ENVIRONMENT AND RURAL DEVELOPMENT COMMITTEE

Wednesday 26 January 2005

Session 2

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ENVIRONMENT AND RURAL DEVELOPMENT COMMITTEE
3rd Meeting 2005, Session 2

CONVENER

*Sarah Boyack (Edinburgh Central) (Lab)

DEPUTY CONVENER

*Mr Mark Ruskell (Mid Scotland and Fife) (Green)

COMMITTEE MEMBERS

*Rob Gibson (Highlands and Islands) (SNP)
*Karen Gillon (Clydesdale) (Lab)
*Alex Johnstone (North East Scotland) (Con)
*Richard Lochhead (North East Scotland) (SNP)
*Maureen Macmillan (Highlands and Islands) (Lab)
Mr Alasdair Morrison (Western Isles) (Lab)
*Nora Radcliffe (Gordon) (LD)

COMMITTEE SUBSTITUTES

Alex Fergusson (Galloway and Upper Nithsdale) (Con)
Janis Hughes (Glasgow Rutherglen) (Lab)
Jim Mather (Highlands and Islands) (SNP)
Jeremy Purvis (Tweeddale, Ettrick and Lauderdale) (LD)
Eleanor Scott (Highlands and Islands) (Green)

*attended

THE FOLLOWING GAVE EVIDENCE:

Dr Simon Allen (Centre for the Study of Environmental Change and Sustainability)
Dan Barlow (Friends of the Earth Scotland)
Fred Dinning (ScottishPower)
Dr Richard Dixon (WWF Scotland)
Professor Brian Hoskins (Royal Commission on Environmental Pollution)
Alan Mitchell (Confederation of British Industry Scotland)
Dr Vicky Pope (Hadley Centre for Climate Prediction and Research)
Dr Richard Tipper (Edinburgh Centre for Carbon Management)
Charlie Woods (Scottish Enterprise)

CLERK TO THE COMMITTEE

Mark Brough

ASSISTANT CLERKS

Chris Berry
Catherine Johnstone

LOCATION

Committee Room 2

Scottish Parliament

Environment and Rural Development Committee

Wednesday 26 January 2005

[THE CONVENER *opened the meeting at 10:03*]

Climate Change Inquiry

The Convener (Sarah Boyack): I welcome the press, the public, panel members and colleagues. First, I ask everybody to switch off their mobile phones. It is irritating when mobile phones go off in the middle of a conversation; they also impact on our recording equipment. I have had no apologies submitted to me this morning, but Alasdair Morrison will be slightly late.

This is the first session in our climate change inquiry. The purpose of today's meeting is to have a round-table discussion. That is not the normal way in which committees take evidence and it is an innovative approach for us. We decided that, because climate change is such a big, complex and difficult issue, we wanted to try to get a sense of the many different opinions and views at the outset. I thank everyone for sending in their written submissions in advance.

Today's session is introductory. We are not trying to get every last word on climate change, but we are hoping to cut to the chase on a few matters. The headings around which we have structured our inquiry are the science of climate change, the potential impact of climate change, mitigation measures that we can take and adaptation measures. We have a particular focus on what will happen in Scotland and the challenges that we need to address.

During the next few weeks, we will look in a lot more detail at energy consumption and efficiency, business issues, public sector issues that can be taken up by local or national Government, the huge land use issues for Scotland with which we have to get to grips, and transport issues. There are few simple solutions on which we will be able to agree. It will be useful if today we identify areas of agreement and flag up areas of disagreement to which we might want to come back when we discuss specific sectors or areas.

I will mention a few ground rules before we kick off. What we seek today is a discussion rather than a traditional question-and-answer session, which is how we usually conduct our committee meetings. I am keen for members and witnesses to be able to ask one another questions, to ask questions to the whole meeting and to make general contributions. However, I say as a caveat that, if general contributions are too long, I will signal that to the speaker, because I want to get a range of contributions from those who are around the table this morning.

To keep some kind of order, I ask everyone to make their contributions through me. If you want to speak, indicate that by raising your hand—as demonstrated ably by one of my colleagues—and I will try to make sure that we have a reasonably structured and fair conversation. I will say your name before you speak—I hope that I have got everyone's name pinned down, although I cannot see everyone's name plate—for the benefit of members of the public and the staff of the official report, so that we attribute remarks to the correct person and not to someone else; I do not want any professional embarrassment after this morning.

We will attempt to have a break at about 11 o'clock and to finish by 12.30. I hope that that meets with everyone's agreement. I kick off by inviting members and witnesses to introduce themselves. We will go around the table. The witnesses should state their organisations and their individual roles. We also have our support staff: our clerks, the official reporters and staff from the broadcasting office.

My name is Sarah Boyack and I am the committee convener and the Labour MSP for Edinburgh Central.

Mr Mark Ruskell (Mid Scotland and Fife) (Green): I am Mark Ruskell MSP. I am the deputy convener of the committee and the Green party MSP for Mid Scotland and Fife.

The Convener: Next we have two members of staff from the official report, who will carefully transcribe every word. Within a week, the report will be on the internet for ever.

Dr Richard Dixon (WWF Scotland): I am Dr Richard Dixon and I am head of policy at WWF Scotland. Climate change is one of the issues that I spend most time on.

Nora Radcliffe (Gordon) (LD): I am Nora Radcliffe and I am the Liberal Democrat MSP for Gordon.

Fred Dinning (ScottishPower): I am Fred Dinning and I am the group energy and environment director with ScottishPower. I also have a number of other roles: I am a fellow of the Energy Institute and I sit on various advisory boards, including the Scottish Energy Environment Foundation and the Church of Scotland society, religion and technology project.

The Convener: Next we have our broadcasting team. Let us carry on round the table.

Charlie Woods (Scottish Enterprise): I am Charlie Woods and I am a senior director at Scottish Enterprise. I am responsible for strategy, research and planning.

Professor Brian Hoskins (Royal Commission on Environmental Pollution): I am Brian Hoskins. I am professor of meteorology and Royal Society research professor at the University of Reading, but I am representing the Royal Commission on Environmental Pollution, of which I have been a member for the past six and a half years.

Maureen Macmillan (Highlands and Islands) (Lab): I am Maureen Macmillan. I am a Labour MSP and I represent the Highlands and Islands.

Dr Vicky Pope (Hadley Centre for Climate Prediction and Research): I am Vicky Pope and I am head of the climate prediction programme at the Hadley centre for climate prediction and research, which is part of the Met Office.

Richard Lochhead (North East Scotland) (SNP): My name is Richard Lochhead. I am an SNP MSP for North East Scotland.

Dan Barlow (Friends of the Earth Scotland): I am Dan Barlow and I am head of research at Friends of the Earth Scotland.

Alex Johnstone (North East Scotland) (Con): I am Alex Johnstone. I am a Conservative MSP for North East Scotland and the Tory spokesman on environment issues.

Dr Richard Tipper (Edinburgh Centre for Carbon Management): I am Richard Tipper and I am the director of the Edinburgh Centre for Carbon Management.

Karen Gillon (Clydesdale) (Lab): I am Karen Gillon. I am the Labour MSP for Clydesdale.

Alan Mitchell (Confederation of British Industry Scotland): I am Alan Mitchell and I am head of policy for CBI Scotland.

Rob Gibson (Highlands and Islands) (SNP): I am Rob Gibson and I am an SNP MSP for the Highlands and Islands. I am the SNP's deputy spokesperson on environment, with responsibility for water and land reform.

Dr Simon Allen (Centre for the Study of Environmental Change and Sustainability): I am Simon Allen and I am from the University of Edinburgh's centre for the study of environmental change and sustainability. I am a lecturer in sustainable development and I have a general interest in how we can move human society on to a more sustainable trajectory. Within that, I have a particular interest in climate change and I have been involved in some research projects on how that will affect Scotland.

The Convener: Our two clerks are also present at the table.

Welcome, everybody. To kick off, let us debate what climate change is and the extent to which it is happening. In last week's parliamentary debate, I think that everyone agreed that climate change was happening and needed to be addressed. However, that might have been because the science can be debated only to a limited extent when we are allowed speeches of only six minutes. Notwithstanding the fact that, unusually, members agreed with one another on the issue, it might be a good starting point for us to spend a bit of time thinking about climate change. To what extent do the experts think climate change is happening? What are the particular issues for Scotland? Perhaps someone with a meteorological or other scientific background can kick us off on that.

Professor Hoskins: I have been vice-chair of the world climate research programme for the past four years, so climate change is very much my area of expertise.

If I may start right at the beginning, I will say why we think that climate change might be an issue. We are pretty confident that greenhouse gases are very important in making the world as warm as it is and in making it habitable for human beings. In that sense, greenhouse gases are good. However, if we start adding more greenhouse gases to the system, we should expect the earth to warm more. Human activities have added greenhouse gases to the system and we have measured that the level of those gases has risen in the atmosphere. The implication from even the simplest science is that we should expect a warming of the earth, which we have indeed observed. Those facts seem pretty solid. The issue becomes more difficult when we think about the future and what might happen in certain regions.

Let me deal just with greenhouse gases for a moment. We are right to focus on carbon dioxide, because that is the major greenhouse gas that we are emitting that is liable to lead to climate change. However, other greenhouses gases, such as methane and nitrous oxide, should also be taken account of. One hears people say that we give no thought to the main greenhouse gas, which is water vapour. Although water vapour is the dominant greenhouse gas in the atmosphere, we do not perturb it directly and the effect of our activities in that area is minute. That is why we need to think more about the other greenhouse gases.

Based on our understanding of the system, our best climate models and back-of-the-envelope calculations suggest that a doubling in the amount of carbon dioxide could increase temperatures by

perhaps 2˚C to 4˚C. There is some uncertainty in that. Indeed, a key thing that I want to mention is that there is uncertainty associated with our understanding of the system and with how we model it.

A difficult aspect is the natural variability of climate. In the past, climate has varied without us and it varies on all timescales. It is certainly dangerous to extrapolate from trends over the past 10 years to say that we are witnessing climate change. Disentangling natural variability from actual climate change is very difficult. Equally, much of the important climate change might happen in that natural variability and in the extremes. Changes in the mean are one thing, but changes in the extremes—extreme summer droughts or extreme winter rains—are probably the most important. Therefore, natural variability, changes in the mean and changes in the extremes need to be considered. It is very difficult to say for certain what will happen, but the science is robust enough certainly to be able to say that it will involve such events.

10:15

Dr Pope: We have been carrying out work at the Hadley centre for climate prediction and research and other places around the world to quantify the uncertainties that Brian Hoskins referred to and to find out the probabilities of different changes in temperature. I have included some examples in my submission.

We are also starting to use that information to get a handle on changes in extremes. The submission contains examples that are representative of London and Edinburgh and show that, for example, changes in average summer temperature might increase by between 2˚C and 5˚C. That said, the temperature in London might increase by 10˚C or 12˚C on the hottest summer day. As a result, it is clear that extremes can change quite significantly.

We have also carried out studies into the 2003 summer, which was the hottest summer on record. Although for all sorts of reasons that Brian Hoskins mentioned we cannot say that a particular event is due to climate change, we can comment on the probability of that kind of event occurring. For example, we can show that, without climate change, we would expect such an event once in 1,000 years but that, with climate change, it is likely that it will happen once every 250 years. We use climate models to pin down that information. We can also show that, in 50 years' time, such an event will actually be an average summer. That gives people some indication of what it will be like to live in a warmer world.

Dr Tipper: It might be useful to clarify the timescale of such changes. How quickly will they happen? Will they happen in the next 20, 30, 40 or 50 years?

Dr Pope: The change that I have just highlighted, which was based on our analysis of the 2003 summer, will come about in 50 years' time. As a result, it will happen within our children's lifetimes—and perhaps within some of ours.

As for changes in extremes, we are talking about the 2080s. However, it all depends on carbon dioxide levels and the climate's sensitivity to greenhouse gases, which is where the uncertainty lies. As Brian Hoskins pointed out, global temperatures could change from between 2˚C to 4˚C. All we can give are probabilities of the different values.

Dr Allen: Most of the climate change predictions that emanate from the Intergovernmental Panel on Climate Change focus on incremental, gradual changes in mean climate as greenhouse gas emissions increase. However, there is also the possibility of abrupt climate change as a result of mechanisms in the climate system that are not well understood. I wonder whether Professor Hoskins or Dr Pope could outline what might cause abrupt climate change and tell us whether it is likely to happen.

The Convener: Do either of the witnesses want to pick up that question? We have seen, for example, television documentaries about the gulf stream shutting off overnight.

Professor Hoskins: I will make a start on that, and perhaps Dr Pope will come in later.

Everything would be made very easy if the science could point to a threshold level, below which we are probably all right but beyond which the system goes off balance. However, I do not think that the science will discover that level; instead, what constitutes dangerous climate change is a socioeconomic and political matter. For example, climate change is dangerous now for people living on an island in the Indian ocean, because of changes in the sea level, whereas the dangers of climate change might be rather different for people in more robust and wealthy societies. As I say, if the science could come up with a threshold, the whole matter would be easier to discuss. However, it has not done so yet and it is probably unlikely to do so.

Some misleading statements have been made about the gulf stream turning off. I do not think that there has been any indication of a threshold in that respect or that, in a global warming situation, things would get cooler for us because of the lack of heat transport in the ocean. It might simply mean that we will not warm up like the rest of the world. I will not go into too much detail, but the gulf stream is driven by the winds, heat and water

transports across the ocean surface. It is not likely that the winds will switch off suddenly. There will be a gyre and the heat transport might vary somewhat, but films such as "The Day After Tomorrow" have rather overemphasised what might happen.

Another interesting suggestion from the science is that the melting of the Greenland ice sheet might become irreversible. Part of the reason why Greenland is so cold is because it is so high. Therefore, if the ice sheet starts to melt, the climate there will become warmer anyway, because the land will lower. We think that that will happen over a 1,000-year timescale, although there might be a point of no return. Quite where that is, however, we are not sure.

Regionally, some events might be seen as abrupt. If, for example, the storm track changed its usual course and moved further north, rather than into north-west Scotland, that could be seen as an abrupt climate change in north-west Scotland, although it would not be abrupt in the context of the whole climate system.

Richard Lochhead: We are talking about the timescale for when climate change will impact on the planet. Is there any consensus on the timescale for action that society should take, which would then impact on climate change? Last week, I spoke to an academic who said that we are committed to the next 20 years of climate change and that any action that we take now to reduce greenhouse gas emissions will impact on the climate only after 2025. Is that the general consensus on timescale?

Dr Pope: Carbon dioxide in particular has a long lifetime; it stays in the atmosphere for 100 years. Any carbon dioxide that we have put into the atmosphere until now will be around for a while and that is the reason for suggesting a timescale of around 20 to 30 years. That does not mean that we should sit back and wait 20 to 30 years before we do anything. I agree that what we do now will influence what happens beyond that time.

Dr Dixon: I was a bit surprised by Professor Hoskins's statement that not many big surprises or events are coming and that we cannot talk about a threshold. There is a pretty sound prediction that, by the end of this century, there will be no permanent ice left in the Arctic in the summer. That ice partly drives the climate and the ocean current system and things that live on that ice will not be terribly pleased about having no ice left. That is a major change over a timescale of about 100 years.

A paper by a United Kingdom scientist suggests that, if we continue on our current emissions track, we will be calling the Amazon rainforest the Amazon desert by 2080 because 80 per cent of the trees will be gone. Those trees and the soil with them lock up carbon, so when they go there will be a burst of carbon.

At the weekend, the chair of the Intergovernmental Panel on Climate Change talked about whether we were about to reach a crucial point or whether we had gone beyond it. He seemed to think that we were about to reach some crucial point. Will Professor Hoskins tell us whether, if we continue on the same track, there will be a point in the next 100 years at which certain critical systems around the globe start to break down? He was negative when he talked about a threshold, but there must be a range of temperatures at which several major things might happen that will cause a problem for human society.

Professor Hoskins: Thank you for providing me with an opportunity to correct an impression that I may have given. I think that human-induced greenhouse gas climate change is incredibly important. I was trying to guard against saying that we can be certain about exactly what will happen and when—I am thinking in particular about abrupt changes and sudden surprises.

I am strongly of the opinion that, at the rate at which we are going, we will see severe changes in our climate system within the 20, 50 or 100-year timescale. Those changes could well include the sort of things that you are talking about—the melting of the Arctic ice and some tropical rainforests being turned into unproductive regions or, perhaps, deserts. The Royal Commission on Environmental Pollution, which I represent, decided that the problem was serious enough that we would need to take action now to try to keep the level of carbon dioxide in the atmosphere at or below the pre-industrial level. We could see that, even if there is a continuum of effects, those effects will be very serious.

It is difficult to foresee, from where we are now, what changes will have taken place by 2050, but we should be trying to ensure that the world produces no more carbon dioxide in 2050 than it does now and that the climate system stabilises at about that level, with changes of the order of 2˚C or 3˚C. However, it will be extremely difficult to do that from where we are now. We have said, "This is the best target that we can set. Can we achieve it?"

The problem is extremely serious. Whether or not we foresee something happening suddenly, we have to take the matter seriously. In the history of the earth, we are on the top of the climate curve—it is as warm as it has been in the past million years—and we are turning up the radiator. We do not know what the effect of that will be, but we know that it will be serious.

The Convener: That is a good image to have in our minds.

Nora Radcliffe: I have a couple of questions. First, you said that we do not currently do much to interfere with water vapour. However, if we moved to hydrogen as a form of propulsion for all our transport, would that become a problem? Secondly, we are talking about a whole system. Is there any natural feedback mechanism that might come into play of which we might not be aware?

Professor Hoskins: How long have you got? Water vapour is important in terms of the feedbacks in the climate system. My comment was that our direct effects on the water are negligible. As far as I am aware, the only way in which we would change that would be if we started—God forbid—to have hydrogen-powered aircraft and supersonic transport in the stratosphere, which is incredibly dry. That would have a much more significant effect than our doing something with hydrogen power at the earth's surface. I am sure that we will come on to hydrogen power, but hydrogen is a carrier, not a source, of energy. Other than if we started powering aircraft from hydrogen, I do not think that that would be a problem.

On feedbacks, we must always be aware that there might be something that we have not thought about. People on one side of the agenda will say that the earth is an incredibly robust system and that climate change will be much smaller than is being talked about. When each one of the negative feedbacks is considered and discounted, they say, "Well, how about this one?" As yet, however, no one has seen what the huge negative feedback is likely to be from the changes that we have seen in the climate system.

When a volcano erupts, that creates a sudden change in the climate system. There have been predictions of what that would do to the temperature of the earth and those predictions have been just about right—they suggest that we are not too far off the mark. However, that involves a shorter timescale. On the longer timescale, I would be surprised if we are missing too many negative feedbacks. There is just as much chance that we are missing positive feedbacks.

Nora Radcliffe: The other thing is that the feedback might suit the system but not necessarily humankind.

Professor Hoskins: Yes, that is right. One of the feedbacks that people have wondered about concerns whether, as we stoke up the climate system, there may be more bubbling in the tropics but more descent in the sub-tropics, so that they dry out, leading to a negative feedback. Again, however, it does not seem that that is too important.

10:30

Dr Pope: I will give a bit more detail on feedback. People might have seen the "Horizon" programme on global dimming last week, which studied the impact of particles on the atmosphere. The particles reflect sunlight. Also cloud droplets form around them, so less sunlight reaches the surface. These processes are now being included in our climate model and in other models. They suppress the signal of the climate warming, so warming does not happen as quickly. When we clean up the atmosphere, which is what is happening now, particularly in the developed world, we get enhanced warming, because we have not got the cooling effect of the particles. That is one example of a feedback that we have taken into account.

Another example is the carbon feedback. Carbon dioxide is absorbed by plants and into the ocean carbon cycle. If we take account of that in the models, we find that we get enhanced warming, because the carbon dioxide absorption is dependent on temperature. In the case of aerosol, warming is slowed down, but when it is taken away the temperature rises; in the case of the carbon cycle, when it is included in the model, it speeds up the warming.

These are examples of feedbacks that have been included in models in recent years. Of course there is potential for other aspects to be included. These areas of science are still under development, so there is uncertainty about the magnitude of the changes, which makes them difficult to predict.

The Amazon rainforest was mentioned. That is part of the carbon cycle feedback. If the rainforest dies back, it releases carbon into the atmosphere. In our model, we found that the die-back was severe. Other models do not find such severe die-back. That is another area of uncertainty, which we are considering actively. The point is that a strong warning has been given, but I do not think that we can say with any certainty that a particular change will happen or what its magnitude will be.

Karen Gillon: My question moves us on from here, so I will let others raise points on this area of evidence first.

The Convener: Okay. I will take a couple of brief points from Fred Dinning and Brian Hoskins. We will then move on to the impacts on us in Scotland. Mark Ruskell also has a brief point to make on the science.

Fred Dinning: I have a brief observation to make. I am a lay person in relation to climate modelling, but I have a scientific and modelling background. On abrupt climate change, I am comforted, but not wholly. There appears to be evidence of rapid and substantial climate shifts

having taken place in the past—others will be much more familiar with the ice-core information than I am. It is difficult to model something if we are not sure of the mechanism by which it has taken place. Therefore I am possibly less comforted in relation to the risk of a rapid shift arising from a particular phenomenon or effect about which we are not sure, although we know that such things have happened in the past. Will you comment on that?

Professor Hoskins: I am happy to do so. In another forum many years ago, with Margaret Thatcher at the other end of the table, I talked about the joker in the pack. If we do not understand the system perfectly, we cannot say that something will or will not occur. What I was saying earlier was that I do not think that we need to say there is a threshold as an imperative for action. I was not trying to discount the idea that there are thresholds. There could well be local if not global thresholds. If we are sitting at a particular point and things change pretty suddenly, that seems like a threshold. There is no need for a global threshold to be passed for change to be important and abrupt as far as we are concerned. I was going to go on to talk about ideas of what the climate change is likely to be in our region. I do not know whether you wish to get into that at this point.

The Convener: I want to take a couple more science questions or comments first.

Mr Ruskell: It is clear that there is a consensus among scientists and Governments internationally that climate change is real, although there is perhaps less certainty about what the exact effects will be in the decades ahead. However, I want to get down to brass tacks on the science. Which sectors of society in Scotland and around the globe are making a greater contribution to the greenhouse emissions that are driving climate change? Which areas should we target for the reduction of emissions?

Professor Hoskins: The Royal Commission on Environmental Pollution found that the area is not one for which we can identify a technological fix or solution by targeting just one sector. We must take account of the situation across the board. There are areas that are growing rapidly, in relation to which there seems to be much more difficulty in finding a solution. Transport is a predominant area in that context. Transport is growing rapidly and it is perhaps the last sector in which the alternatives to fossil-fuel burning might easily come into play. It is certain that large efficiencies could be made and that there could be modal changes, because certain means of transport are much worse than others. We must pay attention to transport, but I do not suggest that there are easy alternatives.

It is clear that we must take account of energy production. We considered the alternatives and the number 1 priority, before we even consider other measures, is to recognise that we must be miserly with the energy resources that we have, wherever we use them. We must ask ourselves, "Do we have to do this? If we do, can we use less energy—in particular less fossil fuel—to do it?" Then we must consider how we produce the energy and whether there are alternatives to fossil fuels.

My answer has been rather general, but I do not want to identify particular sectors. In some sectors that are growing rapidly the situation is more difficult. For example, it is clear that action can be taken in the housing sector, which we might discuss later. The situation is all-embracing; there is no single fix and we must consider in which sectors it might be easier to take action.

The Convener: We will definitely return to the concept of "miserly" use of energy—or sensible use. Four panel members want to comment on the science, but I ask for the briefest of comments, because I want to focus on the Scottish issues that we need to be aware of in the context of the impact of climate change.

Dr Allen: I make a brief, general point, which relates to the discussion about abrupt climate change. I remind the committee that the United Kingdom signed up to the precautionary principle at the earth summit in Rio in 1992. The principle is that if there is a risk of serious or irreversible environmental damage, the lack of full scientific certainty should not be a ground for avoiding appropriate actions. I have considered the evidence and there are very serious foreseeable risks, some of which might be irreversible. That should spur us on to take appropriate action.

The Convener: Does anyone disagree with Dr Allen's remarks? I would like us to capture that thought, which is a good point at which to end that part of our discussion.

I want to move on to consider the key impacts on Scotland of climate change. We have talked about global issues, about the difficulty of being certain that we are at a tipping point or certain about how soon we might reach that point, and about how different parts of the world might react differently. One of the committee's jobs is to consider what should be happening in a Scottish climate change programme. What are the panel's views on the potential impact on Scotland of climate change during the next 25 years, 50 years, and 100 years and beyond?

Dr Dixon: Perhaps I can lead us into the discussion by showing how the Scottish temperature records confirm what the model suggests. The Met Office's comprehensive series of temperature records for the Scottish mainland goes back only as far as 1961. The records

indicate that the warmest year was 2003 and the second warmest was 2004, which was also the third wettest year. I am sure that we will hear more about the predictions of climate change, which are broadly that Scotland will become warmer and wetter, which appears to be exactly what we are witnessing. The eight warmest years were in the past decade. There is no question but that Scotland's climate, as measured by that series, is quite different now from what it was only 40 years ago. A piece of work has been done carefully to reconstruct, using individual temperature records from around the country, the temperature record for Scotland going back to about the 1860s. That work indicates that we are very much in the warmest period since the 1860s. That is the temperature evidence, which links up with the predictions to suggest that we really are heading for warmer, wetter conditions.

Maureen Macmillan: Have we also had stormier conditions? We talk about warm and wet, but what is the record on storms?

Dr Dixon: I am not an expert on that. I am sure that there will be more global evidence, but storminess seems to be much harder to measure, so the evidence is a bit less conclusive. There have been some pretty tremendous storms recently, but there have been such storms in the past as well. We expect stormier conditions and a sea-level rise means that a storm at the coast is likely to have a much more severe effect. Even if it is not really stormier, the fact that the sea level has risen means that the impact might be greater. We expect more storminess, but in Scotland the statistics would say that the jury is still out; we cannot confirm it yet. I am sure that we can hear more on the UK statistics though.

The Convener: Dr Pope, do you have both UK and Scottish perspectives on this?

Dr Pope: I do not have figures for storminess on that smaller scale, but we have looked at northern Europe and found that the number of stronger storms has increased over the past 50 years. However, over the previous 50 years the number decreased. That is an example in which natural variability is important. It is difficult to distinguish between the natural variations and any possible climate change. We have to say that the jury is out on whether climate change is making any difference to the number of storms. It is also difficult to predict what the changes will be. Brian Hoskins mentioned that the storm tracks—the direction in which storms go—can change quite significantly. That in itself would have an impact. The models disagree on how that will happen—we need to improve our modelling to measure that.

There are indications that the number of storms generally—both the mid-latitude storms that affect us and the tropical storms and so on—will not change very much, but it is possible that the intensity will increase. There will be fewer of the weaker storms and more of the stronger ones. It is one of the most difficult areas to predict. We can be much more confident about temperature changes, and to some extent about rainfall and snow changes, than we can be about storm changes. However, when we add any changes that there are in storms into sea-level rise, we see that coastlines will be much more affected in areas where there are storm surges. That is another area that we need to worry about, and it is one where we are trying to quantify the uncertainty in the predictions.

The Convener: Is that particularly an issue for us in Scotland? One of the issues that formed a backdrop to our debate last week was the horrendous storms in the Western Isles. There is no body of Scottish research on that. Is that something on which the Scottish climate change study should focus? We know that the west coast will get wetter and that the east coast will get drier, but do we need more work to get further evidence on storms rather than just temperature in Scotland?

Dr Pope: The modelling effort is an area that we are trying to improve. We are actively working to quantify uncertainty. We do regional modelling, where we consider what is happening in much more detail. I have shown some examples of the UK climate impacts programme reports in my submission. The UKCIP used output from our regional model to show changes in rainfall and temperature. I should point out that that is from one set of model simulations. It includes different emission scenarios, but it does not include different models. The result that it will be wetter in one part of Scotland than another may well vary from one model to another. What we hope to do for the next UKCIP report is to consider the range of possible behaviour—to consider the uncertainty—so that we can give more of a risk assessment on different changes. I should also point out that although the weather will be wetter in winter, it is likely to be drier in summer. That is another factor to take into account when water resources, for example, are being planned.

10:45

Dan Barlow: I have reflected on what was said earlier. I fully concur that it is difficult to identify any singular weather-related event and attribute it to climate change. However, at the end of last year, research by the UK Met Office, which appeared in *Nature* journal, looked at models with different emission scenarios and suggested that the 2003 heat wave, which resulted in the deaths of many people, had been at least twice as likely to happen as a result of human-induced climate

change. The researchers' best estimate was that it had been four times as likely to happen.

I return to the subject of thresholds, which we were discussing earlier. In some way, the research suggests that we are already crossing unacceptable thresholds at the moment. People died as a result of an extreme weather event, the increased occurrence of which a research model has attributed to emissions. I accept that the research focused specifically on the 2003 European heat wave. However, we may see further evidence that allows us to pick out a specific event and, once again, attribute it to the effect of human influence on the climate system.

Rob Gibson: Although I understand that we have to adopt an across-the-board approach to the subject, particular areas of society and parts of the country will be more affected by climate change than others will be. I am old enough to remember the massive storm that hit Glasgow and other places in 1967 and which destroyed a lot of the city's infrastructure. How do the experts view the way in which areas of society and geographic areas will have to cope with the largest impacts of climate change?

Dr Allen: Clearly, we should be particularly concerned about low-lying coastal areas and river corridors. In the Scottish Executive study in which we participated, many of the most concerning impacts for Scotland were from flooding and coastal inundation. In several parts of Scotland, important transport corridors—trunk roads and rail links—run close to the coast and there are also important coastal installations, including power stations.

Mr Ruskell: I want to move on to ask about other impacts. It is clear that the top line for the Scottish Executive is not sustainable development or tackling climate change but the delivery of unlimited economic growth. I will direct my question first to Alan Mitchell from the CBI. What impact in general terms might climate change have on economic growth in the decades ahead? I am thinking of the costs that businesses will incur and in particular of the impact on our growing insurance sector. How will climate change affect our economy in Scotland and the global economy?

Alan Mitchell: Clearly, the impact that climate change will have on business will be similar to the impact that it will have on other sectors of society, in that it will be variable. To that extent, some companies will be winners and others will lose out quite badly. Clearly, there will be opportunities for businesses to gain from the change.

You mentioned insurance. I agree that insurance premiums will go up and that that will have an impact on companies, but the increases will produce benefits for the insurance sector. Another issue that has been highlighted is the opportunity for business to develop new technologies to try to combat climate change.

I challenge what you said at the outset about the Executive's goal of economic growth. I may have misheard what you said, but I thought that I heard the word "unfettered".

Mr Ruskell: I said "unlimited", by which I meant that the Executive does not have a cap or a target for Scotland's economic growth; it is clear that we are going for maximum economic growth.

Alan Mitchell: Well, that is—

Mr Ruskell: Unless, of course you think that there should be a limit on economic growth.

Alan Mitchell: I would simply make the point that many of our members would argue that the Executive's goal is not unlimited economic growth. Although the Executive has said that it has a commitment to economic growth—measures that will help to achieve that are certainly being taken, some of which we may discuss in the context of the impact on climate change—there are many areas in which its policies remain unhelpful from an economic growth point of view. The business community would question the extent to which the Executive has its foot on the gas as regards economic growth and is ignoring all other considerations, including those of the environment and climate change.

Dr Tipper: I would like to point out that as well as considering the impacts of climate change on the Scottish landscape and the physical area of Scotland, we should consider the impact on the Scottish economy, bearing in mind the fact that we are part of a globalised economy. If there are disruptions to the climate that affect global food supply and energy prices, for example, there could be important consequences for Scotland even if the climatic effects are not felt directly here.

The Convener: I wonder whether Charlie Woods of Scottish Enterprise wants to come in on that. To what extent have you thought about issues such as flooding, transport links, food supply and energy prices? Alan Mitchell said that there would be winners and losers and Dr Tipper has said that we could face some big challenges. Has Scottish Enterprise considered what things we must avoid and what opportunities there are over the next 20 to 30 years?

Charlie Woods: We have probably not done so on such a systematic basis as you suggest. However, we are thinking about such issues. Just as the climate systems are difficult to model because of the complexity of the feedback loops and so on, the economic system is difficult to model. There will be all sorts of effects on some industries, not just as a result of things that happen in Scotland but, as Dr Tipper said, as a

result of things that happen elsewhere. We need to consider the effect not just on Scotland but on the global economy, because that is the environment in which we operate.

We are trying to focus on recognition of the fact that there are many trade-offs to be made between guarding against further climate change through environmental protection and encouraging economic growth. We need to examine the areas in which there are obvious overlaps—areas in which steps can be taken that both benefit the economy and improve the environment. The most obvious example relates to Professor Hoskins's reference to being miserly with energy. We should consider how to increase the efficiency with which businesses use resources because of the effect that that will have on the environment and the businesses themselves. There is no question but that the two themes are closely interlinked. We try to keep a close eye on that connection and relate our programmes to it.

Dr Allen: I echo Richard Tipper's comments that climate impacts are global and that we should not focus too much on exactly what will happen in Scotland. We should realise that impacts elsewhere in the world could have a significant effect on Scotland.

We anticipate that there will be significant declines in agricultural productivity in the tropics that will affect food commodity prices. As a result of the predicted significant drying in semi-arid countries, many countries will face severe water stress by 2050. We expect that geopolitical tensions over water will increase in sensitive regions such as the middle east. There could be huge coastal inundation events in places such as Bangladesh, where millions of people are vulnerable to the effects of climate change. Will the global community stand by? How will it respond and what role will Scotland and the UK play? Climate change can be seen as being a threat to global security. When we are thinking about whether we should be taking action or deciding on the strength of the action that we should take, we must be aware of the global dimension. Scotland is not an island unto itself.

Dr Dixon: To add to that, I will introduce two examples—one global, one local—from the insurance industry. About four years ago, the insurance industry examined the rate at which claims were rising because it was concerned that it would have to pay out huge sums of money when places such as Florida got hit by hurricanes. It extrapolated that if the claims continued to rise at the rate at which they had been, the world would be bankrupt in not too many decades' time. Obviously, that is quite a significant impact on the global economy.

At the more local level, there are businesses operating in Elgin today that have no insurance because they have already been flooded and either cannot afford or cannot get insurance. Their livelihoods will disappear the next time there is a flood in Elgin. We have not quite reached the stage—although we soon will—at which such businesses will not be able to operate in even that sort of risky situation because the bank that gives them their overdraft facilities will withdraw those facilities as soon as they lose their insurance.

There are people in Scotland who are living on a knife edge, simply waiting for the flood that will make their home or job disappear. On a global scale, the insurance industry is taking climate change seriously and saying that the problem is so great that the world cannot afford to let it get much worse.

Mr Ruskell: I am not an economist, but I would say that if the costs of dealing with climate change start to increase beyond the increase in economic growth, globally and in Scotland, we will face a serious economic problem.

On the issue of opportunities, surely the Kyoto agreement, to which 136 countries have signed up, presents Scotland with a massive market for Scotland's climate change mitigation services and goods. What is your impression of the size of that market? Dr Mitchell, do you think that there would be an advantage to Scotland in our being a market leader in this area and showing that we can develop the kind of technologies that are needed to tackle climate change globally?

Dr Mitchell: The CBI has not done any detailed research on that issue to examine the opportunities. However, there is no doubt that there will be opportunities for the smartest, the fleetest of foot and most innovative of Scottish companies to create global markets for themselves. We have to realise, of course, that the smartest and fleetest of foot companies in the other 135 countries that have signed up to the Kyoto treaty will also be looking for those opportunities. However, what you suggest can be done is possible. Scotland has innovative, world-leading companies in many areas and there is no reason why we cannot develop the same in the climate change area.

I do not know how big the market is. Clearly, some Scottish companies will do well while others will not and the Executive will have a role to play in putting in place measures on research and development and ensuring that its existing schemes are more effective and user friendly. Some businesses will take advantage of the great opportunities that exist and some will not. That is the nature of businesses. Some are better than others at taking advantage of opportunities. However, the main issue is that our businesses must work closely with the politicians to ensure that the Executive offers the necessary support to

ensure that our businesses can move more quickly than those in other countries.

We can do what you suggest, but we should not overestimate the extent to which we can achieve that.

Mr Ruskell: We need to estimate what we can do before we are even in a position to overestimate.

Dr Mitchell: We should not overestimate what we can achieve or what the benefits to business will be relative to, for example, the disadvantages of over-regulation to solve the problem. It is important to strike a balance.

Richard Lochhead: I am interested in how Scotland is preparing for climate change. Richard Dixon was outlining things that could happen in Scotland and talking about what has happened in the past. Part of our inquiry's purpose is to hold the Government in Scotland to account and to try to learn lessons. Are there any lessons that we can learn from how other countries in Europe or the rest of the world are preparing for climate change? How does Scotland's record compare with that of other countries?

11:00

The Convener: Would anyone like to hazard an answer to that? We do not need to complete the answer to the question today.

Professor Hoskins: Denmark saw the opportunity for wind power and went for it. That is the sort of opportunity that was discussed earlier. The industrial revolution was based on our realisation that we could use fossil fuel; we should now be on the verge of something that goes beyond that. Denmark saw the opportunity for wind power and cornered the market in it. Other countries, such as Germany, have also seen opportunities and are going for them.

We must say firmly that, for the countries that are signed up to the Kyoto agreement, the only way forward is if the developing world has the cleanest possible technology. It is up to us to develop that technology to give to those countries. The Americans will not do that because they are not on board.

Karen Gillon: In the past two years in Scotland, whenever the heat has come on in relation to wind power, the foot has come off the gas and the political imperative has not been to support wind energy, because there must be something wrong with it. I am conscious that it is 11 o'clock and that my point leads to the next set of issues, but when we come up with a potential solution that the public do not like because it may have an impact on them, politicians say, "Oh, oh! We need to back off," even though it is the right thing to do. If voters do not like a measure, we are not prepared to take the hard political decision and press ahead with it.

The Convener: Brian Hoskins and Charlie Woods want to speak. I ask Charlie Woods to start, because there have been a couple of questions about the extent to which we are gearing up the economy to get ahead of the game and make the most of the opportunities.

Charlie Woods: I have a general point that relates to Scotland's position in the global scene. [*Interruption.*]

The Convener: That was just a test of the fire alarm. Go ahead, Charlie.

Charlie Woods: The fundamental economic point is that the external costs are not properly priced in decisions that are made on consumption or investment. As the global economy becomes more integrated, the work that needs to be done to ensure that that happens must be done globally. If one country operates too far out on its own, it will put itself in an uncompetitive position globally. As Karen Gillon rightly said, much of the burden of that process will fall on consumers, which makes it politically sensitive. It is important to change consumer behaviours and perceptions.

The big measures need to be taken globally, given that we are operating within a global system, but many measures can be taken locally, particularly those in relation to resource productivity and looking for opportunities that the changes throw up. The investments that the intermediary technology institutes will make in renewable energy and the work of the Orkney wave energy test centre and the Scottish fuel cell consortium are attempts to get ahead of the game and look for opportunities of which Scottish firms can take advantage. We should do more of that.

The Convener: I will give Brian Hoskins the last word on this issue.

Professor Hoskins: My comment is very much an 11 o'clock sort of one, in response to Karen Gillon's earlier point. The particular challenge is how democracies, with their timescales of a few years, can handle an issue that is serious, but which has a timescale of decades and may relate to someone else in another country. As she said, when decisions may affect people now, politicians too easily run away from them and leave the matter for five years. That cannot continue.

The Convener: I will wind up the discussion. Before we started today, I accepted that climate change was happening, but it seems that more work on regional impacts is needed. I was struck by Dr Allen's point that even if we had a strategy in Scotland that focused on what we could do, events elsewhere that we have not factored in might impact on the food supply. We must think

about the science and the potential impact of climate change in Scotland, but at no time should we lose sight of the wider global impact or the wider global agenda, which Charlie Woods mentioned in relation to the economy.

We will return to those issues, but I want to let them swirl around in everyone's brains for a few minutes. We will have a 10-minute break, after which we will consider actions that we can take to stop climate change or prevent its acceleration and how Scotland needs to adapt.

11:05

Meeting suspended.

11:18

On resuming—

The Convener: We finished the first half of this morning's session in agreement that there is such a thing as climate change and that we have to do an awful lot more work to investigate its potential impacts. In the next hour and a half, we will consider mitigation and adaptation. What do we need to do in Scotland to slow down or prevent climate change? And, regardless of what we do now that may have an impact in future, how do we need to adapt in order to deal with the climate change that we may already be experiencing? We will begin by concentrating on mitigation. How can we slow down or stop climate change?

Dan Barlow: We need to do much more than we are at the moment. It is now acknowledged that, although the United Kingdom might be on track to meet its Kyoto target, it is certainly going to fall short of its own target of a 20 per cent cut in carbon dioxide in that period. The reduction in emissions that Scotland has achieved so far has been less than half of the reduction of the UK as a whole. We have to acknowledge that we are not doing enough. We need to turn things round; the current review, and the consultation on the impacts of the current climate change programme, offer us the opportunity to do that.

Karen Gillon: I want to go back a step and ask the simple question: can we stop climate change, or can we only reduce it?

Professor Hoskins: We can limit climate change, but we cannot reverse what we have done already. If we go for business as usual and burn all the fossil fuel that we think we can dig out of the ground, we are destined for something unimaginable.

The question that we have to answer is at what level we try to limit climate change. Politicians would like scientists to tell them the safe level. However, we find that very difficult, because to do so would be to suggest that below a certain level was safe and above that level was dangerous, whereas there is a continuum.

The royal commission looked into this four or five years ago. If we are going to stabilise climate at anything like a reasonable level, CO_2 emissions in 2050 cannot be any greater than they were in 1990 or are now. That in itself is a huge target. It would mean a 60 per cent reduction in our CO_2 emissions per capita. As to whether that target really should be 70 per cent by 2050, who knows? However, at this stage we can say that we cannot wait until 2045. Although we might change it later, we have to set the target now and say what direction we are taking.

There is general scientific agreement. It seems impossible that we can limit CO_2 to below 400 parts per million. However, even if the limit has to be higher than that, the lower it is the better. We should certainly not be above 550ppm. Beyond that level, it gets increasingly dangerous.

By our actions we can limit climate change. However, we can do so only if we start to limit our CO_2 emissions now and in the next decade.

Karen Gillon: The follow-up question, which I want to ask everyone at the table, is this: what does this mean for the man in the street? What does it mean for consumers, businesses and the public sector? Rather than talking about the theory, what actions do we need to take to change where we are and get to where we want to be—not just for Scotland's sake, but as part of our international obligation to the rest of the world?

Dr Tipper: That is a very useful question. A key problem in dealing with climate change is that we have no single technological solution at our disposal. With sulphur dioxide from power stations, there was a technological fix. It had an identifiable cost that could be engineered in. With carbon dioxide and other greenhouse gases, a wide range of technologies can be applied, but they all have their individual limits and their associated impacts—as has been mentioned, wind turbines have a visual impact on the landscape. The technologies have economic implications. We do not have a single solution that is easy to present to the public.

There also does not seem to be a simple policy fix, because of how society uses energy and the way that ownership and decisions on consumption are distributed. The industrial sector has often been attacked by policy makers as a dirty industry. However, in many cases, industries are simply producing products, services or electricity that consumers want. There is also a complex value chain from business-to-business suppliers. Unfortunately we are not dealing with a simple set of policies that can be deployed, or with a simple

set of technologies. That is the issue and anyone who proposes a simple policy or technology solution will find it difficult to make it effective.

The Convener: I am going to try and work around the table in a fair way. Richard Lochhead is waiting to get in with a question at some point, but I will take Richard Dixon and Fred Dinning briefly and then Richard Lochhead.

Dr Dixon: You will see from our submission that we have had consultants look at the success or failure so far of the Scottish climate change programme. We have expressed the results in simple terms, using smiley faces and sad faces. Adding up those faces, in a trivial way, shows that there are five smiley faces out of 20, so the Executive has delivered on five of the things its 2000 strategy promised. On 11 commitments there has been no, or close to no progress. Halfway through the term of this programme, which is supposed to deliver some unspecified amount of reduction by 2010, we are less than halfway towards completing it.

There are also significant gaps in the strategy. There are areas that are hardly covered, such as transport. There are only very minimal commitments on transport in the programme, but it is clearly a big and growing source of emissions. In the UK, transport will overtake the power sector as the chief source of climate change emissions sometime in the next 10 years. There are also significant gains to be made on waste, but there are no real commitments on waste in the climate change programme. The Scottish Environment Protection Agency suggests that if we do the right things with waste, we could save the equivalent of 2 million tonnes of carbon per year. That means that something of the order of 10 per cent of Scotland's emissions could be saved by doing the right things instead of the wrong things with our waste. That stuff is all significant, but it is not covered by the climate change programme.

The first message is therefore that we have done pretty poorly on the programme that we have set ourselves, and there are still some gaps in that programme.

Karen Gillon's question was about what that means for the person on the street, and that is the key issue. At the moment, whoever you are—a person on the street, an MSP, a business person or a farmer—you do not know what is expected of you in the area of climate change. We do not know how much Scotland is going to do and we do not know how much each sector within Scotland is going to do.

For a long time, we in the environmental groups have been pushing the idea of targets for Scotland so that we would know where Scotland is going and what is expected of the individual sectors. As someone who works in an office, I would know that my office was expected to save a certain percentage of CO_2 or climate change emissions by 2010. The MSPs would know that the Parliament building was expected to make a reduction of a certain percentage in the coming years.

That kind of clarity is missing and that is why the person on the street has no idea of their duty. Even if they understand that they help to cause climate change because they use energy in the home, at work, in schools, in shops, or as they drive about—and they do understand that a bit—they have no way of telling whether they are doing enough and making a fair contribution or not.

Some people have argued with targets. It is certainly true that naming a figure for Scotland would be quite complex, but any good business sets itself targets for things that are important to the functioning of that business. This is the big issue for the environment in Scotland and it seems to me that the Executive must name that figure. It must say, "By 2010, we aim to have this much less CO_2 and this lower level of other climate change emissions in Scotland".

That is complex because some of the levers are controlled by European policies and some are controlled by UK policies. However, many levers are controlled by the Scottish Parliament: transport, building regulations and almost all of environment. Members will know the list well. There are therefore a great many things that the Scottish Parliament and Scottish Executive control and it seems to me that, taking the European Union's promises and what the UK says that it will do, it would be easy to estimate what Scotland could add to that to get a final target for Scotland's contribution in 2010.

We need to acknowledge that, as Dan Barlow said, the UK is not going to meet the 20 per cent target for CO_2 that was promised by Labour in 1997. It is certainly the case that, starting from much further behind, Scotland cannot do it. The minimum that Scotland should think of doing in the period up to 2010 is to go about twice as far as we have, and meet the 12.5 per cent target for all climate change gases that is our European target under the Kyoto protocol. Then Scotland could hold its head up and say, "We have done our bit as a nation. We have done our bit as part of the UK to make the right contribution to Kyoto." After that, Scotland could aim to accelerate and be a leader. Because we have so much in the way of natural resources in renewable energy, we could be a leader in the charge towards the 60 per cent or more reduction that is needed by 2050 for the UK.

11:30

Fred Dinning: Richard Dixon has raised many issues on target setting, which I will come back to later, but I will go straight to my substantial point, which complements what Richard said. It is about what we can do, and it draws heavily on the royal commission's four illustrative scenarios for how we might achieve the 60 per cent target.

As a scientist and an engineer, I am struck that there is no particular problem in achieving a 60 per cent reduction in emissions. We can go down a range of different routes. If we want to do it by renewable energy—a combination of wind, wave, biomass, tidal barrage and solar—we can do that. If we want to go down the route of limiting the amount that we need to do, we can go for intensive energy efficiency. A number of studies, not just the royal commission's, all point to the fact that at least 40 per cent of energy could be saved, and the vast majority of that cost effectively. If we want to go for larger scale technologies, we can go for coal or natural gas with carbon capture and disposal to the exhausted oil reserves in the North sea. Scotland has a huge resource there. We have a huge resource in the potential to sequester carbon dioxide.

I should have pointed out as I went along that Scotland has a huge resource in renewables. We have a huge potential to improve our housing stock. And, of course, we have nuclear expertise if we want to go down that route. The question is not whether we have the technologies and the capabilities. Speaking as a practical engineer in a major company, I think that the royal commission wisely restricted itself to what it knows we can do. It did not rely on a magic bullet that might turn up, like the hydrogen economy. To its credit, it based its work on known technologies that have gradually emerged. For example, the first commercial clean-coal plants are likely to be built in the US in the next two or three years.

The issue is not which technology to use—this is the complementary part to Richard Dixon's observation—it is policy clarity. We have begun to go down a route based on renewable energy and energy efficiency. We have left the nuclear question open. We have left gas, carbon capture and coal largely open. However, we are beginning to see barriers to renewable energy, which Karen Gillon eloquently pointed out earlier. We are seeing a slow uptake of energy efficiency, because the imperative is not felt. I return to what Richard Dixon said. The issue is policy clarity and the removal of barriers. We have to make it clear where we are going, and choose from among the many possible options, because there is no lack of them. We must be set on a course and given some business certainty. We can tackle the problem in a systematic and practical way.

Richard Lochhead: One of the key themes in achieving the targets is the relationship between mitigating climate change and avoiding economic dislocation while doing it. There is a variety of political views in the Parliament on how to achieve targets, ranging from politicians who want to shut airports, ban driving, shut down the oil and gas industries and so on, to others who are anti-wind farm and pro-nuclear, as can be seen from the Conservatives' motion for tomorrow morning's debate. Is it possible to use all the resources that Fred Dinning referred to and achieve a cut in emissions to mitigate climate change without economic dislocation and without shutting down the airports, banning driving and so on? One of the key themes is how to achieve that while maintaining standards of living.

The Convener: Fred Dinning suggested that that is possible.

Fred Dinning: I will respond briefly to that. The royal commission did work on exactly that topic. I am sorry for pre-empting Professor Hoskins, who might like to give details from the study.

Professor Hoskins: I was going to speak about that. We certainly did not talk about shutting everything down. It is amazing where using less energy at a rate of 1 per cent per annum, for example, will get us in 40 years. Doing so will also make everything much easier. Reducing energy demand by only 1 per cent in the scenarios that are put forward makes all the difference.

We considered aviation and did not say that aviation should be shut down. We said that it cannot continue to grow at 5 per cent per year while everything else that is happening is ignored. We suggested that aviation growth should go hand in hand with the ability to reduce fossil fuel burning in aviation. It is a matter of not letting one sector go off and say that it is different. Society may say that something is so important that we should let it happen, but we should not simply let something happen as a result of not thinking about it. Perhaps we should say that aviation can expand, but only at the technological rate at which it is improving. Therefore, perhaps the figure should be 3 per cent rather than 5 per cent per year. It is not a matter of putting on our hair shirts and saying that we cannot do anything.

I wanted to give an example of how we use energy. When fossil fuel is burned in a power station, 70 per cent of the energy goes up in the heat that is lost in the cooling towers. Electricity, much of which is lost on the way, is then sent down the line into people's houses. If the housing is poor, there will be little insulation and cheap heating—that is, electrical heating. Electricity is then turned back into heat, which makes no sense whatsoever. Some 70 per cent of the energy has been allowed to go into heat at the power station,

most of it is lost on the way and a little bit is turned back into heat at the end of the process. We should ask what people want. They need insulated houses and heat. We should then ask what the best way is of getting heat for them. We should not simply say that we must do things exactly how we have done them before. It might be a matter of thinking slightly differently.

Fred Dinning: I would like to say something briefly. I will speak in practical terms. ScottishPower is rapidly moving into wind—we are currently the lead developer of onshore wind power in the United Kingdom—changing the role of coal from a base-load to a supporting role, and acquiring new gas assets to meet our growing customer base. Doing so means lowering our overall CO_2 emissions and building a wind portfolio. We are also building skills in energy efficiency. I am not talking about theory 50 years out and what we might do, but examples of how it makes a lot of sense for a business to do things now.

The Convener: I will try to be fair. Dr Allen wants to say something.

Dr Allen: I want to make a somewhat different point. I tried to highlight the importance of education, awareness and public attitudes in my submission to the inquiry. The Scottish Executive could play an important role in that context through the school education system and possibly through the university sector, although I am not sure what influence it has over that sector. To return to Karen Gillon's point, such things are important because the person in the street must believe that climate change is a serious problem on which we must take action and they must understand the role of their lifestyle choices in the problem. They must be able to see what choices they can make to reduce their greenhouse gas emissions. Therefore, education is important.

My submission mentions a piece of work by David Reay, who is a colleague at the University of Edinburgh. He showed that an average family could easily reduce their greenhouse gas emissions by 13 per cent—which is in line with the Kyoto target—by making some simple changes to how they live their lives. That target is easily achievable. In a more detailed study, David Reay compared the greenhouse gas emissions over the entire lifetimes of two people living in London, one with a greenhouse-gas-aware lifestyle and one with an energy-intensive lifestyle. He found that the greenhouse-gas-aware person could save 70 per cent of the emissions of the person with the energy-intensive lifestyle. Individual members of the public can make massive changes through their personal choices, but that will not happen until there is better awareness of the problem and the actions that can be taken.

The Convener: Is it possible for us to get copies of those two reports—"New directions: my own private Kyoto" and the longer-term comparison of energy-intensive lifestyles with energy-efficient ones? It comes back to Karen Gillon's point about what we can do as individuals. The do a little, change a lot initiative is meant to address such issues, but it is interesting to hear that a household can reduce its greenhouse gas emissions by 13 per cent. We would be interested to look at the reports.

Dr Allen: I can certainly provide them.

The Convener: That is great.

Dr Tipper: I will build on some of the comments that Fred Dinning and Professor Hoskins made on technologies. The Edinburgh Centre for Carbon Management is working with a number of businesses that increasingly regard low-carbon technologies as a real opportunity for economic growth, and I suggest that the Parliament considers how Scotland is placed to exploit the competitive economic advantages that it could have based on its resources for building world-leading, low-carbon-technology industries. I imagine that the wave and tidal power sector could be important because of the combination of engineering expertise that is available. If we were to go for geological sequestration, there would be big potential, building on the country's expertise in oil and gas exploration, to provide an infrastructure that could be expanded.

The Convener: This is a daft question, but will you put into simple language what you mean by geological sequestration?

Dr Tipper: Geological sequestration is the process of taking the carbon dioxide that comes, for example, out of a power station's smoke stacks, capturing it in a chemical form and pumping it down into a facility such as an ocean reservoir. There are many issues associated with the process. It has been done experimentally in a number of areas and it is one of the promising technologies that could be used.

Alex Johnstone: Is the infrastructure not almost all there?

The Convener: Geological sequestration has been written about, but the term is not instantly recognisable to most people. Is the idea that we pump the carbon dioxide back down into the empty oil fields, to put it crudely?

Fred Dinning: The process is in operation in a number of areas, such as Weyburn in Canada. Carbon dioxide is extracted from a combustion process in the United States, piped across the border into Canada and injected into an oil well, which enables more oil recovery. The process is called enhanced oil recovery.

The United States Government has a clean-coal programme called FutureGen, in which a consortium of a number of major companies, including ScottishPower, is exploring the development of a gasified coal plant, in which the coal that is used would be turned into gas. It is easy to remove the carbon-bearing parts of that gas and take the carbon dioxide elsewhere. A number of manufacturers in the US are looking towards building consortia to offer such plants as commercially viable projects. ScottishPower has had commercial discussions with them, and we anticipate that the technology will be deployed in the US within the next four or five years.

The Convener: Is there a catch?

Dr Tipper: Before I answer that, I will add to what Fred Dinning said. BP is also doing work on geological sequestration off the Norwegian coast, so the relevance to the Scottish oil and gas sector is apparent.

You asked whether there is a catch. There are two issues. One is cost, which I imagine will be addressed by technological developments; there is an energy cost to geological sequestration, which means that, in some contexts, Governments will probably have to intervene to make it economic. There is also an issue with the long-term safety of storage. That is not only a matter of achieving such safety technologically, but of convincing the public and concerned stakeholders of it. That is an area of continuing research, which is why the current facilities are test scale. Geological sequestration is an emerging technology, and it is important to note that every technology has its limits.

Another area in which Scotland can excel is in the design of wooden infrastructure—we can see a lot of it in this committee room. Every tonne of cement that is replaced with timber avoids the need for about 2 to 3 tonnes of CO_2 emissions. Scotland now has leading manufacturers of wood-drying technologies, which can be used in the formulation of pre-constructed building elements. Such elements could be used if the UK's large building programme switched to more sustainable building materials. That is another area.

There is a raft of potential technologies in which Scotland should aim to lead. I recommend that the Parliament look at how Scotland can place itself advantageously to develop those technologies.

11:45

The Convener: I ask Karen Gillon and Alex Johnstone to keep their follow-up questions brief.

Karen Gillon: If that stuff is pumped into the ground, does it go away or could it be let back out again somewhere along the line?

Dr Tipper: My understanding is that carbon dioxide can be stored underground in an inert form in such a way that it is likely to remain there, just as oil and gas remain underground unless they are deliberately tapped.

Fred Dinning: The British Geological Survey is involved in monitoring the Weyburn project. Whether carbon dioxide would remain stored, as natural gas and oil have done for millions of years, is a major area of sensitivity.

Alex Johnstone: Is Scotland missing an opportunity by not exploiting our biofuel technologies?

Dr Tipper: Biofuel technologies are a big opportunity in Scotland. I think that a study on the barriers to biofuels in Scotland has been commissioned to take place over the next few months.

The Convener: Three committee members want to ask questions, but we must move on. Is Rob Gibson's question on a different topic?

Rob Gibson: My question follows what Dr Tipper said.

The Convener: Okay. Mark Ruskell wants us to move on to a different topic, but I need to allow Charlie Woods and Brian Hoskins the chance to respond. I ask Rob Gibson to be brief.

Rob Gibson: An important area in which we have not done well concerns our forestry strategy and land use. The need to make greater use of timber ought to spur us on to producing a better forestry strategy. The issue is particular to Scotland because disturbing our high-carbon soils creates extra emissions problems. How can forestry help with that? We can see that there are opportunities for using wood, but what about the forestry strategy, which is an area where the Executive has not exactly shone?

The Convener: That is a totally new subject.

Professor Hoskins: We considered forestry in the context of biomass for energy, which links in with my previous comment. The main use for biomass is to produce low-grade heat. It is much better to use biomass for that than electricity or whatever because the heat can be produced locally and used locally. Biomass is also a flexible renewable, in that it can be used when required, as it is not dependent on things that are sometimes there but sometimes not. Biomass certainly has a role.

Forestry residue could be the way to kick-start the biomass-for-fuel industry. Demand would need to be supplied by crops if the biomass industry got going in a big way, but crops take years to get going. Establishment of the industry will require work, but the forestry residue is already available

because of previous expansion of the forestry industry and because the level of demand for pulp is perhaps lower than it was in the past. Forestry residue could kick-start the industry, if only the plans could be put in place.

I agree totally with the comment about managing land in respect of run-off and carbon emissions from soil. On education, schools can play a leadership role by becoming really green buildings. If kids get involved and see processes in action, they will not see the processes as just something that is imposed by someone else but as part of their lives. School buildings that are built by the Government should demonstrate what is possible.

Maureen Macmillan: Although biomass, wave power and so on present business opportunities, it seems that we need to square a circle. I know that people are anxious to get on, but the market does not exist yet. Are Scottish Enterprise and Highlands and Islands Enterprise engaging in the matter? Are the Scottish banks willing to lend capital to allow green businesses to begin their work?

The Convener: It seems like a very good time to bring in Charlie Woods to answer those questions. I know that he has been waiting a while.

Charlie Woods: Perhaps I should first set the context. We need to use less carbon, to be more efficient with it and to be more innovative in grasping existing opportunities. We have tried to stimulate the market by sponsoring research at the energy intermediary technology institute, by supporting developments such as the European Marine Energy Centre Ltd in Orkney, by working with the forestry industry in Scotland on various issues including biomass and so on. After all, it is much easier to raise the necessary finance if we can demonstrate good market potential.

It is right to point out that, given some of the issues, we need to stimulate innovation, which should be at the heart of any plan to use less carbon or to use carbon more efficiently, which presents significant opportunities that we need to grasp.

My other point relates to Richard Lochhead's earlier question on economic dislocation. The risk of such dislocation will be reduced if we concentrate on measures that have environmental and business benefits. However, that risk will be reduced even more by the global context; we must make global changes that allow countries to change what they do without their running the risk of making themselves internationally uncompetitive.

The Convener: Could you not identify all the obvious win-win strategies first, carry them out and then tackle the difficult issues?

Charlie Woods: Absolutely.

Dan Barlow: I want to go back a tiny step and reiterate the opportunities that are presented. We are not suggesting that we should close down Scotland; instead, we should acknowledge that in tackling climate change we can address a number of other issues. For example, we need look only at areas such as energy efficiency that have the greatest potential but which have perhaps seen least progress. At the moment, a massive improvement in energy efficiency would mean a 30 per cent cost-effective potential. Besides reducing carbon dioxide emissions, such a step would help to alleviate fuel poverty and to reduce fuel bills. Moreover, if we achieved a modal shift in transport towards public transport we would improve air quality in urban areas, reduce the number of people involved in accidents and cut down the amount of time that we waste in traffic jams. Such approaches have huge benefits. The aim is not to close down Scotland, but to make Scotland better and to put Scotland more on track for meeting its obligations to reduce CO_2 emissions.

We have huge opportunities to develop renewable technologies; when those are developed appropriately, communities have plenty of opportunities to gain massive benefits from them. Those benefits can support community economic systems, which represent a much more sustainable economic model towards which we should work. In tackling climate change, we can not only work towards improving our track record and reducing emissions, we can also massively improve the quality of the environment for people who live in Scotland and we can participate in making much greater progress on a global issue.

Richard Lochhead: Most people keep repeating the words "opportunities" and "huge opportunities". Many of the opportunities that we are talking about will be driven by new clean technologies, but I find trying to identify what is happening in Scotland to develop clean technologies to be frustrating.

We know that research and development expenditure in Scotland is abysmal compared with other countries—investment here is far lower than in the rest of the UK and most other European countries. The element of clean technology R and D expenditure is tiny. Many companies are spending billions of dollars to develop clean technologies, but not 1 cent of their budgets is being spent in Scotland. How can we develop clean technologies in Scotland? A few energy companies are honourable exceptions; I am sure that ScottishPower will tell us that it is an exception. Does Scotland have the potential to have a centre for clean technologies? Is that in the pipeline? Does anyone have such a centre? How

can we make Scotland a leader in development of clean technologies?

The Convener: I ask Charlie Woods to talk about how much we are spending and what we are doing on clean technologies.

Charlie Woods: I will address both points. We must grasp opportunities. The rate of R and D expenditure shows that stimuli are probably needed, which is one reason why an important focus of the energy intermediary technology institute is on renewables. Other initiatives that we are pushing through in our energy team include the Scottish fuel cell consortium and work with Highlands and Islands Enterprise on the wave test centre in Orkney. A centre for clean technologies is an interesting idea to which we will give further thought.

I agree with much of what Dan Barlow said. An issue for us is the degree to which we should adopt special initiatives and to which we should mainstream measures in the nuts and bolts of what we do. For example, we have supported several special initiatives on energy efficiency, but we have also just completed development of a module on that subject for all our business advisers who undertake the premier adviser programme, so that when they talk day to day with businesses, energy efficiency and other resource productivity points are at the forefront of their thoughts.

Mr Ruskell: Much of what we have said about mitigation is summed up in Simon Allen's submission, which quotes the Sustainable Development Commission as saying that what is involved is not "crude trade-offs", but

"the pursuit of mutually reinforcing benefits."

That is extremely important, but we must also realise that some crude trade-offs are taking place between the economy and the environment. That applies particularly to the M74 motorway. Apparently, that motorway will have economic benefits, but we also know that it will have an environmental hit of an increase of up to 1 per cent in our climate change emissions. Some politicians will want to deny that, but we must realise that that is a reality. How do we make those crude trade-offs, if we must make them? Are those hits from large infrastructure projects such as the M74, airport expansions and the Aberdeen western peripheral bypass worth taking? Are the economic cases for those hits sufficiently well defined to enable us to make a proper judgment?

I am thinking about what has happened over the past 10 years. I remember protesting against the M77 motorway. One of the key arguments that was used to push through that motorway was the fact that it would deliver economic development to Glasgow. That was a convincing argument for many politicians, but what has been the result? What do we think will be the benefits of the M74? It is clear that there is a trade-off; we cannot ignore the fact that the trade-offs are real.

12:00

Alan Mitchell: I will respond on that, but I want to make a couple of comments about how we seize the opportunities. First, we must consider schemes that exist, such as research and development tax credits. We must do much more to improve the interface between business and bureaucracy so that we can improve access to such schemes.

Secondly, I state that the truth of the matter is that Scotland is not as entrepreneurial and innovative as it used to be. A big challenge for us is how we create more of that quickly enough to take advantage of the opportunities that exist. Many things now happen in schools in respect of enterprise education, but the benefits of that are too far down the road. The issue is a big challenge to us. I have no solution, but it is a problem that we must address.

On trade-offs, we know that congestion costs business money. It is hard to define other aspects of the trade-off. The Confederation of British Industry often asks what people from abroad look at when they consider Scotland as a place to invest. They look at how well developed the transport infrastructure is, but part of that is consideration of how well developed the road infrastructure is. It is hard to quantify what that means in respect of the threshold at which they will decide whether to come. The technology and innovation that we want often comes from companies that come to this country because they see it as a place where they can do good business.

Mr Ruskell: I am interested to hear the views of people around the table about how decisions are made within the Scottish Executive, which is a crucial issue. We are talking about trying to reduce climate change emissions and the impact of transport in particular. I acknowledge that ministers will have to make difficult decisions, but does the Executive have structures that enable discussions to take place between ministers in different departments?

The Convener: Charlie Woods might answer that question, but it is also a point to capture for when we have ministers in front of us. Everybody wants to speak now, so I will be brutal and move round the table, because I want to get us on to adaptation. I ask people to think about their concluding thoughts on how we mitigate climate change. I will try to take everybody who wants to comment. I want the focus to be on how we could slow down climate change.

Dr Allen: I will pick up on a couple of comments that Professor Hoskins made. I echo and support his suggestion that new schools should be environmentally sensitive buildings that demonstrate good practice. There are other possibilities in school design. For example, demonstration renewable energy projects could be incorporated into schools. It is important that schools take clear actions to address climate change because children are very good at spotting inconsistencies between what they are told to do and what they see their role models doing. The functioning of schools should be examined right down to promotion of walking, cycling and use of public transport. Energy efficiency should also be considered in the procurement process. Whatever can be done to reduce greenhouse gas emissions should be considered.

Professor Hoskins also talked about the potential for using biomass energy, particularly wood. I point out that in Finland, which has a large forestry sector, about 25 per cent of its energy is generated from wood, which shows what can be done. I flag up a piece of work that was done a couple of years ago for the Scottish Executive by the centre for the study of environmental change and sustainability. That work examined climate change policies in seven countries in the north Atlantic region. Several interesting points emerged from that work—which it is worth studying—including on much greater use of combined heat and power in community heating schemes in Sweden and Norway and the much greater thermal efficiency of buildings that results from tighter building standards in Scandinavian countries.

Denmark has done some interesting things to control emissions of methane from animal slurry and emissions of nitrous oxide from nitrogen fertiliser applications in agriculture. The Scandinavian countries face the same problems as Scotland over rapidly increasing emissions from the transport sector and they suffer from the same problem of highly dispersed populations. It is, therefore, probably worth monitoring what those countries are doing and seeing whether their best practice could be transferred to Scotland.

The Convener: We move on to Richard Tipper for ideas about mitigation.

Dr Tipper: Along with a number of local authorities in England, our centre has developed a methodology for assessing the greenhouse gas impacts of new developments, especially housing developments, out-of-town retail parks and car parks. Some local authorities in England are thinking of using such an assessment to set conditions for granting planning permission for new developments, which will require developers to implement internal measures to reduce greenhouse gas impacts, such as following design best practice and ensuring energy efficiency.

Those authorities are also thinking of ways in which to require developers to purchase some kind of certificates that would be generated by projects, perhaps internally within their areas. Those projects could be on things such as combining heat and power, provision of plants and use of biomass heating; that is, things that generate emission reductions. That would stimulate a small internal carbon market within those areas, which would encourage innovators to come up with new project designs and a way of financing them.

The Convener: We would be interested in that as a practical way of addressing climate change impacts through the planning system. Fred Dinning commented on the need to have a clear policy driver that is not just something that has to be agreed to but that can be translated into practical effects.

Dan Barlow: We need political leadership to set out exactly where Scotland thinks it is going and how it will get there. That is still lacking.

On Mark Ruskell's comments, it is right that when we make decisions we consider whether the climate change impacts of those decisions have been fully considered and addressed and whether alternatives have been considered. However, there are many examples in which that has not been done. There has, especially in allocation of transport expenditure, been a complete lack of consideration of alternatives to building roads. We should also evaluate investment in aviation against its contribution to Scotland's ability to meet its targets as and when it sets them. Such issues can be addressed partly through implementation of strategic environmental assessments, if we ensure that there is a robust process for that and for consideration of climate change implications.

We have a massive opportunity to increase energy efficiency, and we should urgently set targets for that. We must follow the lead that has been taken by many other countries and stop lagging behind. We should also recognise that, although we have a fantastic resource for generating electricity from renewable sources, there is greater scope beyond electricity generation. Electricity accounts for only one fifth of the total energy that is used, yet we have become fixated on developing that technology. Important though it is—I do not want to take anything away from it—we must move beyond finding renewable sources of electricity to finding sources of renewable energy, full stop.

The Convener: I ask Charlie Woods to wind up this section of the discussion, after which we will move on to adaptations. There are quite a few

economic issues. The comment was made that we should just aim for a 40 per cent energy efficiency target and apply that across the board. How would Scottish Enterprise identify opportunities to do that and make it work? I know that that is a tough question, but Charlie Woods is the only person in the room who is tasked with answering it.

Charlie Woods: The practicalities of that run through to the advice that we are giving to business through our business gateway and so on. I guess that that ties in with one of the points that the convener made. Let us start with the win-wins, where it makes sense both to business and to consumers to do the right things. Energy efficiency is obviously a key objective; there are many examples of small firms and large firms making large strides in cutting costs significantly in that area. That is the first point.

The second point is that, as Mark Ruskell said, we must think carefully about trade-offs and we must do the right cost-benefit analysis to arrive at conclusions. However, in doing that we must be extremely wary about the costs of taking unilateral action that might impact on international competitiveness. We can do loads in Scotland, but it has to be done in a global context.

The Convener: We have not covered everything under mitigation, and we could not possibly do so, but at subsequent meetings we will have to return to quite a few of the issues and consider them in more detail. I would like to push us on to adaptation. Karen Gillon kicked off the previous session by asking whether we can stop climate change. The answer, put crudely, was, "No. We can slow it down."

In the very first session on science, one of the conclusions was that climate change is probably happening now and will certainly happen over the next few years. What do we in Scotland need to do to deal with climate change if it is on the way already, never mind trying to stop it in its tracks in the future? We spent a bit of time talking about storms and, over the coffee break, Brian Hoskins said that we will not necessarily have more storms but that storms might be more severe and more difficult to deal with. Would Vicky Pope or Brian Hoskins like to comment?

Professor Hoskins: I am happy to come in there. We hear many predictions that everywhere in the world will become stormier, but I do not believe that that is the case. However, if there is one place about which there are good arguments that it could become stormier, it is probably Scotland. That is because the Atlantic is probably not going to warm up much, whereas the Euro-African continental area probably will. The temperature contrast is likely to increase and that is what the storms feed off. They also feed off the amount of water in the area and, as the atmosphere will be warmer, we can expect more water.

Taking those factors together, the expectation must be—unless the detailed models show otherwise—that we can expect stormier winters in Scotland. There may be differences because the storm track might shift slightly, but at this time we do not know about that, as Vicky Pope said. The science says that we should first go for a robust situation in which we can cope with variability. Secondly, we expect to have to cope with more extreme winter storms. In the summer, general warmth is all that we seem to be able to predict at the moment.

Dr Pope: At the moment, our models are not able to predict that there will be more storms. As Brian Hoskins said, it is likely that the strongest storms might be stronger, but the evidence is very mixed. In the regions that Brian mentioned, there is more likelihood that there will be stronger storms, but more work needs to be done on that. That is obviously a risk that must be taken into account, but we cannot talk about it with as much certainty as about other changes that we have discussed.

Mr Ruskell: I want to ask about the relative balance between the costs of mitigation and the costs of adaptation, because there is clearly a balance to be struck. To what extent do you see there being a trade-off between the two? Assuming that we can get effective mitigation, would that significantly reduce our adaptation costs in the future? I am interested in exploring that balance. We are considering how we balance the costs within a very long timescale—about 50 years—and it is clear that one will eventually have an effect on the other. I am interested in the different models that you have considered and whether there are different costs.

12:15

Professor Hoskins: I am not sure that I can say with my hand on my heart that we have considered the relative costs of mitigation and adaptation. Mitigation obviously relates to the global context, whereas adaptation is about what happens locally. Adaptation is mainly about our robustness to the environment. We cannot assume that the environment will be the same as it has been during the past 20 years, so we must ensure that we can deal with variation, in the expectation that the variation will be outside what has happened in the past 20 years.

Adaptation and mitigation are obviously linked in certain places, but they are very separate issues and I do not see them as being in competition economically—I suppose that I cannot really speak on the matter, but I find it difficult to see it in

those terms. The two areas are very different. Mitigation is about having a strategy for going forward that considers the entire economy and the use of energy. Adaptation is about robustness; it is about doing things on the ground and ensuring, for example, that we do not become a monoculture in agriculture, that we can cope with floods, and that we do not suddenly chop down all the trees and increase the likelihood of floods. Adaptation relates to such issues, which require us to consider whether we are making ourselves more or less vulnerable to extremes.

The Convener: Does that mean that both approaches are needed? We need a climate change strategy that encompasses mitigation and adaptation.

Professor Hoskins: We absolutely need both. The climate will change and we need to adapt to that. We also need to mitigate, to limit the extent of the change.

The Convener: That is a useful intellectual distinction. We need to prevent climate change as far as we can do, but we must also develop plans to deal with what we are pretty sure will happen.

Dan Barlow: I have two brief points. First, it is important that we work out how to adapt in a sustainable way. We must consider the types of defences that we should use. There are plenty of examples of adaptation mechanisms that were built but which proved to be flawed in the long run.

Secondly, when we consider mitigation and adaptation we should acknowledge that in Scotland, as is the case in many other developed countries, we might be better placed to consider how we spend money to adapt to the consequences of climate change. We must not lose sight of the fact that although we have resources and the potential to adapt, many of the countries that are likely to be most affected by climate change, such as the countries that are preparing evacuation plans, do not and will not have that potential. Our capacity to adapt must not detract from serious efforts to reduce emissions of greenhouse gas and to tackle sources of climate change. The livelihoods of many countries for which adaptation is not an option are at stake.

The Convener: There should be a checklist. We need strategies for both and we must cross-refer from the adaptation strategy to ensure that it contributes to the mitigation strategy. A climate change strategy has many different objectives.

Have panel members considered the Scottish climate change strategy? To what extent should it be beefed up?

Dr Dixon: In 2001 the Executive produced a report, "Potential adaptation strategies for climate change in Scotland", which contained many sensible recommendations. However, if we were to do an audit, I am afraid that we would find that the Executive has taken up almost none of the report's suggestions, with the possible exception of action on flooding. For example, the report said that the transport network is particularly vulnerable to the changing climate, but the Minister for Transport did not commission a study to consider roads that are vulnerable to landslips until after last year's landslips on the A9 and in Glen Ogle.

The report said that farmers are particularly vulnerable, because in wet summers they will not be able to get machinery into fields. That happened last summer, but we were not really prepared for it. The report also said that major infrastructure investment should be climate proofed. However, when I asked Scottish Water whether the infrastructure in which it will invest £2 billion to £3 billion during the next 10 years—some of which will have a lifetime of 30, 40 or 50 years—is being designed for our future climate, with big enough pipes and overflows that will operate infrequently enough, I received a very long answer, which I interpreted to mean, "No; Scottish Water is not able to do that."

Many ideas have been put forward. The "Scottish Climate Change Programme", which was published in 2000, said that there would be a Scottish adaptation strategy. It is certain that there are bits of activity, some of which are doing exactly the right thing. However, they are not joined up into a single Scottish adaptation strategy. It would be a good idea to bring together all that activity, find out where the gaps are and fill them in.

The Convener: You mentioned roads, but I presume that other forms of transport such as railways also need to go through that process. I was in a train the other week and the water was quite close to both sides of the track. It did not feel particularly stormy, but there had been an awful lot of rain. Does that need to be built into the approach?

Dr Dixon: It does; the report identified all forms of transport, including ferries. The landslip and the flood that closed the A9 also closed the railway. Two years ago, Railtrack produced a report suggesting that hot summers would delay trains because the rails would bend as they had not been designed for such hot temperatures. There are a lot of factors that we need to bring together and address.

Fred Dinning: As a quick aside, I am happy to reassure Richard Dixon that we think about such things, but to a large extent the practicality for industry is that the current infrastructure changes are quite large anyway. We have had a number of major storms and we have learned lessons. We have improved tree-cutting and we are building

lines to higher standards, but that is as much for the sake of reliability as for climate change. The two go together and the regulators have begun to think about that.

That brings me to the serious point that I want to make. Mitigation is quite difficult because it is a complex policy; it is about trade-offs and international agreement. Adaptation is quite simple in that the Parliament can control matters such as planning, the issues that are considered and how local authorities are judged. Measures could therefore be taken quickly for new infrastructure projects, funding and programmes. Are we building houses that will be able to withstand the storminess? We have control of matters such as building regulations and planning, so there are practical measures that can be taken.

Richard Lochhead: Are there any lessons that we can learn from other countries about adaptation strategies?

The Convener: Simon Allen was next on my list. Do you want to answer that one?

Dr Allen: I am sure that there are substantial lessons to be learned, but I do not have anything at the front of my mind. However, I have indicated some sources of information that might be worth studying.

The Convener: We can look those up. Did you want to make another point?

Dr Allen: Fred Dinning made quite a few of the points that I wanted to make. However, I highlight the importance of the planning system in adaptation to climate change impacts, particularly for flooding. I advocate a whole-catchment approach to managing building and infrastructure investments near rivers. It is important to ensure that building standards are appropriate so that new housing, for example, is sufficiently hardened against possible storm damage.

Professor Hoskins: In relation to coping with summer warmth, every car seems to be getting air conditioning and the last thing that we want is for houses to start getting air conditioning as well, because that will compound the problem by using more energy. Just as the building regulations should be thinking about insulation for the winters, they should be thinking about natural ventilation for the summers. We can look at countries in which that is done or in which air conditioning is used. I am not sure that we know of any country that has a particular strategy that we could follow, but there are certain sectors that one could examine for good and bad practice.

The Convener: This building was designed to use less energy for heating in the winter and to retain heat, and a lot of the ventilation systems are as simple as windows being opened in the summer and drafts that run through rooms when the windows are open. You are right that we need to examine the best practice and bad practice that exists in all sectors.

I get a sense that people have said almost all that they need to say today. One of the challenges for the committee will lie in capturing the questions that we have outstanding from today, or the difficult questions that have been asked and which no one in the room felt able to answer. A series of expert witnesses or people of whom we would like to ask difficult questions are lined up to give evidence over the next few weeks. Next week, we will look at energy efficiency and consumption, business issues and public sector perspectives. We had an initial discussion about whether we could cover everything in climate change and we decided that we could not. Instead, we have tried to go for most of the issues that have been identified today. The challenge will be to follow them up rigorously.

If any of those who are here today, as expert witnesses, feel that there is further information, even in their submissions, that we have not considered, or that they have new information for us, it would be helpful for the committee to get that information in writing over the next few weeks. I am not requiring you to give us further written information; in fact, just reading your submissions again might be helpful to us. However, if there is any information that is not on our agenda, it would be useful to have that.

Richard Lochhead: I have a question on future witnesses. Do we have any sceptics coming along to speak to us? I have noticed that all our witnesses have similar views on climate change. That is valuable, but there are also many sceptics, who are occasionally quoted in the media.

The Convener: As far as I am aware, we have not invited anyone who would say that they did not think that climate change was an issue.

Richard Lochhead: Perhaps we should make an effort to invite someone who is sceptical.

The Convener: We agreed at our discussion a few weeks ago to try to get a representative sample of scientific witnesses. That is what we tried to do for today's meeting. I think that the general feeling is that most people accept, based on the scientific evidence, that there is such a thing as climate change. The questions are about how fast and extreme the change will be, and those are the issues on which we have questioned today's witnesses. Do you propose a change to our plan?

Richard Lochhead: I propose that the clerks seek someone who is sceptical, so that we can at least hear both sides of the argument.

The Convener: The clerks say that we have invited people to give us such evidence in writing, so you will be able to test it over the next few weeks. I thank the clerk, Mark Brough, for that helpful information.

Professor Hoskins: At the beginning of the meeting, I reflected on the uncertainty that is involved and tried to reflect the range of views. It is easy to come along and say, "This is it", but I tried to say that I believe that climate change is an incredibly important and serious problem but that there is uncertainty about it.

The number of scientists whom I know, including Americans, who think that climate change is a negligible problem is negligible—there may be one, or possibly two. Otherwise, there is a range of uncertainty that is trying to be reflected. Some individuals could say that climate change is a negligible problem; I could give you the name of one individual who would give you that answer. However, we are dealing with a probability distribution, so we try to reflect that sort of uncertainty. Apart from the one person to whom I referred, people would say that climate change is a serious problem—if they are climate scientists. Many people out there think that they have some knowledge that enables them to speak about the issue, but when one probes their credentials on the science, they are usually pretty shallow.

The Convener: That is a useful place to stop, because the committee needs to process the helpful information that the witnesses have given us today. The meeting has been a mixture of robust exchange and questioning. Over the next few weeks, we must go through the different areas that have been identified. Today's meeting has been an excellent start for us. You will be able to read the *Official Report* of today's discussions on the web in a week's time. Those who heard Radio Scotland this morning will know that we are kicking off an on-line web forum as well, so that members of the public who are interested in feeding in information to the debate will be able to do so.

I thank all the witnesses for coming along and being prepared to give us the benefit of their views and research, and to answer difficult questions to the best of their ability. We will try to make the best use of that information over the next few weeks.

I remind everybody who may be interested that next week we will look at energy efficiency and consumption, business issues and public sector perspectives.

Meeting closed at 12:29.

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