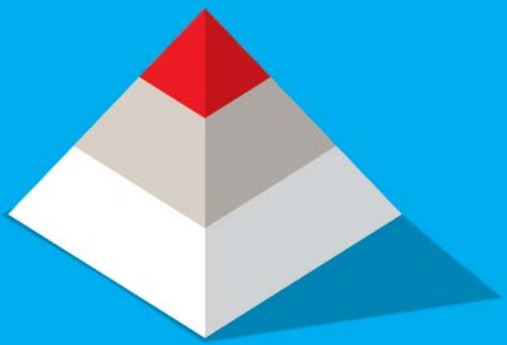
Carbon Scenarios

Blue Sky Thinking for a Green Future



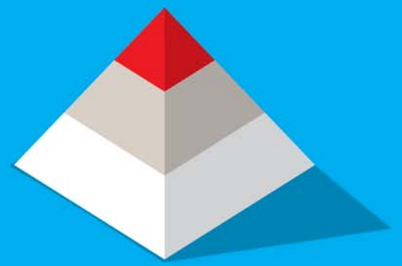
STOCKHOLM NETWORK

Kyoto Plus

The *Kyoto Plus* scenario looks at the possibility for climate change mitigation success in the framework of the current UNFCCC process and develops a future where the process leads to a global framework for CO_2 emissions being put into place in 2012.

Agree & Ignore

The *Agree & Ignore* scenario looks at the current policy context but projects a different path from the one outlined in *Kyoto Plus*. Instead of focusing on the positive momentum present in the current context, it examines opportunities for backsliding and delays. In other words, the scenario tries to envisage what would occur if an international agreement 'talked the talk', but didn't 'walk the walk'.



Step Change

The *Step Change* scenario envisages a future where policy takes a radically different course, prompted by the occurrence of stochastic weather events. It assesses whether a radically different policy course might have a greater likelihood of delivering both climate policy success and high levels of economic growth.

Carbon Scenarios

Blue Sky Thinking for a Green Future

Paul Domjan and Gulya Isyanova

ENERGY & ENVIRONMENT

Contents

Figures

Foreword

"When it comes to the future, there are three kinds of people: those who let it happen, those who make it happen, and those who wonder what happened."
John M. Richardson, Jr.

What can think tanks do to improve policy making on climate change? And how can we help to frame a forward-looking analysis of contemporary debates in the field? This report provides some answers.

Debate on climate change has now shifted decisively from science to policy, generating a new set of questions and challenges. Arguably, there is a lack of clear, synthesised data on the climatic, economic, technological, political and even social consequences of different policy options; how these developments would interact; and their plausible impact on different countries.

Importantly, the information that does exist is often hard to compare and contextualise, given that climate change policy today requires a multi-disciplinary approach. We need a tool to help key stakeholders and the public at large to think concretely about the future impact and implied costs of potential policy options.

Think tanks have a unique ability to bring together on neutral turf people who would not otherwise meet. But this 'intellectual matchmaking' also serves a concrete purpose of devising creative policy solutions. With this in mind, we launched our Carbon Scenarios project, bringing together a range of experts from the worlds of economics, technology, environmentalism, science and policy, to sketch some visions of the future.

Blue Sky Thinking for a Green Future is the written result of that endeavour, providing us with three policy scenarios for the years ahead. We hope they provide some thoughtful avenues for addressing the future.

Our aim as a think tank is to change the climate of opinion and, in this case, to provide a serious contribution to one of today's defining social and economic problems – how to protect and maintain a habitable planet.

Helen Disney
Founder and Chief Executive
Stockholm Network

Introduction

What are Carbon Scenarios?

Scenarios are stories that describe different future trajectories stemming from the same present. The Stockholm Network's Carbon Scenarios describe different possible futures that result from the differentiated substance and implementation of possible climate policies. We hope that our three scenarios – *Kyoto Plus*, *Agree & Ignore*, and *Step Change* – will be a simple yet powerful tool, for discussing the complexity of climate change policy with a variety of stakeholders. They enable thinking about how far climate policies could take us, at what cost, how global energy markets would evolve and how effective the policies will be in addressing the challenges of climate change. While a concept like 'Cap & Trade' may be an abstract idea for many people, concrete stories give life to the issue by showing how we might end up with a particular policy option and what its consequences would be for the environment and for society.

The Stockholm Network hopes that each of its scenarios will provide a basis for an interdisciplinary conversation about the future. Policymakers can use them to assess and explain the trade-offs implicit in climate change policy and help to develop support for climate change policies among other stakeholders. Business can use them as a tool to understand the current and future importance of the issue and to develop strategies to contribute constructively to addressing climate change. The media can use them as a way of connecting the politics surrounding the Kyoto Treaty, the United Nations Framework Convention on Climate Change (UNFCCC) and the International Panel on Climate Change (IPCC) to the everyday lives of their readers, listeners and viewers. Because of their narrative structure, the scenarios can easily be adapted for different audiences and national contexts – the Stockholm Network hopes to do just that in partnership with some of its member think tanks across Europe.

The purpose of these scenarios is not to advocate a particular type of response, but rather to provide a non-partisan platform for building consensus around action that is deemed both necessary and possible. Unlike potentially partisan policy analysis, scenarios provide a framework to enable those from across the political spectrum to discuss the issue based not on what they would like to see happen, but rather on what potentially could happen.

How the scenarios were built

The Stockholm Network has not built these three scenarios by itself. It has, however, facilitated a process that has brought together experts from climate science and economics, the environmental movement, government and business to share their perspectives on climate change, potential policy responses and their consequences. This was done primarily via a scenario building workshop which was held in London in January 2008. At the workshop, these experts jointly identified the key issues that they believe will determine future developments in the area of climate policy – in other words, the components for the stories.[1]

How do we define 'success'?

A greater than 90% chance of less than 2°C of warming above pre-industrial levels.

We began by framing 'success' in the same terms as the European Union and the UK government have done to date, i.e. have a greater than 90% chance of less than 2 degrees centigrade of warming above pre-industrial levels. We then asked a simple question: what can technology alone do and how quickly? Having mapped the possibilities offered by technology mega-trends on their own, we then turned to climate science to ask what reduction in emissions was needed to achieve this 'success'.

It was decided that emissions will need to peak within the next 10–15 years, and technology on its own is highly unlikely to provide this level of reduction in emissions. In other words, low carbon technology is insufficiently developed at this stage to be able to put us on the right track in terms of global emissions on its own – we therefore needed to focus on the crucial role that policy plays in this matter.

We decided that the following key issues will drive the future of climate policy:

1. A new global agreement for a post-Kyoto framework will provide an opportunity to rethink climate policy in light of both improved scientific understanding of climate change and the policy lessons of the Kyoto structure, the EU Emissions Trading Scheme (ETS) and other regional, national and local schemes.

1 We owe an intellectual debt to previous scenario projects aimed at building consensus in difficult policy environments, for example in South Africa during the transition from apartheid, in Columbia during the debate about how to respond to the growing power of drug lords, and in Japan during the debate about Japanese economic malaise.

2. Tension between the developed and developing countries has been a permanent feature of UNFCCC negotiations. While the bulk of greenhouse gas emissions have come from developed countries, developing countries may have the most to lose from climate change, both because they are the most exposed to the consequences of a changing climate and because they may have to forego economic growth in order to avoid greenhouse gas emissions. Meanwhile, developing countries, especially China, account for the bulk of anticipated future emissions growth. Will developed countries ever be able to agree on a wealth transfer to the developing countries to fund mitigation (i.e. reducing emissions) and adaptation (i.e. preparing for the impact of a changing climate)? It is hard to imagine a global solution that will be accepted by developing countries that does not include a credible guarantee of wealth transfer.
3. Similarly, there is an ongoing tension between climate policy as a political project discussed by world leaders and as an expression of popular sentiment. The balance between seeing climate policy as an elite project and a popular project will have a major impact on the nature, degree and success of implementation of climate policy.
4. Historically-high energy prices will continue for the foreseeable future, even if they fall back somewhat from their current dizzying heights. There are at least three aspects of high energy prices that were of interest to us. First, although high energy prices are generally believed to be detrimental to global GDP growth, the global economy has been able to absorb these high energy prices, suggesting that it could also absorb a significant carbon price. Second, high energy prices make green technologies, whether renewable energy or energy efficiency, relatively more attractive. Third, high energy prices provide a strong impetus for investment in unconventional sources of oil that have much higher environmental costs, including substantial carbon emissions during their production. This includes oil sands, oil shale and, arguably, some types of first-generation biofuels.
5. The involvement of the US and China in international climate policy is crucial. Although the US has been surpassed by China as the world's biggest emitter, the US continues to be one of the world's highest *per capita* emitters. The involvement of both is a pre-requisite for any effective global solution and both are currently fundamentally rethinking their approaches to climate and environmental policy.
6. Stochastic weather events will play a large role in people's perception of the urgency and need of addressing climate change, with direct consequences for their willingness to pay a short-term cost to do so. In its Fourth Report (Nov 2007), the IPCC claims that 'extreme events' (a term which collectively covers cyclones, droughts, floods, hurricanes, cold spells and heat waves) will become more frequent, more pervasive and more intense. These events remain stochastic, and their frequency, timing, geographic impact and severity will enhance the general perception of climate change. However, whatever policy is decided upon within the 10-15 year timeframe, it will not have any effect on the climate within that timeframe. Thus, short-term climate events are a one-way driver of policy.

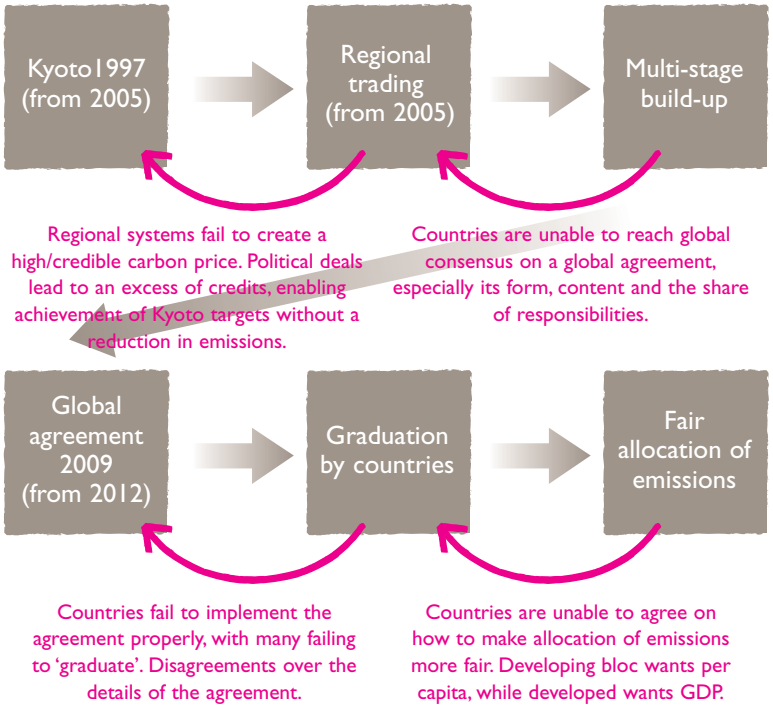
Lessons learned

The scenarios speak for themselves in terms of policy. They will provide a framework for policy makers to assess individual policy initiatives and for business leaders to understand how their business may be affected by future policy. They also provide a framework for other researchers to develop more specific scenarios, whether focused on a particular nation or a particular element of policy, within the context of the main policy types and policy drivers described here.

While building these scenarios, three key policy lessons emerged: (1) **the likelihood that climate change policy will fail to meet the criteria for 'success' defined above,** (2) **the risks in the UNFCCC process, and** (3) **the importance of wealth transfer**. Worryingly, none of these policy scenarios meets the criteria for 'success.' Using emissions modelling done by the Stockholm Network on the basis of IEA Reference and Alternative Policy Scenario emissions models, the Met Office Hadley Centre used a simple climate model to project likely temperature rises to 2100 for all three scenarios.(*) All the scenarios had a likelihood of less than 90% that global average temperature would remain below 2°C. *Step Change*, which is based on a departure from current policy in favour of a more efficient system, saw the least climate change, while *Agree & Ignore* the saw most. This means that policymakers must think seriously about adaptation to climate change now, as some degree of adaptation will be necessary regardless of the scenario. It also means that our response to limiting climate change must be as swift and efficient as possible in order to limit climate change as much as possible. While none of the scenarios meet the current target for 'success,' only *Step Change* meets the weaker target of a greater than 90% chance of less than 3°C of warming. The horse has bolted, but there is still scope to contain the greatest extent of the damage through innovative and efficient policy.

(*) Please see p. 50

Figure 1 – Policy risks in the UNFCCC process

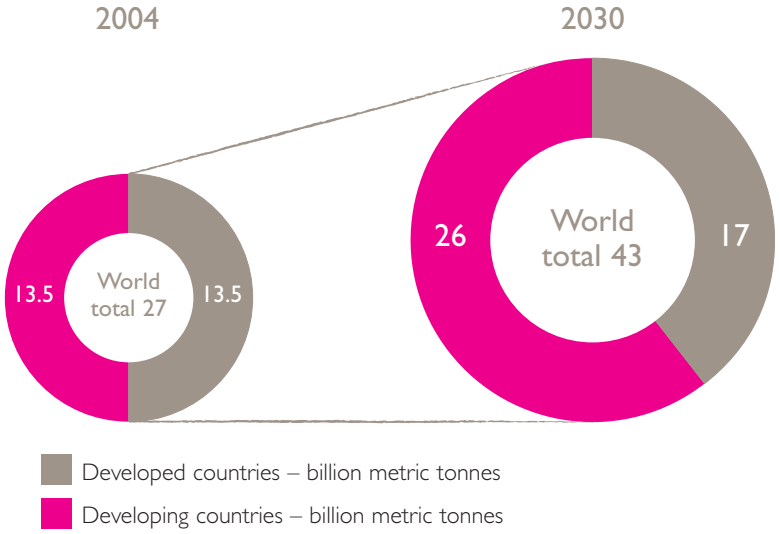


The current thrust of policy, although it could succeed, is fraught with possibilities for backsliding, delay and inefficiency. The UNFCCC process relies on all of the countries of the world moving forward slowly together. As such, at every stage in the process there are opportunities for countries to ask for additional allocations, protection for key sectors, delays in implementation and other modifications that slow the achievement of the goal of emissions reduction or weaken the goal itself. While this does not mean that this process cannot succeed, it does mean that there are great policy risks involved. Our first scenario, *Kyoto Plus*, shows what success of the UNFCCC framework might look like, while our second, *Agree & Ignore*, highlights the risks in the process. Our final scenario, *Step Change*, shows that there are alternative ways of regulating emissions that could lead to both a more rapid reduction in emissions and greater efficiency of emissions allocation.

We also identified wealth transfer as the key stumbling block for future negotiations. The developed world is responsible for the bulk of past carbon emissions, but will not be responsible for the bulk of

Figure 2 – CO_2 emissions for developed and developing countries

Source: Energy Information Administration, International Energy Outlook 2007



future emissions, which will come from the developing world, especially its most dynamic economies. Furthermore, at least in the short term, the bulk of the costs of a changing climate will fall on developing countries. Many developing countries perceive the demands made by the developed countries for cuts in their emissions as forcing them to pay yet another cost (reduced economic growth as well as direct climate impacts) for the excesses of the developed world's process of economic development. As such, any successful climate framework is going to require some degree of wealth transfer from the developed to the developing world. This wealth transfer could come in any number of forms, but it broadly serves three purposes:

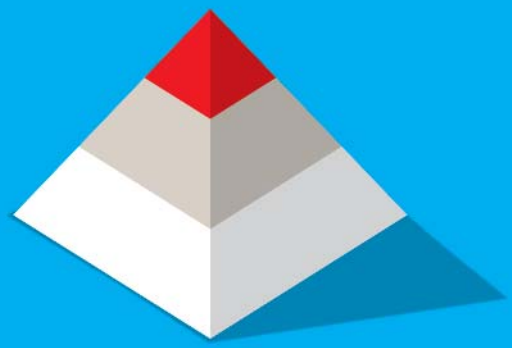
- To help developing countries adopt cleaner technologies in order to reduce emissions growth without stopping economic growth;
- To help developing countries adapt to the direct impacts of a changing climate through improved infrastructure and disaster management;
- To compensate developing countries for short-term reductions in economic growth from changing environmental policies (e.g. conservation of forests).

Developing countries will only agree to an international climate scheme that gives a credible guarantee of, and a clear framework for, this wealth transfer. The two scenarios in which emissions peak in the next three decades, *Kyoto Plus* and *Step Change*, incorporate clear wealth transfer, and it is no accident that the scenario in which emissions peak the soonest, *Step Change*, has a wealth transfer framework that is more generous and is implemented sooner. By contrast, in *Agree & Ignore*, emissions only level out by 2050, in large part because developing countries are not incentivised through wealth transfer to implement climate policies.

Conclusion

These are only three of the many lessons that the Stockholm Network has learned from developing and using these scenarios. We hope that you will find them as interesting and thought-provoking as we have. We trust that you too will find your own lessons in them.

Carbon Scenarios



The story begins: 2008-2009

With accusations still ringing in their ears that the Bali 2007 conference of the United Nations Framework Convention on Climate Change (UNFCCC) was nothing more than a talking shop, ministers at the Poznań 2008 conference try to get down to business and agree on a post-2012 framework. After some wrangling, however, nothing concrete is achieved. Nevertheless, there does appear to be consensus on the need for a methodology which allocates emissions fairly, taking into account the circumstances of individual countries. Yet many issues stand in the way of this being adopted in the foreseeable future. Developing countries understandably drag their feet, as they receive no clear indication of when or how they will receive wealth transfer from the developed world to help them with mitigation and adaptation and, perhaps, to compensate them for foregone economic growth. Moreover, everyone is waiting for the new US president to take office since, without the US, nothing substantial can be agreed upon. The conference ends with world leaders committing to reach a definitive agreement at Copenhagen 2009.

While these pledges in themselves give Copenhagen 2009 a more decisive air, an atmosphere of restlessness also pervades the conference as climatic developments continue to manifest themselves, with the Arctic and the world's coral reefs continuing to undergo dramatic and highly-publicised changes. Between the two conferences, several species have also become extinct. Public opinion has by this stage become more accentuated in its support for political action, and it is increasingly clear that a decision on a post-2012 global response needs to be made at Copenhagen.

An increasingly erratic climate has also continued to put pressure on agricultural production. Food prices remain at their highest for decades. Higher numbers of extreme weather events, while not causing major disruptions in the global scheme of things, nevertheless have a significant economic and social impact at the local and regional levels. Small-scale, cyclical and unpredictable fluctuations between droughts and excessive rainfall and between cold and hot temperature snaps impact on local food production, wildlife and infrastructure. The climate is changing in front of our eyes.

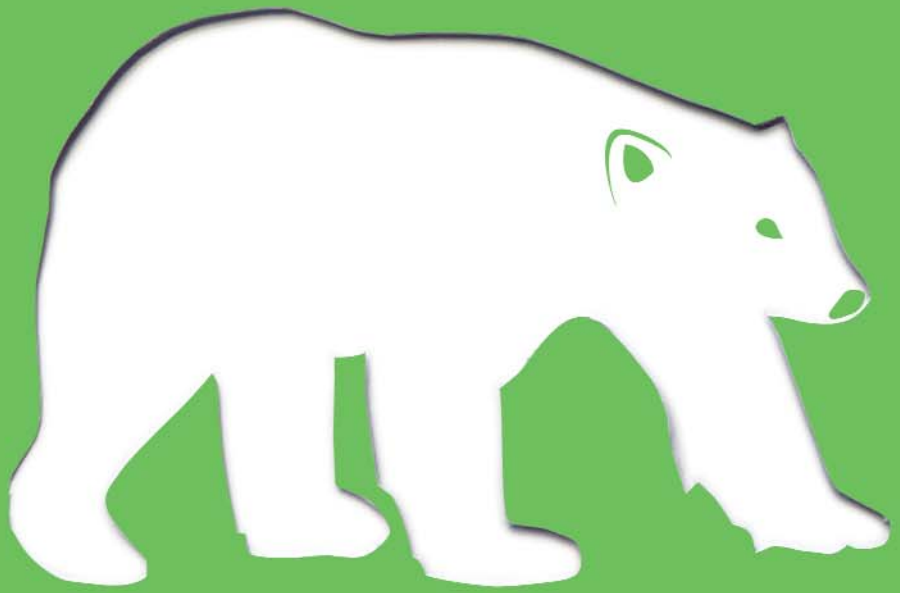
Oil prices remain high, as years of insufficient investment, partly driven by resource nationalism (the reassertion of state control over the energy sector), continue to have a strong bearing on supply. Oil, gas and coal prices are also supported by demand. They remain high but stable at around the $100/bbl mark as some new production starts to come on-stream, especially in the Middle East and Russia. The economic impact of these high prices, as well as concerns about energy security, leads many countries to look increasingly to renewable sources and some to nuclear power. European governments, failing to stay on track for the 2020 targets they have set themselves, and unable to pursue the nuclear option on an EU level due to public opposition, begin investing more heavily in existing green technologies, such as wind, solar and wave, as well as the further R&D and commercialisation of, as yet, unproven technologies, such as Carbon Capture and Storage (CCS).

The trend for green investment has in fact been picking up pace in the developed world as a whole. In the US, overall public sector investment in alternative technologies has been growing but continues to be negligible. A large part of this investment has been going into wind and solar. The federal government has also slowly started to move away from its fixation on first-generation biofuels (made from foodstuffs) and towards second-generation biofuels (made from waste). There is substantial private investment in green technologies, but this is hampered by uncertainty about future carbon prices and some fear that a 'green bubble' similar to the 'IT bubble' is starting to grow.

The global economy manages to absorb the costs of high energy prices and what carbon regulation already exists. High oil prices are no longer seen as an impediment to global economic growth, as growth has continued despite five years of high oil prices. They have simply been accepted as the norm.

Along with public calls for action on climate change, this instils the political decision-making class with a sense of confidence. If the economy has managed to absorb these unprecedented costs unscathed, it could be pushed further. Business and industry also keep urging policymakers to harmonise climate change regulation and establish a framework for a global carbon price to enable them to make long-term investment decisions that are carbon price dependent. Weeks before the Copenhagen conference, representative bodies and consortia send several heavily-publicised, high-profile letters to key governments and international organisations arguing that a global economy needs a global policy framework and a global carbon price.

At this point, our three scenarios diverge.



Kyoto Plus

Introduction

This scenario looks at one possible elaboration of success in the current policy context. In a nutshell, the scenario consists of a process that leads to a global cap on CO_2 emissions being put into place in 2012.

In the last few years, climate change has gone from being a peripheral concern both in public perception and in politics, to being firmly positioned in the mainstream. One only has to look at the major issues being addressed by political campaigns across the spectrum to see that climate change is a permanent fixture. It is hard to pinpoint precise causes for this turnaround, but there have been a number of factors which have nonetheless played a large part.

- Al Gore's 2006 film *An Inconvenient Truth* has been widely credited for raising awareness with the general public. It has received numerous awards and has led to Al Gore being awarded the Nobel Peace Prize along with the Intergovernmental Panel on Climate Change (IPCC).
- The Fourth IPCC Report was released in November 2007, in which over 2,500 scientific experts from around the world collectively stated that 'an increasing body of observations gives a collective picture of a warming world and other changes in the climate system' and that 'there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities'. In other words, for the first time it was unequivocally stated that there is substantial scientific consensus on the anthropogenic causes of climate change. In fact, the criticism that has subsequently emerged is that the Panel was too conservative in its estimates.
- A handful of natural disasters have focused the developed world's attention on the impact a changing climate can have on modern society. Most notably, a heatwave in Europe in 2003 led to healthcare crises in several countries, especially in France, and to a drought which created a crop shortfall in southern Europe. An estimated 35,000 people died. In 2005, Hurricane Katrina caused devastation along much of the US Gulf Coast with severe loss of life and property damage. The US government's inadequate response to the crisis led to shocking scenes of destruction and desperation, made all the more incredible as this was happening in the world's richest nation. Climate change is now at the forefront of the campaigns of all the key Presidential candidates. In the summer of 2007, South Asia also experienced some of the worst and widespread flooding in years.
- Finally, the UNFCCC annual conference in Bali in December 2007 drew political and media attention as never before and culminated in the Bali Roadmap. The roadmap sets out a timetable for future negotiations in the run up to a post-2012 agreement. It includes calls for further technology transfer, the setting up of an Adaptation Fund and for the inclusion of forestation in the negotiations.

This scenario looks to the current gains being made in this momentum for climate change awareness, support and policy. It attempts to answer the following questions:

- How plausible is it that current policy continues in a positive direction and continues to gather pace?
- Is there a sufficient impetus in current trends for decisive action to be taken?
- Will the ultimate outcome of current policy be sufficient to have a greater than 90% chance of less than 2 degrees centigrade of warming above pre-industrial levels?

Kyoto Plus

The summer of 2009 sees the first step in what will become a momentous year for global policy on climate change when the US Congress adopts a domestic Cap & Trade scheme (modelled on California's), with strict quotas that apply to most of US industry. While the scheme does include a 'safety valve' price at which the government will be mandated to sell additional permits in order to keep the price from rising further, it is set at a relatively high level of $25/tonne. This will be raised each year until, after a five year transition period, it is eliminated. Equally importantly, the scheme will use auctioning to allocate permits and will re-invest the revenue this produces into green technology and energy efficiency improvement measures. The scheme is due to start operating in 2012.

On the back of this domestic scheme, President Bush's successor voices strong support for a global Cap & Trade system. A new framework to succeed Kyoto in 2012 is finally hashed out at the December 2009 conference in Copenhagen – an international agreement on a global cap is the result of days of tense negotiations. The agreement resolves the issue of differential economic development with a graduation structure, which takes account of the particular economic circumstances of each participant. In other words, while all developed countries have to adopt a binding national cap, developing countries are differentiated and have the option of starting off with a voluntary cap, then graduating to a sectoral and, eventually, to a binding national cap.

Over a series of follow-up meetings in 2010 and 2011, the details of the new global scheme are agreed. There are three principal parts:

- Under the auspices of the UNFCCC, two 5-year global carbon budgets are worked out for the 2012-2022 period. Countries find themselves slotted into an obligations ladder. Some of the negotiations on obligations are tense, as a number of developing countries try to secure the lowest possible starting position on this ladder. Some concessions are made, as it is seen as important that the scheme gets off to a good head start and that as many countries participate as possible. Despite being the world's largest emitter of greenhouse gases, China, for example, is allowed to start off with only voluntary caps.
- A technology committee is created whose remit is to assess each country in terms of appropriate renewable technologies and to designate it a corresponding amount from permit sales to spend on these technologies via a Country Technology Strategy (CTechS). The government of the country is then free to open the procurement bidding to companies specialising in these technologies. Despite the fact that most of these funds will go to developing countries, developed countries come on board with the understanding that much of the spending will actually go to their green tech firms, as the large majority of these are located in the developed world.
- An adaptation committee is also set up to evaluate financial assistance based on need and vulnerability, with countries signing up for a Country Adaptation Strategy (CADS) which outlines the terms and details of the projects.

The World Bank is designated as the main vehicle for the transfer of both the technology and the adaptation funds and is charged with overseeing CTechS compliance and CADS project planning. Enforcement of the entire scheme is supported by a penalty system, whereby failure to reduce emissions by the required amount incurs a sliding scale of charges, based on GDP.

The US scheme successfully comes into operation in January 2012. A number of US states are by this point already operating schemes similar to California's, with many already having set targets for vehicle CO_2 emissions, following those introduced by California in 2010. These stepping stone schemes have helped to ensure that business is ready for the 2012 transition, which takes place more smoothly than expected and helps the President win re-election in November 2012.

As the global cap is put into place at the end of 2012, the global economy feels the initial pinch. However, this is only a slow-down and not the end of growth *per se*. Although there is some holding of breath, the Stern thesis that the global economy is ultimately resilient and that the global cap option will ultimately be cheaper than inaction has gained an even more dominant position by this point.

Over the next few months, the global cap starts to take a more discernible form. As the sale of permits starts to bring in revenue, and as the technology and the adaptation committees start the evaluation and the project planning stages, respectively, they start to allocate and channel funds through the World Bank. Although there are some minor

administrational and logistical hiccups, the scheme in its early days is seen as a success. This acts to signal to participating countries that it is going ahead as planned, although some countries continue to abstain from the process for political reasons – Myanmar and Venezuela, for example.

The first few CTechS bring an immediate boost in business to companies (and those along their production chains) that specialise in solar, wind and industrial gas abatement technologies in particular, as well as those involved in building gas-fired power plants (in lieu of coal plants). Several CADS are agreed, with measures ranging from building up flood defences to ensuring that an adequate emergency response infrastructure is in place in particular hotspots. Visible results start to emerge when several potential catastrophes are minimised – the worst possible outcomes of a particularly bad monsoon are avoided in Bangladesh in 2014, for example.

The first three years after the global cap is enacted also witness a number of successful graduations, most notably by China, whose government faces growing internal social pressures to resolve its serious pollution problems. In 2013, China agrees to sectoral caps in steel, transportation and chemicals. Another important milestone is crossed in the same year when South Korea agrees to graduate to developed country status and accepts a national cap.

The slow momentum of the global cap process begins to pick up pace, and it starts to gain a stronger institutional identity. Although there is some minor political wrangling along the way, with some developing countries still getting more emissions leeway than they ought to as an incentive to remain in the scheme (i.e. they are temporarily allowed to remain at voluntary scheme level even though their economies could withstand sectoral caps), and despite some of the teething difficulties, the scheme is judged to be a success.

At the 2015 UNFCCC conference, ministers accept a 2022 deadline for agreeing on a new methodology for long-term national emissions quota allocation, as this is still being brought up at UNFCCC conferences by a large number of developing countries. However, not all participating countries are in favour – the US, in particular, lobbies strongly for caps to continue to be set exclusively on the basis of GDP. It is unclear at this stage whether the transition to an agreed long-term methodology will be politically viable, even by 2022.

While possible backsliding has been avoided in the first few years of the new framework and more and more countries are moving up the ladder towards a national cap, international tensions remain and the global scheme remains a difficult process of slowly moving forward together.

Global average temperature has a greater than 90% chance of rising by up to 3.31°C above pre-industrial levels by 2100. This figure is based on emissions modelling by the Stockholm Network and climate modelling by the Met Office Hadley Centre. (*)

(*) Please see p. 50

Agree & Ignore

Introduction

This scenario looks at the current policy context but projects a different path from the one outlined in *Kyoto Plus*. Instead of focusing on the positive momentum present in the current context, it examines the stages at which this momentum can stall and backslide. Indecision and disagreement over the details of a post-2012 agreement play a crucial role in initiating a process of backsliding. These stalling and backsliding tendencies are compounded from 2012 onwards with implementation failures. The scenario tries to envisage what would occur if an international agreement 'talked the talk', but didn't 'walk the walk'.

There are several points to consider here:

- Governments, whether in developed or developing countries, tend to operate within a short-term timescale of no more than 4-5 years. However, by virtue of its own timescale, climate change is at odds with these electoral cycles – it requires short-term sacrifice for long-term benefits. Thus, electoral reality makes it harder for governments to impose costs on their electorate in the present when the rewards will not be tangible for many years to come.
- Running on from the above consideration, political short-termism is shadowed by economic short-termism. *The Stern Report* calls climate change the 'greatest market failure the world has seen' and argues that, in the long term, dealing with climate change in the present will be more efficient and less costly than ignoring the problem and only dealing with the consequences as they arise. However, taking on additional costs, especially when the benefits are not immediately visible, is a difficult decision to make in an economy that is dominated by the next economic quarter, not the next quarter century.
- Climate change suffers from Prisoner's Dilemma dynamics. Although everyone needs to make the decision to participate in climate change mitigation and adaptation in order for policy to work in the long term, any given participant is presented with the possibility of not putting up the costs yet gaining the advantages in the short term, while competitors are hampered by the costs of lower greenhouse gas emissions.
- The international dimension to climate change needs to be considered carefully. Historically, most greenhouse gas emissions have come from the developed world. Developing countries therefore understandably insist on this being fairly accounted for in the calculation of contributions to reducing greenhouse gas emissions. Furthermore, they argue that addressing climate change should not hamper their economic development. Although this is uncontested in principle, negotiations over the details are always laborious. Many developing countries argue that emissions rights should ultimately be allocated on a *per capita* basis, while developed countries often insist that they should be based on GDP or historical emissions. Furthermore, while the Bali Roadmap calls for the establishment of an Adaptation Fund, there has been no substantive progress to date on deciding how to fund technology transfer to, and adaptation assistance for, the developing world.
- Finally, regional dynamics have for years been quite strong, whether in the field of trade competition, standard-setting or as now, climate mitigation. The most prominent regional example of the latter is of course the European Union's Emissions Trading Scheme (ETS). There is even some scope, however, for using regional schemes to build-up a global scheme from the bottom-up. For example, California is considering joining ETS in the future. If the Bali Roadmap succeeds, these regional frameworks will need to be harmonised and integrated into a single global system.

The *Agree & Ignore* scenario therefore looks at the following questions and sketches out one tentative possible answer:

- At which points could the positive climate change policy momentum start to backslide?
- What is the end-point of this backsliding?

Agree & Ignore

The summer of 2009 appears to signal that change is finally in the air when the US Congress passes a domestic Cap & Trade scheme (modelled on California's). It is due to come into operation in 2012. However, due to successful lobbying by the more nationalist and sceptical elements in the legislature, the scheme lacks the strict quotas for which many environmental campaigners had hoped. While the scheme does apply to most of US industry, it has three aspects that weaken its impact.

- First, it includes a 'safety valve' at which the government will be mandated to sell additional permits to keep the price from peaking, which is set at a relatively low $15/tonne, rising each year to eventually reach $25/tonne after five years. When the 'safety valve' ceiling rises at the end of the first year of the cap, sceptics and nationalists lobby to prevent further rises. They are successful, and Congress amends the legislation to fix the ceiling at $17/tonne with only inflation-linked increases.
- The scheme's second weakness is that it allows a wide range of off-setting activities, such as renewable technology investment, to count as carbon reductions in the present even though they do not in themselves produce carbon reductions here and now.
- Finally, although the scheme will allocate 80% of permits for auctioning, the remaining 20% is still reserved for 'critical' industries. Overall, the scheme is therefore not expected to generate sufficient revenue to put towards developing new clean technology and implementing energy efficiency improvements.

Despite the shortcomings of the domestic scheme, the US President voices support for a global Cap & Trade system. A new framework to succeed Kyoto in 2012 is finally hashed out at the December 2009 conference in Copenhagen – an international agreement on a global cap is the result of days of tense negotiations. The agreement resolves the issue of differential economic development with a graduation structure, which takes account of the particular economic circumstances of each participant. In other words, while all developed countries have to adopt a binding national cap, developing countries are differentiated and have the option of starting off with a voluntary cap, then graduating to a sectoral and eventually, to a binding cap.

Over a series of follow-up meetings in 2010 and 2011, the details of the scheme are hotly debated and contested. While a framework for technology transfer is established, including the use of Country Technology Strategies (CTechS), negotiations are otherwise disappointing. In particular, no significant progress is made towards agreeing a framework for transferring funds (generated through permit auctioning) for financing the adaptation strategies of developing countries. As a result, developing countries are generally sceptical that they will receive a meaningful wealth transfer.

Although the world's overall cap level has been decided and two provisional 5-year carbon budgets have been worked out, participants are also unable to reach agreement on specific national carbon allowances. In other words, while some countries accept the provisional targets, others do not.

The US scheme successfully comes into operation in January 2012. However, the politics of implementing the scheme are more divisive than expected, and a divide emerges between one camp, supported by the President, which sees the national scheme as a stepping stone – albeit a small one – to an integrated international scheme and another, led by the opponent in the 2012 Presidential election, that argues that the US must not yield sovereignty to an international body and must keep climate change policy implementation at home. In the course of a bitterly fought contest, the President narrowly loses the election.

After the global cap comes into force at the end of 2012, a number of problems start to emerge. There are cases of continued foot-dragging by certain governments, which fail to meaningfully implement their national carbon cap and continue to insist on overly large allowances. The argument most often put forward is that, despite the need to deal with climate change, for many developing countries economic growth still takes priority. Many countries thus avoid the cap and do not force their industries to accept carbon pricing. South Korea, for example, is unwilling to accept a national cap despite being near the top of the developing country ladder.

As a result, parties that intend to stick to their targets, such as the EU, increasingly face substantial domestic lobbying pressures from business, which is seeking some compensation for increased costs and lost international competitiveness. Business is sceptical that the international agreement will be enacted in a meaningful way and decides to focus on lobbying at the regional level, where, depending on location, it has obtained some degree of certainty. The EU and subsequently

others start to increasingly use carbon tariffs to even out the playing field. In other words, regional trading blocs introduce tariffs that price the carbon in imports that are from regions either outside of carbon trading altogether or those with a lower carbon price than of the importing region.

After two years of *de facto* non-compliance by a significant proportion of countries and strong regionalisation of global trade, the international community finally accepts *de jure* looser allowances at the 2014 UNFCCC conference. Publicly, ministers argue that it is more important to keep the system in place than to get the ideal allocation. Privately, however, all the participating countries (and especially the developed ones, as they have more to lose economically) benefit individually from looser allowances in the short term. The scheme becomes a victim of Prisoner's Dilemma dynamics.

Implementation problems aside, the redistribution issue remains unresolved. At this stage it is compounded by the fact that the poorly implemented international scheme is not generating sufficient permit revenue and the amounts coming in to the World Bank to fund CTechS are too small to have any significant impact.

An unproductive developed/developing dichotomy continues to feature heavily in the ongoing negotiations. Developing countries are still negotiating as a bloc and are unable to agree with the developed countries on the proportional distribution of the incoming revenue. The developed bloc remains reluctant to commit to making large wealth transfers to the developing world, particularly on an ongoing basis.

Increasingly, developing countries read this delay in sorting out wealth transfer, particularly adaptation provisions, as evidence of the developed world's unwillingness to help them to reduce their carbon emissions and to adapt to climate change. As redistribution fails to materialise, developing countries – especially the major emitters, flounder and fail to actively pursue the policies that are necessary for tackling climate change, blaming their lack of progress on the absence of a wealth transfer from the developed world.

As the international scheme fails to come into effect, there is a loss of confidence in the ability of governments to tackle the problem globally and therefore at all. A sense of forlorn acceptance starts to set in as even optimists begin to realise that these difficulties are not mere teething problems.

In actual fact, by 2015 a different pattern has emerged. Drawing lessons from the existing EU and US regional schemes and driven by the frustration

at the international scheme's failure, new regional schemes have cropped up. For example, Russia and China have started to establish a 'Eurasian Climate Community' to promote technology-based responses, particularly nuclear power. The international scheme continues to operate but is essentially an empty shell, with regional schemes now being officially treated as stepping stones towards it. There is therefore some hope left at the international level that a global cap might be attained via a bottom-up approach.

However, although there is scope for limited convertibility of carbon credits between a number of regional schemes, and there is even some talk of combining ETS and the new US scheme, economic competition intensifies during this period, and competitive regional dynamics get in the way of this plan. Economic competition intensifies during this period. The EU and the US, however, are at least on the same side of the fence in terms of facing ever-increasing competitive pressure from Asia. With time, the use of carbon tariffs by various regional schemes only picks up pace. Frustrated at the continuing lack of a global carbon price, business and industry find themselves backsliding towards lobbying ever more strongly at the regional level.

Different regions also show different preferences in green technologies, Asia and Russia generally stick to proven technologies such as nuclear and hydro, in which they have decades of experience. The US and Europe, on the other hand, seek to become world leaders in newer technologies, in particular wind, solar and wave. They are also pursuing the development of CCS technology although it is still very far from commercialisation.

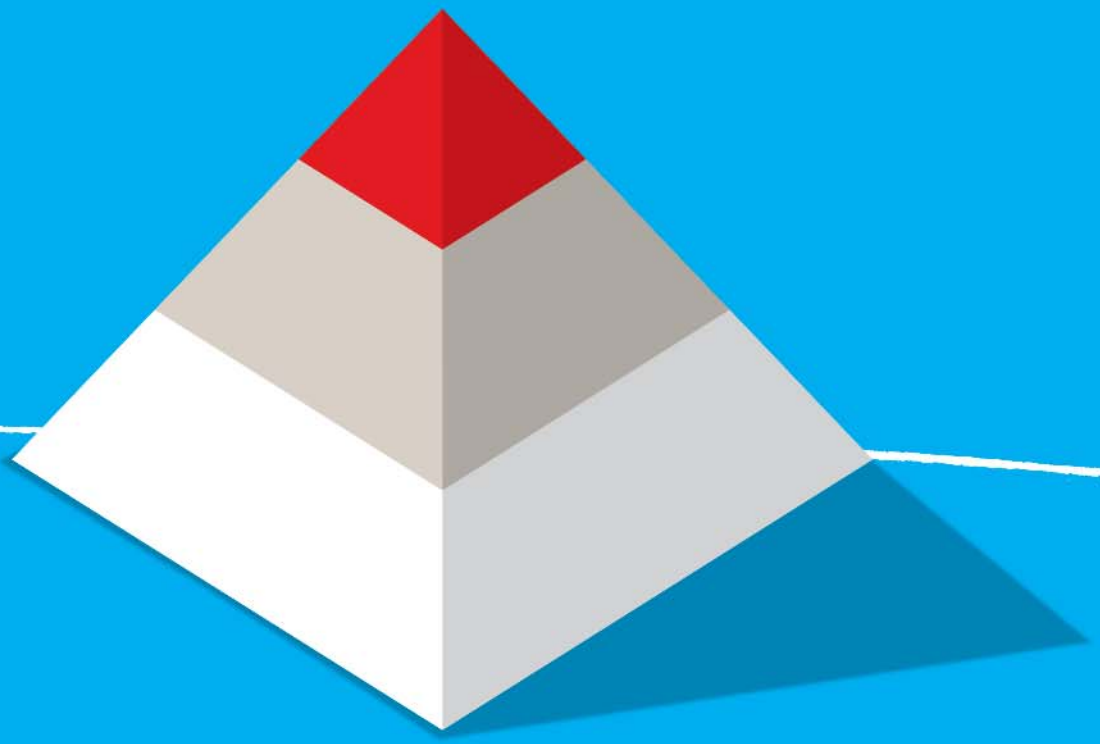
The EU has by this point modified its rigid renewables targets and no longer mandates specific technologies, only the emissions levels. Consequently, increased competition emerges in the green tech sector with third-generation technologies, such as algae biofuel, tentatively starting to push through.

Regional efforts, even with technological progress, are by nature more limited than a global solution. This means that climatic developments are more accentuated in this scenario than in *Kyoto Plus*. There is much less focus on climate change mitigation than in other scenarios and adaptation is emphasised to a much larger degree than in *Kyoto Plus*. Relatively higher levels of emissions lead to a higher likelihood of a temperature increase above the 2° threshold.

Economically, international failure to properly implement the agreement means that initial costs are not borne, only those costs conferred by climatic changes and regional schemes, both of which of course vary by area. However, in the long term, even if the regional schemes join up into a global scheme, economically speaking this would be a less efficient path than a directly global one. Schemes in different geographies have different features and impose additional costs on business by effectively acting as barriers to trade. These implicit barriers, combined with explicit ones in the form of carbon tariffs, cause global trade to decline, bringing down long-term economic growth. Furthermore, in the long term the economy must deal with the costs, among others, of a more extreme climate, including the cost of new infrastructure, more adaptable building construction and healthcare for those affected by a more extreme climate.

Global average temperature has a greater than 90% chance of rising by up to 4.85°C above pre-industrial levels by 2100. This figure is based on emissions modelling by the Stockholm Network and climate modelling by the Met Office Hadley Centre. (*)

(*) Please see p. 50



Step Change

Introduction

Like the other two scenarios, *Step Change* also takes the current policy context as its starting-off point and assumes that developments already in motion continue until 2009. Unlike the other two scenarios, however, this one looks at the possibility of developments taking a radically different course.

The Fourth IPCC Report (Nov 2007) indicates that the most perceptible manifestation of climate change that we are likely to witness in the short term is an increase in the severity and frequency of what is termed 'extreme events'. In other words, weather events such as heatwaves, hurricanes, floods and droughts, which are statistically rare, will become less so. This prediction is taken as the impetus for a radical policy *step change* in the scenario.

It is important to remember that scenarios are *not* predictions or elaborate statements of likelihood. They are rather exercises in plausibility and of carefully thinking through what is possible in causal terms. They aim to map the space of possible futures, not identify the most likely ones. The other two scenarios are very much teased out of present developments. This scenario, however, is more a case of blue sky thinking. We are not saying that the events in this scenario are probable. Rather, we would argue that they are possible and provide a useful exercise in thinking through the causal implications of two statistically-unlikely but not impossible occurrences – firstly, the simultaneous onslaught of several extreme events, and secondly, a quick and straightforward international response. In other words, we are considering the best possible solution to the worst possible problem.

This scenario arose because, having developed the outlines of *Kyoto Plus* and *Agree & Ignore*, we stepped back and asked ourselves: 'Are either of these scenarios likely to deliver a greater than 90% chance of less than 2 degrees of warming?' The answer, sadly, was probably not. As such, we set out to try and construct a scenario that would meet this goal and that everyone in the scenario-building workshop would agree was plausible, if not probable. *Step Change* is the result.

For the policy solution offered in *Step Change*, an upstream global cap, we drew extensively on the work of the Kyoto 2 Project (www.kyoto2.org) and are particularly indebted to Oliver Tickell.

Thus, this scenario answers a very different set of questions than the other two scenarios:

- **Is it plausible that policy might take a radically different course?**
- **What might plausibly cause this change?**
- **What policy would be likely to result?**

Step Change

As the December 2009 conference at Copenhagen comes to a close, the international community is relieved. The conference is deemed a success as it has resulted in an international agreement on a global cap. While the agreement resolves the issue of differential economic development with a graduation structure, a series of meetings needs to take place over the following years to establish the details and the practical side of the agreement. However, these meetings are increasingly framed by a series of accentuated climatic developments.

Having already experienced a particularly hot summer in 2009, Europe goes on to have another scorching one in 2010 – hotter than in 2003, with wildfires worse than those of 2007. Emergency services struggle to cope and low rainfall leads to serious water rationing, especially in the Mediterranean and some of the newer EU Member States.

The Indian subcontinent continues to experience a heavy and long monsoon season, leading to serious flooding and loss of life, especially in Bangladesh. High temperatures and low rainfall also cause several crops to fail in Africa, leading to tensions around water usage terms in the Lake Victoria and the Nile River regions. As a result, many parts of the Indian subcontinent and Africa experience famine. The combined demands on the UN World Food Programme are of an unprecedented level and it is unable to cope. Hundreds of thousands starve.

However, although these humanitarian crises receive media coverage in the West, they vie for attention with the much documented and highly-publicised acceleration in the disappearance of sea ice in the Arctic, which by this point has been projected to completely disappear by 2025.

While these developments are in themselves highly problematic, they have in a sense already been accepted as the norm over the previous few years. What really brings a new sense of urgency to the agenda are events in the US and China, which this time round experience the brunt of nature's force.

Like the European continent, North America experiences an unprecedented heatwave that leads to deaths in the thousands and ongoing blackouts across the Eastern seaboard. Meanwhile, in China a super-typhoon severely damages the port infrastructure at Shenzhen, while the smaller port at Fuzhou is almost entirely destroyed by another.

At the same time, rain from the storm surges leads to flooding all the way up to Guangzhou, disrupting overland transport. The combined disruptions to the transport system caused by these events lead to significant interruptions and delays in China's exports, causing some Western firms to question whether Chinese components can be a reliable part of their 'just in time' logistical chains. Of course, the super-typhoon not only damages the Chinese maritime infrastructure (consequently impacting on international trade), it also causes widespread damage to the region's coastal areas, with social and environmental consequences.

As the international community and the global economy struggle to adjust adequately to this series of misfortunes over the ensuing months, the summer of 2011 brings more of the same. Although the climatic elements are not as forceful this time round, the areas affected by the events of 2010 have only made a partial recovery. The destructive effect of further climatic chaos thus only serves to compound the problem. The social consequences of the two disastrous summers are felt globally, whether directly or indirectly. However, although the numbers affected are much greater in the Indian subcontinent and in the affected parts of Africa, it is the situation in the US, China and Europe that dominates the Western and international media.

The European and the US heatwaves claim many a vulnerable casualty. Hospitals are pushed over their capacity limits and healthcare budget deficits sky-rocket. Water shortages and wildfires have a major impact on agricultural production in many EU Member States, as well as the North American mid-West. As a result, meat and dairy production face a crisis and food prices reach new highs.

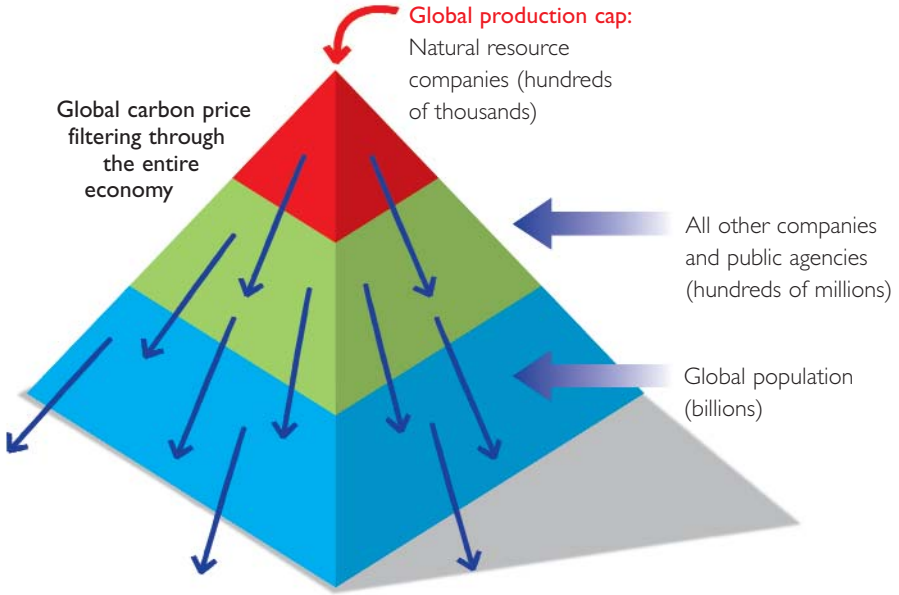
These very visible and consistent illustrations of a changing climate, their immediate social costs and the inadequacy of current policy all act as an impetus for governments, led this time by the US and China rather than the European Union, to take immediate and drastic action on national security grounds.

The US and China are motivated by two things. First, there has been a perceived failure by existing institutions and frameworks to both prevent and to contain the damage. Second, both want to focus on developing a framework for action that is simple and can be implemented quickly, especially given popular pressure on governments to act decisively. Neither can afford to sit back and experience another summer like the previous two. While the EU is somewhat taken aback by the new interest from these two traditional foot-draggers, the push for action is broadly

welcomed by international business, which now recognises that some form of major carbon regulation is coming and seeks a framework that is clear, universal and transparent. It also wants to avoid any further disruptions to trade.

On the basis of Sino-American cooperation, the December 2011 UNFCCC conference sees a major new climate change treaty signed, but the so-called International Climate Treaty (ICT) has a very different structure and a much greater reach than anything observers had expected. The ICT introduces a one-year phased transition from existing emissions-based trading schemes, including ETS, to a single global carbon *production* trading scheme. This scheme places a cap on the global production of carbon, whether in the form of oil, gas or coal, and shifts enforcement and permit auctioning from billions of individual emitters to a small number of firms that produce fossil fuels. This source-focused approach is expected to translate into changes on the demand side, with high energy prices acting to provide a very clear signal to business to invest in reducing demand and to provide alternatives.

Figure 3 – Global production cap



There is a separate mechanism to deal with emissions from deforestation and industrial agriculture, modelled on the Montreal Protocol and funded by permit sales from the first mechanism. At the beginning of each year, after the amounts for the global carbon cap are agreed, a set share of the cap is allocated to this second mechanism. Countries that protect their forests and innovate in their agricultural practices, will effectively receive payments for doing so. Fossil fuel inputs in industrial agriculture, for example, diesel for driving tractors and gas for fertiliser, will of course already be priced through the first mechanism.

As this new trading scheme operates at the global level and with a much smaller number of participants, it is much easier to implement. Moreover, as it takes effect at the highest upstream point in the carbon value-chain, there is no opportunity to debate individual national carbon allocations.

The responsibility for the initial setting of this new global upstream cap and the auctioning system for permits to extract carbon within it (as well as this system's verification and compliance) is assigned to a new 'rapid response' task force – the Climate Security Task Force (CS-TF). It is to operate under the auspices of the United Nations Environment Programme (UNEP) and its 'midwife' remit is to last three years. At the end of the three-year period the UNEP proper is to take over. The CS-TF is to operate from Geneva, Switzerland with its composition being modelled on the UN Security Council. During the initial three-year period, the CS-TF is constituted by a 'party of seven' consisting of the US, China, the EU, India, South Africa, Russia and Brazil, but it is envisaged that after UNEP takes over, the CS-TF will rely on rotating representation.

With two summers' worth of damage, adaptation rather than mitigation is seen as the overwhelming priority among many countries, both developed and developing. Accordingly, beyond the actual mitigation effect of the carbon cap itself, the new treaty is sold to the world on the basis of the revenue it will raise (estimated to be circa $1 trillion per annum)[1] as well as how it will be spent. The CS-TF passes the revenue raised from the scheme to the UNEP for distribution among UN members. Part of this revenue is handed out according to a fixed formula that funds mitigation and adaptation in developing countries based on a sliding-scale of need, rewards fossil fuel producers for foregone potential production and funds research into new energy technologies. The other part of the revenue feeds into the newly set-up Climate Emergency Fund (CEF), where any country experiencing adverse climate impact can obtain funding based on need.

This separation of the administration of the cap and the usage of the resulting revenue is designed to ensure that political competition will be focused on the revenue usage side, rather than the administration of the system. This structure is also designed to ensure that developing countries are assured of continued revenue transfer (as developed world consumers use more carbon, they would ultimately bear the brunt of the cost of the permits), but through a mechanism that is relatively immune to meddling by developed country legislatures.

A series of high-level emergency meetings is set up by the CS-TF straight after the December 2011 conference with fossil fuel producers and OPEC. The producers know that climate change policy is inevitable and decide that their best bet is to seek to influence it. They already face production difficulties and are therefore prepared to do a deal to keep prices high in the context of falling oil production. Ultimately they are after certainty and high prices. Producers are also placated by the payments from the new scheme.

Under the ICT, operators of Carbon Capture and Storage (CCS) plants can claim free permits equal to the quantity of carbon sequestered. This leads to an increased interest in CCS technology, as many natural resource producers see CCS as a potential way of hedging their carbon cost liability in the future. However, as CCS is still costly to adopt, most of these actors remain unwilling to take the plunge and start converting their plants. However, once the global production cap kicks in after the one-year transition period, some companies tentatively start to explore this technology.

For the first time, business is presented with a clear, long-term framework that promises a significant global carbon price in the present and in the future. This certainty about the increasing cost of carbon leads investors and entrepreneurs to focus even greater energy on developing technology for new energy sources and to increase the efficiency of existing energy usage. While the ICT creates funds for research, adaptation and catch-up mitigation in the developing world, it also creates incentives for innovation in mitigation in the developed world.

The combination of the trade disruptions of the summers of 2010 and 2011, along with the process of adjusting to the ICT lead to slower growth from 2010 through 2013, with some commentators worrying during 2012 that the global economy may be heading into recession.
In fact, recession is narrowly avoided, as the long-term certainty about the future cost of carbon provided by the new Treaty actually leads to steadily increasing business confidence and a return to trend growth by 2013.

Global average temperature has a greater than 90% chance of rising by up to 2.89°C above pre-industrial levels by 2100. This figure is based on emissions modelling by the Stockholm Network and climate modelling by the Met Office Hadley Centre. (*)

(*) Please see p. 50

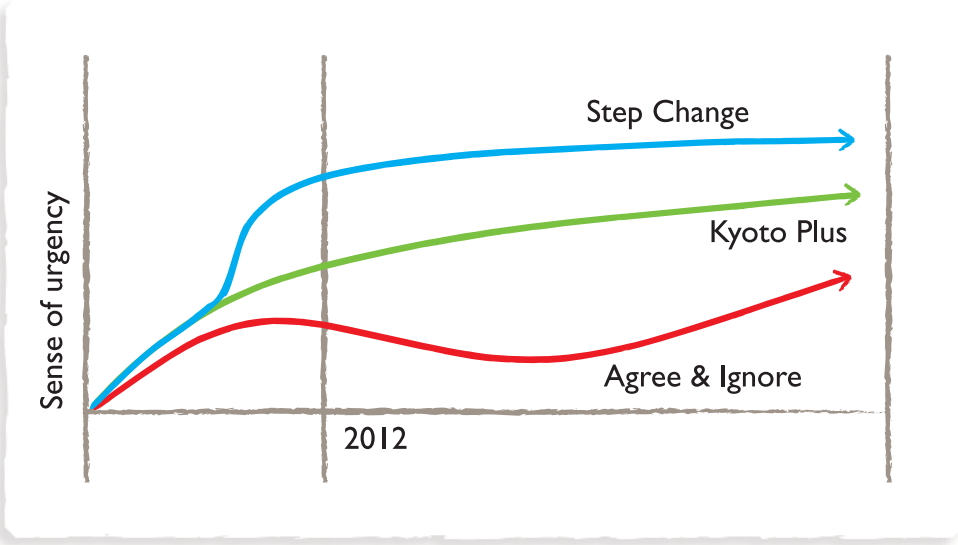
Scenarios compared

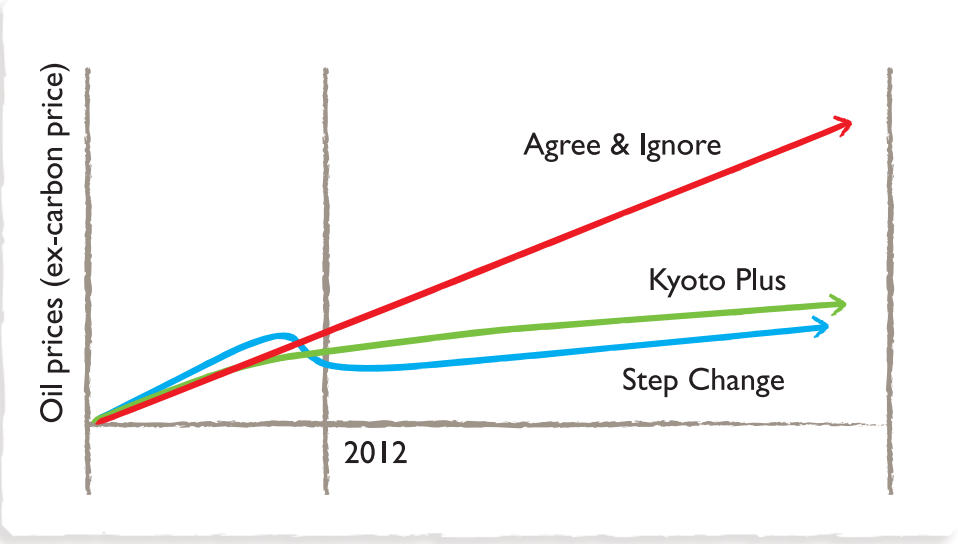
These scenarios present three qualitatively different views of the future where differences in economic conditions, climate events and levels of popular concern affect climate policy choices. *Kyoto Plus* and *Agree & Ignore* explore two different outcomes stemming from present policies. *Kyoto Plus* shows that current policy could deliver significant climate change mitigation, although this would still fall short of 'success' as defined by the UN and the EU, leading to 3.31 degrees of warming above pre-industrial levels by 2100. In contrast, *Agree & Ignore* shows that current policy could at the same time lead to insufficient mitigation due to non-compliance and backsliding. This would entail more than 4.85 degrees of warming above pre-industrial levels by 2100. The final scenario, *Step Change*, departs from the current policy trajectory. This scenario explores the point of departure where an alternative policy is pursued, following the occurrence of a series of stochastic weather events that threaten economic security. *Step Change* suggests that despite the short-term economic and political costs, this new policy could lead to even greater levels of climate change mitigation than *Kyoto Plus*, with only 2.89 degrees of warming above pre-industrial levels.

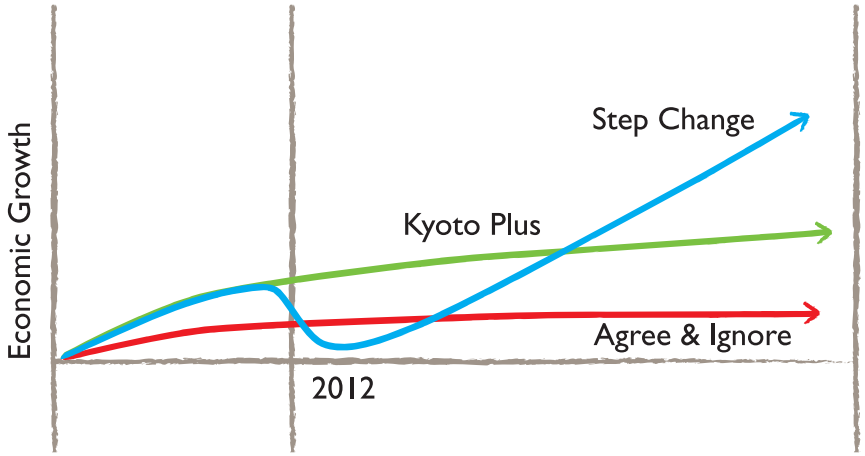
	Kyoto Plus	Agree & Ignore	Step Change
2008	Poznań conference		
2009	US 'cap & trade' – strict. Copenhagen conference – global regulation with a graduation structure.	US 'cap & trade' – weak. Copenhagen conference – global regulation with a graduation structure.	US 'cap & trade' – strict. Copenhagen conference – global regulation with a graduation structure.
2010	**Meetings:** ● two 5-year carbon budgets – minimal compromises to the scheme ● technology committee ● adaptation committee	**Meetings:** ● two 5-year carbon budgets – big compromises to the scheme ● technology committee – weak agreement and lack of funds ● no agreement on adaptation	US suffers a heatwave. China is hit with a super-typhoon.
2011			Another bad summer for the US and China, so they take action leading to the International Climate Treaty.
2012	Early 2012: US scheme kicks in – successful. Late 2012: global scheme kicks in.	Early 2012: US scheme kicks in – divisive. US President loses election to nationalist opponent. Late 2012: global scheme kicks in.	CS-TF sets the cap and implements the scheme. A series of meetings with fossil fuel producers to agree production quotas.
2013	**Successes:** ● China accepts sectoral caps. ● South Korea accepts a national cap. ● World Bank technology and adaptation grant programmes receive proper funds and begin to give out grants.	**Problems:** ● foot-dragging ● non-implementation ● carbon tariffs	Scheme affects growth in the short term, but certainty about the carbon framework leads to robust economic growth. Businesses that invest in green tech early reap large rewards later down the line.
2014		UNFCCC conference – acceptance of non-compliance and regional schemes.	
2015	UNFCCC conference – agree to a 2022 deadline for an agreed long-term method for allocation of emissions	**Effective regionalism:** ● increased economic competition ● different technologies	

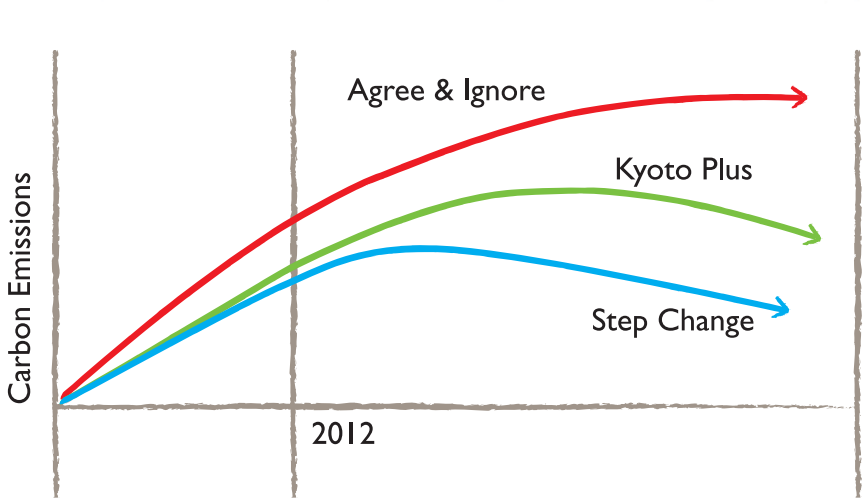
	Kyoto Plus	Agree & Ignore	Step Change
Drivers	International ooperation and public support.	Economic nationalism.	Stochastic weather events and concerns regarding economic security.
Policy	Global cap with a graduation structure.	Global cap, followed by *de facto* and then *de jure* regionalism due to non-compliance.	Global production cap. Second mechanism for deforestation and agriculture, modelled on Montreal Protocol.
Climate	Global average temperature has a greater than 90% chance of rising by no more than 3.31°C above pre-industrial levels by 2100.	Global average temperature has a greater than 90% chance of rising by no more than 4.85°C above pre-industrial levels by 2100.	Global average temperature has a greater than 90% chance of rising by no more than 2.89°C above pre-industrial levels by 2100.
Economy	Adoption of the cap is felt by the global economy as a slight hitch, but it absorbs the new costs and economic growth continues.	Initial costs of global cap are not borne, but regional schemes not as efficient in the long term. Additional costs from regional competition and use of carbon tariffs.	Slow down in global trade and the global economy after the events of the summers of 2010 and 2011. Further costs from the adoption of the production cap. Highest economic growth in the long term due to having the highest efficiency.
International politics	Slow process of moving forward together and maintaining international consensus. EU remains a major driver of policy.	Attempts to end deadlock between developed and developing countries fail. This leads to competitive regionalism, especially between the US, Europe and China.	Serious stochastic weather events lead the US and China to take global leadership. They incentivise and pressure other countries to accept their scheme.

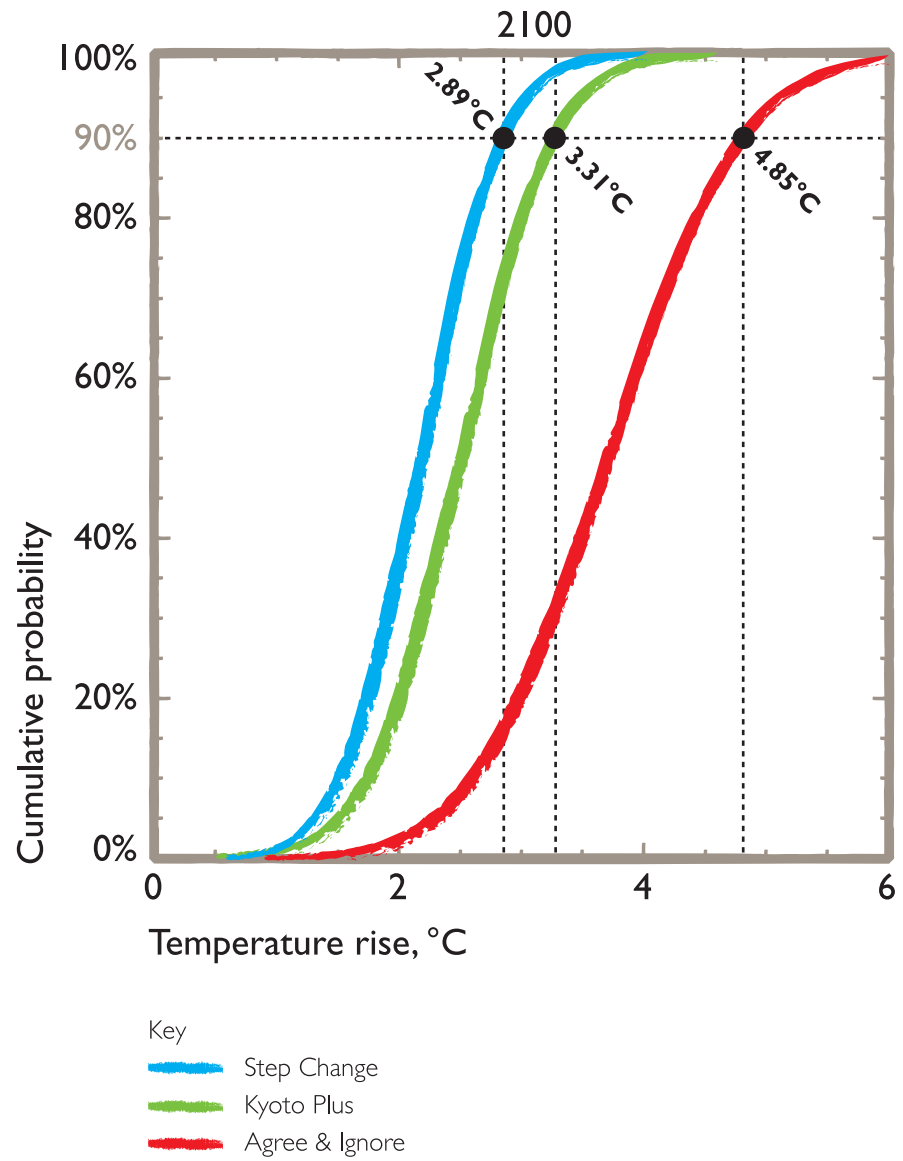
(*) Please see p. 50






Economic Growth
Step Change
Kyoto Plus
Agree & Ignore
2012


Carbon Emissions
Agree & Ignore
Kyoto Plus
Step Change
2012


2100
100%
90%
80%
60%
40%
20%
0%
Cumulative probability
2.89°C
3.31°C
4.85°C
0
2
4
6
Temperature rise, °C
Key
Step Change
Kyoto Plus
Agree & Ignore

Appendix I: How we did it

A methodological outline for scenario practitioners

Preliminary research

In the first stage of the project the Stockholm Network conducted in-house research on the following key topics: climate change science, green technology, economics of climate change, social impact of climate change and finally, climate change policy. The goal was to establish the state of play in each of these areas and to identify key issues of concern to be addressed in the scenarios. We also identified potential participants for the scenario-building workshop, as well as for the subsequent validation and revision stages. A number of people were approached about the possibility of taking part, and a final list of participants was drawn up. Prior to the workshop taking place, all the participants were sent a copy of the preliminary research report.

The workshop started off with a number of presentations by the participants about the state of play in the fields of green technology, climate change economics and climate change science. We began by looking at what emissions reductions were likely to come from existing technology mega-trends. Having looked at what the technology was likely to do on its own, we then turned to the science to ask whether this would be sufficient to have a greater than 90% chance of less than 2 degrees of warming above pre-industrial levels. We concluded that technology would not be able to achieve climate goals on its own and that policy was needed in the near future. This discussion provided the foundation for the policy discussion that dominated the rest of the workshop.

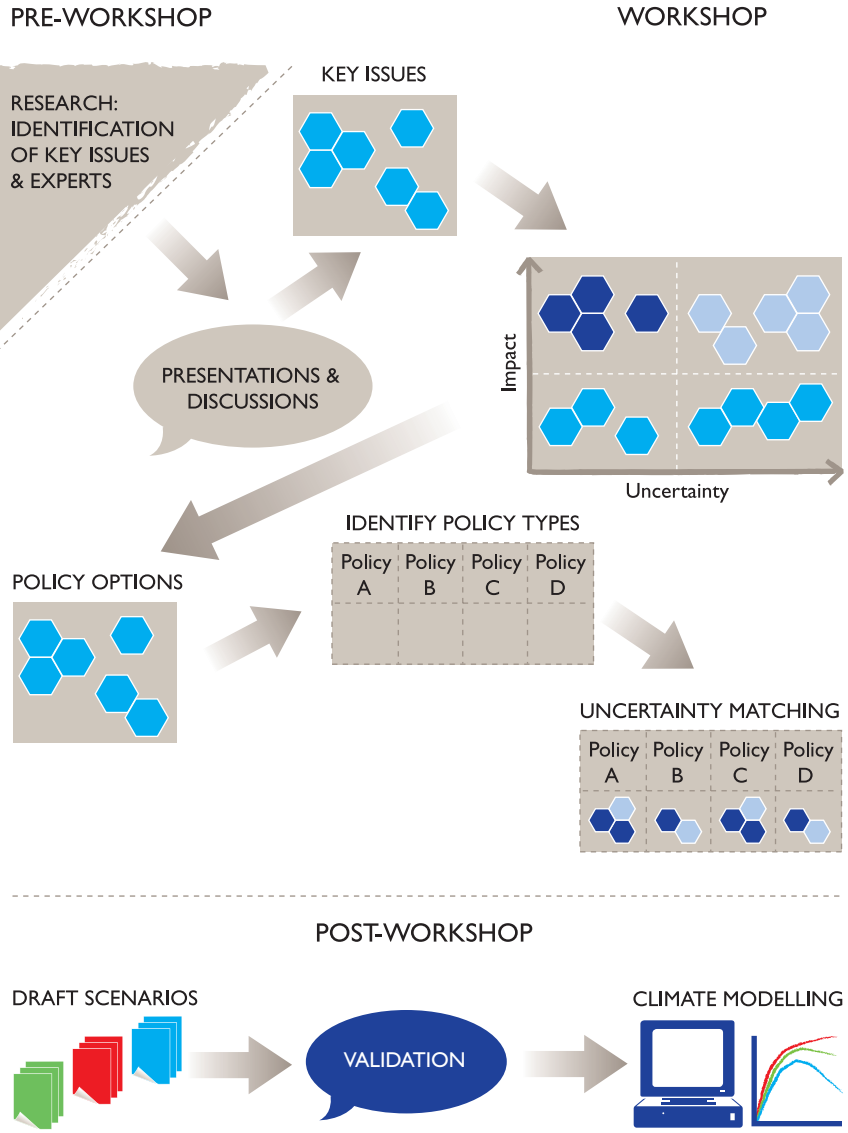
Issues raised during the presentation and discussion were built into a conceptual map that would form the basis of the remainder of the workshop. The participants then mapped these issues onto an impact and uncertainty matrix, with the x-axis representing increasing levels of uncertainty and the y-axis representing increasing levels of impact.

The issues in the top left of the matrix, i.e. high impact but low uncertainty, constituted our drivers – factors that were going to be present in all our scenarios. The issues in the top right of the matrix, i.e. high impact but high uncertainty, constituted our critical uncertainties – factors which were going to differ from one scenario to the next.

Workshop

The following diagram summarises the process of scenario building that we followed:

Figure 4 – The scenario-building process.



This was followed by a presentation and a discussion on climate change policy. As we wanted these scenarios to be policy-oriented, the participants identified the most feasible policy options, taking practical as well as political realities into account, and proceeded to map the drivers and the critical uncertainties onto these policy types. At the end of the workshop we were left with five scenario groupings.

Scenario development

The next task was for the Stockholm Network to develop distinct scenarios from these scenario groupings. The first decision we made was to merge the five groupings into three scenarios, due to high levels of similarity and resonance between some of them. For example, rather than several different stories about different ways that the UNFCCC process could stall, we developed one story, *Agree & Ignore,* that incorporated most of the key elements of these stories.

Once all the key issues were split up between three potential scenarios, we set about writing them out. Having finished the drafts, copies of the scenarios were sent to the workshop participants for comments and validation. With all the feedback collated and incorporated, the scenarios were subsequently sent to a wider group of experts for further comments and validation.

Modelling

Finally, we wanted to clearly connect the policy in these scenarios to their ultimate impact on the climate in order to determine if any of these scenarios would lead to a greater than 90% chance of less than 2°C of warming above pre-industrial levels. In cooperation with the Met Office Hadley Centre, we developed the key inputs to the climate modelling process, including CO2 emissions for each scenario, decisions about the peak year of emissions for each scenario and the rate of change. The emissions modelling was done using the International Energy Agency (IEA) Reference and Alternative Policy scenarios as a basis. The IEA numbers were adjusted based on differences between the policy logic in the IEA scenarios and the SN Carbon Scenarios. Other greenhouse gases were modelled by applying ratios from B1 marker scenario in the Special Report on Emissions Scenarios of the Intergovernmental Panel on Climate Change to the Stockholm Network scenarios. Finally, aerosol levels and deforestation were adjusted based on the policy in each of the SN Carbon Scenarios. Once the inputs were ready, to produce the temperature curves for the scenarios, the Met Office Hadley Centre ran the scenarios through a simple climate model, HadSCCCM1, which was tuned to the C4MIP OAGCM ensemble model study of climate models with interactive carbon cycles. (*)

(*) Using emissions modelling done by the Stockholm Network on the basis of the IEA Reference and Alternative Policy Scenario emissions models, the Met Office Hadley Centre used a simple climate model, HadSCCCM1, which was tuned to the C4MIP OAGCM ensemble model study of climate models with interactive carbon cycles, to project likely temperature rises to 2100 for all three scenarios. It is important to note that the emissions modelling was done by the Stockholm Network. The Met Office Hadley Centre's role was to convert the emissions into climate scenarios. The Met Office does not prefer any particular scenario or advocate any particular set of future emissions.

Appendix II: Abbreviations used

CADS	Country Adaptation Strategy
CCS	Carbon Capture and Storage
CS-TF	Climate Security Task Force
ETS	European Union Emissions Trading Scheme
ICT	International Climate Treaty
IPCC	Intergovernmental Panel on Climate Change
UNEP	United National Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
CEF	Climate Emergency Fund [after CCS]
IEA	International Energy Agency [after ICT]

Acknowledgements

The Stockholm Network would like to thank the following people for their participation in the Carbon Scenarios Project.

Dr John Constable, *Director of Policy and Research, Renewable Energy Foundation*

Dr Laila Gohar, *Research Fellow, Met Office*

Dr Tooraj Jamasb, *Senior Research Associate at the Faculty of Economics and Electricity Policy Research Group, University of Cambridge*

Dr James Keirstead, *Research Associate with the BP Urban Energy Systems Project, Centre for Energy Policy and Technology, Imperial College*

Scott Livermore, *Director of International Macroeconomic Forecasting, Oxford Economics*

Dr Jason Lowe, *Climate Change group of the U.K. Meteorological Office's Hadley Centre for Climate Prediction and Research and his colleagues*

Mark Lynas, *author (Six Degrees), journalist (Guardian, New Statesman, Daily Telegraph) and environmental campaigner*

Jeremy Martin, *Policy Adviser on International Climate Change at Department for Environment, Food and Rural Affairs (Defra)*

Dr Mattia Romani, *Senior Economist, Scenario Group, Royal Dutch Shell. Currently on a secondment with Sir Nicholas Stern*

Dr Swenja Surminski, *Policy Adviser on Climate Change, Association of British Insurers*

Wim Thomas, *Head, Energy Analyses, Scenario Group, Royal Dutch Shell, and his colleagues who helped to validate the scenarios*

Hardin Tibbs, *Associate Fellow at the Saïd Business School, Oxford University*

Oliver Tickell, *journalist and campaigner on health and environment issues*

The Stockholm Network would also like to thank all its staff who helped with the project.

Design: With Relish

Paul Domjan is Energy Fellow at the Stockholm Network and a director of John Howell and Co Ltd.

Gulya Isyanova is a Researcher at the Stockholm Network where she works on the Energy & Environment and the Intellectual Property & Competition research programmes.

Stockholm Network
35 Britannia Row, London N1 8QH
United Kingdom
Tel: (44) 207-354-8888
Fax: (44) 207-359-8888
E-mail: info@stockholm-network.org
Website: www.stockholm-network.org

STOCKHOLM NETWORK