

Amigo Transcript

Thursday 6th March 2008

Our two speakers for today are Paul Domjan, Energy Fellow of the Stockholm Network. He has advised on energy and energy security for the U.S. and European Command and the Department of Defence. He has also done a great deal of scenario building for Royal Dutch Shell.

Our other speaker is Mark Lynas is the UK's foremost writer on climate change. He has written two books, *High Tide* and more recently *Six Degrees*. He's also a columnist for the *New Statesman* and he's also a regular contributor to the *Guardian*.

Paul Domjan

Scenarios are a kind of collaborative endeavour. We build scenarios not to quantify the future and not to try and categorise all the possible futures, but in order to make better decisions. So what we have here is a set of decision scenarios that are essentially targeted at policy-makers and what may be termed policy-takers. In other words, groups like business, which are waiting for a policy to respond to. Because they are decision scenarios we try to look at current trends and the current direction of policy making, and try to establish some of the problems and branching points in these trends – things that policy makers need to be aware of.

We have built three scenarios. We have not tried to capture the entirety of the carbon policy space, nor have we tried to capture every possible policy variation. What we tried to get at was what we think are three very interesting and instructive places in that carbon policy space. This we have done that by looking at some key drivers and tried to gauge how they might develop. However, in building these scenarios, we chose some constraints that we have placed on ourselves, and they are important for understanding why we have chosen these three final scenarios out of the possible five or six scenario groupings that we started out with.

First of all we learn from climate science and technological ecology that we are very unlikely to have a categorical massive technological step-change in the next fifteen or twenty years, and that even if that technology is developed today, the process of implementation, commercialisation, and diffusion mean that this technology is not going to solve the climate problem on its own in this timeframe.

Secondly, we learn from climate science that if we do nothing over the next 15 years, we face a very high probability of a substantial temperature rise. On that basis we decided that not only do we need to exclude a scenario where massive technological change solves the problem (of course, if that happens, it would be great) but that we also need to exclude a scenario in which there is a complete failure to do anything about climate change. This decision was made on the basis of some of my experience at Shell. Unless you're doing military planning, scenarios for

nuclear war, for example, are unnecessary because decision makers and business would not be able to plan for that – something that changes the entire world. The question is how we avoid these kinds of cataclysmic outcomes.

So what is the plausible policy space for the next 15 years, excluding a failure to do anything and excluding a massive technological change? Shaping this future, we see four key drivers. These are things that, on the one hand, governments will have to take as external drivers, but on the other hand, governments may be able to influence.

The first driver is a combination of energy prices and the resilience of the global economy. One starting point we make here is that even though we are not in a peak oil world *per se* (there is still some debate about the geology of inaccessible reserves), we are in something of a *political* peak oil world. Those reserves that could potentially prevent a peak oil world are not easily accessible. These are areas where there is substantial potential growth but for political reasons it will not be produced in the current framework, for example offshore Mexico and domestic Russian gas.

The second driver is that there is uncertainty about how much global agreement there is about climate change policy. One of the things we found in the course of building the scenarios was that one of the main causes of this lack of consensus is uncertainty about the wealth transfer from developed countries to developing countries (in order to enable them to implement low carbon technologies and implement adaptation measures to cope with climate change that is already likely to happen). In order to get a global consensus around a single global regime there needs to be some certainty in the developing world that some sort of wealth transfer will come from the developed world to compensate for foregone economic growth and to enable low carbon technologies and adaptation.

The third driver is that there is uncertainty about the extent to which this is an exclusively elite project or whether this is an elite project that has strong popular support. The Kyoto treaty, certainly at the beginning, was largely an elite project. However, we now see popular support growing dramatically with respect to climate change. What direction will this continue to go in, and to what extent would a lack of popular support open up opportunities and create incentives for backsliding by elites?

The final driver is stochastic weather events. Certainly, in the first part of our 15-year time frame climate change policy does not determine what happens in weather and climate. Weather is, therefore, a largely stochastic system in the short term. Nevertheless, what happens with the climate has a big impact on the *perceived* cost of climate change and on the *perceived* urgency of climate change.

On the basis of these drivers, we have come up with three scenarios. They currently do not have great names. A successful scenario needs a good name which accurately but succinctly conveys the essence of what happens. If you have any ideas for names in the course of this talk, please do let me know.

There are some key parts that are still missing. For example, the World Bank has taken a major interest in climate change but so far has not been incorporated into these scenarios. So, if there are things that you think would definitely happen, please let me know and help us to make these scenarios better. On that note, let me take you through what we have done.

Up until the United Nations Framework Convention on Climate Change (UNFCCC) Copenhagen conference in 2009 the scenarios all follow a similar, though not identical, trajectory. At the 2008 conference in Poznan the current US administration is still in power so there is still no substantial agreement. We are effectively waiting for the new administration to come in. There are continued concerns about climate icons disappearing, particularly in the oceans, things like coral reefs. There is also growing consensus that climate is changing.

We get a new US President. Whether it is Barack Obama, John McCain or Hillary Clinton, the new US President supports the Cap & Trade framework, and the new President brings about a domestic US agreement for short-term Cap & Trade.

The new President in Russia may or may not open up Russia's energy production – we see this as a key component to the extent that it impacts energy prices. We also get increasing green investment, a trend which is already growing. It may even potentially become a bubble.

This brings us to Copenhagen 2009 where we get a new international agreement. The question now is what happens next, what kind of international agreement do we get and what direction does it take us in?

Our first scenario is provisionally called *Global Cap*. It used to have an even longer, equally bad name. In some sense, this is the 'official' future – a story about how current trends could succeed. This story asks two key questions. First, how plausible is it that current policy continues in a positive direction and continues to gather pace? You could characterise our current approach as 'we all walk slowly together and we hope that if we walk slowly enough, the group can grow bigger and bigger internationally'. Would that approach succeed, and is there sufficient impetus in the current approach for decisive action to be taken?

In this story the answer is very much yes. Oil prices remain above \$100 a barrel, but stable, in part because of some opening to foreign investment, particularly in Russia. In other words, there is an ability to respond in the short term. EU governments are not on track with their renewables targets, but the stable oil prices lead governments to believe that given that, because global economy has successfully absorbed a 60% rise in oil prices in 2007-2008, it will be able to absorb a carbon cost. By this point, we have had a couple of years of stable oil prices, the global economy is fine and there is a consensus that growth will continue.

In the summer of 2009 there is a real Cap & Trade agreement in the US for a substantial regime with a high 'safety valve' and permit auctioning – something that is clearly compatible with the European Trading System (ETS), which is important here. We are now in a position where the EU and the US are moving pretty much in the same direction with their domestic Cap & Trade regimes.

We get a strong agreement in Copenhagen with both US and European support. This agreement has three key components to it. First, it has a *binding* cap for developed countries – effectively the US and EU agree to merge the schemes they have adopted. Second, it has a *staged* approach for less-developed countries. This is key to breaking up the developing country bloc, as at the moment we have countries like South Korea, which are basically developed countries and should be accepting if not a national cap then at least a sectoral one, whereas a national cap makes much less sense for a poor country like Mozambique that is not going to be able to monitor it or implement any kind of cap.

Effectively what we have is a staged ladder, where countries start off with targets in specific special initiatives and sectors. Eventually, as less-developed countries become more sophisticated in their climate policy, they will move up this ladder and into the developed country cap.

Finally, the agreement has a clear framework for technology transfer and adaptation assistance. There is a guarantee that there will be some kind of wealth and technology transfer to enable less-developed countries to implement low carbon technologies and to provide them with assistance to help them adapt to climate change.

In 2012 the US scheme comes into force successfully. California provides a precedent. By 2012, some other states have already moved in that direction. The US President is re-elected on that basis, the system is working. Crucially, when the new Copenhagen framework replaces Kyoto, in 2013, South Korea and China, two of the most important members of the developing country bloc – China because of its size and South Korea because of symbolism and degree of development, agree to start moving up that ladder. So, South Korea quite rapidly graduates to a national cap showing that you can break that deadlock between developed and developing countries. In 2015 we finally get to the point of agreeing an equitable allocation of carbon on a nation by nation basis in the long term. This is in some sense the way that we see the best case consensus scenario around the current UNFCCC process.

Then we have two scenarios that challenge this in different ways. The first one we call it *Agree and Ignore* which is scenario about going your own way, and it asks two questions that are very much like the two questions behind *Global Cap*. First, at what points could positive climate change momentum start to backslide? Second, what is the end point of this backsliding? Now this scenario is a composite of a whole variety of elements that could go in different directions for problematic scenarios. You could have a scenario where there is no agreement in Copenhagen; you could have a scenario where agreement brakes down further down the road. This is just one example of the kinds of things that happen in an agreement breaking-down type of scenario. I think it is important to look at this because there are in the current climate agenda of the official future scenario, *Global Cap*, quite a number of milestones that have to be met. There has to be a Cap & Trade scheme in the US that works. That scheme has to be connected to the European scheme. There has to be a ladder that is credible, that countries actually move up, and they need to be willing to accept some international sovereignty over their domestic emissions. If those key points are not met, there is a real question about whether this system can continue to function.

So, in this scenario we get the agreement in Copenhagen, but it is not that strong, and it comes the wrong way. Why is that? First, in this scenario Russia does not open up. The oil system is not able to produce the necessary oil and gas, and prices continue to rise. There is a real concern in the short term about whether the global economy will be able to absorb a meaningful carbon price. In 2009, we do get an agreement on the US scheme, but because of economic concerns and nationalism concerns it is a much weaker scheme, with a very low safety valve and free allocation of permits, rather than auctioning. While it is a cap and trade scheme, it is a cap and trade scheme that it is difficult to meld with ETS. We get an agreement at Copenhagen, but in 2010 and 2011 the ancillary agreements on specific protocols on technology transfer and adaptation assistance are missed.

While we have the framework, we are not able to fill in under it effectively because there still is a logjam between developed and less-developed countries, because the US and the EU are not

able to agree how to develop the pot of money for that wealth transfer. In a situation where the US is using a free allocation scheme, and that free allocation scheme is not generating revenue to put into wealth transfer. You have a core problem. If there is equal contribution to adaptation and technological transfer assistance, then that is going to have either to come out of US budget revenue or be funded largely by Europe or happen at a very low level. There are questions among less-developed countries of whether they are actually going to get assistance with technology transfer and adaptation. In 2012 the US scheme comes into effect, but it is very divisive. It happens in an election year, it happens in a slowing economy. The President who is a strong proponent of the global cap narrowly loses the election in part on the basis of the weak implementation of the scheme, the fact that the scheme was seen as a failure and seen as detrimental to American interests, to a nationalist opponent who then goes in 2012 with an attitude of we may have made this agreement in Copenhagen but we are not going to surrender our sovereignty easily.

As a result, between 2012 and 2014, countries fail to implement the new scheme and less-developed countries fail to graduate. One of the key signposts here is that, whereas in a *Global Cap* scenario that works South Korea moves up to developed country status and China accepts sectoral caps, in this case the less-developed countries are very unwilling to break their solidarity about a single means of treatment. So there is a lot of pressure put on South Korea by other less-developed countries and by its own industry to say 'why do you need to take a national cap? Continue to drag your feet, continue to backslide and let's try to get a better deal out of the developed world in terms of technology transfer. So the ladder doesn't work. The ladder is set up but nobody moves up the rungs. As a result by 2014 we are in a world where there is an acceptance of non-compliance. I'm a big believer that if you want to understand the future, you need to see the signs of the future in today. One of the key signs of the future in today here is Canada's approach to Kyoto. Canada has signed and ratified Kyoto but is not actively complying with it in any meaningful fashion. Because of that acceptance of non-compliance – some initial not only *de facto* but also *de jure* loosening of the international framework to keep it in place – we end up in a system of competitive regionalism in carbon tariffs.

The only way to make ETS work, or even make the US free allocation scheme work in this framework, is to have some kind of carbon tariff at the border to assuage national pressures to protect industry to make sure it is not outcompeted by those that are not exposed to a tariff. We already see some discussion of this in Europe around the steel industry. Why should Europe let in steel that is produced in China with no tariff when steel here has to be produced in accordance with ETS terms? In the short term there is an argument to make that this is a process of learning, there is a first mover advantage and being one of the countries that first imposes this kind of regulation. But if it becomes clear that we are not moving towards an international scheme it is much harder to justify not having a carbon tariff. As a result, as part of this competitive regionalism, instead of moving to a single international framework, while we are still talking about a single international framework, we end up in fact with competing and connected regional frameworks. The US and Europe develop some convertibility. Things like joint implementation that should fade away continue to be used. Clean development mechanisms continue to be used.

We end up with a very fragmented carbon market. That produces three kinds of economic costs in this scenario. First, explicit barriers to trade. Second, lack of investment, because of business uncertainty about the direction of climate change policy. Third, in the long term, the actual direct cost on the economy failing to deal with climate change effectively. This is a

scenario that is more costly, and probably, though we have not done the numbers yet, it is going to deliver less emissions reduction. Because of the short term backsliding, we are unable to come up with an international agreement that works, and we end up with a regional framework that has direct and indirect costs on the economy.

We have a third scenario called *The Security Council Model*. Once again it needs a new name but the name used to be worse than this so this is an improvement. This asks a very different set of questions. The first two scenarios were kind of flip sides of one another. This third scenario is about what would happen if policy took a different direction. Here we ask first 'is it plausible that policy might take a radically different course?' I think the answer we came up with is yes. That's definitely true. Secondly, what might plausibly cause this change? We paint one picture but there are certainly a range of them. We discussed a range of different options that would trigger something like this. And thirdly, what policy might result? Here, we have chosen one particular policy outline. We have reasons for that but it certainly could result in other things. This is really about do we have to stay on the tracks of the UNFCCC, whether we are going forwards or backwards or is there an option for a different route?

In this case, we have all the same developments, including a domestic cap in the US. But the summers of 2010 and 2011 are really quite terrible and lead, because of stochastic weather events, to some significant damage. I have to emphasize here, this is not because climate change accelerates, it's because the weather system is stochastic. But it leads to much greater concern about the long term impact of climate change. In the summer of 2010 we have a terrible typhoon season and a normal hurricane season. The terrible typhoon season leads to massive disruption at ports near Hong Kong, like Shenzhen, and destroys the port of Fuzhou, which is a minor port, really showing to the Chinese government that actually their export economy depends on maritime transport, and maritime transport depends on not having terrible typhoons. So, there is a direct cost to the Chinese economy. It is worth noting that Fuzhou came very close to being destroyed by a typhoon several years ago. This is very close to something that really happened. In the western hemisphere we have a normal hurricane season but one very bad hurricane that is in the wrong place and damages the Houston ship channel. So there is a perception in the US that weather events can have a direct impact on the economy. The Houston ship channel is the main import route for much of the oil in the US. The typhoon season in the Pacific leads to flooding in Guangzhou near Hong Kong disrupting land-based transport. So you have problems getting goods out of ports and problems getting goods to ports. It leads to significant loss of life in India and particularly in Bangladesh. At the same time, crop failures and heat waves in Africa and Europe lead to deaths in Europe, particularly in Africa, with Southern African crop failures. This shows that need for the UN World Food Programme to have much larger famine relief. This has direct economic consequences because of the disturbing weather and transportation disruption which slow down the world economy.

Business begins asking, 'In a world with this unpredictable weather can our just in time manufacturing work? Can we rely on just in time parts from China when China has real questions about exports?' This year, 2008, business had the same question for opposite reasons, because of the disruption to Chinese infrastructure that came with the snow storms. Is it a reliable part of the manufacturing system? In 2011 we have similar problems; they are not as bad, but, because we have not recovered from 2010, the summer of 2011 leaves both the US and China feeling that their economic security is tied to a stable weather system. That leads to major change. I have been through them all, typhoons, flooding, heat waves, fires.

So the US and China decide they need to spearhead a radically new approach to ensuring climate security to maintain their economic systems. What does this look like? It is driven by a desire to do something that is effective, can be quickly implemented and is global. Not by a desire to do something that is naturally equitable or that is implemented at a national level. The focus is almost entirely on what can we do that we can implement now that will effectively reduce carbon emissions quickly. The answer, we think, in this case is some sort of upstream cap. Here instead of monitoring emissions which are directly proportional to the carbon input into the production process, we monitor global carbon production. There are two important things here. First is that it is designed to be set up quickly through existing UN institutions primarily. Secondly, it is designed to give a clear indication to business that there will be a long-term carbon price to incentivise business to begin quickly moving to low-carbon technologies. Thirdly, it is designed to give a clear indication to less-developed countries that there will be a wealth transfer and that they will have some control over it.

So what happens in this system? In this system there is a global carbon production cap with a safety valve at the top and a reserve price at the bottom, so there is a band at which carbon trades. You need a carbon permit to produce oil and gas, to produce coal. So, instead of having potentially millions of power companies around the world or billions of individual citizens with carbon allowances in this system we are only looking at a few thousand natural resources producers. So, it is much easier to administer. We know who the companies are, who produces these things. Because it happens so remote from the point of consumption, it is very hard to get into debates about fuel poverty and debates about fair national allocations. There is no national allocation. It is a global carbon cap. And the market is allowed to sort out the rest of the system. It is administered by the UN Security Council to keep it tightly under the control of the Chinese and the United States, and the revenue is used to incentivise and pressure oil producers in developing countries to accept the system.

So, what happens? The UN Security Council sets up what we call the Climate Security Administration that administers this carbon cap and takes, we think, probably something like a trillion dollars of revenue a year. That revenue is immediately transferred to the General Assembly. The General Assembly, where politics takes place and there is a debate about what is a fair allocation, is not allowed to disrupt the signal to business because the signal to business happens at the Security Council level, and as soon as that clear signal is provided the money then moves to the political arena. In the political arena, the General Assembly debates compensation for lost oil production, compensation for foregone economic growth, developing world adaptation, technology transfer, assistance to green technology research, etc. So, we are separating the political side of it and the spending of the revenue from the raising of the revenue. In the short term this kind of system leads to significant dampening of economic growth. It quickly puts in a much higher energy price. It takes business a while to adjust to where it is going, but in the longer term it leads to much higher business confidence, because of the clarity it provides. You are now able to make 20 year investment decisions in the natural resources sector and in power generation and the clarity provided by these high carbon prices, paradoxically, leads to higher long-term economic growth.

So, how do we compare these scenarios? First of all, these are graphs of their sense of urgency. The first scenario, *Global Cap*, is the green line, a rising and then steady sense of urgency. It is sufficient to enable the UNFCCC process to continue, but not so great to lead to real questions about whether it is the right thing to do. In *Agree and Ignore* urgency never reaches the same levels as in a *Global Cap*, and it falls off very quickly and leads to the acceptance of backsliding. As it falls off, we end up in a prisoner's dilemma, and the incentives to cheat rise as the sense of

urgency about the climate falls. If we were to extend these further, this graph it goes up to 2020, eventually because of the changing climate that has to come with *Agree and Ignore* because of the failure to deal with the climate, that urgency will have to spike dramatically as the climate does change. Climate change becomes unavoidable. In the *Security Council Model* we get a sense of urgency that is probably a bit below the *Global Cap*. There is a sense that things are going well, but then there is clear step change. In 2010 and 2011 we move up to a much higher level. That step change in urgency, there as you see, the *Security Council* blue line crosses the *Global Cap* green line, is what enables the new approach.

The oil prices in *Global Cap* are steady, only rising slightly from today. In the *Security Council Model* they fall as the cap comes in, because oil demand does begin to respond. In *Agree and Ignore* they are high, that is one of the drivers of this scenario, this feeling that the global economy can't deal with high oil prices, and they continue to rise because there isn't an established international framework for implementing non-oil technologies. So, oil demand continues to grow.

What happens to economic growth? In *Agree and Ignore* economic growth is low. That is in part in response to rising oil prices and it continues to be low, because of barriers to trade and weather costs. This is a story in which low economic growth and the perceived threat of more low economic growth leads to policies being adopted that produce more low economic growth. So, we end up in a situation where in trying to address low economic growth in the short term we actually continue to push growth downwards in the long term. In *Global Cap*, growth is fairly steady and on trend. In *Security Council Model* we see this drop in growth, as the model is implemented followed by a recovery as the certainty to business leads to new investment decisions and feeds through the system. The *Security Council Model* is the most efficient system for allocating carbon. It provides the least drag on growth. In *Global Cap* growth is never going to recover much above from it is now, because the monitoring system required to ensure compliance with the diffuse national emission targets is very costly in and of itself. The financial infrastructure needed to trade these credits is very costly in and of itself.

Finally, and now I hand over to Mark, what happens with emissions? This is just our first guess. These aren't quantified numbers. The next step in this is to quantify these numbers and use some climate models to develop temperature growths. We think that we will end up in a situation where *Agree and Ignore* definitely will lead to the highest emissions. In the *Security Council Model* the emissions will be a bit higher, the US system that comes will be a bit less strict but emissions will fall and level off quite quickly because there is a direct lever to control emissions. In *Global Cap* we have growing but eventually flattening emissions. The next step in this is to get feedback from people like you and to take these general emissions curves and turn them into specific incremental emissions curves and generate temperature growths which will give us a much more quantified basis for this. On that note I am going to turn over to Mark to make some additional comments and then open the floor to you.

Mark Lynas

Thank you very much Paul. The reason why I got involved in this process, I don't have a background in scenarios modelling or anything like that like Paul does, is that it is actually, if you look at it in the real world context, trying to address the most important question which today faces humanity, which is simply whether we can peak global emissions within the timeframe which is necessary to stabilise and gradually reduce the resulting atmospheric temperatures at a level which doesn't completely destroy natural eco-systems and human society. That's a pretty

big question. These scenarios are trying to envisage within the timescale where this decision has to be made and this question has to be answered which is really only ten or fifteen years. What the most likely and the most plausible outcomes could possibly be.

For those of you who are familiar with the Intergovernmental Panel on Climate Change (IPCC) process, which I presume is everybody, right? The scenarios which exist and are underpinning all of those modelling outputs are called the SRES scenarios, the Special Report on Emission Scenarios which was published in 1999, driven by economic factors, projected rates of economic growth during the century, social factors, in terms of globalisation, localisation, and other factors like population growth and so on, those of the inputs into these scenarios which the IPCC uses, but it misses a very crucial piece of the jigsaw, which is policy. So there is no policy component whatsoever to the IPCC scenarios which then drives the temperature outputs. For me this is actually trying to fit in, this crucial real world component of what the emissions are actually going to be in this century actually it has to do more with policy than these underlying drivers which are happening for natural reasons. Given the timeframe that we are talking about, 10 to 15 years, this is crucial because if you look at the data of the Fourth Assessment Report (December 2007) and some of the more recent modelling work, it is essential that we peak emissions within the next decade, preferably by 2015 if we are to keep the resulting temperature rise below 2 degrees. It is essential that we do that, and it is an EU policy for this reason, that somewhere above 2 degrees most likely there are tipping points in the Earth's system which could add a degree or more to the eventual temperature change and usher in many catastrophic results.

These scenarios have been useful for me because they helped me envisage the fact that only scenario number three, *Security Council Model*, is likely to keep temperatures below this 2 degrees level. I think the first two, the ones which are called *Global Cap* and *Agree and Ignore*, actually would have different temperature outcomes. I think it is important to quantify these in the real world, which is what we will do next. *Agree and Ignore* for example is likely to lead to, and this is back of the envelope, sort of gut feeling, 4 degrees and above temperature rise, which is in itself likely to lead to probably a disintegration in the west Antarctica sheet and very accelerated rates of sea level rise by the end of the century which could add up to, in the worst case scenario, up to five meters or so of sea level rise, plus a commitment to many, many more meters beyond that, potentially with the elimination of all ice on the planet, if you look back at the geological analogies for that. So, continually shifting coastlines throughout the future, throughout centuries of human existence. We would also see the disintegration of the Greenland sheet, potentially more rapidly, because the ice dynamics of that particular ice sheet are much more interesting in the sense of how rapidly the ice flows off the continent and into the ocean. We'd see the disappearance of the Arctic ice cap very early on in the process. We would see mass extinction of life on earth of above 50% or more. So, we would lose half of life on earth at least, probably a good deal more than that in what would be the worse mass extinction since the end of the Cretaceous 65 million years ago. We are already moving into that area.

Somewhere between 2 and 3 degrees, and this is why the *Global Cap* scenario is interesting, are these tipping points, which the IPCC tries to quantify but doesn't do so to any useful extent, in my opinion. Principally, what happens with the world's carbon cycle, so the Amazonian collapse scenario where most of the Amazon rainforests burns down and there are huge amounts of carbon that come out of the trees, come out of the soils, which according to Hadley Centre models in particular, give another degree and a half of eventual temperature rise by the end of the century. That's a crucial tipping point. Other tipping points which could be crossed between

the 2 and 3 degree level are methane release from the Siberian polar frost, at least half of that would melt within this kind of temperature change. Other tipping points potentially are methane hydrate release from the saturation of the oceanic sink, things like that are less understood and not quantified to any significant extent.

That is why we have to keep temperatures within 2 degrees and it seems to me only the *Step Change* scenario, which I think it is a preferable name actually for the *Security Council Model*, has any chance of doing that, and because we are talking about a system which actually regulates not emissions, but actually regulates carbon going in the economy with a much greater degree of precision. You can actually have a much better idea of what the atmospheric ppms are likely to be a decade or two or three further on down the line. If we manage to keep temperatures within two degrees we will still have some pretty significant impacts. We will see heat waves along the 2003 lines every summer or so in Europe for example. We would still lose much of the world's coral reefs. But we could probably stabilise eventual sea level rise to within 50 cm by the end of the century. We would keep the mass extinction of life below a quarter of existing species and perhaps even less than that if we manage to find ways to help natural species adapt to the rates of change. We would probably see migrations of populations within, I would say, less than half a billion, whereas if you look at the high scenarios it could be half of humanity, above 4 degrees, who would be on the move due to the uninhabitable zones in the subtropics spreading towards the poles in each hemisphere. So, a completely different planet would be coming into existence, whereas a planet below two degrees would be significantly affected by climate change but it would be one which is still recognizable and one that human society, I think, could tolerate.

For me, we are taking a big risk in simply pursuing business as usual within the current policy context. I think we do need to step change, and I think that's something that policy makers need to address. Even in the short term, when we are talking about policy up to Copenhagen, having this sense of clear direction is probably the most important thing, particularly for guiding business investment decisions. I am encouraged having been to Bali, and I'm sure various other people here were in Bali as well, of the degree of consensus which is now being forged. I think the *Step Change* scenario is actually just as likely particularly if you have better climate inputs to it, because I don't think that typhoons and hurricanes are very good ones, because these happen all the time. It would be much better to have ones which do indicate rapid climate change. These already exist. I mean the rate of disappearance of the sea ice in the Arctic last summer was off the scale, there is a great graph I could show of that, where the models projected are actually has going down like that and actually it is almost going vertically down. These indicate massive changes in the earth system, which are actually very much indicative of the climate change process which is under way. And if these continue, we are talking about continuing trends here, I think it would have a significant impact on public opinion and drive things forward in that sense.

It doesn't have to be only climate events which influence a shift in urgency, if you go back to the urgency graph; it could be things like a new film which has impact equivalent to Al Gore's *An Inconvenient Truth* which led to a step change in public awareness in the US and other places too. This could come from different areas too. Also, one of the things which has made me more optimistic recently is the degree of investment which is already going into the renewable energy sector. This is without an all encompassing global framework, and also the degree of consensus, the marginalisation of the contrarians, the sceptics who have no discernible impact on climate policy any more. And, the consensus within business that the 2 degree target is something that we need to aim for. You could see this within the Bali communiqué and other significant

communiqués from the business sector which is actually demanding, pretty much in exactly the same language as Greenpeace, an outcome which would stabilise global temperatures below this dangerous level. I think I will stop there and we will open it up to wider discussion.