Committee on Energy Independence and Global Warming, US House of Representatives http://www.petersoninstitute.org/publications/papers/paper.cfm?ResearchID=1093

[104] US Environmental Protection Agency http://www.epa.gov/solar/energy-and-you/affect/air-emissions.html

[105] IEA Key World Energy Statistics, 2008, http://www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf

[106] Global Wind Energy Council press release 2 February 2009 http://www.gwec.net/index.php?id=30&no_cache=1&tx_ttnews[pointer]=1&tx_ttnews[tt_news]=177&tx_ttnews[backPid]=97&cHash=b73fd0fa52

[107] US EIA http://www.eia.doe.gov/pub/international/iea2006/table64.xls

[108] IEA Key World Energy Statistics, 2008, http://www.iea.org/textbase/nppdf/free/2008/key_stats_2008.pdf

[109] Financial Times report

[110] IPCC report on carbon capture 2005 http://www.mnp.nl/ipcc/pages_media/SRCCS-final/SRCCS_SummaryforPolicymakers.pdf

[111] European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP) Proposal for EU demonstration CCS plants http://www.zero-emissionplatform.eu/website/docs/ETP%20ZEP/EU%20Demonstration%20Programme%20for%20CCS%20-%20ZEP's%20Proposal.pdf

[112] Newsweek article 23 January 2009 http://www.newsweek.com/id/181143

[113] Tesla Motors Inc http://www.veva.bc.ca/wtw/Tesla_20060719.pdf

[114] The Independent article 14 May 2007 http://www.independent.co.uk/environment/climate-change/deforestation-the-hidden-cause-of-global-warming-448734.html

[115] European Union press release, 17 October 2008 http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/632&format=HTML&aged=0&language=EN&guiLanguage=en

[116] UNFCCC briefing November 2008 http://unfccc.int/files/press/backgrounders/application/pdf/fact_sheet_reducing_emissions_from_deforestation.pdf

[117] Discover Magazine http://blogs.discovermagazine.com/80beats/2008/07/23/a-solar-power-plant-in-the-sahara-could-power-all-of-europe/

[118] UNFCCC http://unfccc.int/kyoto_protocol/items/2830.php

[119] UNFCCC http://unfccc.int/kyoto_protocol/items/2830.php

[120] UK Department for Environment, Food and Rural Affairs (DEFRA) website http://www.defra.gov.uk/environment/climatechange/uk/business/crc/index.htm

[121] Australian Department of Climate Change website http://www.climatechange.gov.au/emissionstrading/timetable.html

[122] New Zealand Government website http://www.climatechange.govt.nz/

[123] IPCC http://www.ipcc-nggip.iges.or.jp/

[124] Greenhouse Gas Protocol http://www.ghgprotocol.org/

[125] Guardian article 3 April 2007 http://www.guardian.co.uk/business/2007/apr/03/carbonemissions.environment

[126] EU Press Release 15 May 2009 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/794&format=HTML&aged=0&language=EN&guiLanguage=en

[127] Carbon market data http://www.carbonmarketdata.com/pages/Press%20release%20EU%20ETS%202008%20-%206%20April%202009.doc

[128] BNP Paribas, *Carbon Capture and Storage: How close are we to a potential shake-up of the energy sector?* May 2008

[129] UK BERR website http://www.berr.gov.uk/energy/sources/renewables/policy/renewables-obligation/page15630.html

[130] Environmental Research Web article - http://environmentalresearchweb.org/cws/article/opinion/35659

[131] UK Department for Transport http://www.dft.gov.uk/pgr/roads/environment/rtfo/

[132] German government website http://www.bmu.de/english/current_press_releases/pm/43987.php

[133] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/632&format=HTML&aged=0&language=EN&guiLanguage=en

[134] White House website http://www.whitehouse.gov/issues/energy_and_environment/

[135] White House website http://www.whitehouse.gov/issues/economy/

[136] HSBC A Climate for Recovery http://www.globaldashboard.org/wp-content/uploads/2009/HSBC_Green_New_Deal.pdf

[137] HSBC A Climate for Recovery http://www.globaldashboard.org/wp-content/uploads/2009/HSBC_Green_New_Deal.pdf

[138] UN Environmental Programme Press Release 16 February 2009 http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=562&ArticleID=6079&l=en

[139] An outline of the case for a 'green' stimulus, Bowen, Fankhauser, Stern, Zenghelis, Grantham Research Institute on Climate Change and the Environment, February 2009

http://www.lse.ac.uk/collections/granthamInstitute/publications/An%20outline%20of%20the%20case%20for%20a%20'green'%20stimulus.pdf

[140] EU Press Release 13 November 2008 http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/693&format=HTML&

[141] DEFRA website http://www.defra.gov.uk/environment/climatechange/uk/household/supplier/cert.htm

[142] Carbon Trust, Climate Change: A Business Revolution, September 2008 http://www.carbontrust.co.uk/publications/publicationdetail?productid=CTC740

[143] NEF data http://www.cleanedge.com/news/story.php?nID=5859

[144] The Summary Case For An Efficient Building Scheme, Lendlease, Lincolne Scott, Freehills, http://www.lendlease.com/sustainability/pdf/EfficientBuildingScheme.pdf

[145] EU Press Release 17 December 2008 http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/796

[146] Statement by Ed Miliband, Energy and Climate Change Secretary, 23 April 2009-05-19 http://www.decc.gov.uk/en/content/cms/news/090423_ccs_sta/090423_ccs_sta.aspx

[147] The Independent article, 23 April 2009 http://www.independent.co.uk/environment/green-living/goahead-for-carboncapture-power-stations-1673141.html

[148] Guardian article 24 April 2009 http://www.guardian.co.uk/environment/2009/apr/24/energy-coal-carbon-capture-environment

[149] US Department of Energy http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm

[150] US EIA http://www.eia.doe.gov/oiaf/aeo/otheranalysis/aeo_2005analysispapers/prcreg.html

[151] Database of State Incentives for Renewables & Efficiency http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA25R&state=CA&CurrentPageID=1

[152] US EIA http://www.eia.doe.gov/oiaf/archive/aeo99/supplement/sup99f.pdf

[153] American Wind Energy Association, Press Release 27 January 2009 http://www.awea.org/newsroom/releases/wind_energy_growth2008_27Jan09.html

[154] Hansard, Commons 22 January 2009 http://www.publications.parliament.uk/pa/cm200809/cmhansrd/cm090122/debtext/90122-0001.htm

[155] Germany government website http://www.bmu.de/english/current_press_releases/pm/43987.php

[156] UK BERR website http://www.berr.gov.uk/energy/sources/renewables/index.html

[157] World Bank press release 5 January 2009-05-19http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22024264~pagePK:64257043~piPK:437376~theSitePK:4607,00.html

[158] EU Press Release 15 May 2009 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/794&format=HTML&aged=0&language=EN&guiLanguage=en

[159] European Union press release 17 December 2008 http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/796

[160] Carbon Market Data press release 7 April 2008 http://www.carbonmarketdata.com/pages/Press%20Release%20EU%20ETS%20Data%20-%20April%202008.doc

[161] Rasmussen Reports poll, 18 May 2009 http://www.rasmussenreports.com/public_content/politics/environment/energy_update

[162] Guardian article 8 December 2008 http://www.guardian.co.uk/environment/2008/dec/08/ed-miliband-climate-politics-environment

[163] Examples at http://www.balicommunique.com/pressrelease.html; and http://www.cpi.cam.ac.uk/PDF/Press%20Release%20Embargoed%208%20Dec.pdf

[164] US Climate Action Partnership http://www.us-cap.org/pdf/USCAP_Blueprint.pdf

[165] Speech by Gordon Brown, 6 March 2009-05-19 http://www.number10.gov.uk/Page18530

[166] Barack Obama speech, 20 January 2009 http://speaker.house.gov/newsroom/reports?id=0156

[167] See for example Hansen http://arxiv.org/abs/0804.1126

[168] http://www.globalurban.org/projects.htm

[169] http://www.forceforgood.com/Blogs/New-Energy-Economy-Let-the-National-Conversation-Begin-282/1.aspx

[170] http://www.interfaceglobal.com/Sustainability.aspx

[171] Pollin, et al *Green Recovery*, 2008

[172] Houser, et al, *A Green Global Recovery?,* 2009

[173] Literature Review at Force For Good website: http://www.forceforgood.com/Uploaded_Content/tool/422009101848100.doc

Article by Matthew Kiernan of Innovest at: http://www.bsr.org/reports/leading-perspectives/2006/2006_Fall.pdf

[174] UN Environment Programme, press release 26 August 2008 http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=543&ArticleID=5902

[175] Presidential Climate Action Programme http://www.climateactionproject.com/

[176] Green Indian States Trust website http://www.gistindia.org/abtWhatwedo.asp

[177] Force For Good website http://www.forceforgood.com/Tools/Ubuntu-Declaration-for-a-just-and-sustainable-world-economy-162/1.aspxg

[178] UNEP press release 16 February 2009 http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=562&ArticleID=6079&l=en

[179] HSBC A Climate for Recovery http://www.globaldashboard.org/wp-content/uploads/2009/HSBC_Green_New_Deal.pdf

[180] Swedish Ministry of the Environment (2008) “Towards a Low Carbon Society”, http://www.sweden.gov.se/content/1/c6/11/66/69/f7b9ac55.pdf

[181] Swedish Institute (2008) “Generating Power for a Sustainable Future”, http://www.sweden.se/upload/Sweden_se/english/factsheets/SI/SI_FS3_Energy/Energy_FS3_Lowres.pdf

[182] Hansen, K. G. & Stephan Barg (1994) “Making Budgets Green: Leading Practices in Taxation and Subsidy Reform**”,** Ottowa IISD.

[183] Swedish Ministry of Enterprise, Energy and Communications (2009) “Energy Policy”, http://www.regeringen.se/sb/d/5745/a/19594

[184] Swedish Ministry of Sustainable Development (2006) “Renewable Electricity with Green Certificates” http://www.sweden.gov.se/content/1/c6/06/47/22/2°C000830.pdf

[185]IEA (2004) ” IEA Urges Portugal to Consistently Maintain its Oil Stockholding Obligation and Commends Initiatives to Develop Competitive Regional Energy Markets” http://www.iea.org/Textbase/press/pressdetail.asp?PRESS_REL_ID=136

[186] Tremlett, G. (2009) “Europe’s Biggest Wind Farm Switches On”, *The Guardian*, http://www.guardian.co.uk/environment/2008/dec/02/portugal-wind-power

[187] Jha, A. (2008) “’Wave Snakes’ Switch on to Harness Ocean’s Power”, *The Guardian*, http://www.guardian.co.uk/environment/2008/sep/24/renewable.wave.energy.portugal

[188] Energy Matters (2009), “Portugal’s Largest Solar Farm Opens”, *Renewable Energy News,* http://www.energymatters.com.au/index.php?main_page=news_article&article_id=266

[189] European Renewable Energy Council (2008) “Portugal: Renewable Energy Policy Review”, http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES2020/PORTUGAL_RES_Policy_Review_April_2008.pdf

[190]The Climate Group (2009) “China’s Clean Revolution”, www.theclimategroup.org/assets/resources/**Chinas**_Clean_Revolution.pdf

[191]World Bank (2008) “China’s energy efficiency the target of three new World Bank projects”, http://web.worldbank.org/WBSITE/EXTERNAL/EXTCHINESEHOME/EXTCOUNTRIESCHINESE/EXTEAPINCHINESE/EXTEAPCHINAINCHINESE/0,,contentMDK:21781719~menuPK:3885783~pagePK:2865066~piPK:2865079~theSitePK:3885742,00.html

[192]The Climate Group (2009) “China’s Clean Revolution”, www.theclimategroup.org/assets/resources/**Chinas**_Clean_Revolution.pdf

[193]World Bank (2008) “China’s energy efficiency the target of three new World Bank projects”, http://web.worldbank.org/WBSITE/EXTERNAL/EXTCHINESEHOME/EXTCOUNTRIESCHINESE/EXTEAPINCHINESE/EXTEAPCHINAINCHINESE/0,,contentMDK:21781719~menuPK:3885783~pagePK:2865066~piPK:2865079~theSitePK:3885742,00.html

[194]The World Bank (2007) “Catalyzing Private Investment For A Low Carbon Economy”, http://siteresources.worldbank.org/INTENERGY/Resources/renewableenergy12407SCREEN.pdf

[195]The Climate Group (2009) “China’s Clean Revolution”, www.theclimategroup.org/assets/resources/**Chinas**_Clean_Revolution.pdf

[196]Farnworth, E (2008), “Picking up the Baton – China’s Race to lead a Low-Carbon Economy” http://www.climatechangecorp.com/content.asp?ContentID=5545

[197] UNEP 2009 “A Global Green New Deal”

[198] UNEP 2009 “A Global Green New Deal”

[199] EurActive.com(2009), “Carbon Capture and Storage”, http://www.zero-emissionplatform.eu/website/docs/ETP%20ZEP/ETP%20ZEP%20Recommendations.pdf

[200] Zero Emission Fossil Fuel Power Plants (2008), “The EU Flagship Programme for CO2 Capture and Storage (CCS)”, http://www.zero-emissionplatform.eu/website/docs/ETP%20ZEP/ETP%20ZEP%20Recommendations.pdf

[201] Zero Emission Fossil Fuel Power Plants (2008), “The EU Flagship Programme for CO2 Capture and Storage (CCS)”, http://www.zero-emissionplatform.eu/website/docs/ETP%20ZEP/ETP%20ZEP%20Recommendations.pdf