COMMONWEALTH OF AUSTRALIA

Proof Committee Hansard

JOINT STANDING COMMITTEE ON TREATIES

Reference: Kyoto Protocol

WEDNESDAY, 13 SEPTEMBER 2000

MELBOURNE

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JOINT COMMITTEE ON TREATIES

Wednesday, 13 September 2000

Members: Mr Andrew Thomson *(Chair)*, Senator Cooney *(Deputy Chair)*, Senators Bartlett, Coonan, Ludwig, Mason, Schacht and Tchen and Mr Adams, Mr Baird, Mr Bartlett, Mr Byrne, Mrs Elson, Mr Hardgrave, Mrs De-Anne Kelly and Mr Wilkie

Senators and members in attendance: Senators Bartlett, Cooney, Ludwig and Tchen and Mr Byrne, Mr Andrew Thomson and Mr Wilkie

Terms of reference for the inquiry:

- The implications for Australia of proceeding or not proceeding to ratify the Kyoto Protocol and meeting its target emissions levels by 2008 with regard to anticipated and/or predicted economic, environmental and social outcomes both nationally and in specific regional areas.

- The veracity of conflicting current scientific theories on global warming and any solutions proposed for it.

- What definitions and criteria Australia should develop and actively pursue in its national interest with regard to:

- grandfathering,

- trading credits,

- carbon credits,

- sequestration,

- revegetation,

- land management, and

- definitions (eg "forest").

- The economic, environmental and social implications of a punitive approach to any domestic regulation of industry including such proposals as a carbon tax and an incentive-based approach.

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WITNESSES

Committee met at 9.05 a.m.

BARRELL, Dr Susan Lesley, Supervising Meteorologist, Policy and Secretariat Section, Executive and International Affairs Branch, Bureau of Meteorology

McAVANEY, Dr Bryant John, Senior Principal Research Scientist, Leader of Model Evaluation Group/BMRC, Bureau of Meteorology

VOICE, Ms Mary Elizabeth, Head of National Climate Centre, Bureau of Meteorology

CHAIR—I declare open this hearing of the Joint Standing Committee on Treaties. I welcome all the witnesses and members of the public and media who are here for the first hearing of the committee's inquiry into the Kyoto Protocol on greenhouse emissions. We intend to undertake a number of hearings across Australia over the next few months to ascertain the implications for Australia of ratifying the protocol. Today, we will be taking evidence from various organisations and some individuals that represent a spectrum of views on the issue. I welcome to the table representatives from the Bureau of Meteorology. Would you each briefly tell us your role in the Bureau of Meteorology?

Dr Barrell—My capacity is as the bureau representative on Australian delegations to the IPCC and to the Framework Convention on Climate Change.

Ms Voice—I am the head of the National Climate Centre, which has responsibility for looking after the national climate archive and for monitoring the climate on time scales from weeks, to months, out to seasonal, interannual and beyond.

Dr McAvaney—I conduct research in climate change using models. I am also a coordinating lead author for one of the chapters of IPCC which is investigating climate change.

CHAIR—We do not normally require evidence on oath, except in the most contentious matters and I hope we do not quite get to that, but I have to advise you that these are proceedings of the parliament as if they were taking place on the floor of the House of Representatives or the Senate, so any misleading or false evidence could be regarded as a contempt of parliament. Would you like to make an opening statement, and we will then have a question and answer session from members of the committee.

Dr Barrell—The Bureau of Meteorology is pleased to make a submission to the Joint Standing Committee on Treaties' inquiry into the Kyoto Protocol. Our comments are limited to the second term of reference relating to the veracity of conflicting current scientific theories on global warming. In introducing the bureau's submission, I will outline briefly the bureau's credentials for submitting its views and conclude with a short summary of the key points raised in our submission.

Meteorology, of which climate is an important component, is one of the most inherently international of all fields of science and human endeavour. The Bureau of Meteorology, as

Australia's national authority for the observation, understanding and prediction of Australian weather and climate, is strongly interconnected with institutions around the world both in relation to the operational side of its activities and, particularly important in the current context, with respect to its monitoring and research activities. The bureau also works closely with other government and academic institutions within Australia, including the CSIRO and the universities, in advancing understanding of climate and climate change science. Through the work of the National Climate Centre, the bureau maintains the long-term observational record on Australian climate. Through analyses of these data and routine monitoring of the climate system, the centre is a source of expertise on the patterns and causes of climate variations in Australia and surrounding regions. The National Climate Centre has achieved world-class recognition for its work in developing high quality data sets. The centre is a key contributor to international efforts on the development of indices for identifying trends and/or changes in climate, including participation in detection studies in association with the Intergovernmental Panel on Climate Change assessments.

Understanding and simulating the causes of major fluctuations and changes in global climate, with a particular focus on Australia and on the Southern Hemisphere, is a principal focus of modelling studies and related research within the Bureau of Meteorology Research Centre, the BMRC. A recent review of the BMRC by a panel of leading international scientists applauded the international standing of the centre and cited the high level of collaboration and interchange with overseas research centres as critical factors in both the high quality of the research produced by the centre and the level of influence that bureau scientists have achieved in international research coordination and assessment bodies. BMRC scientists have made a significant contribution to the work of the IPCC from its commencement and have served as coordinating lead authors, the highest level of scientific contribution for both the second assessment report and the third, which is currently going through its final review stages.

As the national meteorological authority for Australia, the bureau takes very seriously its responsibility to ensure that government policy is well informed on the latest and most comprehensive research findings on climate, climate change and associated observational evidence. Since the earliest stages of the United Nations framework convention on climate change, the bureau has been represented in a scientific capacity on the Australian delegations to sessions of conferences of the parties and the subsidiary bodies, taking a lead on all scientific elements of the negotiations.

The second term of reference for this inquiry relates to conflicting scientific theories on global warming. Put simply, the main areas of perceived conflict in the science of global warming relate to whether global warming has actually occurred and, if so, the extent to which the cause is related to increasing atmospheric concentrations of greenhouse gases. Within the expert scientific community—and based on sound and objective science—there remains little contention on either of these issues. There is now wide acceptance that the world has warmed significantly over the past century. This finding is based not just on the direct instrumental record of the land surface and of the oceans but is confirmed and extended back further in time by a range of independent proxy indicators of temperature, such as ice cores, tree rings and coral cores.

A substantial effort has gone into identifying the cause of the warming and, in particular, that element of the warming that might be due to natural variability of the climate system. It has been shown clearly that natural variations, such as the El Nino and Southern Oscillation phenomena, dominate the year to year fluctuations in climate. However, there is now a high level of confidence in the expert scientific community that at least a large part of the warming over last century is due to enhancement of the natural greenhouse effect through increasing atmospheric concentrations of greenhouse gases.

Given the large uncertainties and the level and pattern of future emissions of greenhouse gases, global climate models are unable to predict the magnitude of global warming. However, global climate modelling capability has advanced now to the extent that the models are able to provide fairly confident projections of future warming for any of a wide range of plausible greenhouse gas emission scenarios. Models can now provide credible simulations of future climate on a continent and ocean scale, but substantial uncertainty still surrounds regional scale projections.

In the early stages of the global warming debate, when the issue first came to the attention of governments, there was concern over the diversity of opinion on both the science of climate change and the strategies to address it. The establishment in 1988 of the Intergovernmental Panel on Climate Change, a unique experiment in bringing together scientists and policymakers in an intergovernmental process, was an attempt to alleviate that concern. While the process remains subject to some criticism and it is recognised that the process of developing consensus obviously involves compromise, the overwhelming view is that the IPCC has largely delivered on its purpose. Through the active participation of the expert scientific community, the IPCC is able to produce balanced, objective and up-to-date assessments of the climate science in a form that is both policy relevant and understandable by policymakers. The third assessment report of the IPCC is currently at an advanced stage of preparation and will be an important consideration in the context of negotiations towards ratification of the Kyoto Protocol.

In closing, I would like to introduce my colleagues from the bureau. Mary Voice is head of the National Climate Centre, which is responsible for the continuous monitoring of Australia's climate. Dr Brian McAvaney is leader of the model evaluation group within the Bureau of Meteorology research centre. Dr McAvaney is also the coordinating lead author for the chapter on global climate model evaluation for the IPCC's third assessment report. I am present in my capacity as the bureau's representative on Australian delegations to the conference of the parties and subsequent sessions of the United Nations framework convention on climate change. We will be pleased to respond to any questions you have on the Bureau of Meteorology submission to this inquiry.

Mr BYRNE—Your submission speaks about satellite monitoring of the lower troposphere. I have a quick question as a reference point. You say here that the length and continuity of satellite records are not sufficient to confidently identify any long-term trends. Yet you refer to sea temperature measurements as well as land temperature. In your view, what is a sufficient period of time to establish a trend?

Ms Voice—The climate varies on many time scales, from the seasonal to the interannual. There is decadal variability evident in the climate as well. If you are really looking for long-

term trends, one needs to look beyond the decadal time scale. So what we have looked at is the trend over the whole century where that information is available. The satellite record is of the order of a couple of decades: two, three, that sort of order. You could imagine that, if we are having decadal variability existing as well as the long-term trend, that decadal variability could be somewhat of a problem in the satellite record.

Mr BYRNE—How long have accurate sea temperature measurements been taken for?

Ms Voice—Accurate and comprehensive I think is the thing that we are really looking for. Comprehensive means that the oceans are sufficiently covered with observations. There were good observations last century from ships, but the ship routes were fairly sparse in some parts of the globe and there has been quite a bit of variation over time. Before the Second World War the trade routes were somewhat different to the present, so the ship observations were in somewhat different areas. In terms of the current assessments that are being made by the climate research community, generally speaking we feel that over the last century or a little bit longer there is a reasonable body of surface observations. In recent times that has been complemented by satellite observations of sea surface temperature, and so we now have a better coverage for sea surface temperature. But again it is the same problem, that increased coverage from satellite has only been in recent decades.

Mr BYRNE—So how long has there been comprehensive sea surface measurement taken?

Ms Voice—A comprehensive global temperature record for the land based and the sea based situation?

Mr BYRNE—Yes.

Ms Voice—For the Australian region, we believe that from about the early 1900s we have a very satisfactory comprehensive record. For the globe as a whole, from late last century or early this century is when the confidence is highest. With some fairly detailed scientific detective work, the global record has been pushed back to the late 1800s.

Mr BYRNE—In terms of accuracy, I was looking at one of your arguments about comparing sea surface measurements with land surface measurements. To some extent, for you to be more certain, you would need to wait for more comprehensive data with respect to the satellite measurements as compared to the existing sea surface measurements. How comprehensive is that data? How reliable is it? It seems to me that there were some sporadic measurements taken with respect to sea surface over a period of time that may not have been as comprehensive as land surface measurements. That has been buttressed by satellite measurements. How comprehensive in reality is this data which you are relying upon with respect to the previous sea surface measurements compared to the land surface measurements and now with the satellite measurements?

Ms Voice—I have not brought with me a map showing the extent of the record through the century. I am not sure whether subsequent present delegations will have—perhaps Professor Karoly or CSIRO. You may wish to check with them. But the general scientific view is that the sea surface measurements through this century are adequate, when combined with a good land

coverage, to provide the data needed to give a global scale estimate, not necessarily a regional scale estimate.

Mr BYRNE—So what degree of discrepancy would you have with respect to that data? In any sort of analysis you have a margin of error. What in-built margin of error do you have in your calculations with respect to your outcomes?

Ms Voice—With respect to the global surface temperature, that is a single number. The number that has been estimated is 0.6, plus or minus 0.2. That gives you a range from about 0.4 to 0.8.

Mr BYRNE—So your margin of error is 0.2.

Ms Voice—Yes. You will find in the CSIRO submission that they quote about half a degree to one degree. So they are talking about 0.7, plus or minus 0.2. That gives you a feel for the error bars around the number.

Mr BYRNE—So if the margin of error was about one—ranging from 0.2 to 0.9, more accurately—how does that then affect your prognostications for what might transpire in the future? How far can you be off with respect to this particular calculation about the greenhouse warming?

Ms Voice—I am not sure that I am actually following the question.

Dr Barrell—There are two issues. One is what we know about the climate changes that occurred in the past. You are asking about the impact that that has on how well we can predict climate into the future. Probably a key point is that climate models do not necessarily need to understand what has happened in the past in order to project into the future because they are based on the physics of the climate system rather than on the observations that occurred in the past.

Mr BYRNE—But you would have in the equation a margin of error built in for any invariability. In economics, part of the equation is a margin of error which affects the final outcome. I am referring to not only the future prognostications but also the calculation method that you use, taking those mathematical factors into account, to calculate the actual outcome of the equation.

Ms Voice—The margin of error relates to our certainty about what has happened in the last century. I think Sue was distinguishing that from confidence in the ability of the models to make projections into the future.

Mr BYRNE—I would like to ask you a question about the model that you use. I am conscious of the fact that we are running out of time.

CHAIR—We have plenty of time.

Dr Barrell—Perhaps Dr McAvaney can help you.

Dr McAvaney—The distinction may be that a model that is used for weather forecasting needs observations to be fed into it to create the initial state for that model. Given that initial state, the equations that describe the situation are then projected for a short time into the future. For a climate model, that input data is not so important. What is important is having the physics correct and having conditions from outside, like the amount of CO_2 in the air, the solar constant, those sorts of things. They are what really determine where the model goes. So the accuracy of the input data is not a crucial concern—it is for weather prediction, but it is not for climate.

Mr BYRNE—Although to some extent part of your equation would have to be the factor of variability. There are other components. I am not sure precisely what the formula is of the model that you use, but there must be a component. I guess it is the contentious part of the equation which refers to the possible variables or the possible alternate factors that might come to bear on the warming, the predicating factor that you would have to use there.

Dr McAvaney—The models are constructed in such a way that the equations that they are trying to describe do contain all modes of variability that we think the climate has. The variability that comes out from the model depends on how it is forced, what is changing external to the model. That will decide final behaviour.

Mr BYRNE—So there is no argument about what you might use in your equations with respect to the variability component. That is accepted commonly throughout the scientific community.

Dr McAvaney—Yes, that is generally accepted.

Mr BYRNE—The contention, I presume, is the accuracy of the input data that you use, the accuracy of the measurements that have been taken. Is that correct?

Dr McAvaney—The contentious issue is the accuracy and availability of the forcing factors, for example, the time history for carbon dioxide over the last century, the time history of volcanos, these external things, which are part of the equations and are something that we have to give to the model.

Mr BYRNE—So how do you do that? I guess it is a little like economics to some extent, where you factor in a model and it comes out with an outcome predicting consumer spending, but then there is another variable out there which is not factored into the equation or the model and completely changes what the real outcome is, which people recognise after the event. To some extent, do you have that potential to occur in the models that you are using with respect to your predicted outcomes and the bases for coming to a determination about what the cause of global warming is?

Dr McAvaney—Yes. Certainly, if we omit a forcing because we do not know about it, obviously the model cannot take that into account.

Mr BYRNE—So you would acknowledge that there could be a component there within these hypotheses as well as in your future prognostications about this that you may determine in 10 or 15 years time due to technology improving, or something?

Dr McAvaney—We are reasonably confident that we are capable of including all known forcings.

Senator COONEY—Can I get a picture of how much division there is in serious scientific thought in this area? I think you said before that there is wide acceptance of it. What is the strength of scientific opinion against this? Would you have refereed articles saying that this is not right, first of all, in terms of the data that you use and, secondly, in terms of the consequences?

Dr Barrell—There are two separate issues really that Mr Byrne was talking about—the modelling and the data. I think you are coming from the data point of view.

Senator COONEY—What I am trying to get at is when we are writing our report we can say, 'Dr Susan Barrell said this and this other person was clearly wrong, but nevertheless has some standing in the community.'

Dr Barrell—That sounds fine to me!

Senator COONEY—In terms of a refereed article.

Dr Barrell—In terms of a refereed article, the ultimate authority on this is the IPCC, which has carried out objective assessments. Since 1988 when the IPCC was formed, we have been through two full assessments and we are now onto our third. The weight of opinion within the IPCC is increasingly in support of the validity of the warming trend. That is based not just on one piece of data; it is based on a considerable amount of quite independent data. You can look at your land surface record and, while some people may contend that that is artificially warmed through urban land effects, the data that we use to determine the trends are high quality data sets from which as many as possible of these effects have been taken out.

As I said earlier, the National Climate Centre is a world leader in compiling these sorts of data sets. Data like the change of site of an actual observing station and stations that are in increasing density areas such as inner-city areas are taken out. Where possible, any data is cleaned out to remove any trends like that. So we have a long, high quality record of land surface data. In addition, there is data from proxy sources, from ice cores and from tree rings, all of which may individually have problems, because it is impossible to perfectly measure these things. All of them separately show a warming trend, and while each one of them may have problems in some respects, they are different problems and they are increasingly smaller. So within the community, as put forward by the IPCC, that consensus is growing.

Senator COONEY—So we could confidently say that the data is agreed upon by a responsible scientific community.

Dr Barrell—Yes, I think that is pretty confident.

Senator COONEY—What about the cause of it? Can we say a similar thing about the cause, or would we have to say that there are some very learned people who say that the cause varies?

Dr Barrell—There is still some uncertainty about the exact cause of all of the effect. But our understanding of climate variability and the contribution that natural climate variability may be making to that record is growing. Certainly the consensus now is that, while a part of the change in climate may well be due to natural variability, it is extremely unlikely to account for a substantial part of that variability. The work that has been done on identifying the causes of anthropogenic greenhouse gas increase is showing that the level of confidence that that is the explanation for at least a substantial part of the warming is growing.

Ms Voice—I would like to add something. The IPCC process involves thousands of scientists from around the world. The second assessment report, which is now nearly five years old, had the words 'the balance of evidence suggests' that the observed warming trend that we have seen has some human influence associated with it.

CHAIR—So there is a discernible human impact?

Ms Voice—Yes, the balance of evidence suggests—

CHAIR—The crucial phrase we were told yesterday at the climate change centre was 'discernible human impact on climate'. What is interesting is that the fellow who was the expert about sulphate aerosols said to us that that phrase, in the meaning of the report in terms of warming, included not just temperature but also cooling, because of the effect of these sulphate aerosols. So he was stressing that it was not really as significant a phrase as was perhaps being put about. Of course there is some discernible human influence because of these aerosols, as well as perhaps a little of the carbon in the atmosphere and so forth, so he warned us not to make too much of that phrase. But we can get to that a little later.

Ms Voice—I was going to say that we understand that the third assessment report will strengthen those words.

Senator COONEY—Irrespective of whether it comes from natural causes or human causes, or heavenly causes for that matter, is there agreement about the consequences of the warming? I remember years ago that Barry Jones said that the Labor Party was about to lose Denison, not in an election but because the waves were going to wash up and take Duncan Kerr's seat away from him. Is there agreement on that? Leave aside the cause. We will not argue about the causes but just the fact that you have got global warming, whatever the cause. Is there agreement about the consequences?

Dr Barrell—I think that is getting beyond our area of expertise. I would rather you spoke with CSIRO about that. But I would say certainly there is still considerable uncertainty on exactly what the impacts will be in any particular area.

Senator LUDWIG—Where does your level of expertise stop, then? Do you simply tell us about climate and its change without extrapolating the effect?

Dr Barrell—We do not go into the area of impacts. The Bureau of Meteorology is about climate science, and climate change science is an important part of that but it stops at the

science not at the impact. It does not go beyond that into the impacts area, in terms of socioeconomic or any other aspect beyond physical impact.

Senator LUDWIG—We had the opportunity yesterday to have a look at the atmospheric research. We saw a couple of graphs that showed there was a significant increase in CO_2 emission. They show a predicted rise from something in the order of, say, 280 parts per million in 1000 AD to above 320 parts per million CO_2 in the year 2000 AD. What is the level that is sustainable? Is there any view on that?

Dr Barrell—I can only talk from my knowledge of IPCC work, which basically says that, to stabilise concentrations at anywhere near the current level—in essence it is impossible now to sustain them at exactly the level we have them—but to stabilise concentrations of CO_2 in the atmosphere at close on double what the current levels are would require emissions to be reduced, globally, to something of the order of about a third of the level that they are now. That would require everyone, now, instantly to cut their emissions to that level if we had any hope at all of stabilising CO_2 concentrations in the atmosphere at a level of perhaps between 450 and 550 parts per million—which is a very big ask.

Senator LUDWIG—Have you done any predictions as to what the level in parts per million will be in 50 years, at the current CO_2 emission rate?

Dr Barrell—No. Emissions are well and truly out of our gambit, I am afraid. The IPCC has carried out studies looking at scenarios of emissions. The recent *Special Report on Emission Scenarios* looked at a range of factors that would govern future emissions and looked at a range of plausible scenarios. The sorts of factors that have to be taken into account in developing those relate to economic growth, population growth and a lot of human factors that are well beyond our area of expertise.

Ms Voice—Carbon science itself is more appropriately the responsibility of CSIRO than of the Bureau of Meteorology.

Senator LUDWIG—Yes. I am just trying to explore the width of your responsibility so that I can target my questions a little better perhaps. Or, at least, by the time I get to CSIRO I might be able to. If the range of the observed data that you have continues, what do you think the climate impact in Australia will be, per se? You say ‘global warming’, but does that have consequences? Do you go into that or do you simply stop at the point of saying, ‘There will be global warming’?

Dr Barrell—In order to start seriously thinking about consequences, you have to get into the area of regional scale climate modelling. That is an area that I think it is accepted has more uncertainties than global climate modelling. The science still has a fair way to go in that area. But that is about as far as we could offer.

Senator LUDWIG—How far away are you from researching into the area of regional climate change?

Dr McAvaney—We believe the models are reasonably credible up to the scale of Australia as a continent, but they lose credibility due to the variance between models and their sensitivity to changes is very large when you get down to the size of, say, Victoria. So the reliability of any climate change projection we might make reduces as we reduce the area. At the scale of Australia the models do give what we think would be reasonably reliable estimates of temperature change, given the things that have been put into models. But the smaller the scale the larger the errors become.

Senator LUDWIG—Do you have any papers that you produce in relation to the critics of your predictions—in other words, the counterargument? I am familiar with economics where you have one writer from one of the schools writing a paper and then you usually end up with a writer from another school criticising or critiquing it. I guess the debate rages within your area of science. If so, can you point the committee to the papers that might be written that either argue against or support your case? Does the same debate rage?

Ms Voice—Very much so.

Senator LUDWIG—I would have thought it did.

Ms Voice—The science of climate is part of the process of science and, as with economics, this debate rages. The debate rages in straight science as well as economic science—if I may be so bold as to use that distinction.

Senator LUDWIG—Please do.

Ms Voice—It was not meant to be derogatory in any way.

Senator LUDWIG—No, I might agree with you.

Ms Voice—That debate has raged for now some 10 years within the IPCC process, and we have had, as I said, several hundred of the top scientists around the world coming together to debate the issues. So it has been a debate for 10 years. You asked for particular papers or—

Senator LUDWIG—If you say the debate has raged, it obviously has not raged in a room with 100 scientists; it must have raged on paper.

Dr McAvaney—The process is in two parts: the scholarly debate where papers are exchanged, published and critiqued and the IPCC, which takes that scholarly debate, assesses it, and in a room literally like this, argues it out amongst the people given responsibility to look at that particular area. So two things are happening. A scientist may have written a paper that says that a certain model is good in terms of the climate of Australia; another scientist may have looked at that same model and some other models and said that it was not quite so good. That has to be resolved in some fashion. So at the first cut you simply have two papers. The IPCC process tries to resolve these two conflicting views, and it is simply a statement of what the scientists involved in that process believe about those papers and other papers. There are two steps. There is the classic scientific approach of finding things which are wrong. Scientists delight in finding things which are wrong because we learn something and we go onto the next

step. In terms of an assessment we try to find what is correct about something and also some of the deficiencies.

Ms Voice—It might be helpful to show you a model diagram.

Senator LUDWIG—I think I had a look at that. After an exchange of papers after a debate, they come up with a conclusion that there is a discernible human influence on global climate. That is a significant statement to make. I am interested in the process that got them to make that statement, because in my view it has to have some credibility—certainly some acceptance amongst the scientific community—for them to make that statement.

You have outlined a two-step process, the first step being the debate whereby scientists prepare and write their papers about their views on scientifically observed data. The debate occurs in a clearing house, and a judgment is made by that body as to who, on balance, is right or who is wrong. Do the scientists who form part of that body agree with the outcomes? Or do they simply say, 'Well, that is the view of that particular organisation, and I still hold my view'? Is there a vote?

Dr McAvaney—No, there is not a formal vote. The IPCC process tends to come with statements, which have qualifications in front of them. In the next IPCC report, the use of terms such as 'likely', 'less likely', 'highly unlikely', which have specific meanings, will be explained in depth. So they are qualitative words, but there are very tight meanings associated with them. The IPCC process is trying to come up with statements which are intelligible to policy makers and the general public but that have some quantitative backing to them.

Dr Barrell—The IPCC process is not just a bunch of scientists getting together and coming up with a common view. Through the IPCC they write reports. Those reports get reviewed not just by the scientists that actually contribute to writing the review but by the global expert community and by global government representatives. The IPCC process goes through a peer review process by scientists in the field and also a review process with governments involved.

Senator LUDWIG—Yes, I understand that. I was making it a simple process, but I do understand the complexity involved.

Dr Barrell—The point I was trying to make is that, at any point in that process, anyone can put in a remark that says, 'I disagree with this.' As part of the IPCC process this time—the third time around—a new step has been introduced, with the instigation of these people who are called review editors. The role of these review editors is to track that review process right through. They participate in meetings of the lead authors. Every single comment that is made has to be considered by the lead authors. The lead authors for a chapter could be anything from 10 to 30 people, depending on the chapter. They consider each comment and decide, 'Yes, we can accommodate this,' or, 'No, we can't,' or, 'We agree,' or, 'We disagree.' The role of the review editor is to make sure that every comment is treated fairly and that, if there are any particularly contentious issues that remain at the end of the process, that they are highlighted in the report itself and reported to the IPCC. So, any comment or disagreement that is sustained at that level is visible. It is not hidden. It is not dosed under an average sort of result.

Senator LUDWIG—That was some of the information I was trying to glean from you. I understand the rigour that scientists put into meeting, for argument sake, ISO9000 in paper tracking to ensure that their results are credible. The same rigour I suspect would have to apply to if you were going to make statements about a discernible human influence on global climate.

Dr Barrell—I understand that anyone who made a comment at any part in the process can go to the IPCC secretariat after the event and ask, 'What happened to my comment?' In fact, there should be documentation on every comment, which says what the response was, how this was regarded and what was done about it.

Mr WILKIE—Based then on your experience, current evidence and theories, do you believe Australia should ratify the Kyoto Protocol?

Dr Barrell—I am sorry, that is something we cannot comment on. I am afraid that is up to you.

Mr WILKIE—We have to formulate an opinion based on expert advice, so I am wondering what that advice is. Do you have an opinion?

Dr Barrell—No.

Ms Voice—We might have opinions, but it is not our role as representatives here to give you our opinions on anything beyond our scientific expertise.

Senator BARTLETT— Without disputing that there has been some warming, it has been suggested in one of our submissions that if the theory behind the greenhouse effect was real you would get not just the surface warming that you have identified but also warming in the lower atmosphere as well, which reputedly has not happened. Can you comment on that—whether there has been any warming detected in the atmosphere as opposed to the surface and whether lack of warming is inconsistent with the greenhouse theory.

Dr Barrell—In terms of the expectation that if we have warming at the surface we should have warming in the atmosphere: in fact the fingerprint pattern that one would expect from warming due to increasing greenhouse gas concentrations is warming at the surface but cooling higher up in the atmosphere, in the stratosphere. So generally one would expect perhaps a decreasing trend as one goes up through the atmosphere. I do not think it necessarily follows that there must be warming through the lower atmosphere just because it has occurred at the surface.

Ms Voice—The observations show that there is some warming in the lower atmosphere. The latest observational evidence points to that. The atmosphere in its natural state cools as it goes from the surface upwards. We are seeing a surface warming that is clearly detected. We have seen a cooling in the stratosphere, around about the 20-kilometre height above the surface of the earth, of about 0.3 to 0.35 of a degree Centigrade per decade since the mid 1960s.

That is, we have warming at the surface and a cooling at around 20 kilometres above the surface. In the immediate kilometre or few kilometres above the surface there has been a

warming that is in proportion. In the natural state you expect the temperature to be cooling as you go through the atmosphere. If there is then an enhanced warming at the surface and enhanced cooling at high levels, then you see in the observational record some warming in the lower layers.

Senator BARTLETT—Those changes in atmospheric temperatures at various levels are consistent with the theory behind the greenhouse effect?

Ms Voice—People are quite comfortable with the consistency. A certain amount of debate has occurred over recent times about the middle of the atmosphere, just below that 20-kilometre level and from about two kilometres up to 10 kilometres or so. Satellite records can now give you some temperature information about the body of the atmosphere. There has been a bit of work done recently on the observational record through balloon flights versus the data from the satellites. A satellite measures the temperature for a slab of the atmosphere. Balloons measure points as they go up and they send a signal back to the surface of the earth.

Initially there did seem to be some discrepancy there in that the satellite record seemed to show no warming. What we are talking about is that slab of the atmosphere which includes the part where we are swapping over from the warming at the surface to the cooling at the stratosphere. There had to be some work done to understand what was happening there.

It depends what level in the atmosphere you are asking about, but the observational record shows warming at the surface and warming in the lower layers of the atmosphere, then a gradual change to no observable trend towards the upper layers of the atmosphere and then cooling observed in the stratosphere.

CHAIR—I am interested in the process of the IPCC and what is in a sense the most important part of it. It seems to come down to this distinction you make in the modelling between projections and predictions. I appreciate your fear of being misunderstood about this, about how we have got to be careful not to dwell too much on this business of observed data being the inputs to the model and hence linked to the outcomes on which policy is asked to be made. So I would like to get a better understanding of this notion of projections in the model. Yesterday at the centre at Aspendale we spent a short time being instructed about how the model is constructed. Your amplification of that this morning about the physics has made that a little clearer to us. So in writing the equations they are based on, if you like, physics of different parts of atmospheric science and fluctuations in temperature, cloud cover, precipitation and so forth, yet there is a bit of ambiguity in there in that I do not understand the relationship between an equation and then a linear projection, or a combination of equations and linear projection, versus the notion of the unpredictable, abrupt climate change regionally perhaps caused by these other events that Dr McAvaney described as all modes of variability that you think are in the equations, and then where there is something you do not know about, because ipso facto you cannot know about it, it is not in there. We have seen modelling, as my colleague Mr Byrne referred to, and even on a smaller scale in markets, for example stock indexes, commodity prices and so forth, where much of the same ambiguity comes out—this notion of linear projection on which you are asking us to make policy versus these unpredictable events. So, while I assume you are confident, as you say over and over, and Dr Zillman says that there is great confidence about these physical equations in the atmosphere, what other causes of abrupt

climate change might there be? What else is in there apart from the atmosphere? I think Senator Ludwig touched on the causes of this. What is not in the model that might cause abrupt climate change?

Ms Voice—Unknown volcanic activity in future.

CHAIR—That was mentioned.

Ms Voice—That is an example. With respect to the volcanoes that we have seen in the last century or so, we know that their influence on global temperature tends to last just a few years. We need to distinguish between a volcanic eruption that might cause a temporary change in the temperature for a few years versus massive volcanic eruptions, which have happened in the geological history of the earth. We need to distinguish between those, I suppose. We would not expect that the sort of volcanic activity that we have seen in the last hundred years or so would make any difference over a century time scale. So you would really be having a massive volcanic eruption, and a really large number of them, to make a difference to the projections are made from increasing greenhouse gas emissions. That is one example of a surprise.

Dr Barrell—I guess the collapse of the Antarctic ice shelf or major cataclysmic things like that could occur.

CHAIR—Could you go into that to the same degree you have just talked about the volcanoes?

Dr Barrell—I am not sure that I am competent to say too much about that.

Dr McAvaney—The west Antarctic ice shelf sits on the sea bed. It is not floating. So if something were to happen such that it was released from the ground, then the potential for sea level rise as a result of that would be very large. I understand from colleagues that it is not thought to be very likely, but it is possible. It is not something one can simply rule out.

CHAIR—Within the bureau, who studies the effect of ice on climate.

Ms Voice—In terms of understanding the dynamics of the ice sheet over Antarctica, that is not a topic of research in the Bureau of Meteorology. There is research going on I think still in Tasmania—

Dr McAvaney—Yes, at the Antarctic research centre.

Ms Voice—But the dynamics of the ice sheet itself and the issue of stability et cetera are not under research in the Bureau of Meteorology.

Mr BYRNE—So if there were an increase of equatorial surface water into a region, are you saying that that would not be factored into your model? There has been a theory postulated, as I understand, for a period of time between 1925 to 1944 that part of the increase in the sea temperature was the increased flow of equatorial surface water into the Arctic via the North Atlantic. That touches on the point you raised, Chair, and I thought it was relevant.

Ms Voice—The ocean modelling and the dynamics of the ice cap are a little different.

Mr BYRNE—Doesn't it factor in an increase in sea temperature somewhere? It should be a variable that should be factored in.

Dr McAvaney—Implicitly within the ocean component of the climate model the mechanism is available. Whether it is acting in a particular model or not will depend a great deal on the way that that particular model is constructed.

Mr BYRNE—It is perceived to raise temperature. But that is a factor the chair touched on. Can you adequately say that that factor has been ruled in into the calculations of your sea warming temperatures and warming of the Arctic?

Dr McAvaney—Yes. The ocean models used in the climate models in general do do a reasonable job of what is called the conveyor belt circulation of thermohaline circulation.

Mr BYRNE—So you take that sort of fact of flow of equatorial surface water into account.

Dr McAvaney—Yes.

CHAIR—How do we test the veracity of that part of the model? If this is a significant factor in regional changes in climate, where is the evidence that that part of the model, the equation—and if it is an equation of the collapse or flow of ice sheet, then it has to be a linear equation; it cannot be a random one, I assume—has been subjected to review?

Dr McAvaney—That is the sort of thing that was done in the second assessment report for IPCC and it has now been done in the third. Processes are important in the model. You look at the physics of the process, such as the thermohaline circulation. You decide whether the models adequately represent the physics. If you decide they do, you then try to find observations of some key quantity—the strength of overturning, for example. You then check whether the models are producing that sort of number in the right place and at the right time interval. If they do not, you call into question that particular aspect of the models. If the particular thing you are looking at is important for climate projection and you find that the models are not doing a good job, that would naturally caution you on using that for the future. That is the process we go through. No model is perfect.

CHAIR—What about the random nature of this phenomena? Is this ice stuff a linear thing or a random thing?

Dr McAvaney—The climate models take into account the complete non-linearity of the system. So is not necessarily a linear process. The model may produce something that looks like linear but it will be a result of the complex non-linear things that are going on inside those models.

CHAIR—If you use an example of trying to model an economy or a market for a commodity it must, likewise, be built on equations to project that. You have to have A+B=C, basically. How can you have what you call non-linearity in the sense of a random outcome in an equation?

Dr McAvaney—The equations themselves are non-linear.

CHAIR—How can you rely on them to project if they contain some element of randomness?

Dr McAvaney—That is the way the climate system works. To produce a forecast each day, the Bureau of Meteorology uses a number of climate models, all of which are based on these non-linear equations.

CHAIR—Or probability?

Dr McAvaney—No, they are non-linear equations. We give an initial state, a set of non-linear equations and we then project or predict in the future. We see the result of the prediction every day. That process, which is not the same as the climate process but is related, seems to be working.

CHAIR—Yes—although you did distinguish between the models that produced the weather predictions and these projection models.

Dr McAvaney—Yes.

CHAIR—That was very clear in the beginning, and we want to respect the distinction. But I still do not understand your answer to Mr Byrne about the ice surges being in the ocean part of the model.

Dr McAvaney—There is no model of the surge of the Antarctic ice sheet in any climate model that I am currently aware of. It is simply a possibility that it is out there. There is no explicit model of that.

CHAIR—I see. But there is an ocean model of these—

Mr BYRNE—It is an alternative hypothesis to explain some of the increases in sea temperature over the past period.

Ms Voice—The ocean circulation is definitely in the models. The transport of heat in the ocean models is modelled and observed and does not depend—if I am understanding the question—on the collapse of the west Antarctic ice sheet.

CHAIR—So it is the oceans as they are now?

Ms Voice—It is the oceans as they are now, yes.

CHAIR—That is clear. I see what you mean. When I was talking about this linear business, I was trying to get some idea of how these currents, as Anthony was implying, might change and whether you could get that in the model. But, fair enough, it is a static thing—it is as they are now.

Ms Voice—If the west Antarctic ice sheet did collapse, the sea level would be very different.

Mr BYRNE—Yes, there would be fairly obvious proof.

Ms Voice—Yes. You would have different surface conditions that you would have to put into the model based on that. There is not a model of the west Antarctic ice sheet and its internal dynamics built into the climate models.

CHAIR—If we have some expertise in the Antarctic Division in Australia then obviously we had better hear from them. Can we come back and, in a gentle fashion, cross-examine you again after we have listened to the ice people?

Ms Voice—Yes.

CHAIR—In a sense, we have to have this cross-examination at some stage. We are not really an inquisitorial inquiry; we really want this good old common law style, if you like, rather than just taking everything on board and trying to figure it out.

Senator TCHEN—Can I put a question which will require a yes or no answer? Dr McAvaney, are you saying that there is no model which actually takes account of the possible collapse of the Antarctic ice sheet? It seems to me just intuitively that if, due to global warming, the surface temperature rises then the sea water temperature will rise as well. Certainly that would have an impact on the stability of the Antarctic ice sheet, wouldn't it?

Dr McAvaney—Yes, it certainly would. It is independent of current models, but it is certainly taken into account and discussed at considerable length as a possibility.

Senator TCHEN—But say there is a catastrophic occurrence in 10 years time and the ice sheet collapses. That would put all your predictions out, wouldn't it?

Dr McAvaney—That would be catastrophic.

CHAIR—It is like the OPEC oil price rise in the sense that you can model an economy and then a whole lot of oil producers get together and have a fight and everything sort of catastrophically changes.

Mr BYRNE—When were the first greenhouse gases produced in measurable and substantial quantities? When did they first come on stream? With the greenhouse gases, you talk about chlorofluorcarbon, for example, which is identified as one of the main ones.

Ms Voice—There is a curve, so where do you say—

Mr BYRNE—When did we first start using CFCs, for example?

Dr Barrell—That is different. Carbon dioxide is probably the main greenhouse gas that we are talking about in this context. If you look at the trend of the change in CO_2 concentration in

the atmosphere going back about as far as we can get it with proxy measures—say, around the 10th century—the trend goes along fairly static, a bit up and down, until the early 1800s when it started going up. So pretty soon after the Industrial Revolution, greenhouse gases started increasing as a result of both increased use of fossil fuels through that period and also increased clearing of forests in the Northern Hemisphere. A lot of factors started occurring in the early 1800s.

Mr BYRNE—Why then would you attribute sudden observable jumps in the graph that you have provided between 1925 and 1944, and then it drops to under zero until 1978 when it then increases again?

Ms Voice—Which graph are you referring to?

Mr BYRNE—I think it is on the first page of what you have given us, but in a separate submission it basically notes an observed warming or significant changes in two tranches—between 1925 and 1944, and 1978 to the end. Can you explain why, if that is the case, the average mean surface temperature of the globe actually dropped between 1925 and 1978?

Ms Voice—Or stayed about static?

Mr BYRNE—It appears to have actually dropped according to that graph that you were using.

Ms Voice—I would suggest that there are two reasons that can be put forward for that. The first one is the natural decadal variability that we mentioned right at the start: you will see decadal variability in the climate record in the past and you will continue to see it in the future.

Mr BYRNE—But that is three decades roughly. So if you are talking about decadal variability, we are talking about three decades. Are you saying that we are expecting in our projections about where we can potentially go that some of these things might change and in another three decades time we might be dropping back down again? You are talking about decadal variability. In this graph that you use as some of the evidence for warming, there are drops in the actual average global temperature.

Ms Voice—That is right. And there will be decadal variability in the future superimposed on the projected trend.

Mr BYRNE—I can recall in the seventies— around 1975 or 1976—that there was a projection that, because of a drop in the temperature, we were about to enter an ice age. That was used by some of the experts who are now coming forward and saying that we are now having a warming.

Ms Voice—That was probably an example of scientists trying to understand the climate system with the best information that they had available to them in the 1970s. That was 25 or 30 years ago. The observational evidence has been very comprehensively amassed since then and scientific understanding has increased, as has the attention to detail. For example, the IPCC process is a much more detailed process. In the 1970s when you had some scientists saying that

we could be going into another ice age, there was not an IPCC process to assess that. There certainly were hypotheses that were around. I would suggest that 30 years later the process for testing hypotheses like that is much tighter.

CHAIR—If you compare the processes of the 1970s when this theory was powerfully put with the processes now, what has changed? As we observe scientists at any particular time, there is still tremendous work done, breakthroughs, new knowledge discovered and so forth. We have had the League of Nations and the United Nations—each one supposed to be a cracker effort to stop all the blood and guts that is being spilt—so how can you get stuck into those in the 1970s for their theories and observations? What evidence is there that this IPCC is better than what the scientists were doing then? Qualitatively, why is it better? Sure there is peer review, but there was peer review and all that then. Are the return of pension funds any better now from investment in the stock market than they were then, even though you have more computing power? This qualitative thing is a very difficult path to go down. If you want to bring evidence to destroy these blokes in the 1970s and say that they did not know what they were talking about but you do, then bring on the evidence.

Ms Voice—I do not want to destroy them.

CHAIR—But if you are saying that they were wrong and you are right—

Ms Voice—The other thing that has changed in that 30-year period is the climate modelling. Computers were available to atmospheric science after the Second World War onwards. The concept of having a numerical model which could model the atmospheric processes slowly evolved as people started to do numerical weather prediction. So in the early 1970s there was not a global climate model with an ocean model—a coupled climate/ocean atmosphere model—in existence.

CHAIR—Neither was there a model of the stock market.

Dr Barrell—One thing which I think has changed is the level of political accountability. When we started talking in the 1970s about heading into an ice age, what you were heard were a few people who were doing some work, which was cutting edge work at the time, and they were probably very vocal. I think that was when issues about climate change first started to get to the attention of governments and people started to see it as a global issue and something that would affect the whole planet. Since then it has been taken on board as a global issue and the process has been set in place to ensure that governments get a consensus view of the science. So part of the difference is that you are not hearing individual loud voices; what you are hearing is something that is a much more considered process. It is a feedback process. Governments have become more involved and science, through funding, computers and technology advances, has leapfrogged quite substantially. So there has been almost a synergy in terms of the political involvement and the growth in the science. I think we are getting to a stage where we can perhaps come up with something that is a lot more objective on a global basis.

CHAIR—We could go on for hours about this. In a couple of months we will have gone further with our thinking after more evidence. The best thing would be if you were to come

back then and for us to talk again in a qualitatively better way perhaps from our point of view. Thanks kindly for your contribution. It was very thorough.

[10.22 a.m.]

KAROLY, Professor David John, Director, Centre for Dynamical Meterology, and Professor, Department of Mathematics and Statistics, Monash University

CHAIR—Welcome. In what capacity do you appear?

Prof. Karoly—I am appearing as an employee of Monash University but in no way am I representing the opinion of the university. I am also a coordinating lead author of a chapter in the Intergovernmental Panel on Climate Change's third assessment report. The chapter is on detection of climate change and attribution of its causes, which might be relevant to some of the discussion that you had before.

CHAIR—Certainly. These proceedings are proceedings of the parliament, as if they were taking place in the Senate chamber or the House of Representatives chamber. The giving of any false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. Would you please make an opening statement and after that we will ask some questions.

Prof. Karoly—I have provided a written submission and I certainly do not intend to go through that. In my written submission and in my statement here I am principally going to address only the second term of reference of this inquiry, on the science of climate change. I will not restate it to you, because I am sure you have read it several times. I want to put two specific areas of submission. One is on the science of climate change. As I said in my introduction, I am one of the coordinating lead authors of the chapter on detection of climate change and attribution of causes in the third assessment report. The conclusions of the third assessment report are at present not available to be provided to the inquiry. They are in fact under review. I cannot state those; I can only state my own assessment of the material that is being produced. I believe that there is almost unanimous expert scientific agreement that the observed global warming over the last 100 years is real and is due, at least in part, to increasing greenhouse gases in the atmosphere. There is substantially stronger evidence now of a human influence on climate than at the time of the second assessment report of the IPCC in 1995. It is likely that increasing concentrations of greenhouse gases in the atmosphere have made a substantial contribution to the observed global warming over the last 50 years. That is an area in which I have been working substantially over the last 15 years and in which I have been involved in this intergovernmental panel assessment. I would be happy to answer questions on that later on.

Another aspect that was discussed earlier on was the question of greenhouse gas emission reductions and what reductions would be required to stabilise atmospheric concentrations of greenhouse gases. This is an aspect of what is called the carbon cycle of the atmosphere and earth system. That system is extremely complex and has a long response timescale. It is not like a tap with water going into a bucket where, if you turn off the tap, everything stabilises instantly. In fact, to stabilise atmospheric concentrations of greenhouse gases at any constant level—which is one of the objectives of the framework convention on climate change, to

stabilise them at any level—the total global emissions due to human sources of greenhouse gases would have to be reduced to approximately one-third of present levels.

CHAIR—So that means reduced by two-thirds?

Prof. Karoly—Reduced by two-thirds to about 30 per cent of present levels.

CHAIR—To cause the growth rate to flatten?

Prof. Karoly—To flatten, at any level. To maintain constant concentrations at the current level is impossible unless you start withdrawing; that is, if you have negative emissions—reductions.

CHAIR—How do you do that?

Prof. Karoly—There are a number of carbon sequestration mechanisms, which are—

CHAIR—Yes, sinks.

Prof. Karoly—Yes, sinks, but more sinks than sources, so negative emissions. That is not an area in which I am a strong expert. People at CSIRO are greater experts than me, but I have worked in that area with colleagues.

The issue of global emissions being reduced to 30 per cent probably would mean that developed countries might be required to have greater emission reductions than developing countries, in some sort of equity. I have been involved in some very preliminary analysis which would suggest that, just on equity concerns, a long time in the future Australia might be required to reduce its emissions to approximately 10 per cent of 1990 levels if greenhouse gas concentrations in the atmosphere were going to be stabilised at some level in the future.

I have a number of diagrams with me that can both answer previous questions and can certainly answer this question. I have copies of the diagrams available for the panel members.

CHAIR—Let us go through this material. It is worth seeing these.

Prof. Karoly—I have a number of other diagrams that are relevant to questions that were asked earlier on of the Bureau of Meteorology.

Overhead transparencies were then shown—

Prof. Karoly—On the left-hand side is a diagram which shows the atmospheric concentrations of greenhouse gases. This is the last page of the handout. The top part of that last page shows the atmospheric concentrations of greenhouse gases as observed over the last—

CHAIR—Yes, we were instructed about those yesterday.

Prof. Karoly—There have been rapid increases from a concentration of around 280 parts per million to concentrations at present which are around 350 parts per million. This diagram is a projection into the future using the carbon cycles. The bottom curve demonstrates what would have to happen to emissions if we wanted to maintain concentrations at, say, double pre-industrial level, 550 parts per million. Around 2200, which is way beyond the next election for federal parliament, emissions would have to be reduced to 30 per cent of present levels. Even if you wanted to maintain concentrations at treble pre-industrial levels, at about 700 parts per million, beyond 2200 you would still have to reduce to one-third of present levels.

Senator LUDWIG—At what level can we go a little bit higher?

Prof. Karoly—In this same diagram there are indications that you can increase above present levels. But, if you want to stabilise concentrations in the future, you have to come down to below 1990 levels at some stage. Yes, you can increase above present levels, but if you want to stabilise concentrations then at some stage in the future they have to be reduced.

Mr WILKIE—Are you talking about the worldwide trend?

Prof. Karoly—These are all based on global trends. This diagram was published in 1995 in the second assessment report of the intergovernmental panel on climate changes. It will be updated in the third assessment report. The science of this has not changed dramatically.

Mr BYRNE—Are you saying a sustainable level is 550 parts per million?

Prof. Karoly—I am saying that, if you want to stabilise at 550 parts per million, that curve or one close to it is what you would have to follow.

Mr BYRNE—Is 550 parts the 1990 level?

Prof. Karoly—550 parts per million is double the pre-industrial level and substantially above present levels. Present levels are 350 parts per million.

Mr BYRNE—Are you saying, though, that the sustainable level is 550 parts per million? If it is a tolerance level of a nuclear reactor, what are you saying? Are you saying that that is the sustainable level for us? Why are you coming up with 550 parts per million?

Prof. Karoly—Because it is double pre-industrial.

Mr BYRNE—If I called upon you to make an assessment about what we could sustain—

Prof. Karoly—Who is ‘we’?

Mr BYRNE—Say, politicians. We are talking about a level of, say, X number of parts per million that we could sustain realistically. Could you give me a figure?

Prof. Karoly—I still do not understand your question.

Mr BYRNE—CO_2 concentration.

Prof. Karoly—So what level could the global economic and business system maintain? I do not believe any of those levels are sustainable because—and this is a personal comment—I do not believe the global economic system in the near term can reduce greenhouse gas emissions substantially below this rate. That means that greenhouse gas concentrations keep on increasing and that means that the climate will continue to change. I am talking about stabilisation. I do not believe that is achievable, but that does not mean we should not try to reduce the rate of emissions to slow down the rate of climate change.

Mr BYRNE—Given that that will continue to escalate, what are we to anticipate as far as climate change as a consequence of that?

Prof. Karoly—Increased global warming.

Mr BYRNE—By what sort of temperature?

Prof. Karoly—The global temperatures are likely to increase in the order of half a degree over the next 40 to 50 years. By 2040 the increase in temperatures is going to be of the order of half a degree—the minimal estimate being in the order of two-tenths of a degree and the highest estimate being larger than seven-tenths of a degree.

Mr BYRNE—What would you anticipate to be the effect in a rough sense on our environment as a consequence of that?

Prof. Karoly—I am not an expert on the environmental impacts of those in terms of biological systems. In terms of direct temperature impacts there would be increases in temperatures in Australia, most likely greater increases in night time minimum temperatures than daytime maximum temperatures. Increases in night time minimum temperatures have dramatic impacts on things like frost frequency, which in some cases is beneficial and in other cases is disadvantageous—particularly if you like going skiing.

Mr BYRNE—I presume it also means that where we have areas of rain that might change?

Prof. Karoly—It may change. Rainfall is much less certain than the temperature changes.

Senator TCHEN—Professor Karoly, you were talking about carbon dioxide concentration. In your discussion, are you focusing on carbon dioxide or carbon concentration?

Prof. Karoly—This diagram talks about carbon dioxide concentrations and calculated emissions of equivalent carbon in the carbon dioxide. It makes relatively little difference, except in a scaling factor if you were talking about mass of carbon or mass of carbon dioxide. This is in fact the equivalent emissions of carbon dioxide.

Senator TCHEN—From all sources?

Prof. Karoly—From fossil fuels and land clearing—from all sources.

Senator TCHEN—What I mean is all carbon emissions converted to carbon dioxide.

Prof. Karoly—Yes.

Senator TCHEN—In terms of the carbon content or in terms of the heat trapping capability?

Prof. Karoly—In terms of the equivalent carbon dioxide.

Senator TCHEN—Heat trapping?

Prof. Karoly—Yes, but this is carbon dioxide.

Mr BYRNE—As far as existing motor vehicle transportation, how much of that results in the CO_2 concentration?

Prof. Karoly—I am not an expert on that. I recommend that you ask that question to the CSIRO expert. I can at least pass the buck as well!

Mr BYRNE—I just wonder whether it would be a fairly significant factor to have a sudden change in a mechanism for delivering transportation over the next 25 years. That may impact quite substantially.

Prof. Karoly—Transportation is a significant contributor to that fossil fuel source. So is power generation.

Mr BYRNE—If, hypothetically, we had a substantial change in the delivery of those sorts of mechanisms, that could substantially alter your prognostication for the future?

Prof. Karoly—Are you talking about Australia, or are you talking about the world?

Mr BYRNE—I am talking about the world. If, all of a sudden, we came up with a new car that did not use fossil fuels, and all of our transportation systems changed as a consequence of that, wouldn't that have a significant impact on the projection that you are making?

Prof. Karoly—That depends upon the energy source. If, for instance, the energy source is an electric car, and the electric car gets its electricity from oil or gas generated electricity, it will not have much impact at all.

Mr BYRNE—But if it did not?

Prof. Karoly—If it in fact burns hydrogen, which is produced from water, and you have another energy source which does not require electricity to split the water, then maybe you could reduce fossil fuels. I am not an expert in that.

Senator COONEY—What led to the fall in carbon dioxide content between 1600 and 1800?

Prof. Karoly—Probably changes in global temperature. In fact, if we look at the global temperature curve in this overhead—I believe the first page mirrors this one—there is a period of relatively colder temperatures, sometimes called the 'Little Ice Age', between 1600 and 1800. You can see in the reconstructed temperature curve up the time scale—over the same sort of period—which indicates that temperatures were rather cooler between about 1600 and 1800. In the very pronounced cool period around 1470 to 1480 there appears to have been a very major volcanic eruption.

Senator COONEY—So the very dramatic rise since 1800 could only be explained by human development?

Prof. Karoly—I believe that is the most likely cause. My conclusion is that increasing greenhouse gas concentrations in the atmosphere have made a substantial contribution to increasing temperatures since about 1900.

Mr BYRNE—You hypothesised about a major volcanic eruption. Where is Krakatoa with respect to a drop in temperature? That is a comparable sort of explosion. There is a drop, although not quite as substantial as the 1400 one.

Prof. Karoly—Correct.

Mr BYRNE—So you are potentially speculating volcanic activity that was far in excess of Krakatoa.

Prof. Karoly—Yes, and there is evidence for that.

Senator COONEY—As the temperature goes up from, say, 1800 to the present, have we any data to show the effect that has had on the earth in the growth or development of particular sorts of maladies?

Prof. Karoly—I am not an expert in climate impacts on health, but I have read substantial scientific literature that indicates that the preponderance of malaria and infectious diseases transported by mosquitoes is strongly affected by the temperatures. There is significant evidence over the last 20 years of an increase in the anopheles mosquito—the one that transports malaria—geographically, more specifically in Africa, as Sue Barrell mentioned before. Temperature decreases normally with height—if you go up a mountain it is colder—so if the temperature increases the mosquitoes can go higher up into the mountain areas. So, in Africa, anopheles mosquito has been found at higher altitudes because temperatures are warmer. So, yes, there has been evidence of an increase in malaria.

Senator COONEY—I know you are not an expert in this and I do not want to take you beyond your expertise, but you would have impressions about this. Are there any other problems that have occurred for the world as temperatures have gone up? I suppose what we have got to do in some ways is say, 'Yes, there is going to be this increase in temperature, there is going to be a greenhouse effect, and it is all due to human activity.'

Prof. Karoly—I never said it was all due to human activity.

Senator COONEY—I know; I am putting a hypothesis to you. Do not get superconscious just yet. This is a hypothesis I am putting to you—that is, that the temperature goes up and up and up. What we have to do is measure what the consequences are of that rise against what the consequences are of trying to keep it down. Clearly people say, 'Yes, there is going to be an increase in the water level, and in the level of disease even, but if we try to turn it back there are going to be people without warmth and electricity and it is going to be awful.' Have you got any impressions as to what will happen if we try to turn the trend back and what will happen if we keep it going?

Prof. Karoly—If we do not or if we do?

Senator COONEY—Both. I want to try and balance things: do we say, 'Righto, let us take it down to not only 10 per cent but five per cent,' or do we let it run? If we let it run, what happens?

Prof. Karoly—Those sorts of issues can only be addressed by people who have greater expertise in climate impacts and who then can value or assess the costs of different actions. I do not have expertise substantially in climate impacts or in the economic valuation of those impacts. Both of those are very important.

Senator COONEY—Where would we get that expertise? Do you know?

Prof. Karoly—In terms of climate impacts, CSIRO would be able to tell you some possible impacts. In terms of the economic valuation of those impacts, the Intergovernmental Panel on Climate Change Second Assessment Report in what is called 'Working Group 2: Adaptation and Mitigation Mechanisms'—or maybe it is 'Working Group 3'—have done costings of various processes that might adapt to or militate against climate change associated with greenhouse gas emission concentration increases. They are also part of the Third Assessment Report. There are some experts involved in that in Australia, but I must admit I do not know their names. My suggestion is you should contact the Australian delegate to the Intergovernmental Panel on Climate Change, Dr Zillman, and ask him for contacts in Australia who are experts or contributors to the Working Group 3 Assessment Report on Adaptation and Mitigation of Climate Change. Did I duck far enough?

Senator COONEY—No, that is fair enough. What you are saying, quite properly, is, 'All I can do is show you—

Prof. Karoly—Climate science.

Senator COONEY—You noted 'CO_2 ice core data': what does that mean?

Prof. Karoly—When snow falls it produces deep layers and within the snow crystals small bubbles of air are trapped. The snow gets packed down and forms ice and within that are bubbles of air that are trapped. In places like permanent glaciers or in Antarctica that ice gets thicker and thicker. If you go deep within that ice, you can sample air trapped thousands of years ago. This is not proxy evidence; these are actual measurements of air from thousands of years ago. Again I am not an expert. People in the Antarctic Division or in CSIRO would be

able to comment more. It would be a good question to ask of the people when you visit the Australian Antarctic Division of the Antarctic CRC.

Senator COONEY—The chairman says that we may have that knowledge. What about Cape Grim?

Prof. Karoly—Cape Grim is in north-western Tasmania and that is where they measure air. That data is collected and is being analysed at CSIRO—I am sure you can talk to the person from CSIRO who is going to speak in a few minutes.

Mr WILKIE—These are obviously global figures. I have a query about Australian figures. The Southern Hemisphere is vastly different from the Northern Hemisphere. You have talked about how, in order to stabilise greenhouse emissions, there needs to be a reduction of 70-odd per cent. Where does Australia fit into that in the Southern Hemisphere?

Prof. Karoly—Carbon dioxide is a relatively inert gas in the atmosphere. It does not react very quickly with other chemicals in the atmosphere. The average lifetime of a molecule of carbon dioxide in the air is long. It does not get emitted and get absorbed into the atmosphere or disappear very quickly. The average lifetime is about 50 years, maybe longer. That means that any molecule that is emitted into the Northern Hemisphere is mixed around by the wind patterns and the concentration of carbon dioxide in the Southern Hemisphere is very close, a few parts per million lower than the concentration in the Northern Hemisphere. The global concentrations of carbon dioxide and the rate of increase in the globe is very much the same in the Southern Hemisphere and the Northern Hemisphere because the lifetime of carbon dioxide in the atmosphere is long. So global emissions affect atmospheric carbon dioxide concentrations over Australia and Australia's emissions affect atmospheric concentrations anywhere else in the world because of the large scale atmospheric circulation that takes place all the time. It is very well mixed and Australia in that sense is part of the global atmosphere. We cannot say, 'We will not reduce our emissions and, therefore, it will not impact on Australia,' or 'We will reduce our emissions and we will have much lower concentrations in Australia.' Unfortunately, the carbon cycle and the atmospheric circulation mean that it is the net global emissions that affect the global atmospheric concentrations and they vary relatively little across the whole of the atmosphere.

Mr WILKIE—I wondered about that. Do you think then that Australia's target of six per cent below 1990 levels for the Kyoto Protocol is realistic in the scheme of things or should it be higher or lower?

Prof. Karoly—Australia's target is not six per cent below; Australia's target is eight per cent above. The global target averaged over all the developed countries is six per cent below, approximately. If the question is whether Australia's target of eight per cent is too high or too low, this again is an issue that has both impact questions and economic questions. In terms of trying to meet the Framework Convention on Climate Change, which has a target to stabilise greenhouse gas emissions, then Australia's target is too high because you cannot stabilise greenhouse gas emissions by continuing to increase greenhouse gas emissions. So in that sense, as Australia is a signatory to the Framework Convention on Climate Change, I would argue that Australia's target is too high. You cannot stabilise greenhouse concentrations by increasing

emissions; you have to reduce emissions. An eight per cent increase might be a reduction over business as usual but it is not a reduction in net emissions.

Mr WILKIE—Is it realistic compared with the rest of the world's reductions or increases?

Prof. Karoly—That is a question of equity. I am not an expert on either equity or economic impacts. I can make a very personal comment, if you would like me to.

Mr WILKIE—Please.

Prof. Karoly—I believe on equity concerns that developing countries which have substantially lower per capita emissions of greenhouse gases are likely to need to increase their greenhouse gas emissions per capita to reach similar levels of development as developed countries. Therefore, I believe that equity would be equal per capita emissions of greenhouse gases. Based on that, developing countries might be allowed to continue to increase their emissions well into the future and Australia, the United States and other developed countries might be required to reduce their emissions to 10 per cent of present levels—on equity concerns based on per capital emissions, which are related to per capita energy use.

Senator LUDWIG—In the same vein—

Prof. Karoly—This is an area outside my expertise.

Senator LUDWIG—I know you will certainly preface your remarks with that. I am very confident of that. Do you have a view about whether Australia should ratify the Kyoto Protocol?

Prof. Karoly—I have a strong personal opinion that Australia should sign for two reasons: first of all, to provide a first step to reducing global greenhouse gas emissions, and as an indicator of commitment to mitigating—reducing—global climate change. Developing countries are unlikely to believe that developed countries have any commitment to this until they sign on to the Kyoto Protocol and make some first steps. Again, this is a personal opinion not to do with my scientific expertise.

Senator BARTLETT—In relation to the Kyoto Protocol and some of the figures you have given us, in the context of the overall amount of reductions worldwide through that six per cent just with developed countries—so globally it is probably closer to no reduction at all—

Prof. Karoly—That is correct.

Senator BARTLETT—in the short term, would it be fair to say that Kyoto, whether it is ratified as it stands or in some other form, is likely to be only a very small first step to addressing climate change?

Prof. Karoly—I believe that those are exactly my words in the summary of my submission. The emission reductions in the Kyoto Protocol are a very important first small step in achieving the target.

Senator BARTLETT—In that context, what will the consequences be if the Kyoto Protocol was to fall over for various reasons—if Australia and the US, et cetera did not ratify it and it sort of dwindled away into international diplomatic squabbling for the next decade of two? Is there some sort of time frame when the environmental imperative is going to be so strong that it will force action?

Prof. Karoly—Greenhouse gas concentrations in the atmosphere would increase faster if Kyoto was not ratified and followed than if it was ratified and the emission reductions were followed. In terms of the time scale in which things need to happen, that goes back to the diagram that I showed before. At what time scale do you want to stabilise and at what level do you want to stabilise atmospheric concentrations? That determines the rate at which emission reductions have to take place. But there is a very long time scale for stabilisation of greenhouse gas concentrations and an even longer time scale for stabilisation of climate. The climate will continue to change long after atmospheric greenhouse gas concentrations are stabilised because the time scale for climate response is also very long—more than 100 years.

Senator LUDWIG—You have said that we should sign—and it is a personal view that you have adopted. The next question in that series is: why?

Prof. Karoly—The simple answer is because I believe that the economic and societal impacts of climate change, if not mitigated, will be substantially greater than the costs of reducing emissions. I believe that if we do nothing—and this is again a personal opinion—the costs will be substantial. There will be loss of life, changes in economic systems and changes in society which will cost more than the costs of reducing greenhouse gas emissions. I cannot provide evidence of that because I am not an expert in that area.

Senator LUDWIG—I was not going to ask you that next question. I was simply trying to explore your view.

Senator COONEY—I understand you have not done any research in that and this is just your personal view, but is it a personal view that you just woke up with or have you thought about this a bit?

Prof. Karoly—I did not just wake up with it this morning. I have been thinking about it for quite a while.

Senator COONEY—I do not want to bind you to your expertise. What sort of research have you done on reaching that conclusion?

Overhead transparencies were then shown—

Prof. Karoly—Let me show another diagram. This answers a question that was raised before as to what caused or might have caused the warming in the last 50 years and the cooling from, say, 1940 to 1970. This diagram is included in that set of notes. This is a climate model simulation. In fact, it is the same simulation repeated four times to see how different it is. On this side, the thick line is the observed temperatures. It shows this cooling from about 1940 to 1970 and then the pronounced warming in here from the 1970s onwards. This side only includes the climate model with natural variability and volcanic eruptions as observed and

changes in the amount of sunlight that the earth has received as estimated at the top of the atmosphere. What we see is that the model simulation shows cooling in here, warming in here and then cooling from about 1940 onwards. That is just natural forcing—solar forcing, volcanic forcing and natural variability.

The year to year variability you can see in here is just part of the natural climate variability that Mary Voice and Sue Barrell talked about before. This simulation does not include any natural variability, and the multiple lines in here are different simulations of the model run from different initial conditions. You start from a different year and just run it out with the same forcing. You see that all the simulations with increasing greenhouse gases show pronounced warming in the last 70 years. This model has included increasing greenhouse gases and increasing sulphate aerosols in the simulation. So it compares very well with the observed temperatures. You notice that the different model simulations done from different initial conditions are all showing the same sorts of results; there is not a wide scatter. There is a large uncertainty from one year to the next; on an average there is a pronounced warming trend in this model, which is due to increasing greenhouse gases and the impact of sulphate aerosols. The cooling in here is to some extent simulated in some of these models. You get, for instance, this individual case which shows cooling but later on they are all very similar and all are showing pronounced warming. All model simulations that have been run with increasing greenhouse gases and sulphate aerosols show a pronounced warming over the last century.

Mr BYRNE—So what is your hypothesis about why there is such a suddenly leap from the late 1970s onwards?

Prof. Karoly—At that stage the effect of the radiative forcing due to the increase in greenhouse gas such as carbon dioxide is dominating the natural climate variability and the diminishing effects of sulphate aerosols. You can see that there is in fact a warming from here to here in the model simulations but that there is also a lot of variability. After here the increase in greenhouse gases is starting to dominate over the diminishing effects of the increase in sulphate aerosols. There is also a lot of natural variability.

Mr BYRNE—Has there been any other significant component that you have seen that could possibly contribute to this sudden acceleration? I am not sure of what the atmospherics are.

Prof. Karoly—Apart from natural internal climate variability?

Mr BYRNE—Yes.

Prof. Karoly—No. The other question that was raised before was about temperatures in the lower part of the atmosphere. Unfortunately, this diagram does not reproduce very well. I have not included it in my submission because I could not reproduce it properly, but I am happy to leave this transparency with you if you would like to have it. This shows satellite temperatures in this layer from one kilometre to six kilometres above the surface, which you have read a lot about and which Bob Foster will be talking about later, from 1979 onwards—which is just in here. That is this thick line. The other lines in here are the radiosondes, the balloon measurements of temperatures, and they exist at this thinner line. The thick line in here is the surface temperatures. So there are actually three lines in here. The satellite only comes in here

and, if you look at the satellite line relative to the surface temperature line, you see the satellite shows less warming relative to the surface in the period from 1979 to the present. There is no question about that. The satellite agrees with the radiosondes and the satellite shows less warming in the layer from one to six kilometres than at the surface.

But notice that there is a lot of variability. There are very warm temperatures in here which are associated with an El Nino episode, internal climate variability in the ocean atmosphere system. There are also cool periods. Here in 1982-83 there is a cool period associated with the volcanic eruption, El Chichon. Here is the Mount Pinatubo eruption, marked down here. These are the temperatures in the stratosphere. This shows a cooling trend, that every time there is a volcanic eruption there is a warming because that puts aerosols into the stratosphere which warm. So there is El Chichon and there is a cooling in there. There is Pinatubo and there is a cooling. Here is Agung and there is another cooling. Agung was another volcanic eruption in 1963. If we go back to the 1960s, now in the lower troposphere we only have balloon measurements; we do not have satellites. But if we look at that longer record we do see a warming trend which is consistent between the surface and the troposphere over the longer record. Only over the shorter record from 1979 to 1999 is there this difference in trend. But that difference in trend could be due to the effect of volcanic aerosols, the effect of internal climate variability and the effect of stratospheric ozone reductions, which have been pronounced over that period. It is the stratospheric ozone reductions which are most likely causing this long-term cooling trend. I hope I am not lecturing you, but it is an issue that will come up again and again.

CHAIR—You use the adjectives ‘short’ and ‘long’. How are we to satisfy ourselves that this chart, really only in my lifetime—I was born in 1961—is representative enough a sample on which to base some rather drastic policy changes?

Prof. Karoly—In terms of temperatures above the surface, we do not have observational data which can indicate the natural climate variability on longer time scales than, say, 40 years. Then we have to go to surface data, or we go to what is called proxy data to look at natural climate variability. So we go back to this diagram, which I showed you before, the range of temperatures at the surface, and we can estimate those from ice cores and things like that.

There is another mechanism that we can use, and that is to say, ‘What would a climate model run for many thousands of years estimate as the natural climate variability, with no forcing, and could it simulate the temperature trend over the last 100 years?’ I can leave this diagram, one that I did not include. It shows thousand-year simulations with a climate model from the UK, a climate model from the United States and a climate model from Germany. These climate models are complex models that include the atmosphere, the ocean and the sea ice systems. They are not just like economic models: they have many millions of variables which represent the geographical distribution of temperature, winds and pressure fields in the ocean and the atmosphere. These are the observed temperature variations in the last 150 years, from 1850. It is approximately constant, then it warms, cools and warms. We can compare this with the variability in the models. What we see is that none of the models simulate a warming trend of the order of six-tenths of a degree in 100 years without anthropogenic forcing. If you look at the simulations, none of them show a warming as large as six-tenths of the degree over 100 years, which is the magnitude of this observed warming in the last 100 years.

CHAIR—Almost every one of these excursions in our evidence this morning gets back to these models. In those charts you have described the carbon cycle and so forth and the drastic nature of the policy changes that are required to meet those necessities and stabilisation. Once again we are back with this business of these equations. I am not sure whether I want to pursue this business of making a correlation between surface temperatures and upper atmospheric temperatures or making a correlation and then modelling it back to that extent—

Prof. Karoly—That is not how the climate models work. The climate models are not like economic models. Many economic models are based on correlations between observed variables—or economic variables—and predictors like exchange rates. They are based on correlations. Fortunately, climate models are not produced in the same way. They are a set of partial differential equations which represent the physics of the climate system from fundamental first principles. So they do not correlate upper air temperatures and surface temperatures. The same sorts of equations that are used to predict the weather are used to predict the average state of the climate system in the future. They are exactly the same sorts of models that are used to predict tomorrow's weather—and they do a reasonably good job at tomorrow's weather, although they are not able to predict the weather exactly more than seven days in advance.

CHAIR—We are back to the evidence we began with—this distinction between prediction and projection. It was made very clear to us by the Bureau of Meteorology witnesses this morning that we have to be careful not to take them out of their proper scientific context and assume that they are making predictions. They dwelt much on this business of projecting these equations.

Prof. Karoly—That is correct. These mathematical equations are solving the climate system as a function of time. As Dr McAvaney said, they take as inputs things like greenhouse gases, sulphate aerosols, solar constant and things like that. So you can run them out into the future. They are not running as correlations. In the sorts of simulations in this slide that I showed a couple of minutes ago, the models were started way back in 1860 and run out with a time step every 10 minutes with these forcings, either natural forcings or an increase in greenhouse gases, for 150 years for the whole globe, producing lots and lots of data. They were then averaged to produce a global average temperature. They are not predictions in this case. They are simulations of the climate system including greenhouse gases or including only natural variability. They can be run into the future. I would call those 'simulations' or 'projections in the future'.

CHAIR—Again we get back to the factors involved in the simulation—that is, the equations.

Prof. Karoly—And the processes.

CHAIR—Mathematical processes aside, the debate between the natural forcing and the anthropogenic forcing, and the weight the models give to each—which I assume is written in the equations—

Prof. Karoly—That is correct.

CHAIR—We have to find some way, as a process of government, of subjecting those equations to some scrutiny. We can try and derive from you, by way of evidence, as much as possible of what is in them. We heard about the volcanic activity bit—I accept we saw good evidence of that—and the likely volatility of that, in the sense that Ms Voice said you would need a huge series of volcanic eruptions to make a change that lasted more than a few years, so to speak. I am not sure that 'volatility' is quite the right word for it, but, if you like, the 'amplitude'. We have heard of the solar and the ice this morning. These are also natural forcing phenomena. Where do we go to review the strength or the validity of the equations in the model that give weight? There must be some determined weight to their role in climate change.

Prof. Karoly—Certainly. There are two ways to do that: one would be to start an undergraduate course in climate science and spend the next 10 years getting a PhD and then understand the equations; the other would be to take international assessments of the equations—like the IPCC, which has done a very thorough assessment of the way that the climate models are developed—and to actually look at their assessments, the second report and the third assessment report, because normally those assessments have been accepted by more than 100 governments around the world. So you can either start the process again, which might be appropriate, or accept these international intergovernmental assessments. I would recommend the latter, because you probably do not all want to go back to university again.

CHAIR—No, although you have to understand that in the same way as your models are limited by the equations in them policy is limited by the processes of government. We are not allowed to accept evidence by assertion. We cannot. We just cannot sit here and make a recommendation without some cross-examination.

Prof. Karoly—I understand that. But you are allowed to accept published evidence that has been accepted by international bodies as being either reputable or not reputable. You are expected, I presume, to make your own assessment of the value of this evidence. And the value of evidence from 100 scientific experts and 1,000 contributing authors reviewed by many thousands of experts from around the world is perhaps slightly more valuable or weighty than the evidence from a single expert.

CHAIR—Yes, true. The only thing is that we have learned by experience that lots of international mechanisms frequently fail in terms of their processes. You can look at all sorts of institutions that claim they know some great role in our lives and yet, frankly, really do not measure up. So we have to stand above that. What does occur to us, and this is what it all comes down to, is if this treaty is being sold to us as an insurance policy of some form—so that we pay the premium you are asking us to pay and we are protected from the disaster—we have really got to judge whether it is good value or not. Given the cost of the premium that you outlined before, these equations and the science have got to be subjected to, frankly, more scrutiny than ever before.

Prof. Karoly—I understand that.

CHAIR—So you appreciate where we are coming from. Where do we go to get someone to attack the equations that go to giving weight to the natural forcing in the climate?

Mr BYRNE—Is there a reputable international expert that would have a countervailing view to what you are putting forward here that we could examine? I think that is what the chair is asking.

Prof. Karoly—There are a number of reputable international scientists who have specific expertise in climate science who would be able to provide contrary arguments about the magnitude or the likely consequences of greenhouse climate change. I am not aware of any active research climate scientists within Australia who have countervailing arguments. There are a number of people who are making submissions, but I believe that the majority of those either accept these arguments or are not active research climate scientists. However, of the people that you might want to contact who are contrary scientists, Professor Pat Michaels in the United States and Professor Dick Lindzen in the United States are perhaps the two leading advocates arguing that greenhouse climate change has been exaggerated. However, I believe that you will find that both of them accept that the increasing temperature over the last 100 years—that is, global warming—is real and that increasing greenhouse gases have made some contribution to that.

CHAIR—As we said with our witnesses from the bureau, we may ask you to come back for some more contributions as we have a good road to travel.

Prof. Karoly—I would be very happy to do so.

Resolved (on motion by **Senator Tchen**):

That the committee receive as evidence and include in its records as an exhibit for the inquiry into the Kyoto Protocol the documents received from Professor Karoly.

[11.17 a.m.]

MITCHELL, Dr Chris, Manager, Greenhouse Key Accounts, Atmospheric Research, CSIRO

CHAIR—Welcome, Dr Mitchell. Do you have any comments to make on the capacity in which you appear?

Dr Mitchell—I work for two divisions of CSIRO. For the Division of Atmospheric Research, I coordinate research into climate change. I also work for the Division of Energy Technology where I manage research into greenhouse gas mitigation.

CHAIR—I formally advise you that these are legal proceedings of the parliament, as if they were taking place in either chamber, so the giving of false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. Would you like to make an opening statement, and then we will ask some questions?

Dr Mitchell—The statement I am going to read is largely the executive summary from a submission we prepared for this committee. I am not sure whether committee members have received that submission because it was transmitted via the Australian Greenhouse Office as part of a larger Commonwealth effort. Climate change science shows that greenhouse gases continue to increase in concentration in the world's atmosphere. In the case of most of these, and in particular the important greenhouse gas carbon dioxide, most of the increase can be clearly attributed to human activity. Carbon dioxide concentrations will continue to grow through this century. Globally, stabilising the concentration of this gas at approximately double pre-industrial levels would require emissions to be reduced to about a third of their current rate. This is unlikely, given population growth and investment and technological dependence on fossil fuels as the prime source of energy and driver of global industrialisation.

The global atmosphere, ocean and biosphere have limited capacity to absorb future emissions of carbon dioxide. The complete combustion of known fossil fuel resources over the next centuries—and I add here, if that were possible—would raise carbon dioxide concentration in the atmosphere to almost 1,000 per cent above pre-industrial levels or at any time in at least the last 400,000 years. The growth rate of methane is slowing. If this trend continues, the concentration of methane will have stabilised by about the time of the first Kyoto commitment period. Similarly, the growth rates of CFC gases are slowing in response to the Montreal Protocol on Substances that Deplete the Ozone Layer.

Observed climate change: the surface of the earth warmed by between half a degree and one degree during the 20th century. This warming is evidenced in a wide variety of observations. Predictions of climate change made in the late 1980s and early 1990s are broadly consistent with changes now being observed. If we think about predictions of future climate, we note that climate has always varied and will continue to vary for a number of reasons. On the time scale of this century, that is the 21st century, most mechanisms for causing such variations either are highly improbable or cause changes that will impact for short periods or with small magnitude. The most likely sustained and significant climate change of this century will be human induced and due to emissions of greenhouse gases.

Confidence in projections of future climate have improved over the past five years due to better understanding of important climate processes and to improvements in climate models. Nonetheless, gaps in our understanding remain, and these translate to uncertainties, particularly in projections of regional climate. Investigations into regional climate change continue to suggest that changes in climatic extremes would produce more significant impacts than changes in averages. Changes in climatic extremes by definition are difficult to detect and to attribute specific causes. Given the difficulty in reducing greenhouse gas emissions both nationally and globally, it appears inevitable that the concentrations of greenhouse gases will continue to rise and global climate will continue to change. However, the rate of warming will be influenced by the changes of growth rates in all greenhouse gases and in aerosol emissions.

Responding to climate change: scientific and technological understanding does not suggest a single or best solution to addressing climate change, only sets of solutions. There are no short-term solutions, and some focus needs to be retained longer term beyond the first Kyoto Protocol commitment period. Global warming will occur, so we must pay early attention to issues of impacts and of adaptation. While Australia is unusual in being a developed country with significant and uncertain emissions associated with land management, most of Australia's emissions come from the use of energy. Successful greenhouse mitigation will require interventions in the energy cycle. Such interventions may relate to the reduction of use of fossil fuels and/or the capture of the emissions resulting from that use. There are many energy technologies that might be employed to mitigate greenhouse. These technologies include: using renewable forms of energy such as biomass, solar, wind and other; high-efficiency gas utilisation technologies for power, heating and cooling, including fuel cells, micro-turbines, engines and hydrogen based systems; hybrid fossil renewable approaches; energy induced efficiency and capture; and sequestration of carbon dioxide and methane. In terms of biospheric sequestration, there are opportunities to gain greenhouse benefits from tailoring activities with other objectives, such as tree planting to counter salinity and measures to prevent problems from acid sulphate soils.

Any system of carbon or emissions trading will depend heavily on measurement and accountability, and by that we mean scientific measurement and accountability. Further measures will be required beyond the first Kyoto commitment period. We must identify and conduct the long-term science and consider the policy and response implications of future requirements stemming from the United Nations framework convention on climate change and the inevitable evolution of the agreements under that convention. The responses listed here represent parts of a comprehensive approach to the management of the greenhouse issue. Science and technology does not provide all the answers. It needs to be an integral part of the collaboration between government, industry, commerce and the public in seeking innovative ways of ensuring economic environmentally and socially acceptable solutions.

We note that the Intergovernmental Panel on Climate Change, an international gathering of several thousand scientists, periodically assesses the progress of the international science that underpins our understanding of the global warming issue. The intention of our submission is not to repeat or summarise material that was included within previous assessments—the first assessment report and the second assessment report. CSIRO scientists actively participate on the Intergovernmental Panel on Climate Change and believe that at the time the second assessment report represented the best overall available assessment in terms of consideration of all

scientific viewpoints, the comprehensiveness of its coverage and its balance between peer reviewed input and currently active research.

We also wish to note that substantively the material in this submission does not differ from a submission that CSIRO made to the Senate Environment, Communications, Information Technology and the Arts Reference Committee inquiry into Australia's response to global warming. The reason for this is that the science underpinning the climate change issue has not changed substantially since we made our previous submission. Nonetheless, we have elaborated upon some issues, including reference to some recent work that has become available since March 2000, and slightly reworded some material for clarification. CSIRO does not advocate a policy position with respect to how Australia should respond to the framework convention on climate change or the Kyoto Protocol. Rather, it wishes to ensure that policy development proceeds with the best possible scientific and technical underpinning.

CHAIR—At the moment, in the government schematic diagram, which department does CSIRO come under?

Dr Mitchell—It is a statutory authority and Senator Minchin is the portfolio minister.

CHAIR—Is it the government's only source of scientific advice?

Dr Mitchell—No, the Bureau of Meteorology is another source of scientific advice. That is within the governmental system. The Australian Institute of Marine Sciences produces some information in relation to climate change; then, of course, you have the universities. The Bureau of Rural Sciences is involved in some aspects of climate change science. ANSTO, the Australian Nuclear Science and Technology Organisation, also conducts some research that is relevant to climate change. They are just a few that come off the top of my head.

CHAIR—It struck us as a bit strange that your submission should be parked in the Australian Greenhouse Office and not delivered directly to parliament, as the Bureau of Meteorology, for example, has done. Why would your submission go to the Greenhouse Office and not directly to us?

Dr Mitchell—We had some discussion about that. Our Senate inquiry submission did go directly from CSIRO to the committee. The request actually came, as our understanding is, via Minister Hill and Minister Minchin that you would see a Commonwealth submission. CSIRO's part of that submission is clearly identified. It has not been influenced in any way by any of the government departments. But it was just a request that we acceded to from the ministers. The reason behind that I could not guess at.

CHAIR—So we should inquire of Senator Minchin, who is your minister, as to why the Greenhouse Office was intervening?

Dr Mitchell—I would not say it was intervening.

CHAIR—But where is your submission? You have read out a summary and, in a sense, the burden of proof ought to rest with you as to why we should take any more evidence now.

Dr Mitchell—We are scheduled to see you on the 27th, so we would be quite happy to leave it if you would prefer, but I am available to answer your questions, knowing that you might wish to tackle our submission in much more detail. All CSIRO does in these matters, as always, is to try to be helpful by the best information possible.

CHAIR—I appreciate that.

Dr Mitchell—If you would prefer to hear from us later, which you will do in any case—

CHAIR—Obviously, we cannot question you on a submission that is not here. As you have come, members may want to ask you to reflect on things that other witnesses have said this morning. So fire away.

Mr BYRNE—With respect to the contribution of greenhouse gases on human activity, could you give me a breakdown of transportation?

Dr Mitchell—It depends whether you want it for Australia or globally. Every country's profile is different.

Mr BYRNE—But there must be major contributors.

Dr Mitchell—Yes. In general terms, roughly 80 per cent, sometimes higher, is associated with the use of fossil fuels. Australia's transport emissions are of the order of 17 to 18 per cent. That is not atypical for a Western, developed country. As we indicated in our submission, Australia is somewhat different because we have fairly substantial emissions associated with land management, largely land clearing for carbon dioxide. We are also unusual in that we have higher emissions than many other First World developed countries from livestock, particularly methane emissions.

Mr BYRNE—If we were committed to reducing carbon dioxide emissions, greenhouse gas emissions, has the CSIRO looked at the manner in which that could be done without obliterating Australian industry? We heard earlier this morning that there has been some forecasting and an example of what would need to be done with reducing greenhouse gas emissions down here. If we were committed to a course of action, has CSIRO examined some sort of modelling? What would the economic cost of that be and how would that feasibly be done?

Dr Mitchell—No, because that is outside CSIRO's remit. The Australian Bureau of Agricultural and Resource Economics, the McKibbin group—I am not sure where they are—and other econometric modellers deal with that kind of question. CSIRO is not an economics outfit.

Mr BYRNE—But it has not asked that question at all? So basically CSIRO is saying, 'We accept the science of what has been put forward.' I assume that the CSIRO position is a commitment to the Kyoto Protocol. What is the CSIRO's position?

Dr Mitchell—I think there is a graph in our submission which shows that. We have said, 'Look, what are the implications of the Kyoto agreement for future concentrations of greenhouse gas in the atmosphere?' So it is purely a physical approach, not an economic approach. What you can see from that is, if you adhere to the Kyoto thing—I will show it to you and explain a little further.

Overhead transparencies were then shown—

Dr Mitchell—It is on this kind of assessment that we say that future atmospheric change appears inevitable. We have taken one scenario of future greenhouse gas emissions. I want to point out that the range of those future scenarios is in fact very wide, if you look at the international reports of the possibilities in future emissions, but here we are talking about concentrations. If you compare the concentrations you would get from something like a business-as-usual scenario—whatever that is, and we do not define it because we are not prognosticators of that sort—with the implied commitment under the Framework Convention on Climate Change, which asks in an implied way for developed countries to stabilise their concentrations at 1990 levels, you would see a difference of the amount that I am indicating on that black line on the slide. If you then went further and said, 'Okay, the developed countries meet their Kyoto obligations and in fact go the further step, that is, maintain their emissions at those new levels,' in other words, not allow them to grow after the first Kyoto commitment period, that is what we estimate, fairly crudely, is the difference.

Mr BYRNE—If the minister for industry agrees to a recommendation to subscribe to that particular protocol, does he come to CSIRO for your organisation to verify the current scientific evidence for that argument? The government has to have some sort of body that advises it as to whether or not the evidence that is being put forward is acceptable. Is that you?

Dr Mitchell—Yes, in part, although the government also formally accepts through the processes, internationally, the evidence of the Intergovernmental Panel on Climate Change. As I understand it, government policy is to accept the Second Assessment Report. The Australian government has not accepted the third assessment report because it has not yet been asked to because that report is not ready.

Mr BYRNE—Are you a contributing party to that third assessment report?

Dr Mitchell—CSIRO is, at a number of levels. Some of our scientists are convening lead authors of some chapters, some are lead authors, some are contributors and some are review editors. We estimated that our commitment to the IPCC was of the order of half a million dollars. It is very substantial. Yet we are aware that it is an assessment report—and we have said this before. It is a consensus document. We believe it is the best overall assessment, but within that ambit. That means that not everything in it is perfect. It is not the be-all and end-all, but it is a fair overall assessment of the state of the science.

Mr BYRNE—So, in a sense, the government will make a decision fundamentally, with respect to the science on it, by accepting the IPCC's verdict?

Dr Mitchell—I think it is much better to ask the government itself how it does that. We are just essentially research providers in the process.

Mr BYRNE—So it will not, basically, come back to you and say, 'Notwithstanding the fact that some of your members have contributed to this particular thing that we may have a disagreement with, what is your independent assessment of it'?

Dr Mitchell—They may or may not. I do not know what their intentions are. We are always available and we participate in the discussion about climate change science in a whole range of ways. This kind of committee is one. We have participated in the Senate global warming inquiry. We are quite often asked to provide briefing material to parliamentarians or ministers on specific aspects of the science, because it is not one big lump. It has a lot of detail within it.

Mr BYRNE—Is there anyone within your organisation that has a countervailing view with respect to the science behind this, or some of the predictions?

Dr Mitchell—It depends on how broadly or how narrowly you want to ask that question. The science is quite considerably debated, obviously, within CSIRO. And CSIRO is so broad: you would find people who might have an expertise in biomolecular engineering of proteins for vitamin A tablets or something who might take a contrary view, but they are not working in that field.

In terms of the climate scientists within CSIRO, you would find that they would all accept that the greenhouse effect as a mechanism is real. This is well-established science. It has been established for 100 or more years. We actually could not explain the current temperature of the planet without the reality of a greenhouse effect. That these gases interfere with radiation in the atmosphere is certainly well known and I do not know whether it is really debated or not anywhere.

Mr BYRNE—Has your organisation conducted an assessment of the countervailing viewpoints and conducted an analysis of that?

Dr Mitchell—Yes, consistently. The countervailing viewpoints come up all the time and we are always abreast of them. The difficulty is, however, trying to do it systematically, in that the way this discussion is conducted is at a variety of levels. So at one level you have the formal peer review processes of the international literature, and clearly we are involved in those. Then it goes right through to random emails that we have from people we do not know, from some part somewhere and everything in between.

Mr BYRNE—If that was the case, is the department in a position to provide to this committee a summary of the arguments as put forward that would be seen to be critiques of the current viewpoint and then an analysis of that?

Dr Mitchell—Yes, we could do that, if you requested it.

Mr BYRNE—Chair, I was basically asking whether the CSIRO could provide to the committee an analysis of the arguments that might be seen to be countervailing the arguments that have been put forward and that be brought back to Treaties to examine.

CHAIR—Frankly, the minister's chief of staff does not know anything about this business of the AGO. He has just told me. So he is looking into exactly why parliament is having its evidence vetted by a government department on the way from apparently an objective source of scientific advice such as you. We will deal with that in due course. Could we wait until we are satisfied with the process?

Dr Mitchell—We must have been naive in that respect. As I said, we just did what we were asked to do.

CHAIR—I appreciate that. There is no personal element in this. The integrity of the scrutiny that these committees give to the executive depends on the transparency of the advice given. This is nothing that any of our colleagues seem to have come across before. Anyway, we will deal with that.

Senator LUDWIG—On the graph that you previously showed on the overhead projector, if you can see the red line, which is the business as usual—

Dr Mitchell—A business as usual.

Senator LUDWIG—One projection of what could be described as business as usual.

Dr Mitchell—It is actually not a projection; it is a scenario. We do not know how human behaviour is going to change, what technology is going to change, how economic growth is going to change—any of those things. So scientists in broad terms do not produce those curves of future emissions. We rely on essentially economists, as it were. These are just the annex 1 emissions according to that other scenario, rather than concentrations. Because the possibilities are so broad, there is a very broad range of future possibilities for emissions.

Senator LUDWIG—Yes, I can accept that.

Dr Mitchell—We simply take a central one to have a discussion. That is why we call it a scenario.

Senator LUDWIG—So that scenario would be an average of the range of scenarios that are available.

Dr Mitchell—Probably not an average—a midpoint for a mid range.

Senator LUDWIG—Okay. I understand the difference. You then compare that to whether Australia and the world should ratify the Kyoto agreement, which is then in the order of magnitude of the dotted line. The question that could be posed then is: is that a statistical significant difference?

Dr Mitchell—From?

Senator LUDWIG—From the red line?

Dr Mitchell—Yes, we have gone through this and we have done some—

Senator LUDWIG—If you say that the red line is the midpoint, then its range will go higher and lower and the Kyoto line will also go higher and lower. Should the world ratify the Kyoto agreement and everyone adhere to it—that is your best case scenario—then is it a statistically significant event?

Dr Mitchell—We have done some analysis and the answer is yes. I would much prefer to go down—

Senator LUDWIG—The line is very narrow, and it is still going up hyperbolically.

Dr Mitchell—Yes, that is right. But the difficulty with the protocol is that it actually only goes out to the first commitment period. As I explained earlier, this continuation is merely our assumption that developed country parties maintain that level of emission in the foreseeable future at the same rate. We do not know what might happen under the Kyoto framework beyond the first commitment period, so we just have to guess.

Senator LUDWIG—I understand that. I am really only looking at that first commitment period to begin with in any event. But why do you then say it is statistically significant?

Dr Mitchell—We have actually done some work on it, and I would have to pull out the reports.

Senator LUDWIG—If they were available, that would be very helpful. Just on the narrowness of the two lines, it might take a bit more convincing than—

Dr Mitchell—The overall target in the Kyoto Protocol for developed countries is, as I think somebody mentioned, five per cent for the developed or NSB nations.

CHAIR—I look forward to seeing you when you come back after I have read the submission and will ask some questions then. I would like to thank CSIRO for the tour of their gas lab yesterday. I thought it was excellent.

Senator BARTLETT—I have two questions. The first is in relation to that graph, following on from the previous question. If the red line is the midpoint, the key thing is that the red line and that dotted line are still relative to each other. So if you had a scenario where the red line was higher or lower, the Kyoto line would go up or down along with it. Would that be right?

Dr Mitchell—That is right.

Senator BARTLETT—The other question is linked to that. At the moment Australia's commitment is to 108 per cent of 1990 levels by 2008. Is it fair to say that there is no way Australia will meet that commitment?

Dr Mitchell—I actually do not think we can comment on that because CSIRO do not know the impact of current government policy on Australia's emissions. We know that after 1997 the Department of Foreign Affairs and Trade published the situation and their numbers, but the government does, for example, have a new program known as the Greenhouse Gas Abatement Program. We have no knowledge at all of what impact the Greenhouse Gas Abatement Program might have on Australia's emissions.

Senator BARTLETT—What are we currently running at in relation to the 1990 levels?

Dr Mitchell—I cannot recall offhand, but it is well above the 1990 levels.

Senator BARTLETT—The other question on Kyoto goes back to that. Given that it appears—at least from how it has been demonstrated there—to make a reasonably minor impact, is it worth all the bother of going through all this, given how difficult we are finding it to even meet our own first stage commitments?

Dr Mitchell—That is really a policy question. That is what you are here to answer. One of the difficulties with science is that it produces data or information on a relatively narrow palette, as it were. So I would not argue that that is a defining graph in any sense. As I continue to point out, we have just made an assumption about what might happen after the first commitment period to produce some kind of illustration.

Senator BARTLETT—The CSIRO does climate scenarios about environmental impacts. Obviously, there are some imprecisions in those scenarios as well but, as a very general statement, is it fair to say that all of those scenarios indicate overall negative environmental impacts?

Dr Mitchell—No. We have previously discussed that as well. Firstly, considering the impacts of climate change, it is important to keep in mind the uncertainties associated with the regional scenarios of future climate. It is also clear, for example, that one of the consequences of elevated levels of carbon dioxide in the atmosphere is that you get a phenomenon known as the carbon dioxide fertilisation effect. This effect is physiologically based and, all things being equal, it produces increased plant growth. Also, all things being equal, it increases plant water use efficiency. Some of the modelling we have done with respect to wheat suggests that, as climate change unfolds in the earlier part of the decades of this century, you may in fact get increased wheat yields in certain locations. However, at some point in the future it is also possible for that benefit to pass through a threshold and you begin to lose that benefit to the point that you are much worse off than you started off being. So in trying to consider the impacts of climate change you need to think about the way climate change evolves into the future and whether or not any important physical or biological thresholds are being crossed. It is not only the magnitude of climate change that is important, it is also the rate of climate change that is important.

CHAIR—The source of advice about Australia's carbon emissions: where should we go for that?

Dr Mitchell—That is done formally under what is known as the national greenhouse gas inventory. The government body that has carriage of that is the Australian Greenhouse Office. CSIRO, as have many other organisations, have participated in putting that inventory together. It is a very complex exercise. We have had carriage of certain parts where we have developed, for example, the methodologies associated with how you might calculate non carbon dioxide greenhouse gases from the biosphere. That gives you some sense of how specialised parts of the inventory are. The inventory is published, it is available on the Web, and the Greenhouse Office is right across all those numbers.

CHAIR—I was outside when you were explaining this chart. Can you give me a little time for explanation of it?

Dr Mitchell—I will take you through it a little more slowly.

An overhead transparency was then shown—

Dr Mitchell—First, I want you to consider emissions of greenhouse gases. These are for the developed or annex 1 parties only. We have just taken a scenario of future emissions. This is a standard scenario, but I have been pointing out to the committee that there are a whole number of other scenarios and the envelope of future emissions globally is actually quite broad because we do not know what future economic growth is going to be, future technological change, future population and all those drivers. CSIRO accepts these from other people who do that sort of work. We take the mid-range case, which is what is known as the ice study 2 scenario. We have said, 'Okay, what does the United Nations framework convention on climate change in its implied statement ask the developed world, annex 1 parties, to do?', and that was to stabilise emissions at 1990 levels. Then the Kyoto Protocol asks for something like a five per cent cut for those parties by 2008-12. We have added an assumption, just for the point of drawing a graph, that that commitment is carried forward and developed country parties do not increase their emissions thereafter but, mind you, they do not decrease them thereafter either. I will leave the other one aside. Then we have asked: given that kind of picture of future emissions, what impact does that have on the concentrations of carbon dioxide in the atmosphere? So that red line shows you that, with that so-called business as usual case, emissions continue to go up along a path like that, with the framework convention on climate change you get a decrease, and you get a smaller decrease under the Kyoto Protocol.

So it shows that the commitments under the protocol itself do not lead to substantially larger outcomes than under the framework convention itself, provided no further action is taken after the first commitment period. That is an extremely important proviso because the protocol itself, as we understand it, is silent after the first commitment period. You would be much better off talking to Foreign Affairs and Trade and the Greenhouse Office about the Kyoto Protocol itself.

CHAIR—That evidence would suggest that the difference between business as usual and ratification of the protocol and meeting the commitments is really quite small in that sense.

Dr Mitchell—That is right; if nothing else were done after that. Going back, that is why in our submission and our summary we have said that we need to consider what happens after the first Kyoto Protocol commitment period.

CHAIR—In the submission that is stuck in the AGO, why do we see a small piece of evidence that would tend to argue that we should ratify the protocol but we do not see the rest of the submission? Why is this piece of evidence presented this morning?

Dr Mitchell—Because I was asked a question about it.

CHAIR—But in a sense if you are able to present that piece of evidence, why not present the rest of it? Do you have it with you?

Dr Mitchell—Yes, I could give you a 20 minute presentation.

CHAIR—But it is a submission in the sense that the CSIRO has to put its name to evidence.

Dr Mitchell—I have no problem at all handing a submission across today. I have a loose leaf version of it and I have a non-colour version of it.

CHAIR—It all seems a bit strange that you have in a halfway house the evidence and we just get a slice of it.

Dr Mitchell—I do not know what happened. We are scheduled later on with other parties and I am not sure that people were aware that we were scheduled today as well. It has been pretty busy.

Senator COONEY—What we might do now is ask you some questions and you can bring the answers back to us.

Dr Mitchell—Sure.

CHAIR—Frankly, I think that for your own credibility you ought to leave what you have. Otherwise, you risk the view that the AGO has some surreptitious role in your submission.

Dr Mitchell—I will try to find all the bits.

CHAIR—We are not going to compel you to produce it but, believe me, that is our advice. Anyway, thank you, Dr Mitchell; we will deal with all of this later and proceed to the next witness.

Dr Mitchell—I am quite happy to hand across essentially the copy of the submission that I have. It is actually only part of it. We actually have an attachment that I did not bring, which is a paper that I wrote with the chief of EnergyTech.

CHAIR—That can come later. Give the submission to the secretariat and they will copy it and distribute it to us.

Senator COONEY—Dr Mitchell, what is your position? What happened? What was your understanding as to why you are here today? That might be helpful.

Dr Mitchell—I have no idea at all other than we got some emails saying that we had been scheduled for such and such a date. What I had understood would happen was that our submission would go in ahead of this date. I do not know why it has not. I cannot remember when we put it in; it was a week ago or more. I thought it would be transmitted. I did speak to an officer of the Greenhouse Office, who said, 'Oh, you're appearing on Monday.' I said, 'Yes, but our submission hasn't gone.' 'Oh, hasn't it? I thought it would have by now.' Then there was some discussion between your secretariat and the Greenhouse Office, who agreed that the material that we presented to the Senate global warming inquiry would be adequate background for today since it was not substantively different; I would turn up today—and we have had this discussion.

CHAIR—We appreciate that.

Senator COONEY—And you were just trying to help in the situation?

Dr Mitchell—Absolutely.

Senator COONEY—I suppose, fundamentally, all the inquiries have been about risk management—that is, what the risk is. Is there any agreed position amongst the scientific community as to what the risk is, say, 50 years from now, 100 years from now or even 20 years from now, or really is it the case that all we can do is get a feel for the thing?

Dr Mitchell—Again, it depends. Because it is so multilayered, you have different levels of agreement and different amounts of uncertainty. In broad terms, the climate community agrees that there will be global warming and there will be associated changes in climate with that global warming. These changes in climate may involve changes in the patterns of rainfall, the intensity of rainfall and quantities such as that. The consequences of that for the impacts are not, in broad terms, well known, but we have what we would call indications. They are more than based on supposition, they are based on sound work, but these are still subject to ongoing research and they are still discussed.

Let me give you an example from some CSIRO work. One of the outcomes we would be more confident of is a decrease in the amount of snow lying on the ground in the Australian Alps as we move forward next century. The reason we would say that is that that kind of change is tied very closely to temperature changes. It is not really tied so tightly to precipitation changes from the work that we have done. On the other hand, if you were to ask us about future damage from tropical cyclones, then we would be much less confident for a whole range of reasons. Firstly, it does not only depend on whether or not tropical cyclones become more or less intense; it also depends on the average steering that you might get under climate. But in terms of damage to communities and economy, you also need to consider whether more or fewer people are living in the area and the quality of housing and buildings in areas that might

be subject to tropical cyclones. There is a whole range of issues that need to be considered when trying to evaluate the impacts of the change in climate.

Senator COONEY—If we asked ourselves the question, 'What will certainly happen?' we will not get an answer to that. If we asked ourselves the question, 'What could we reasonably expect to happen?' could we get an answer to that?

Dr Mitchell—Yes, but in broad terms and for different parts of the globe and the global system. Let us talk about what we are confident about. We are confident that there will be global warming. We are confident that much of that global warming will be driven by increases in greenhouse gases. We would expect that some of the climate changes associated with that will be changes in what is known as the hydrological cycle—that is, patterns and distribution of rainfall. However, to go to the next step and say, 'Are we confident about where and how the rainfall will change?' the answer is no.

Senator COONEY—In terms of catastrophe, can we make any reasonable predictions about that, or is that too soft a concept?

Dr Mitchell—Catastrophe is a soft concept in that what might be a catastrophe to one group of people may not be to another. Let me give you an example: the available scientific evidence suggests that a country such as Bangladesh is likely to be much more vulnerable to changes in climate than a country such as Australia. Why would we say that? Firstly, we know that, with its existing climatic variability that it already experiences, that already poses significant problems to that country. Secondly, we know that it is a low lying country, so it would be more vulnerable to the combined effects of, say, sea level rises, changes in storm surges, et cetera. Thirdly, we know that it is less economically developed and it is less robust in those senses. So for a whole variety of reasons we can say, 'Yes, a country such as Bangladesh is likely to be more vulnerable to climate change. It is likely to experience more difficulties in the future because of this phenomenon.' Whether that is catastrophic then becomes a value judgment.

CHAIR—Thank you. We will deal with our next witness.

[12.05 p.m.]

BOEHMER-CHRISTIANSEN, Dr Sonja Anita, Independent Academic, University of Hull, The Lavoisier Group

CHAIR—Welcome. I should ask you first to say something about your background for the purposes of our recording of evidence.

Dr Boehmer-Christiansen—I did not bring enough stuff, but I have five short summaries of what I am going to say. I was educated at University of Adelaide but did a doctors degree in environmental politics and international relations at the University of Sussex. I am now a reader at the University of Hull. My speciality in the last 20 years has been environmental politics with an emphasis firstly on marine pollution control and then on acid rain. Out of this came the study of politics, particularly the science politics of global warming.

CHAIR—Thank you. I have to formally advise you that these are proceedings of the Australian parliament and it is as if they were taking place in the House of Representatives or the Senate. The giving of false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. Would you like to make a statement of five or 10 minutes and then we will proceed to questions.

Dr Boehmer-Christiansen—Because I have come in late, I thought I would start off making a few little comments on what I have just heard and then go into my piece, for which I have an overhead transparency to help me. I have an outline of this for some of you if you are too far away to see it. I will put it on when I come to it. My first comment is that we have not heard much about water vapour, which, in my understanding, is the most important greenhouse gas, and that cannot be modelled. The second point is that we have not heard much about the actual treaty, the Framework Convention on Climate Change, which can deal only with dangerous man-made warming, not with warming which is due to other causes. A lot of people say that other causes are more important than the IPCC assumes or has built into its equations. The equations are in fact very faulty, and I want to say a bit more about this.

My message to you is shocking, from what I have heard so far. My message is almost a plea for Australia to be the small child to say, 'The emperor has no clothes,' and not ratify it. The science is good. A lot of wonderful science is being done, but it is not good enough for policy. That is my opinion as somebody who has worked for almost 30 years now on the relationship between science and environmental policy. I would warn you that that is the baseline of the message, not trust, scientific opinion or scientific advice coming from the IPCC, because it is basically research science. Research should not create consensus. Research science should make many blossoms flower. There should be debate, and the debate has been suppressed. I can give you a lot of evidence from a great deal of interviews, including some in Australia last year. For all sorts of reasons we can go into later, there is not an open debate about the different hypotheses.

This is the aim of my research. I was able to do this because I was working in the science policy research unit at the University of Sussex in the energy policy group. With some scientific background and a great interest in science and policy, I was able to observe from the eighties

onward the development of the climate change debate—you call it greenhouse here—in relation to fuel competition, technology competition and the political objectives which always emerge when there is a debate about the environment. The environment is one of the most useful means for doing politics, and I have studied this. So do not take advice from research science too seriously, because most of the IPCC advice comes from government research institutions which have major problems of funding. They cannot, and do not, dare to make proposals which do not—to some extent—appear strategic and fit in with the policy context. I want to go back to the political and economic context under which the IPCC was established—where it came from, how it divided itself and, therefore, why advice from it is biased. It is fundamentally biased, and it is biased in favour of emission reduction.

One of you used the term 'scientific community'. I have lived in the scientific community—the Max Planck Institute. My husband was a plasma physicist and a space scientist. He was a very senior scientist—the name Christiansen may mean something to you. I know from that, from observation, there is no scientific community. There is a front scientific community on occasion to the public or when they want money. That is good. They are hugely divided amongst themselves. They compete with each other for funding; they compete with each other for status and political influence. The term that came from someone else was better: they used the term 'climate community'. But there are other communities out there, like the solar community, some chemistry areas, some of the hydrology people, the ocean people and the geomorphologists—lots of communities which are not in the IPCC. That is where I have done my research in the last four or five years.

These communities are speaking with great anger—astonishing anger sometimes—about what is going on in the IPCC. I will read you a statement by a former editor of the *New Scientist*, Nigel Calder—who wrote a book in the mid-nineties called *The Manic Sun*, which is a bit dated already; he describes the solar hypothesis which puts a great emphasis on the solar influences on the warming we observe now. This is studied by ESA, which is not in the IPCC, and the space science community. By the way, if you want the latest debate, get reports from Tenerife. Next week, a major conference starts in Tenerife, where the IPCC anthrop-botanic carbon dioxide emission people will confront the solar people. I am in communication with both. See what comes up there. It is going to be a clash with Sir John Houghton.

I have interviewed most of the leading scientists, like Bob Watson, the Chairman of the IPCC. I know Sir John Houghton very well, although we do not agree on anything much. I have interviewed Bert Bolin, the former Chairman of the IPCC, and—because of my position in London—I am well aware of what goes on in the Hadley Centre. I was in Australia last year, and I interviewed a lot of your scientists and American scientists. I cannot name their names—a lot of my research is confidential information—but there is a genuine tension surrounding what these scientists will say in public, because of the funding situation. Most of the IPCC's research is done either directly in government institutions, where directives come down—from the CSIRO or whatever—not to say certain things, because funding applications are being made to the government. Many governments want global warming to be dangerous and man-made, particularly European governments, and I will explain why this should be so in a minute.

They are funded like a grade of the social science research—and I have done them myself—by soft contracts. So the funding situation is something you might inquire about when you are

taking scientific advice. There are very few people left in the independent community, who are not directly funded, and a lot of self-censorship takes place. I have a quote from Nigel Calder, a former editor of the *New Scientist*, who is one of the proponents, if you like, of solar. I am just taking a quote from an email. I have not asked his specific permission, but I hope he would give it. The whole debate came from a debate on the Internet about the third IPCC assessment report, which, as a reviewer, I have already read. He said:

The physics of climate change will become transparent in the next few years. There are privately-funded free-thinkers out there, and people in other disciplines, whom the authorities still can't touch. But publicly-funded climate science has already suffered ten years of control in support of one unproved hypothesis . It's exerted by the grants system, by misuse of peer review and by the imposition of weasel words—as in your example and more famously in Chapter 8 last time.

I do not think have to bother you with this. The weasel words refer to the wonderful sentence about the 'discernible impact of climate'. This does not blame scientists, because I think what was negotiated is not science; it is a negotiated political statement. It says:

The body of statistical evidence now points towards a discernible human influence on global climate.

That is completely vague and means nothing, because we all agree that human beings have an influence on climate. It does not even use the words 'global warming'. But even this sentence, which became the phrase most misused by environmentalists and by those environmental bureaucracies that base their legislation on environmentalist positions was followed by this other sentence, which you could also quote if you wanted to. It says:

Our ability to quantify the magnitude of these effects is currently limited—

the causation is not even clear—

by uncertainty in key factors including the magnitude.

So the IPCC is extremely careful, even in its summary statements, to have one sentence followed by another sentence and then, depending upon what side you are on, you can pick one or the other. But it is true that, internationally, there is now a very strong alliance in favour of emission reduction. This is really what I want to explain to you: why I think, from my perspective of working with the energy policy institute, that the science being funded is the science that is likely to prove that there is global warming. Nobody denies that there is global warming, but the bit of global warming that we can observe is actually due to human emissions—'net emissions' is the latest phrase, in fact.

Overhead transparencies were then shown—

Dr Boehmer-Christiansen—Here, very briefly, I want to stress the word 'intergovernmental'. What comes out of the IPCC is vetoed by governments. But not by all governments, only by the handful of governments that have the scientific capacity to really participate. This is mainly the United States, which is very lukewarm. I can talk about American policy, but I do not want to here. The Third World will not have anything; they have been bribed into participating by promises of various mechanisms, such as development and emission trading. The main government that is actually behind the science is undoubtedly the United Kingdom, where the secretariat for working group 1 of the IPCC is situated, in the Hedley

Centre. I have had access to the first three years of all their internal documents. I think they regret, perhaps, that I have seen all of this, because the peer review is not the normal peer review. It is very selective. That has improved, I think. I cannot really talk about the detailed mechanisms of the IPCC more recently. I have taken more note of critics, I think, more recently.

But if you look at the history of the IPCC, you will find it quite fascinating. Have a look at the oil prices in this diagram. The recent tripling in the oil prices is not included yet. But have a look at when the IPCC was set up. It was set up in 1985; negotiations started in 1986; it was formally established in 1987 at the point when the long period of very high fossil fuel prices came to an end. All the investments in nuclear power and alternative energy—the big increase in investments in non-fossil fuel technologies and fuels—came to an end or were threatened. At that time, obviously somebody looked around for justification for making fossil fuels more expensive and hence protecting some of the investment including nuclear power.

Let us go back to this diagram. When you look at where the IPCC actually came from, it didn't come from government. It came from the research lobby, particularly the United States one, the International Council of Scientific Unions, and also a conference in the 1980s. Even in the early 1980s it was still possible to study either global cooling or global warming or just study climate change. But if you look at the politics at that time and, if you think about it, the involvement of the energy sector already—remember the 1970s change in fossil fuel prices—global cooling hypotheses would not have attracted the political system at that time. You had to hypothesise global warming to attract a biased range of interests. There are two institutions who really had the capacity to interact with government and to get the necessary funding for a vast research agenda, which is a research agenda of earth systems analysis and earth systems modelling—I can talk about that too, but we haven't got time. The first is the WMO, the World Meteorological Organisation, which is closely linked to government and the military even. Australia is a good example. A better example is the United Kingdom. Then this new organisation, UNEP, does not, if you are looking for a global environmental problem, have any reason to exist at all, and particularly to grow. UNEP had the ozone convention and it now hoped it could do a similarly great thing with climate.

So that is where it came from—from the research lobbies desperately needing funding. Meteorology was not a highly regarded science at the time. Through climate change modelling, with the need for large computers and so on, it made itself into a much more respected and much better funded science. But this was only possible by excluding other groups.

I have mentioned the emergence of the IPCC as an intergovernmental body. They do not fund research directly but they, through national influence, will encourage certain scientists to be funded who have links with the IPCC. It has certainly become a matter of scientific status to be a contributor to the IPCC. The interesting thing also is—and again I could talk greatly about this—why the IPCC science group, under Sir John Houghton, was actually based in the United Kingdom. The United Kingdom had just gone through a very bad period of becoming a European pariah because of the acid rain story—the Dirty Man of Europe—and the policy makers and people already knew they would prefer carbon dioxide. Wow! They could make wonderful promises and statements without having to spend any money because, under the acid rain response, Britain had closed down its coal mines, was switching to natural gas and

suddenly had this enormous drop, first in sulfur but also in carbon dioxide emissions. This meant that it could become and has remained a leader in the carbon dioxide debate.

All of you know the enormous pressure Australia came under for the Kyoto Protocol, with John Prescott, my local MP, actually turning up and putting pressure on you saying, 'You must save the Kyoto Protocol,' or you are the Dirty Man of the South Pacific, or something. The British are incredible advocates now for emission reduction and for getting rid of fossil fuels, because they have done it. This is also a policy very attractive to the European Union. I could talk more about this.

So if you look at the setting up of the IPCC in more detail, the meteorologists had been branching out with the physics and chemistry on the one hand—and they have done good work—but at the very same time, before they ever came to any conclusions, two other working groups were set up. I know quite a bit about them, not from having done the work myself but from watching them. One was on the impacts. All the impact studies were based on the worst-case scenario. You conclude—from something that has not been concluded, and which should still be in the research debate stage—that global warming is significant, it is man made and it is dangerous. From there, you have a vast amount of impact studies. I think far too many good scientists were removed from doing studies on genuine environmental problems and entered into speculative research. Even more supporting of my hypothesis is that the third working group on responses knew all the answers already. The answers were nuclear power or the new green energy efficiency—the renewables. These solutions existed already; they were the solutions to high fossil fuel prices. When the fossil fuel price dropped, they were looking for justification for new regulations or new subsidies.

The amount of advocacy at the moment in Europe to switch the 'wicked' coal industry subsidies to the renewables—to windmills or solar power—is quite astonishing. It is a contradiction. The Europeans should switch their subsidies. There is a great deal of energy policy and energy politics involved. But for me and you, the interesting thing is that the solutions existed. They were researched and papers were written. Trading and technology transfer debates started before the scientists had concluded what the real scientific problem was and how much of the global warming could actually be altered by changes in energy policy. Adaptation could have been researched from the beginning, but it is only just beginning now. The first 10 or 15 years of the IPCC was straight out emission reduction, in particular getting rid of coal. That is where it does impact on Australia. I think that Australia does have a right to question it

Europe had a good reason for getting rid of coal; their coalmines were terribly expensive. But it does not mean that Australia should follow suit. Looking more closely inside the IPCC, I would typify the IPCC—and this is a bit cruel, but I still stick to it; it is an interpretation if you like—as being the tip of a research iceberg of the institutionalised research lobby. This is United States based with lots of support, largely in the north and pretty well resented in the south because the south, on the whole—China now being the exception—cannot also build big models. Australia is one of the few countries, in the Southern Hemisphere at least, that can actually argue a little because it has its own models and has provided very useful information to the IPCC from the Southern Hemisphere. But I think it is quite clear that, whatever the IPCC has put forward, it has been exaggerated. From population predictions from emissions scenarios

used, you can show that what the IPCC said 10 years or so ago was all pretty heavily exaggerated.

The information in this overhead transparency came from the Internet—I think from the 'contrarians' to whom I listen. I cannot vouch for the accuracy of these figures, but one could ask the overseas labs. You can see the carbon dioxide emissions, which they predicted in the early 1990s in the first report. The actual figures are much lower. I am not saying the IPCC was wrong; all I am saying is that from the beginning they tended to exaggerate. You can see the concentrations are not as high as they predicted. By the way, the solar hypothesis argues—I do not know how convincingly to all scientists but very convincingly to the layman—that the main reason for the increase in carbon dioxide is that the earth is swollen because of solar effects. So as the ocean surface warms, more carbon dioxide comes out of concentration, and it is this increase in concentration that leads to the solar warming. That is not the early effect, but it is a more important one. But you can see it has not been as big. The temperature increase has significantly reduced. I think you ought to ask serious questions about whether the little climate change—the warming that is in the pipeline at the moment—is really serious. Is it dangerous? Dangerous to whom? Will it be dangerous to the whole of mankind or only to some groups, who could be compensated if abatement were more expensive? Should there be an acceptance of global warming?

I will quickly tell you about something else, because it is just so amusing for those people who know where the whole thing came from. If we start backwards, the 1890s was when the chap discovered global warming, a Swedish physicist. There is a school of thought now in the United States—and I make contact with them—which says that increasing problems outside is a positive thing because of the fertilisation fact. Again, I am sure it is all things being equal. By the way, the same view is still held very strongly, and I have links with those people too and I can get you information. For example, the Russians on the whole still would like a bit of global warming. It would do them good. That is why they fell out, and the Russians were actually the first group of scientists excluded from the IPCC. There was a big meeting in London and the Russians were chucked out more or less because they had a fundamental disagreement. So we have this problem—that is, is the global warming that is in the pipeline going to be harmful or not?

Coal production was also hugely exaggerated in the initial scenarios. By the way, there is a whole critique of the IPCC which concentrates not on the science of atmospheric forces but on the emissions now. It is a huge exaggeration. As was admitted, the emission scenario was used by the IPCC to ignore technological change. Some people say there are so many technology changes in the pipeline without government interventions and without subsidies, and they will reduce the emissions anyway. This Kyoto thing is incredibly complicated. You have no idea how many calculations will be involved to include sinks so that you reduce not your emissions but your net emissions. I have the Australian submission to the IPCC on how to measure carbon accounts. It is just going to be a bureaucratic nightmare.

Senator TCHEN—Dr Boehmer-Christiansen, thank you for your submission. You have taken us into an area which actually considers the impact of policy decisions on greenhouse gas emission, but I am also conscious of the fact that, in the evidence we have received so far today,

the witnesses have been meticulous in pointing out that their evidence is based purely on science—

Dr Boehmer-Christiansen—I do not make this claim now.

Senator TCHEN—whereas you have taken us further.

Dr Boehmer-Christiansen—I am a political scientist. I should have said that earlier.

Senator TCHEN—Can you make any comments on the science they are relying on? Do you consider it to be good science as they claim it to be, or do you feel that the science they have been relying on is deficient in some way?

Dr Boehmer-Christiansen—I think it is deficient for policy, particularly for global policy. If the Europeans want to cut their emission, let them on the basis of no regret policies. The professor has written in public and said to me in private, 'No regret policies are okay, but don't go beyond it because we're not certain enough.'

Senator TCHEN—That is the point exactly I am pursuing, because to some extent it is our job to consider all evidence and make some policy decisions. I would like to have some basis to compare apples with apples, because your evidence is not so much comparing apples with pears but comparing apples with a recipe. From your knowledge of the science involved, do you think the climate change science that the previous witnesses base their evidence on is good science or deficient science—not the application of it, but the science itself?

Dr Boehmer-Christiansen—This can be only an opinion because in the narrow confines of meteorology, atmospheric physics and chemistry base it is good science, but I do not think it is good climatology. Climate is too complex a system and, because the models are mathematics based, there is so much missing in them. I would not have much confidence. They are good science to the extent of what is possible, as a lot of the scientists have said to me, but that is all we have. That is good; let us do more scientific mathematical experiments with these models, but I do not think they should be used for policy prescriptions.

Senator TCHEN—So your concern is that climatology study has been taken out of the context of science and applied to the policy?

Dr Boehmer-Christiansen—Too early, yes. That is my view.

Senator TCHEN—The second question I want to ask you is on the way you presented the way the IPCC sponsors science at close rank, but I noticed that you said that you are actually a reviewer of the IPCC assessment report. Obviously, you hold different views from the current view of the majority, but they have not excluded you.

Dr Boehmer-Christiansen—I was very surprised that the British government did not veto it, not that I had that much time. I did respond a little bit in the last one. I am not a reviewer, and I could not be, of the science report. I am a reviewer of the responses because of my interest in science and energy policy and in energy technologies. There my response would generally be

that this is technically correct, that this is a very good report technically, provided the assumptions are correct. I do not quite agree with the assumptions. My second general critique also to the working group three was that there is no politics in it. You are not looking at the political acceptability of the proposed strategies and you are not looking at the political consequences of these emission cuts. As a political scientist, I am worried that the political consequences of these 60 per cent emission cuts could be so disastrous that I would rather have a world adapting to climate change, particularly as there are so many uncertainties, than go full speed ahead to sign the Kyoto Protocol as a first step, as they say. I have thought it through for 10 years.

Senator COONEY—The question we have to decide is who is going to make the decision on the Kyoto Protocol. What would you say about that? Would you say that the people there were wrong or that the governments were wrong? What is your political science analysis of what happened there?

Dr Boehmer-Christiansen—My analysis is that the no-regret policies, broadly defined, are now so powerful internationally that it would take a small child to say that the emperor wears no clothes because the environmental bureaucracies around the world and a large number of United Nations bodies, again for financing reasons, I suppose, and for the power, influence and the jobs which this new agenda gives them, are totally behind a relatively successful Kyoto. Even if it is a fudge, if it does not agree and does not get what the Europeans want, which is much more than what the Americans want, the pressure on Australia to ratify will be enormous. But even then, there are a lot of negotiations still taking place about how tough you make it. For example, the Europeans want a proper regime of compliance enforcement. So, if you do not achieve your targets, let's not ask how you measure all this compliance. Then you have to pay fines and the fines may go to United Nations peacekeeping. The whole thing is seen as a big money raiser.

Senator COONEY—I can follow that, but do you say that the wise thing would be to stay right out of this?

Dr Boehmer-Christiansen—It is going to be hard for Australia. It would be a very difficult decision because there are so many vested interests, from the environmentalists to bureaucracies. The United Nations are hoping, but I think it might be a good thing.

Senator COONEY—I take it that what you are saying about the Kyoto decision is that the decision made there is a wrong decision because it is corrupted by self-interest, or what? How do you put that decision?

Dr Boehmer-Christiansen—There is an underlying—

Senator COONEY—Does it have any merit at all?

Dr Boehmer-Christiansen—That is why I am a bit ambivalent about this. Many good policies relating to foreign aid and relating to a certain amount of international supervision of the energy industries have tied themselves to Kyoto, but I think the priorities are wrong, particularly if it is imposed on the Third World and on countries like Australia. There are more

important things to spend this amount of research funding on. If we are going over to subsidising renewables, subsidising highly uneconomic forms of energy, if we go over to this carbon budget, the amount of money and human resources it will require will be enormous, I think. These people who are already in the game would like to continue it, but I think it would be a misuse of scarce resources.

Senator COONEY—Do you say that the evidence that they have relied on at Kyoto is wrong or just that the evidence at Kyoto really does not justify the strong measures undertaken, or is it a bit of both? I am trying to get from you whether you are saying that Kyoto is wrong because the evidence is wrong or Kyoto is wrong because, even though there is evidence there, the consequences are not going to be of the devastating kind that is talked about? Or are you saying that there are problems but to try to cure those problems you going to bring more disasters upon the world? I am trying to get the basis of your position.

Dr Boehmer-Christiansen—It is a very good question. I will have to go back and think, because in a sense it is all three, I think.

Senator BARTLETT—We have spoken about scientists around the world, including here through CSIRO, because of funding pressures or opportunities producing the sorts of recommendations or suggestions that they have come out with in relation to climate change. My experience with scientists, as we saw even this morning, is that they tend to refrain from giving categorical statements; they tend to qualify things in a range of uncertainties. Why would it be that on this issue there seems to be an extremely high degree of consensus whereas on a lot of other issues you can pick there is not that consensus?

Dr Boehmer-Christiansen—For the reason that you asked that question. I think governments are not asking advice from the scientific community very broadly defined; they ask scientific advice from an institutionalised part which they themselves have set up or within which only a group of governments actually have the knowledge to give advice. The range of scientists involved in this advice giving is fairly narrow, and what I am trying to argue is that it is related to the proving of a hypothesis which will provide a problem for which a solution already existed. There may be a problem but the IPCC, given enough time and freedom may very well—Hansen is the one who started it all in America in 1988 by saying he believed there was evidence for man-made global warming. The other day he was published saying, 'Look at this diagram. I think we should move way from carbon dioxide. Let us look a bit more at CFCs and ozone.' This is only last week. I would not trust him either because he comes from NASA. The Americans are not keen at all on Kyoto or they only want a minimum thing. So I think the scientific community in an issue that is so complicated just serves government policy.

Senator BARTLETT—With Australian scientists, I think it would be a reasonably fair statement to say that this current government would be quite pleased if they had CSIRO giving them advice that greenhouse is not something they have to worry about, particularly Senator Minchin.

Dr Boehmer-Christiansen—That would be breaking ranks with their mates, because there is lovely phrase called epistemic community. I think a global epistemic community exists now on

the basis of a mixture of facts, selected facts or rather facts where there are a lot of unknowns, and a belief that human activity is negative.

Senator BARTLETT—Why in an area like this one would they be scared of breaking ranks with their mates and therefore not disagreeing whereas with an issue like electromagnetic radiation and mobile phones there is a wide variety of opinion and there is disagreement among scientific people about whether or not that is a problem? What doesn't the same thing apply there? How come people are breaking ranks with their mates on that one?

Dr Boehmer-Christiansen—It is very early days in those areas. I think there is no institutionalised advisory body yet. I think that if you took the IPCC away and just had a free for all, you would get a greater situation. This comes from consensus. Through email and by talking to people, I know that the sentence on discernible statistical evidence was hugely fought over. It took three or four months and there were all sorts of allegations flying around. In the end, I am basically saying what the IPCC says in its verbal statements, that it is open to interpretation.

Senator BARTLETT—Scientists say that all the time about everything.

Dr Boehmer-Christiansen—I know, but I am more worried about the interpretation given to it or the selection of statements from the IPCC by those people who use IPCC science. I think the statements I read this morning were very careful. They do not really know to what extent the climatic change that is in the pipeline is caused by human beings or if it is caused by changes in the chemistry of the atmosphere. We do not know what the causes are entirely and whether they are due to human activities. I think the IPCC, when you talk to the actual scientists, are very careful. But when somebody like Topfer from UNEP or Meacher from the British government or even some of your politicians say, 'We're 100 per cent certain that global warming is caused by human beings,' or when environmental lobbies speak out in public, I never hear the IPCC say, 'Wait a minute, that is exaggerated.' They are confined by their intergovernmental role. They are experts in one definition; they are serving those in power; they are not independent anymore, because they cannot become too independent and actually contradict government policy. The stories I hear in Britain are that people who seriously challenge IPCC cannot be published.

Senator BARTLETT—Last week or the week before, in Parliament House in Canberra, we had the coal association giving presentations about greenhouse related issues. With that industry it is quite obviously very much not in their interests for Kyoto to go ahead and it is an industry that does have a little bit of money. Surely, if there were legitimate scientific researchers out there who were wanting to put forward this alternative view, industries such as that one would be gladly funding them. I think it would be a pretty small investment for it in comparison with other costs. Why do industries like that even accept the legitimacy of the climate change argument?

Dr Boehmer-Christiansen—I think they struggled till about four or five years ago—I am not quite sure how long. For a long time OPEC even funded some of the conferences of the contrarians. Anyway, there is some evidence that they tried this. I think there was probably a policy decision that they would run with it, like the German coal industry now or BP, if they

were to agree up to a point. Otherwise, they could not stand the political pressure on them. It does not mean they are actually keen to do very much. Someone could explore this further. It depends on which coal industry you ask.

CHAIR—I want to go back to your earlier description of the various communities, as you call them, in science. If we are to make anything from your evidence, we are going to have to do a bit of research ourselves to figure out these communities and how they exist in Australia and globally. What are the other communities? You talked about space, for one.

Dr Boehmer-Christiansen—One is a space community looking at the influence of things—it is not just changes in sunspots, it is a much more complex explanation. You get a lot of very good introductions to this group in the book I mentioned by Nigel Calder called *The Manic Sun*. If you really want to observe the debate going on in a place where all the contrarians put their papers and their complaints that the IPCC has not listened to them, look at John Daly's web page. I hope you talk to John Daly. It is easy to discredit these people too. I had some discussions with Sir John Houghton about this and he rightly said, 'Well, these people haven't published anything so we can't include them in the IPCC.' If you talk to these people, you find that they say, 'With our position we haven't got any knowledge to oppose it with. We don't know enough about clouds. The clouds aren't in the equations.' Or they say, 'We don't know enough about the sun yet,' or 'We don't know enough about cosmic radiation's effects on clouds.' There are large areas where they have only hypotheses—which have not been funded—to counter this. We are also playing a funding game I suppose.

CHAIR—Just back to the communities. There was solar—

Dr Boehmer-Christiansen—Yes. The oceanographers are very worried. I had a chap apply for a job at the university who said that we pulled one over the governments with this one because the modellers always come to us for information about a hydrological site and we have not even got it yet. So the hydrology is not in there. Land use changes—the effects of human beings on Albedo.

CHAIR—What is that?

Dr Boehmer-Christiansen—The reflectivity of the earth's surface changes if you change agriculture and forests. I am publishing stuff from people in Finland on this one. The most sceptical people I find in Adelaide and in Britain are the geomorphologists, who have seen decadal ups and downs in climate—huge changes in climate long before human beings existed.

CHAIR—What is geomor—

Dr Boehmer-Christiansen—Geomorphology—most of the earth scientists, the geologists. The geologists are very sceptical. Have a look at this diagram. What we are arguing about is the tiny little squiggles in the carbon dioxide concentration here. For geologists, this is the changing carbon dioxide concentration in the atmosphere in geological times. It has by no means been steady. There are tiny little fluctuations here. The current debate is about why we had an ice age and why people were growing crops in Greenland and why grapes were growing when the Romans were in England. The anthropologists now say that the reason why human beings have

a good brain and developed more than any other species is the climatic change after the last ice age. There are very interesting links now that climate change is actually one of the main reasons for the evolution of human beings as intelligent creatures.

CHAIR—You indicated at some stage that the United States research lobby was quite pro global warming in a political sense, yet you seemed to say that the United States government was very sceptical.

Dr Boehmer-Christiansen—No. Somebody mentioned Pat Michaels and Fred Singer. There are quite a few scientific lobbyists or groups in America which are not part of the IPPC but are critics and would call themselves independent, but their opponents say that we cannot believe them because they are funded by the coal industry and they are probably going to say that about me now because the Lavoisier Group paid for my trip here. So the insults are flying and people have personal commitments to one hypothesis or another. It has become quite unpleasant in the scientific community, whether you are for or against. Scientists are human beings. If you have done 15 or 20 years research on one of these models, the model becomes reality. Also with economic modellers, the model becomes the world and if somebody challenges that model then they attack your identity.

CHAIR—We had a guy who led a political party like that. Apparently he wants back in too.

Senator COONEY—You are saying that we should show some great caution about the Kyoto—

Dr Boehmer-Christiansen—The emission reductions.

Senator COONEY—You started off by saying, 'You should have some worries about that because the political machinations were such that you ought to have great suspicion about the whole thing.' When you were answering the chairman you said, 'No, it is more the difference between scientific opinion.' I am trying to work out why you say that we should be very careful about the Kyoto convention. Is it because of the political machinations or because of the science or because of a combination of the two? If so, how much weight would you give to each? Could you help us there?

Dr Boehmer-Christiansen—I think it would be a combination because what I am saying basically is that there are many competing hypotheses about what is causing climate in the first instance—and, as a geographer, I do know that climate is an incredibly complex phenomenon. We do not know whether climate is the outcome of these mathematic equations you heard about or whether it is a real outcome of the feedbacks which result from all these partially understood biophysical chemical processes. I think one should be careful. What I am saying is that the political system, for reasons of technology forcing, basically in Europe and environmentalism by definition are opposed to human—this combination has created an answer: emission reduction.

Senator COONEY—Say the scientific evidence was more or less all the same. Would you then say that Kyoto was right or would you still say that because of the political machinations there ought to be some suspicions?

Dr Boehmer-Christiansen—I would still urge caution, even if the science is right that the warming we see is man made. Even if there were winners and losers in the future, I still think that, as obviously has not been done, we should look at the political consequences of the response strategies which they advocate. The world is already in a pretty bad shape and it will get worse. You have seen what happened to the recent change in oil prices. OPEC has been incredibly cunning. I am sure it is not by chance that the oil price has tripled just before COP6—I cannot prove this, but politics is like that.

Senator COONEY—Are you saying that, because of the organisations behind this, this committee ought to be very careful because they are powerful forces who tend to be able to get their own way?

Dr Boehmer-Christiansen—Yes, and I think all environmental issues have this tendency, not just climate. Being such a complex issue, environment will be picked up by the political interests to play their games.

Senator TCHEN—Dr Boehmer-Christiansen, can you leave the information you presented with the committee, preferably if you can source them as well?

Dr Boehmer-Christiansen—Yes, I can. I certainly have something for you here. I have written many papers on this and I would recommend that you read my journal.

Senator TCHEN—Also, could you source the tables and graphs?

Dr Boehmer-Christiansen—Yes.

Proceedings suspended from 12.57 p.m. to 2.12 p.m.

FOSTER, Mr Robert, Consultant, Bob Foster Consultancy

ROWDEN-RICH, Dr Robert James Murray (Private capacity)

CHAIR—Welcome. Do you have anything to say about the capacity in which you appear?

Dr Rowden-Rich—I am a consultant engineer and, latterly, a glaciologist. I have been associated with the Antarctic program since 1971. In 1971, I enrolled for an expedition to Casey. I spent over 12 months there. Since then, I have been associated either with the Antarctic Division or with the meteorology department at the University of Melbourne. I completed my MS in 1982 and enrolled for a PhD. I eventually completed the PhD in 1993. Since 1993, I have been putting into the public area new thinking in glaciology, which is that the ice sheet collapse processes are inducing climate change and sea level rise.

Mr Foster—I am here as a private consultant. In fact, I consult in energy economics. I am also a director of the Lavoisier Group, which is a contrarian group on greenhouse, but my submission is my own—it is not a submission on behalf of the group. I sent in my original two-page submission and then I sent in a 100-page supplement. I am sorry to say that I did something terribly wrong in the collation of the supplement. Six pages are repeated twice and six pages do not appear. I have copied it again. I will hand out copies of the perfect version.

CHAIR—I have to formally advise you that these are legal proceedings of the parliament, as if they were taking place in the chambers of the Senate or the House of Representatives, and they warrant the same respect. Accordingly, the giving of false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. I suggest each of you give a presentation of five to 10 minutes and then we will proceed to questions from the committee.

Mr Foster—What I would like to say at the beginning is that, in science, dominant paradigms dominate. I learnt this when I was associated with the geology school at Adelaide university in the fifties, when the controversy on continental drift was at its height. The faculty at the university fought like tigers against the overthrow of their paradigm and the destruction of a lifetime of build-up of intellectual capital and a lifetime of published papers. When plate tectonics became accepted, all their work or a lot of their work was irrelevant. What beat the old paradigm in the end was a continual stream of new evidence, and their explanations of how the old paradigm fitted the new evidence became more and more bizarre until in the end the law of empirical dispute, or disproof, beat them. Now we are dealing with another dominant paradigm, and that is the paradigm of the IPCC. Their book *Climate Change 1995: The Science of Climate Change* from Working Group 1, on the science of climate change, is 572 pages. My paper deals only with the first 50 pages, which is the summaries.

The dominant paradigm in this book is that climate change science is atmospheric science. The second is that all or most of the warming that has been seen at the surface this century is caused by anthropogenic changes to the composition of the atmosphere—greenhouse gases, of which CO_2 is the most important. The last—although the book leaves you to infer it, and most people accept it—is that if we only could limit sufficiently the output of greenhouse gases to the

atmosphere we could stabilise world climate. That is really the paradigm. It is my belief first of all that the paradigm is wrong in the sense that the two tranches of warming we have seen this century are almost certainly not greenhouse warming and, second, because of the remarkable scale and speed of natural climate change in the past that there is virtually no chance that anything humans can do can keep climate as it is. So really, there is my paradigm and IPCC's paradigm.

I know that they have 2½ thousand of the world's top climate scientists supporting their paradigm. That is their consensus. But the advancement of science is not a matter of voting. And already the law of empirical dispute is chipping away at their position. I believe that the extent of evidence against them is growing and in due course—I am not saying for their third assessment report next year—it will be necessary for them to acknowledge other branches of science than atmospheric science in the climate change issue. What I am saying is that until such time as all relevant climate change science is included it would be most unwise indeed for Australia to ratify the Kyoto Protocol.

I have noted a couple of quite bizarre occurrences in this report which I think are important and I would like to mention. Already in this report there are big problems. The first of the problems is the series of warm events in the North Atlantic basin mega-region during the last glacial. It is the North Atlantic basin where things happen. Because of geometry, that is the place. There were a number of climate movements of five degrees Celsius or more in that region in a few decades or even less, and the IPCC simply could not ignore these; it had to mention them. What it has said in *Climate Change 1995* is that these are probably caused by precipitation and run-off, extraordinarily heavy rainfall. We know that just is not true because they are associated with trillion tonne layers of ice rafted detritus on the seabed of the North Atlantic. Even on the tops of sea mounts in the North Atlantic you get these layers of iceberg deposited sediments. It cannot be anything to do with run-off.

Why would they do that? I have worried away at that. The reason is that, if you except that the surging of icesheets can influence climate, you have to put the surging of icesheets in your models—and they have not. They have put in sea ice. Sea ice is in the models, but not the surging of icesheets. Murray Rowden-Rich will tell you that there is surging going on, on a much smaller scale, right now in Antarctica and through the current 10,000 years of interglacial you can see these intermittent surges. So this is a serious flaw in their models.

The models also have the big flaw that they overestimate warming over the last century. The validation of the models from which they project the future is by 100 years of actual measurements of surface temperature. The models way overestimate. We have overwarming models in an underwarming world. How the IPCC have coped with that is to attribute cooling to sulphate aerosols. But CO_2 is a long lived gas; it mixes all around world, so we know that the warming from CO_2 is worldwide. Unless they have a cooling gas to reduce the level of CO_2 warming, their models are shown to be much too responsive to changes in CO_2. I think that is what has happened: the models are far too responsive to changes of CO_2 because the sulphate aerosol cooling appears not to exist. I can show you that.

Overhead transparencies were then shown—

Mr Foster—This is in my hand-out, but regrettably it is in black and white and it is not a very good graph to project. If you look at this area, you will see that the warming is in Siberia. This is for the last 35 years. This is to do with surface warming in Alaska and the Yukon. There is not much warming in the Southern Hemisphere. The Northern Hemisphere is getting all the warming.

Mr WILKIE—What is the situation with Western Australia?

Mr Foster—I am sorry; I hope there are no Western Australians here.

Mr WILKIE—There is one.

Mr Foster—All that means is that over the last 35 years there has been no cooling and no warming in Western Australia; it has just remained steady.

Mr WILKIE—Okay.

Mr Foster—The blue is cold and the brown is a little bit of warming. Here is the scale, and you see that there is nothing there. The big warming is in Siberia but not for all year, only in winter. Global warming is to a great extent warming in Siberia and to a lesser extent in northern North America in the depths of winter—to temperatures which are still far below freezing.

This next graph shows the cooling aerosols, and this is in the Northern Hemisphere summer, which is when aerosol cooling is less because it is in the Northern Hemisphere winter when people are having space heating—particularly China, for instance, where it is much worse. Even in the Northern Hemisphere summer, more than 90 per cent of the cooling aerosols are in the Northern Hemisphere. I just showed you at the surface that it is the Northern Hemisphere that is warming, but the cooling aerosols are there and, because their life in the atmosphere is only four days to a week, they cannot get to the Southern Hemisphere. The cooling effect is not there. The model is needed. That jagged one is the average surface temperature over the last 100 years or so, and here are the models. The models are way overestimating. You need to bring them down to match with the cooling of the sulphate aerosols. There appears not to be sulphate aerosol cooling. That is the first extraordinary point in this book. What a mistake not to mention all this stuff.

Senator TCHEN—Is the solid line the summation of the warming gas and the cooling gas?

Mr Foster—Yes. That solid line is the greenhouse warming, from the IPCC's models, minus the supposed cooling effects of aerosols. That is why they can say there is not bad agreement and why, having got not bad agreement in the past, you can go on to projecting supposed not bad agreement in the future. But in fact the models are duds, and they are duds for two reasons. They do not allow for the inertial impacts of ice surges into the sea that redirect oceanic heat. They are also duds because they have overestimated the warming effect of CO_2 and they have far overestimated the cooling effect of sulphate aerosols. There is something seriously wrong with the models.

I said there were two things in here that are wrong. This one is from the famous Santer paper. In the preface of the report, there is only one bit of science. It is a only a page and a third long and it says:

> ... observations suggest 'a discernible human influence on global climate', one of the key findings of this report, adds an important new dimension to the discussion of the climate change issue.

When you look in the text, you find that the summary is repeated; but when you look at the body of the text there is no support for it. It was not peer-reviewed work—not that I think peer review means much—it was published later, and this is the paper.

This graph I am showing you now has the models. This is what humans have put in the atmosphere. There is CO_2 warming; brown is warming. It has the surface, the South Pole, the North Pole and the stratosphere where the cooling is. It shows the warming because of the CO_2 and the cooling because of the sulphate aerosols. Most of the cooling is in the Northern Hemisphere because, remember, most of the aerosols are in the Northern Hemisphere. When you add the two together, you get nothing much happening in the Northern Hemisphere and big warming in the Southern Hemisphere, because both hemispheres warm from CO_2 and the Northern Hemisphere is cooled by the aerosols. We know it is completely spurious, but that is what they say.

They then compare this with this bottom graph here. I will now blow that image up. That is the warming of the models. You see the warmings in the Southern Hemisphere. These are the actuals, and those actuals here you see are not too dissimilar a pattern in the actuals from the balloon measurements. The Southern Hemisphere atmosphere 30 to 60 degrees south warms, there is cooling in the north and you can say, 'There you are, the aerosols cool the north.' All the warming is there, and that fingerprinting of the models against the balloon measured actuals is what they say proves—they do not even say proves, nearly proves—discernible human influence on climate. That is the second thing wrong with the report, and that was a very serious mistake. It really got people going at Kyoto, and it still does. But look at this. This is the same data. These are the actuals again. What they used was the actuals for these years here. They dropped out the five earlier available years, they dropped out the eight later available years and they only used those 25 years. Why did they start there? They do not say why they started there, but you and I know why they did. It is because that is a cooling episode from the Mount Agung volcano that started their record at the coldest year they can find because they need a warming trend. They have stopped it on an El Nino year. Why didn't they go back here to another volcano and start on a cool year? The reason is that they would have got a flat thing. The whole warming trend used in that book is based on an artefact of years chosen.

CHAIR—Let us go back for a moment. Do the coloured charts you showed us before come from the IPCC's report or from the Santer article in the journal?

Mr Foster—All IPCC has is those words which appear in the preface, in the policy maker summary and in the technical summary. They are not in the report. The peer review paper was published afterwards as an ex post justification of what the report said.

CHAIR—Who is Mr Santer?

Mr Foster—He is an American climate scientist. There are a dozen authors in it. David Karoly was one of the authors. A stack of IPCC scientists were joint authors of this paper.

CHAIR—So after this 1995 volume was published this article appeared with this data—

Mr Foster—In *Nature*.

CHAIR—And which part of the data was the previous line chart?

Mr Foster—The line chart is the balloon actuals. There is CO_2 alone from the models. That CO_2 man has put in atmosphere. A hemispherically symmetrical ball. There is cooling from the sulphate aerosols. Cooling concentrates in the Northern Hemisphere—

CHAIR—The Northern Hemisphere is a left-hand side of those boxes.

Mr Foster—Yes. Then they combine to this, which is the warming is all in the Southern Hemisphere, and then the actuals show the warming trend in the Southern Hemisphere. They are comparing this and this.

CHAIR—So the second one down, Santer is saying that is real, or is that the model?

Mr Foster—That is the model. He says it looks awfully like the real one, and it does.

CHAIR—I see. So he is trying to validate his model.

Mr Foster—Yes. They call it fingerprinting. So that is the model prediction.

CHAIR—And because that little bit of red is in roughly the same zone—that is, the Southern Hemisphere—he validates his model by that. But the line charting the actuals lies behind the bottom right-hand one?

Mr Foster—Yes. This line chart is the actual balloon measurements for 30 to 60 degrees south in the lower atmosphere, which is that line, you see. But they have only used a selected 25 years. When you use the five early years that they wouldn't use and the eight later years available to them which they wouldn't use, there is no trend. There is no warming trend.

CHAIR—At the bottom of the line chart, there is a reference to Michaels and Knappenberger and the magazine *Nature*. So they published something?

Mr Foster—A rebuttal. The Victorian state government a couple of weeks ago put out a new greenhouse study, and they quote these words I have quoted there as though they were still true.

CHAIR—You are saying that in any consideration of the science we had better read this article by Mr Michaels and Mr Knappenberger.

Mr Foster—I reckon, yes.

CHAIR—We will get a copy of it. Do you want to go on or pause there and go to—

Mr Foster—I think we should. I have one more point to make but I think we should—

CHAIR—No, go ahead and make it now.

Mr Foster—Remember, that was from their second report. This point, I understand, will be in the third report. This morning you saw a coloured copy of this graph I am showing you. This is the 'man's hockey stick'. There is a thousand years of decline in temperatures. Remember, the IPCC cannot have a Little Ice Age. They have to stamp out the Little Ice Age. Once you have a Little Ice Age, you have to have rebound from it. But they need all the heat that they can get, because the models overperform. They cannot have a Little Ice Age. They have fudged this—I believe they have fudged it—to get 900 years of declining temperature and 100 years of soaring up temperature. How they have done that is that for the 900 down-years—this is all Northern Hemisphere, and it should be: that is where the action is—they have used proxies based on tree rings and then they have added to 900 years of 'apples' a hundred years of 'pears'. They have used a hundred years of pears! These are surface measured temperatures. These are tree ring proxies. But you and I know—we all know—that the warming in the Northern Hemisphere has largely been in the winter. The problem with trees is that they grow in the growing season. They do not grow in the winter.

CHAIR—You are referring to another article in that reference at the bottom of the page.

Mr Foster—Yes, that is Mike Mann's big article. That is going to be in the new one. That is going to replace that 'discernible human influence' with a new discernible human influence—and this is it. The difficulty is, because their tree rings are from high latitudes and high altitudes, that when you look at real trees that grow there, you find that the trees only grow for about six weeks in the year and it is not in the winter. So they have added apples and pears.

This chart is from a paper that squabbled a bit with what they have done. These are about 600 boreholes around the world where they have measured paleotemperature. This portion is the last 500 years or so. Look at the borehole temperatures. Look how they rise. Most of them are in the Northern Hemisphere—these are global; that is Northern Hemisphere. Mike Mann shows his slight decline like that—there is nearly no character in it—and then away up like that. There is global. That is measured temperature. It seems to match. This data from the Arctic, based on other data, nothing to do with tree rings, seems to match. But Mike Mann just plain does not match, because he has got two entirely different things.

I do have something here that does match. It is in the report at figure 65. That is the thousand years that Mike Mann has used, but these are all tree rings. It is not 900 years of tree rings and the rest are measured temperatures; these are all tree rings, so we are measuring it at exactly the same time of the year and the same thing. There are problems with it, but it is a whole lot nearer, and it does not look like Mike Mann's hockey stick. This is from Vaganov.

Last of all, these are temperatures from ice cores. Ice is a very good insulator. You can re-enter a core from which ice was taken years ago and you can get the temperature because of the insulation. Here you can see a twin trough little ice age and the medieval warm period. What

Mike Mann has done is put his ruler there and, in effect, drawn a downward trend like that, and that is the downward trend you see on his graph. This really is not science.

CHAIR—Thank you. Dr Rowden-Rich, would you like to make some comments?

Dr Rowden-Rich—There are three points I would like to make by way of summary. The first point I would like to make is that there is a vast amount of knowledge, science and information out there in the scientific community which the IPCC do not use and they selectively ignore. I have applied to be an author on the IPCC, and I did not even get a response to the letter I sent in.

The second point is that sea level rise is here. It is a scientific fact—and I am different from my scientist colleagues this morning because I am absolutely certain of this fact—that the sea level rise will continue to escalate in the future. I think it is important for people in the political area to be aware of this. They can spend zillions, trillions and hundreds of zeros of dollars—10 to the hundreds of zeros—and it will not make one iota of difference to the fact that the sea level will rise. We have a situation where the IPCC are basically putting across the scientific nonsense—I could use stronger words like 'scientific hoax' or 'scientific fraud'—that, by introducing all these controls on energy supplies, they are going to stop the flooding of the islands in the Pacific.

The third point I would like to make is that the Antarctic science program is driven largely by the agenda of the IPCC. It has been corrupted. The government, in order to get a neutral, balanced and objective assessment of what is going on in the Antarctic area as far as science, climate change and sea level rise are concerned, should transfer the operations of the Antarctic Division out of the control of the environment minister and into a neutral area such as the geological area, which is under the control of a different minister. I have witnessed the Antarctic program for the last 25 years, and it has been totally hijacked by the agenda of the meteorologists. They are just my introductory points. I have also prepared a five-minute summary, so I can read that out.

CHAIR—Yes, please.

Dr Rowden-Rich—Sea level rise is inevitable. The rise in the sea level in the next 100 years will be in the order of one metre. This will have the effect of flooding Bangladesh, Holland, northern Germany, some Pacific Islands, low-lying parts of England and vast tracts of prestige real estate in Australia, Florida and the Caribbean. What is the cause? The west Antarctic icesheet is disintegrating. How do we know? We know from NASA satellites. What are they showing? They show that the ice streams flowing to the Ross Sea are eroding their way back to the interior of the icesheet. The margins of the fast flowing ice streams are continually changing, moving towards the interior ice divide by influx of ice from the slow moving continental icesheet into the fast moving ice streams. This is an internal collapse process in the Antarctic icesheet. It has been happening for the past 8,000 years. It will continue to recede for a thousand years, based on presently observed recession rates—and I emphasise 'presently observed'. How do we know this? We know from satellite imagery and computer modelling. The computer modelling is related to the imagery, not to the meteorologists.

Has this marine icesheet collapse occurred previously in the glaciers? Yes, at least once before the last ice age. The evidence for this is in fossils retrieved from the base of the ice which were deposited as it collapsed, from the examination of ice cores and from oceanographic studies. In the last 12 to 18 months, for the first time in scientific history, glaciologists have identified the onset of a mass of surge event in the west Antarctic. The particular glaciologist's dating on is that it is from 7,966 to 6,600 radiocarbon years past. The evidence for this is in the ice cores. Geologists working on coral reefs in Florida, almost at the opposite end of the globe, have identified a rapid sea level rise of 45 millimetres per year between 7,600 and 7,200 years past. The sea level rise in this geologically short time period of 400 years was 6.5 metres. So we have an example of geology matching glaciology.

What happened to the sea level as the icesheets disintegrated? There was a total rise of 120 metres. But this did not occur uniformly at one even rate. We know that, from 17,000 years to 12½ thousand years before present, there occurred a slow 20 metre rise. Then there occurred a catastrophic rise of 24 metres during the next thousand years, and then the sea level rise continued slowly for another thousand years. Then, once again, it accelerated with an extremely rapid rise of 28 metres from 10,000 years past to 9½ thousand years, in melt-water pulse. We are presently still coming out of the ice age. I have asked the committee secretary to pass out some photocopies, and while she is doing that I will put up this overhead.

Overhead transparencies were then shown—

Dr Rowden-Rich—Just to summarise what I read out in the last paragraph, the last glacial maximum—in my submission there is an error where the figure of 14 should be changed to 20—was about 20,000 years past. The icesheet started to break up and then there were some massive melt-water pulses. These came from pro-glacial lakes in Canada and Russia. This data is produced by a composite of records from Barbados, which was published quite some time ago in 1989, by Fairbanks, which is matched onto some very recent work done by Toscano and Lundberg, at the University of Florida. So the Fairbanks data stops about here and, using a different dating technique, these scientists in Florida, using Florida corals and peats, have extended the original 1989 curve up to the present.

The curious thing is that we know—and I have some overheads about this which I will put up later—from about 10,000 years past that northern European, the Northern Hemisphere and the Canadian-North American icesheets had practically all disappeared by then. There were only very small remnants left and a few ice shelves. So how do we get a roughly 20-metre sea level rise since the icesheets disappeared? The answer to that puzzle is in the west Antarctic ice sheet. It has been disintegrating all this period. This graph here is just an approximation. It has not been a straight line all the way; this is only a representation. As for the actual disintegration and the sea level rise, we had to say that there had been periods of rapid sea level rise interposed with relatively calm periods.

I will now put up representations of imagery of the west Antarctic. I will make some general comments to introduce the topic. This is 'Nature, 3 February 1994, CO_2 and glacial cycles'. In the glacial cycle the CO_2 levels go all over the place. There is nothing fixed about CO_2 levels.

CHAIR—Would you explain what the Y axis is in that?

Dr Rowden-Rich—The Y axis is the ice mass data in 10^{19} kilograms. This comes from some work done by what is called Specmap. It is relating CO_2 level to the mass of the ice sheet.

CHAIR—The CO_2 level in the atmosphere?

Dr Rowden-Rich—Yes, it would be atmospheric.

CHAIR—Would the ice mass be the total amount of ice on the globe?

Dr Rowden-Rich—That could be ice mass in the major icesheets, the continental icesheets.

CHAIR—There is no time line although, as the previous chart showed, over time the ice mass diminished. I suppose the time line will be coming down the Y axis. Would you put that graph up again? There is something in it that we ought to try to clarify.

Dr Rowden-Rich—Certainly. I once gave a talk to the Royal Society and I said, 'This is a typical diagram produced by a meteorologist. You can't understand it!' I can give you the paper. You really need to read the paper. But the main point that I am trying to project is that the actual CO_2 level goes all over the place. During the glacial cycle it goes up and down like a yo-yo.

CHAIR—In a sense all those dots show a randomness of CO_2 levels on the X axis, so there is no correlation.

Dr Rowden-Rich—That is basically it.

CHAIR—It is what we can see.

Dr Rowden-Rich—It is basically totally erratic, so there is nothing fixed or immutable about CO_2 levels; they go up and down for all sorts of reasons. I will introduce some general background as to the last ice age. This shows the schematic extent of the major Northern Hemisphere icesheets during the ice age. You had a very large ice sheet over North America which continued into the North Pole area and Greenland. It is all interconnected. There was also a very large ice sheet over the north-west Canadian mountains continuing into Alaska. There was a very large ice sheet over England, Scotland, Ireland and the Scandinavian countries which extended right through to the eastern part of Siberia and right out into the Arctic Ocean. I have put that up just for general background information.

Again, this is for general background. This shows the icesheets over the last 400,000 or 800,000 years, and how the ice temperatures have gone up and down. It is based on the oxygen isotope ratios, which is retrieved from ice cores. The work is based on work done on ice cores from all over the world. You have had this long period of icesheets. This is just relating to the last ice age, which is roughly 100,000 years past. It shows the CO_2 level during the ice age. Pre-industrial it was around 270. As the temperature got much colder, the CO_2 levels were reduced. There is a lot of evidence now that CO_2 reacts to temperature. You can track through the detailed analysis of this work and you will find that there is a phase shift between the CO_2 level and the temperature shift. The temperature changes and then the CO_2 changes as a consequence of that.

CHAIR—Is that the opposite of what is based on the greenhouse theory—that it is CO_2 that causes temperature changes, that is warming? Yet you are leading to a conclusion that it is the other way around?

Dr Rowden-Rich—Yes, certainly. The evidence from the bulk of palaeo work in geology—palaeogeothermology, palaeoglaciology and palaeoclimatology—is that the CO_2 level reacts to other changes that are going on. We then get to the idea of a surge. Basically, that is the area I work in: what is the cause of surging? In trying to get a grip on what is meant by a surge, it is very easy to start talking about surges in the Antarctic, but what do you mean by that? We go back to a location on a small scale where a surge actually occurs. This is a very small base in Canada and it shows some range structure. Essentially, the surge is only about four kilometres long, but what happens is the ice goes off in a big bulge like a plum pudding. If you did not quite get the cooking right and the plum pudding goes all over the place, that is very much like what actually happens. This surge front propagates from up glacier down to the snout of the glacier. That type of thing is what goes on on a continental scale.

Way back in 1988, which was a landmark year for glaciology, a chap by the name of Heinrich working out of an institute in Germany discovered on the floor of the North Atlantic a series of layers of detritus, which have been since traced back to rocks over near the Laurentian ice sheet. There were a whole series of surges. These events were called Heinrich events, and they occurred roughly 6,000, 7,000, 8,000, 10,000, 50,000, 56,000 years back in time—not exactly the same beat.

This part of the graph shows the insulation cycle—in other words, the variation in the solar flux with the sun cycle. These are the sun cycles, the blanketed cycles. As the sun goes around, because the orbits are not all uniform, from time to time the flux changes the amount of solar radiation from the sun because of a tilt of the axis. This is a graph of the change in the flux over a period wayback to 140,000 years.

This is an example of what happens when science discovers something that is truly revolutionary and groundbreaking and totally causes a revolution in glaciology. In the second half of his paper, Heinrich tried to prove that these iceberg deposited layers were caused by these solar cycles. Sometimes even when people make their own discoveries they just cannot accept the whole import of it.

There was a lot of work published from 1988 to 1994 by Wally Broecker from Lamont Doherty Laboratory at Columbia University. He published this review paper, ‘Massive iceberg discharge triggers global climate change’. This created a revolution in the earth sciences.

This gives a bit more detail on the Heinrich event. That is by way of introduction. I will get onto the detailed analysis of the Antarctic. This is Professor Hughes’s analysis of how a surge happens. There is an initial trigger. The ice speeds up and starts moving very fast and discharges. Eventually the water from the ocean gets under the ice and carries the whole lot out to the ocean. First you have the surge and then you get this complete catastrophic break-up process. This happened in the Hudson Bay area in Canada at least six or seven times in the last 70,000 years.

I got involved in this because I was a glaciologist in Antarctica in 1972. We were drilling through the dome and the drill was done here. There was a surge event. There was a massive fracturing, a shaking of the drill at the top and the drill got stuck here. We could not get it up. That is just a little thing that triggered my interest in this.

I will now get into Antarctica. I will put up a background map so that people are aware of the general geography of Antarctica. Some people have been more aware than others. Essentially, you have the Antarctic Peninsula near the South American chain of mountains. There is a chain of mountains here and another chain there which are fairly high at 12,000 and 14,000 feet. The particular area the Australian government operates in is this area of the Lamont glacier. This is a very big basin that feeds about one-third of the total surface area of Antarctica. The Weddell Sea is where Shackleton got stuck and the Ross Sea is where Scott went through to the Pole.

In my submission I sent in a report of some work done last summer in the area that the National Science Foundation are looking at, the Amundsen Sea. There are some major very fast glaciers flowing into there. Professor Hughes at the University of Maine describes this area as the soft underbelly of the West Antarctic icesheet. He proposes that, if it continues to disintegrate, this is where the main action will be.

CHAIR—I would like to give the committee the opportunity to ask you questions and draw out the relationship between these events and climate. We have seen this authority for the site about this phenomenon and accept that it is a real authority, but we have to get on to the climate.

Senator TCHEN—Dr Rowden-Rich, I think it is fair to say that the information you present is probably new to us. I have some suspicions in this area. I did ask a question of an earlier witness about putting in their model, taking into account the possibility of catastrophic failure of the iceshelf, and the answer I received was negative. Given your experience with the Antarctic division, do you know whether the division is taking any interest in this work?

Dr Rowden-Rich—At the end of 1995—and I think there was an election in early 1996—I wrote a letter to the then environment minister, Senator Faulkner. I pointed out to him the new thinking in glaciology where you have catastrophic events that disturb the climate. I also pointed out to him that the activities of the Antarctic CRC, which is focused primarily on the affected CO_2 on the Antarctic icesheet, are essentially a waste of time. By far the strongest driving force in the climate system is the disintegration process of the Antarctic icesheet. A bigger focus of their work should be the follow through as to how the icesheets change in the first place, then affect the ocean currents around the Antarctic, and in turn how the ocean current changes to change the climate.

It is quite incredible. A colleague of mine was bailed up as he walked up the gangplank of the *Aurora* by two very senior executives in the environment department. He was threatened with all sorts of things if he continued to collaborate with them. My contact is mainly personal with some of the people in the Antarctic program. As far as I know the program is primarily driven by the agenda of the IPCC. All this important information—and I have some very recent information from NASA—is totally excluded from the purview of, first of all, the Australian Greenhouse Office and, secondly, the knowledge of the government.

Senator TCHEN—Thank you. I am sure that is something we can follow up later. In the mathematical modelling we have been told about can the collapse of the iceshelf be added into the model?

Dr Rowden-Rich—It can be added in, but then it becomes 99 per cent of the game, and the main game becomes the collapse of the icesheet. What happens from the effects of the icesheet, and the effect of the CO_2 becomes a very small second-order issue. Of course, the people in the meteorological fraternity do not want to know about this.

Senator TCHEN—Most of the information you presented to us in terms of atmospheric CO_2 and temperature change is very interesting. We have not viewed it from that perspective before. My understanding is that climatologists now talk about carbon content rather than CO_2 content because carbon in other forms also causes global warming. In fact, in another inquiry I put that question to the experts who were presenting and they assured me that they were measuring carbon rather than CO_2 content. However, your information focuses on CO_2. Can you comment on that? Do you know whether my impression was wrong?

Mr Foster—Senator, I think you are thinking of the global warming potential of a number of gases in terms of the warming potential they would have if they were carbon or CO_2. That, therefore, includes methane—which of course has carbon in it—and other gases that do not contain carbon and the total global warming potential, of which about three-quarters is CO_2.

Senator TCHEN—Three-quarters is CO_2. So CO_2 is still the major component.

Mr Foster—It is the biggest.

Senator TCHEN—Thank you. Mr Foster—this is probably a bit of an aside—in the resume you provided to us, you describe yourself as having withstood examination in the Federal Court for your 'false and misleading oil price forecast'. Can you tell us why it is described as 'false and misleading'?

Mr Foster—I used to work for a little Aussie battler called BHP and a big person called Mr Robert Holmes à Court wanted to take us over. I had done my annual forecast of the future of crude oil prices for our annual budget. Unknown to me, our head office put that in a document in which they calculated the value of our company to demonstrate that Mr Holmes à Court's Bell Group offer was too low. The next thing I knew was that action was being taken against me by Mr Holmes à Court, claiming that my crude oil price forecast was false and misleading. They did not take the company to court; they took me. Happily, the company paid for my defence. But I faced a full day of adverse cross-examination from Mr Tom Hughes, who was a well-known adversarial barrister.

Senator TCHEN—I take it that this 'false and misleading' forecast has since been vindicated.

Mr Foster—Yes. Thank you, Senator Tchen.

Senator TCHEN—Perhaps I can draw you back to your two-page submission to which you referred earlier. You said that you drew three conclusions from your assessment of the greenhouse argument. First, you said that the idea that a human can stabilise global climate by doing the right thing is mistaken—and, in fact, if we focus on that it might prevent us from focusing on human miseries that need to be alleviated. Could you expand on that comment?

Mr Foster—Two things are going on that I think should change. We are focusing on greenhouse, and putting money and zeal into greenhouse is diverting attention from other better-founded and more pressing environmental needs. That is one side. The other side is that it is diverting attention from focusing on the mitigation we need. Climate is going to keep changing whether we like it or not, and countries that are less fortunate than Australia are going to keep suffering from terrible disasters. UNEP, and in fact the Australian government, could spend more money on identifying how to alleviate human misery caused by climate changes and extreme climate events that we will never be able to stop. We cannot stabilise climate. Instead of throwing our money at the wrong things, we should start mitigating the misery of people who are going to be hurt, and are being hurt all the time. That is really what I am trying to say there.

Senator TCHEN—Thank you. I will leave it there for the time being.

Senator COONEY—I am trying to get some sort of basis upon which we can make our decisions. Do you believe the human race makes no effect on climate? Do you go that far?

Mr Foster—I believe the human race has two big effects on climate. One is, obviously, by putting greenhouse gases into the atmosphere, and that has been much overestimated. I do not know if that is good or bad; it is a thing that I want to spend time looking at.

Senator COONEY—But you would say it was true that human activity puts greenhouse gases in the air?

Mr Foster—Yes.

Senator COONEY—So there is that agreement. But then you say, as I understand it, that it is not the main game.

Mr Foster—It is not the main game—that is, the greenhouses gases. We do other things to the climate, with deforestation and so on, altering the amount of respiration. I gave the example in there of the rabbit in Australia over the last 100 years. The rabbit will have done a lot to warm Australia's climate over the last 100 years. Actually, Australia has not warmed much, but we ought to blame the rabbit for a lot of it. Heat island effects in urban areas, land use changes, deforestation, overgrazing and all these things are other human impacts. IPCC belittle them; IPCC is a meteorological body.

Senator COONEY—Can we get some idea of which other scientists agree with you—not in name, but some sort of profile of the people who would take up your position, not exactly but generally—and who would oppose you?

Mr Foster—First of all, there are what I choose to call the loyal opposition; that is, dissident climate scientists. Richard Lindzen, Pat Michaels and Robert Balling are the three best known, and they are all in the States. They are dissidents playing the IPCC at their own game. But they are the loyal opposition; they are not taking any account of one of the two factors that is most important—probably the most important factor. One of the factors that is important that the IPCC belittles is the role of the sun. I believe that is more important—at least in the first half of this century—than greenhouse gases in the atmosphere could possibly be. But in both parts of the century and in both tranches of warming, the big game is the continual, albeit now rather small-scale, surging of ice into the sea. The alteration—taking ice from high latitudes and putting it into the sea—raises sea levels in the tropics, increases the radius of gyration of the world quite abruptly—not when it melts but when it hits the sea—and increases the length of day. Those inertial effects change the direction of ocean currents. We have not begun to look at that. Remember that the earth sciences are getting zero funding from the Australian Greenhouse Office in Australia and from the US government in the States on this. The Hadley Centre do not do it; no-one has got the money to do it. I do not want the money, but I agree with Murray that the real main game is almost certainly the surging of ice in the sea—absolutely like it was during the little ice age.

Senator COONEY—I can follow, but what I am trying to do is get some idea of where the thinking is and who is thinking what. The rest of them are all outstanding scientists, but I am not—you can see what I am saying. I said it in a facetious way, but we all have to rely on the evidence we are given and that depends very much on credibility. When you talk about dissidents, would it be right that most in the science would support the greenhouse effect?

Mr Foster—The dissident atmospheric scientists say the greenhouse effect is grossly overestimated. They do not go on to say what Murray, I and Professor Hughes are saying, which is that the real game is the intermittence of surging of ice into the sea. Professor Hughes—if you had one name it would be—

Dr Rowden-Rich—Can I make a comment? In Australia is there is no professional glaciologist other than me putting this point of view—another half a dozen work in the Department of Primary Industries, Water and Environment in Hobart, and the piper plays the tune and they respond to that. But in the United States it is much more dispersed. There are some very prestigious geophysics schools, and by and large in the United States the study of the ice sheet is conducted not by meteorologists but by geophysics schools. On the geophysics schools, off the top of my head, the bete noir is Professor Hughes at the University of Maine; and you have got the University of Wisconsin; Bentley; you have got Texas A&M; you have got Lamont-Doherty, which is Columbia University; you have got University of Washington in Seattle; you have the University of British Columbia; you have got CALTECH; Barclay Kamb; and I have probably forgotten three or four. They are all working in this area.

Senator COONEY—Would you they support your—

Dr Rowden-Rich—Certainly, because they publish papers along this line.

Senator COONEY—What about Europe—and Asia, for that matter? What about anywhere outside America? You may have to think about that, but can you see what I am trying to get at—some sort of profile of what the scientists—

Dr Rowden-Rich—There is a whole body of geophysics schools in America which are basically working along the line of Bindschadler. For instance, this one is part of NASA. NASA have a whole oceans and ice branch, which are putting out papers like this, saying that the ice sheet has collapsed. I am referring to *Science*, which is journal of the American Association for the Advancement of Science. This shows the way it was 20,000 years ago, and this is the way it is now. In this last 20,000 years it has lost two-thirds of its mass. This is mainstream science in NASA, which is a civil servant.

Mr Foster—Dr Boehmer-Christiansen reminds us that there is work going on in Russia too which is in the earth sciences side and disagrees with IPCC.

Mr BYRNE—I have a question, Mr Foster, on the other branches of science. We have heard from Dr Boehmer-Christiansen about other communities, and we are getting a picture of a universe of communities of science. And we have heard from Dr Rowden-Rich that there is a community of glaciologists—indeed, a new community of them that are bringing to bear evidence that is pertinent to climate change. What are the other communities that we ought to seek out contrary views or information from?

Mr Foster—In Australia, the people who I think should be putting the contra view are the Geological Society of Australia. In fact, I have been asked to make a presentation to them on the 28th of this month. I do not feel they have done enough, but there are a number of geologists that are interested in the field. One, of course, is Professor Ian Plimer from Melbourne, who has been pretty outspoken in this area, although—Murray will know directly—I do not think he actually works in it. Professor Neil Archbold from Deakin University is another one who has been quite outspoken in the field. There are several. But I do not think the Australian geological community has done nearly enough. You see, you cannot get funding outside the paradigm; that is the problem.

CHAIR—We will go into that. Let us leave it there. I am sure we will be back in Melbourne for another hearing in a couple of months time when we have followed some of these trails ourselves. We will come back for more cross-examination of you, and we will draw some more out. Thank you kindly for that.

Senator TCHEN—Can I ask quickly, do you know whether the Sydney University geophysics department is in the game?

Dr Rowden-Rich—I, personally, do not know. The one person in Australia who is participating in the Antarctic program is Professor Lambeck at ANU. I was talking to him about three days ago, and he said he is going to Sweden for three years.

Senator TCHEN—That is a bit surprising.

[3:26 p.m.]

ROONEY, Miss Catherine Sheila, Senior Manager, The Allen Consulting Group

STANFORD, Mr Jonathan Geoffrey, Director, The Allen Consulting Group

ACTING CHAIR (Senator Cooney)—Although the committee does not require you to give evidence under oath, I should advise you that the hearings are legal proceedings of the parliament and warrant the same respect as proceedings of the House and of the Senate. The giving of false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. I will now let you lead the discussion.

Mr Stanford—Thank you, Senator Cooney. Let me say, first of all, that we are definitely not scientists: our bent is economics and economic policy. We have been working in greenhouse for the last two years for the Kennett government, for the Greenhouse Office and for major corporates. Previously, I was in the Public Service in PM&C and I was the Chair of the greenhouse interdepartmental committee. So I have worked in greenhouse for almost a decade.

We have given a paper to you. This handout summarises our most recent thinking; it is very short. We have set it up in overheads and, if it is helpful, we would be happy to present that to you, Chair.

CHAIR—Yes. You can do it by overhead and go through it rapidly.

Mr Stanford—We will.

CHAIR—It is good to have the overheads; it is just that you are putting bullet points.

Mr Stanford—That is right. The presentation is fairly short and concise.

CHAIR—But if you dwell on each one for too long, we will lose track.

Overhead transparencies were then shown—

Mr Stanford—No, we shall be concise. Let me say something positive about the protocol. The government at Kyoto, within that framework did well, first, to get a higher target than most Annex B countries; and, secondly, late at night to bring in land use change.

CHAIR—Sorry, did you say ‘late at night’?

Mr Stanford—Yes. That was brought in at about 3 a.m., which was quite a sensible tactical way of handling the issue. I must make some criticisms of the protocol. First, it is a major catalyst for business uncertainty. A number of major investment projects around the country are currently wrestling with the uncertainty of future energy costs.

The protocol was signed in 1997-98, but we may not know until 2003 if it is likely to enter into force. There is a further number of serious uncertainties over the treatment of sinks, flexibility mechanisms and land clearing—plus the huge issue of the treatment of non-annex B countries. Broadly, we think there are three major flaws with the protocol. First of all, it leaves out the countries which generate half of the greenhouse gases. Second, the time frame is clearly insufficient to accommodate the technological change which is needed to deal with the climate change issue. Third, it will create major economic hardship in certain countries and regions. We will tackle those separately and quickly.

Firstly, climate change is a global problem. It is similar to pollution in a city. It would not seem sensible to tax solely rich households' fuel use and not the poor. The economic answer is to tax the fuel and then deal with wealth distribution issues separately through the tax or welfare system. That is economic policy 101, and this protocol totally contravenes it. Looking at the chart, we can see that the Kyoto Protocol will not solve the climate change problem if it leaves out the DCs. In 10 years China will generate around 20 per cent of the global emissions.

Secondly, the ultimate answer to climate change is technological change. As a US commentator said, 'Gee, the stone age did not end because we ran out of stone.' The fossil fuel age will not end because we run out of oil. Technological change is the answer. One way of driving technological change is to tax fossil fuels, but that is a fairly clumsy single-ended blunt instrument, and needs to be complemented both by a reasonable time frame for that change and by a major global R&D effort.

This chart from Holden shows that within 30 years electricity will take over roughly 80 per cent of new car sales as a source of energy. Fuel cells are a practical science but they just cannot enter in any major way within the time frame of this protocol. Clearly, if governments pumped in money this time frame might be shifted. We are, though, only looking at new vehicle sales and not at the whole car fleet.

Our third point is on the economic hardship. This chart was put out very recently by the US energy agency. It shows that, if you are sitting anywhere other than in the Kremlin or Whitehall, for different reasons, you just do not have a snowball's chance in hell of meeting those Kyoto targets without causing major economic problems.

CHAIR—What is BAU?

Mr Stanford—That is business as usual. That chart on the right looks at the changes that countries would need to make from the forecast of business as usual to meeting those Kyoto targets. We have modelled the costs for this country and for all nine jurisdictions using a thesis that the targets would be met by bringing in a policy of domestic emissions trading. That would, in our theory, come in during the year 2005. At the end of the Kyoto commitment period, our GDP would be 1.3 per cent lower than otherwise, which is equal to roughly $8 billion. The sharing out of that burden is less than equitable. Western Australia and Queensland suffer very much. Tasmania booms on the basis of hydro and forestry. It benefits from greenhouse policy.

CHAIR—You said one per cent humidity over the total period?

Mr Stanford—It is three per cent annually.

CHAIR—Annually?

Mr Stanford—Yes, that just carries on. This is a very complex model. It is Monash University's MMRF-GREEN model. It is part of a family of models that started in 1975 and is highly credible and reputable.

CHAIR—Almost every model we have heard of is like that.

Mr Stanford—We all say that.

CHAIR—That was tongue in cheek. Go ahead.

Mr Stanford—The jobs picture is interesting. For WA, we estimate a fall of 4.5 per cent which is, I think, fairly major. A natural question is: how many of those jobs would be lost in Perth? You would have to say: probably not all that many. It is out in the regional and rural communities of WA, Queensland, and the Hunter and La Trobe valleys that these burdens will fall.

Senator TCHEN—I am curious. I can understand how Tasmania will benefit—which is not a bad thing, I suppose—but I cannot see why the ACT should benefit, too. That is not all a big addition of bureaucrats, is it?

Mr Stanford—It is actually partly that, Senator Tchen—you are right, it is. These permit programs are fairly friendly to the bureaucrat industry and they get most of their energy from the Snowy, so that is hydro.

Loser industries are the black and brown coal generators which see production falling by up to 20 per cent—aluminium, oil, coal and, in the case of agriculture, as CSIRO pointed out earlier, it accounts for about 20 per cent of our greenhouse gases.

CHAIR—Methane.

Mr Stanford—Methane from belching livestock. Finally, we think that that chart of the likelihood of most countries meeting the Kyoto targets means that it will not be ratified. We think that it also probably should not be. We would further say that it is quite possible to meet the same or better climate change targets as specified under Kyoto by a different approach that would push out the Kyoto targets, bring in the non-annex B countries, based on a program of global subsidies and technological transfer, and put serious money globally into R&D in the energy sector.

Senator TCHEN—In your calculation of the economic impact of the Kyoto Protocol on the Australian economy, does the model that you used take into account the possibility of Australia taking a lead role in developing new technologies, whereby we might develop new industries to compensate for what we might lose from the traditional industries?

Mr Stanford—Certainly. As industries' costs rise in the model their production falls. In each industry, there is an in-built technological change forecast, that changes as a consequence of this greenhouse action so, say, the brown coal generators bring in coal drying techniques that are costly but justified at a certain level. Certainly, industries like high-tech industries benefit from this greenhouse policy.

Senator TCHEN—I mean extending beyond that, Mr Stanford. For example, in the greenhouse renewable energy electricity act, which passed both houses recently, the government had three objectives. The first two refer to Australia developing new renewable energy technology with the intention of positioning Australia favourably in future development in this technology. That basically implies the establishment of a new industry, apart from what you have studied here. Was that possibility factored in?

Mr Stanford—No. This was all based on 1998 policy settings. There is a loss in the sense that the model fails to take in new industries but it also fails to account for the costs of structural change in the regions too. That is almost a balancing factor.

Senator TCHEN—I am wondering whether the study should have taken the beneficial structural changes into your modelling.

Mr Stanford—Future projects will. Currently we are doing further work bringing in ABARE's estimates of international permit prices and so on.

Senator TCHEN—Is your recommendation that perhaps Australia should not ratify the Kyoto Protocol?

Mr Stanford—Certainly so without getting everything that we have said that we are seeking at COP6, which is flexibility mechanisms without bubbles, full credit for cuts in land clearing, sinks and so on, and some path to non-Annex B country participation. I would say that we ought not ratify it without that.

Senator TCHEN—My question perhaps is unfair because it is political. Considering that you are an economic consultant it is probably a fair question to you as well. In that case, where do we go from here? If the Kyoto Protocol is not ratified by the majority of nations and collapses, what is the likelihood that the next stage will come on fairly quickly where we can achieve some sort of more equitable protocol compared to what the Kyoto Protocol might take us forward to?

Mr Stanford—I think that is a terrific question, Senator. Thank you for that. I think that the US will not ratify it. I think that they are currently looking at a Kyoto follow-up—a son or daughter of Kyoto, as it were. I think that in Canberra we are not currently looking seriously at those sorts of fallback policy options. I would like to see us leading with a climate change friendly but more equitable and technologically driven solution to the problem.

Senator TCHEN—So you think the demise of the Kyoto Protocol actually might accelerate the progenitor of Kyoto.

Mr Stanford—I would not actually call it a demise; I would call it a modified Kyoto Protocol.

Senator COONEY—The Kyoto agreement was based on a particular science. Have you given us an analysis of that science? Have you listened today?

Mr Stanford—I have listened. I shall go home and put some icepacks on my head, Senator Cooney. We are not actually scientists. We just accept the science that underpins this policy. We are not qualified scientists.

Senator COONEY—So your analysis is based on the science that was adopted at Kyoto?

Mr Stanford—Yes.

Senator COONEY—Were you there?

Mr Stanford—No. I was there earlier.

Senator COONEY—Do you know whether or not the propositions that you have heard today about the challenges of science adopted at Kyoto were put forward at that time?

Mr Stanford—Yes, the science is generally put forward. The thing is that nobody is much interested in alternative minority theories even though they may be quite valid. I am just not qualified to comment.

Senator COONEY—I have not looked at it myself but did any countries put forward alternative science or did the countries tend to fall in behind the one approach?

Mr Stanford—I think there are just basically lone voices falling in but the US was driven very much by Vice-President Gore who was passionately in favour of all of this. Europe was keen also, partly in that they saw trade benefits versus the US because they had moved from coal to gas and nuclear, so they thought they could meet these targets quite painlessly. There was plenty of politics at Kyoto and its aftermath.

Senator COONEY—I suppose that goes without saying. It is a matter of us deciding how cynical they were. The invitation is that we find them quite cynical. I do not know whether you got any impression about that.

Mr Stanford—I would have thought that a parliamentary committee would be on stronger ground if it sought to challenge the actual policies rather than the science that underpins it. That is just my thinking and I am not seeking to be impudent.

Senator COONEY—No, that is a very proper suggestion, if I may say so.

Mr WILKIE—You have sort of suggested that you would be better off putting your money into R&D. If we are losing just about under l.5 per cent of GDP, are you saying we should put that 1.5 per cent of GDP into R&D?

Mr Stanford—No, I am seeing it as an alternative to losing that 1.5 per cent of GDP. If the global governments were serious about climate change, we should be working out a 'who does what' situation in terms of R&D. Here in Melbourne we are good at ceramic fuel cells—why is nobody putting money into that?

CHAIR—What is your estimate of market capitalisation among the listed equities in Australia of companies developing renewable fuel technology?

Mr Stanford—I will have to take that on notice.

CHAIR—Are you aware of much? Is there much listed?

Mr Stanford—Obviously there is hydro, which is fairly sizeable. Otherwise, we have some promise in wind. There is that terrific Derby tidal project, which Mr Barnett seems not to like much. It is in the wrong place, I suppose.

CHAIR—Generally speaking, though, as an economist you would accept that the free capital markets will seek out the best return for the least amount of risk, and so forth. If that is the case, and if these technologies are promising—although I am not quite sure you said that—why has the investment community not already sought out these renewable energy technologies and put big dough into them, listed them, given them a dot com, sought institutional equity, the whole thing?

Mr Stanford—That is a very good question, but I think that the main problem is the uncertainty: nobody knows that in 10 years time the brown coalies will not still be paying dollars per tonne for coal, and churning out all those emissions.

CHAIR—You may decline to answer this but, going back to your experience within the Commonwealth officialdom, what is your impression of the science community and this notion of funding? Have you seen examples where groups of scientists have gone after funding because it seems to be the flavour of the month of some particular line they are pursuing, or is too random to say? Is this habit discernible—to use a common phrase? Is there a discernible human influence on seeking of funding among scientists? You were at the top of the tree at PM&C.

Mr Stanford—I certainly was not in PM&C. Let me say, first of all, that the Monash modellers lost all of their Commonwealth funding, and they think it was because they went off message on issues like the GST and so on. So these things happen.

CHAIR—We dish it out, and we take it away! So those discernible human influences have been known?

Mr Stanford—Yes. I think that CSIRO looks at climate change in a fairly neutral sort of way. I was here when you were questioning them over how they routed their submission through the Greenhouse Office. I do not think they play those sorts of political games.

CHAIR—We did not mean to imply this morning that they did. We were very interested in the instruction that they were given. It is our general experience that government-wide instructions emanate from PM&C, and that is why it is there. But that is a matter for another inquiry.

Senator LUDWIG—What you are suggesting in summary is that—Kyoto Protocol aside—there are better ways to deal with the problem of global warming through specific policy measures that can be taken. You do not actually support the signing of the Kyoto Protocol. Is that a fair statement or is it a neutral event to you because there are better policy mixes to achieve more equitable distribution of measures to mitigate global warming?

Mr WILKIE—Or are you just pointing out the economic impact?

Mr Stanford—No. First of all, technically we have signed it but not ratified it. Secondly, I would say that signing it makes it difficult not to ratify it if you get everything that you are asking for in terms of ratifying it. That was getting everything we were seeking at COP6. That is not likely to happen. I would then say that it would be in our interests not to ratify the protocol.

CHAIR—Very good, thank you kindly.

Senator TCHEN—I have to declare my political interests. I just wanted to know whether those Monash forecasts on the impact of GST are likely to be unfounded.

Mr Stanford—That is absolutely separate from me. We are just clients of Monash for this exercise.

Senator LUDWIG—If you then do not suggest we sign the Kyoto Protocol, are you then asking: what measures should we take? Are they embodied in your submission in terms of scenario four?

Mr Stanford—No, not really. I think that scenario four has been largely discredited around the place. There are assumptions of some costs that just are not realistic. I just would say that I would like to see us working to set up an alternative to the current Kyoto Protocol and to take some sort of international leadership in that.

Senator LUDWIG—If you are suggesting that we take a lead agency role in developing an alternative to the Kyoto Protocol, have you considered what elements you would include in it or is this getting too far down the track?

Mr Stanford—No. There are those three things. There is, first of all, working out a package to bring in China and non-Annex Bs, which means subsidies. There is, secondly, a real emphasis on accelerating necessary technological change and global research effort. There is,

thirdly, pushing those Kyoto targets out within a reasonable technological time frame. We are just currently working up such a framework that we think would produce equal or better climate change outcomes to the Kyoto outcome with far less economic pain.

Senator LUDWIG—That might also allow the science to catch up and the alternative funding of scientific endeavour in other areas.

Mr Stanford—We are doing some further work which will come out in the next month or six weeks, so we would be interested in talking to you further.

CHAIR—If you would contact the secretariat and request another appearance, we will schedule that. Thank you.

[4.06 p.m.]

RAE, Hon. Peter Elliot, Chairman, Renewable Energy Generators of Australia Ltd

STEENBERGEN, Mr Ronald, Environmental Officer, Hydro Tasmania, Renewable Energy Generators of Australia Ltd

CHAIR—I formally advise that these are legal proceedings of the parliament as if they were taking place in the chamber of the Senate or the House of Representatives and they warrant the same respect. The giving of false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. Would you make a statement and then we will go to questions.

Mr Rae—We have provided a submission and we are grateful for the opportunity of providing the submission and speaking to it. We would like to run through a presentation that we have made which summarises the submission. Then we would like to add a few more comments, because I think they are particularly relevant after some of the evidence that I have heard today, and it might put a little balance into the discussion. Then we would be most happy to answer any questions. Let me quite quickly run through the document.

REGA was formed last year. It represents the major generators of renewable energy in Australia. They produce, at present, 10.7 per cent of Australia's total electricity generation. This is made up primarily of hydro but it does include a number of other forms of generation, including bagasse and some wind as well as some relatively small amounts of solar energy—photovoltaics and others. A question was asked about investment; I can get the exact figure for you, but my recollection is that the figure is about $7 billion of investment in renewable energy generation in Australia at the moment. But I say that without having checked it in recent times, and I would like to come back to you to confirm it.

The industry supports and encourages the government initiatives for the reduction of greenhouse gas emissions and the growth of the renewable energy industry. I pause here to say, because of some of the evidence that you have heard, that the potential for growth in the eco industry area is something which, at Davos earlier this year, was regarded as being comparable to the opportunity for growth in the world economy of information technology. So the opportunity for growth which Australia can miss out on or can take advantage of is something which is very significant.

The Australian response to the Kyoto Protocol includes the two per cent mandated renewables target, which has been before the parliament recently and was the subject matter of a parliamentary committee inquiry. I will not pause to talk about that in any detail. The remote renewables power generation program is a program which is starting to work well in developing new approaches to remote area power supplies, which is one of the problems which the Australian community faces.

One of the problems has always been that you tend to get aggregations of population because the distances are considerable and the cost of distribution of electricity, which is required by most people as a necessity of life, is expensive, and therefore it is one of the disincentives to

decentralisation. The program, which has been developed by the Greenhouse Office, is working well in making possible some research work which could not be done if those involved had to pay the whole lot themselves. It is encouraging, but they are practical propositions. For instance, there is one on King Island, which Senator Cooney may be interested in. Not only does Hydro Tasmania have a small wind farm there at the moment, which is a trial wind farm aiming to reduce greenhouse gas emissions caused by diesel generation, but a grant has been made available for looking at using wind energy to pump water during the night and for that water generation to be used during the day when the demand is there, so you get a pump storage operation. So whenever the wind is blowing, you can pump and store. There is battery storage, as well as water storage, and the three work in combination to provide, in a relatively small demand area, an economic means of producing without having to be hooked into a mains transmission system. Quite a lot of hope is being held out by the Greenhouse Office on this one and also by those who are involved in developing it.

The Greenhouse Gas Abatement Program is one which, I think, does not need any further explanation, and there are funds being made available in relation to that, as with the Renewable Energy Commercialisation Program. Emissions trading has also received a considerable amount of work, and I would like to refer to that again in the context of what Europe is doing. With regard to business sustainability, the evidence which we rely upon is that virtually the developed world has accepted—and the undeveloped world insofar as it thinks about it has accepted—that sustainability is an essential aspect of looking at the future of the world and, as population growth takes place, it becomes a more pressing problem. There are a number of aspects to it but to try to deny the importance of sustainability is to look at an unreal future. It is probably the most significant policy question throughout the world, and the aspect of renewable energy and the eco-industry, as it is called, is probably the most important part of that. As I mentioned earlier, in Davos this year it was recognised as being the growth area equal to information technology.

Looking at ratification, there are significant human and financial costs associated with greenhouse gas emissions, and I will just mention one that is in the paper—asthma. There are all sorts of others caused as a result of greenhouse emissions and the interference with the atmosphere, which have tremendous costs. Sustainability in the natural system capacity is a key element in the new economy. I was quite surprised to read in recent times of some people who appear not to recognise the linkage between all of the aspects of the new economy—information technology and the other things—and the eco-industry, which is an equally essential part of the development of the new economy in the world.

The viability of renewable energy will increase as the cost of emission permits increases, and I think that is important to bear in mind. I do not think anybody would suggest that it is likely that renewable energy generation, without some form of balancing factor, would be able to be brought down to be totally competitive with some of the coal fired generations. It is just not likely; it is possible. Everything is possible, but it is not likely within the foreseeable future. If we want to change, we have to have some form of balancing to effect that change, and I think that is the starting point on which the rest of the submission is based. As the cost of emission permits increases, you will get more and better development in renewable energy generation. Although it is not perhaps in the submission at this part, let me refer to the rate of improvement in the cost of generation as demonstrated by the fact that the cost of wind generation in Europe has been reduced by three-quarters—it is now a quarter of what it was 15 years ago.

That is technological development and there is no reason to think that there will not be quite substantial further technological development in obtaining efficiencies. We were talking only last year about looking at one-megawatt machines; we are now looking at two-megawatt machines—this is the installation of two-megawatt wind generation machines in Australia. People are talking about when they will get their five-megawatt machine in operation. The rate of change in relation to the wind area is quite dramatic. One of the traps, I believe, is that a number of people—and the Redding report, which was made for the Australian Greenhouse Office is an example—made the assumption that technology would not change. They made an assumption that by 2010 there would be only 13 megawatts of wind generation in Australia. There are already 300 in actual operation or in the planning stage. That is two years after the Redding report was completed and less than 12 months after the government's announcement of the two per cent mandated renewables measure.

I think it is reasonable to assume that the rate of change in the introduction of wind generation and the improvement in efficiencies will continue rapidly, as will other areas as further work is done and further incentive is given. We therefore see the need for the two per cent legislation to encourage that early change. Without it, the incentive for change is not there, because there are certain forms of greenhouse gas unfriendly generation which are far more competitive than anything that is renewable. That is, I think, a simple fact.

On the ratification question, the international competitiveness is enhanced by renewable energy in the new economy. The renewable energy industry can link economic growth with low greenhouse gas energy production and the regional manufacturing industries will provide an opportunity to remove regional areas from government assistance. I would like to pause on that third one, taking the first two as having been already referred to.

The third part is that I am aware of the fact that, in Australia today, we are on the edge of being able to introduce manufacturing for wind generation under technology transfer agreements with some of the major manufacturers in Europe. That is not simply for part assembly in Australia but for the manufacture of all but some of the parts that have to be brought from specialised areas of manufacture. But the towers, the blades, a large part of the turbine equipment and certainly quite a large part of the electronics can all be manufactured in Australia. We have European manufacturers who have put proposals to Australian groups about the detail of what would be required for technology transfer arrangements to take place—what size orders would be required—and they are well within the capacity of Australia to be able to get together and purchase those amounts.

So I think I can say with a degree of confidence, on behalf of REGA, that we would anticipate Australian manufacture in the very near future. It is a new industry that is growing world wide at a tremendously rapid rate and the opportunity for Australia is one that will not only be of importance to Australia but be of importance to regional Australia, because most of the development will take place in areas well away from the major urban manufacturing areas. The opportunity is one to offset some of the disadvantage which may be brought about as a result of the changes in some of the coalmining areas. In fact, you might find that, whereas there have been some adverse impacts in Newcastle, for instance, as a result of changes that have taken place in recent times, some of the manufacturing for some of the new technology—the energy generation industry—will take place in Newcastle.

I will go on to global warming. The anthropogenic climate influence is discernible and scientific, and political opinion demands significant action. Renewable energy is a major component of the initiatives that form the solution to global warming and we support those and the Australian participation in COP6.

I would suggest that grandfathering is not an approach which we would support. The emission trading system has a potential which needs to be explored. Early greenhouse action is required, but land management flow-on effect for catchment environmental management is extremely important for the future of this country. Thirty years ago I was a member of the Senate Select Committee on Water Pollution. One of the most horrifying experiences that I have ever had in my life was to find out how much had happened to a water short country—a country which is one of the driest continents in the world—and how we had absolutely dissipated the assets which we had been given. When you look today at the problems of the Murray-Darling, you see how much the problem still faces us 30 years later. There have been attempts to approach this matter in various ways. The time to start is yesterday—not tomorrow—on land management, water management and general environmental matters for this country. I acknowledge that the rabbit has also played its part in changing the environment of Australia, but that is no reason to say that we should not be doing everything else that we can to improve it.

With respect to the approaches which we suggest, the renewable energy industry can mitigate Australia's greenhouse liability, and provide significant economic, employment and environmental benefits. We believe that Kyoto is something which will work—and I would like to quote some of the approaches from Europe in a moment. Australia's renewable energy industry can respond quickly to international markets. There is the emission trading suggestion, that would reflect the full environmental cost of production in the marketplace and improve the viability of renewable energy technology. We conclude by supporting the protocol. We urge active participation at COP6, which we will be attending. REGA supports also the efforts of the Australian Greenhouse Office, particularly the two per cent mandated renewables measure.

I refer to the European situation, because I think it is relevant to look at what the world’s largest trading bloc and social entity is doing in relation to these questions—and the European Union has become that. The commissioner's speeches on behalf of the European Union are instructive. On 11 September this year, just a few days ago, Ms Margot Wallström, the commissioner responsible for the environment, said:

According to the latest figures available, the EU is on track to stabilise emissions by the year 2000 as we committed ourselves to do under the Convention. Generally, however, emissions in industrialised countries are still going up. To curb this trend we need to intensify our efforts. Entry into force of the Kyoto Protocol is essential to convince both politicians and citizens of the need to act.

A little later she said:

We want to get started: we want to move from ambitious objectives to concrete actions.

And then she said:

To start with, the industrialised countries must show leadership in tackling climate change. This calls for substantial investments in energy efficient production methods, renewable energy sources and in sustainable transportation.

… … …

The Kyoto mechanisms should be seen as an opportunity to reduce the cost of the effort that will be needed for industrialised countries to fulfil their commitments. I am convinced that technological innovation is a key to a sustainable future for our planet. I see it as our joint responsibility to ensure that the decisions to be taken at COP6 put us clearly on this track of technological innovation.

Earlier this year, on 10 February, she said that, in particular:

At the end of the day, all products and consumer goods will have to be environmentally friendly. This is the only viable solution. I find it encouraging that many companies seem to agree!

A little later in this speech she said:

In fact, the industrialised countries have to reduce their greenhouse gas emissions much further if we are to prevent the climate changing at a speed to which nature and mankind cannot adapt.

… … …

However, the overall orientation can only be right and is fully in line with the Commission's thinking. We have to make energy more expensive to provide incentives for better energy efficiency, and we have to reduce the fiscal and social security charges on labour in order to create jobs. We cannot continuously talk about changing our lifestyles and protest when we are asked to undertake the first small steps.

… … …

I am convinced, ladies and gentlemen, that without a restructuring of our tax systems we will not be able to meet our climate change objectives.

Finally, she said:

... sustainable development can only be achieved at the global level. Sustainable development in one country or one region does not exist. In our global village, development here automatically affects other parts of the world.

Those quotes from the EU commissioner's speeches this year are an indication of the approach which is being adopted by the largest trading and social entity in the world. These days, we in Australia tend to hear rather more from the United States about their objections to Kyoto than perhaps we do from Europe about their very strong support. I would like to also refer to something that I believe is extremely relevant for your purposes—if I may, with all due deference, suggest that it would be of use to you—and that is the reference to the royal commission of the United Kingdom in relation to environmental pollution. It was set up in 1971. It has been operating since that time. There were some questions about scientific standing in relation to the views on these issues.

The current membership of the royal commission on environmental pollution is really a Who's Who of those available in the UK who could possibly have a view which would be respected by everybody as coming from great experience. It varies from the scientific side through to the Chief Executive of United Utilities, the former President of the Electricity Association of the UK, the Director of Europe Economics Ltd—who was a member of the Retail Prices Advisory Committee and the *Guardian* Economics Advisory Panel—and the Director of NERA. It is a very wide cross-section, and I have handed in a copy of its most recent report—which came out in June this year—to which I would like to refer. I will quote

from a brief statement from the Chairman, Sir Tom Blundell, when he said, in tabling the report, some words which I believe we cannot ignore:

> Recklessly causing large-scale disruptions to climate by burning fossil fuels will affect all countries. It is the poorest that would suffer most. We cannot expect other nations to do their part in countering this threat—least of all if they are much less wealthy—unless we demonstrate we are really serious about it.

That comment—together with some of the recommendations, which are strong and clear recommendations—puts to one side the suggestion that it is not a scientifically acceptable fact. This body is one which I believe most Australians would not find difficult to relate to—the way in which the body has been created, the way in which a royal commission operates and the way in which it would have brought together its evidence. It said that the challenge climate change poses for the world is so fundamental, however, that a complete transformation in the UK's use of energy will be an essential part of an effective global response. It is a very strong report. It is one which, bearing in mind the membership of it, I do commend for consideration. It is something which REGA would adopt.

I also refer to the fact that, on behalf of REGA, I visited the World Business Council for Sustainable Development in Geneva earlier this year and had discussions with them. When Shell, BP, AMACO, DOW Chemicals and those sorts of companies all start joining together to form the World Business Council for Sustainable Development and when they start taking very seriously all of these questions, I do not think you can start saying that it is a greenie trick or it is something which is just a fiction of the imagination. They have accepted it, they are doing something about it and I imagine Greg Bourne will be giving evidence to you. Whether he has or not, I do not know. In Australia, he is a strong representative of what industry is doing from a point of view of reacting to the reality that has come about.

There is so much other material to which I could refer. Time does not permit it. I have lodged some other documents which you may wish to refer to. I believe that, in summary, we have an opportunity in Australia, we have an opportunity to go along with the major parts of the world. There is a suggestion, quite strongly abroad, that Kyoto Protocol will go ahead with or without the United States, that there is sufficient strength in other parts of the world to support it, that they will not be prepared to wait for the United States to sign it and that there are other ways in which the United States may find it necessary to come along. The opportunity for Australia is to develop the renewable industry at a time when our region is rapidly moving towards environmental work—the eco industry—which provides us with a trading opportunity. There is the opportunity to provide environmental management services, there is the opportunity to provide scientific research work in relation to particular areas, but there is also the opportunity to manufacture and to install in South-East Asia everything from waste water management through to electricity generation from renewable sources. This is an opportunity which we wish to see Australia able to take advantage of.

Senator COONEY—I must confess that I am vastly influenced by what the Hon. Peter Rae has to say. I think he is as lucid as every he was. All that integrity that you had is clearly still there and I think, as far as committees go, you have suffered for the sort of work that you have done on committees. It is great to see you here.

Mr Rae—Thank you very much.

Senator LUDWIG—I take it that you say that the Kyoto Protocol should be ratified. Do you say that the time frames are reasonable and can be met by Australia, given our present position, and that the use of renewable energy is a cost-effective way of achieving that?

Mr Rae—We would like to see the mandated renewables measure introduced immediately, with a steeper curve for its introduction to enable the achievement of the intended result with a greater degree of certainty. At the moment, if it is slow at the start, it is likely to then be terribly steep and disadvantageous towards the end. It will come in too quickly towards the end. If it comes in too quickly, there will be a strong resistance, whereas it can be relatively painless at the moment. We would wish to, for instance, submit that the figures used by Allen Consulting are out of date figures—that the percentage GDP influence is much less than he was quoting—but that is another matter. The answer is as follows. Let us give the mandated renewables measure introduction as soon as possible. Let us look at emissions trading introduction. Carbon tax is something which we have said is a matter to be kept under review. I do not think that Australia is likely to achieve its objective any more than any of the other countries in the world are likely to easily achieve their objectives. It is a hard one. We are already over where we ought to be at this time, but that is no excuse for not starting. What we ought to be doing is getting forward as soon as we can and achieving the maximum that we can without totally disrupting our economy. I completely support the concerns that people have—that we must not make it so onerous that it starts to throw employment into jeopardy. But there are the two sides to it. One is that, as you will see from a paper which I have left with you, the assessment done for the European Union is that the employment generator capacity is very substantial indeed.

Senator LUDWIG—Yes, I read that. Given that you say that we should ratify but we are over our target at present—albeit, I suspect, from reading some of these papers, Germany is as well and a number of other European countries are significantly over, not to mention the countries in annexure B—should it come into force, what about the downside of a taxation measure if that is introduced? Wouldn't that create a resistance to actually signing it before we do?

Mr Rae—There will always be resistance from those who will be adversely affected by any change. But change is something which is taking place, and it is a matter of how we can best adjust to the change that is being imposed on the world by everything from information technology to climate change. They are all changing the world, and it is a matter of how Australia can best adjust. The adjustments we need to make are ones which will have some adverse effects on some businesses. Those adverse effects are likely, if they are introduced quickly and in the way that has been proposed at the moment, to be relatively insignificant and digestible. The longer they are left, the more severe they will have to be.

Senator LUDWIG—I do not mean to interrupt you, but that is the problem we face. They are not going to be introduced now, are they?

Mr Rae—I hope the two per cent mandated renewables is going to be introduced.

Senator LUDWIG—The bill is currently before us. I suspect it will be passed, but I do not want to be presumptuous about that.

Mr Rae—That is why I said I hoped.

Senator LUDWIG—That alone will not mitigate, once we sign, once we have actually ratified the treaty, the negatives that would accrue to us as a consequence, because we will be over. I cannot see, going on the current figures—unless someone wants to criticise my poor judgment—that we will meet the target. Or do you say we will?

Mr Steenbergen—The possibility of meeting the target depends on the impetus and correct signals given by government and other industries. The UK and Canada have already implemented schemes. They have tried to implement something as soon as possible. They have recognised that leaving it longer simply increases the cost and the adverse effect to everybody in their economy later. The longer it is left the greater the hurdle there is to jump, and the sooner you start jumping the small ones the lower the hurdles are going to be in future years. So the sooner you can bring it in the less you are going to adversely impact everybody.

Senator LUDWIG—All right. We seem to be going in a circuitous fashion, but I understand the drift of your argument.

Mr Steenbergen—That is the reason why the UK and Canada have implemented early.

Senator LUDWIG—So you are not actually saying that we ratify in due course but that we ratify as early as we can and also look at the two per cent—as well as other measures to increase the possibly of meeting the target? What would those other measures be, broadly speaking?

Mr Steenbergen—Emissions trading is an obvious mechanism and so is the adoption of those flexibility mechanisms from Kyoto.

Senator LUDWIG—For emissions trading you would have to have the world market there and, to be able to have that, you would have to have the treaty ratified, so we are looking further down the track. I am talking about mitigating now.

Mr Steenbergen—There are national emissions trading systems in process at the moment, so we can start soon. We do not have to adopt an international one. We can have a system that would be congruent with an international system when it comes in, because we do have some understanding of the way an international system will pan out. We can implement something that is congruent with that on a national basis.

Senator LUDWIG—Yes, I understand.

Mr Rae—We do have the early measures in relation to emissions trading with things such as the much publicised Japanese investments in tree plantations.

Senator LUDWIG—Or the Tasmanian ones.

Mr Rae—We have also had inquiries from international financiers for the purchase of rights from our various members' wind generation. They have all been approached by people who wish to obtain emissions trading benefits from those developments. I would best answer by

saying that the dramatic change that has taken place in the world in the past 12 months has taken a whole lot of people by surprise. If you take it over two years it is very dramatic—it is virtually a doubling of wind generation.

If COP6 is at all successful, the changes will, I think, be very rapid indeed; they will be rapid in Australia as well as elsewhere. The biggest problem is balancing out the new approved increases in the amount of non-renewable generation, particularly in Queensland where a number have been planned and, before we got to the stage where Queensland drew the line, a number had been approved. So we have got some gas which is to go ahead, which is a lot less—

Senator LUDWIG—We do have them in Millmerran, though.

Mr Rae—Yes. You have two major coal fired ones to go ahead—

Senator LUDWIG—I am not sure Kogan Creek is going ahead, is it?

Mr Rae—The last that I heard was that it was likely to.

Senator LUDWIG—So did I, but I heard others say no.

Mr Rae—I will put it this way—

Senator LUDWIG—We know Millmerran is half constructed.

Mr Rae—There is quite a bit to be taken up. However, the growth in demand in Australia is considerable. One of the things we need to do is to try to tailor that rate of demand off a little bit by energy efficiency of various sorts. That is another matter; I do not want to drag off onto that at the moment, but I do not want it to be taken that I am ignoring it. I think what we are going to find is that a large part of the growth in Australia can come from renewables and that will increase quite dramatically over the next 10 years or so. Therefore, the prospect of getting up to 12.5 or 12.7 within 10 years it is not an unreal expectation.

Senator LUDWIG—Yes, I see your argument.

Mr WILKIE—I have heard a lot about wind and also hydro. I am from Western Australia and I am interested in your thoughts about tidal.

Mr Rae—We have some members who are involved in tidal work, and I speak on behalf of REGA in saying that. We have been in association with SEDA and in discussion with ACRE, who are both involved in that. On the prospects of tidal, there are two major forms of work which have been done, quite a lot of it in Europe: one is in relation to tidal rise and fall and the other to tidal flow. Both of them hold considerable prospects. What the particular questions might be in Western Australia in relation to whether the area where tidal generation is available is an appropriate place to be developing it is something that I would make no comment about. But, in relation to tidal, I would have thought it is one of the ones which will be the next generation after wind and probably solar; it is probably going to take a while to get there. Wave

is another aspect. Quite a bit of work has been done on wave power, including both rise and fall of waves and waves crashing into a container which then creates the drive forces.

Mr Stanford talked about technological change, as it did in the stone age, taking us away from fossil fuels. I think tidal is one of the ones that is going to play a part in that in the years to come. Obviously, it is a tremendous resource that is waiting to be harnessed; it is a matter of the effective harnessing of it. Work is going to have to be done, at what rate I do not know. I can say that Western Australia is developing at the moment and Western Power have just taken a new contract with Enercon for the development of a new wind farm there. They are moving ahead fairly rapidly, so they have got Esperance and the new one at Albany. I see the wind farming as something which is going to accelerate at a very rapid rate because the technology has now got to a pretty refined stage.

We have still got a major problem with solar because it takes such huge areas to be able to gather enough energy. That does not mean that, in five or 10 years, we will not have something coming out of it. But I do remember in the early 1970s being on the council of the ANU when we supported the development of the trial station at Whitecliffs in western New South Wales. That has done 25 or more years of work on trying to harness the sun and it has not been successful yet on an economic basis, so there is still quite a way to go.

Photovoltaics is another example: the film on buildings so that you can have your own internal generation from most buildings coming from what is taken out of the air onto the sides and the roof of buildings. All of these measures are being introduced.

I have not mentioned major renewables yet so I would like the opportunity to do so. We see at the moment new wind and gas development—which will take place quite significantly in Queensland; Stanwell is doing a lot of work on it, as are others—but also new efficiency in hydro. When people say that most of the hydro has been developed in Australia, they forget that the two per cent mandated renewables measure will probably mean that you can spend an amount of money on hydro to get an extra 10 per cent or so out of the existing hydro, which then starts to take up quite a significant part of what is required to meet the Kyoto target of 9,500. The 9,500 target is two Snowys or one Tasmanian hydro. If you can get 20 per cent of it from the existing hydro by improving its output, you will have moved quite a long way. If you can then get another 30 per cent or 40 per cent out of wind, which should be quite possible, you are more than halfway towards achieving the 9,500.

CHAIR—Please be precise with your answers, Mr Rae. We cannot really let them run on.

Mr Rae—I am sorry. I was carried away by my enthusiasm. I apologise.

CHAIR—I was interested in your relying on European authorities for some of these propositions. What is your view of EU policy, and indeed British policy, towards Australia in the area of agriculture where we have significant interaction with them? Do you think they have our interests at heart in that area of policy or would you say they are hostile towards us?

Mr Rae—Having led Australian delegations to the European parliament on several occasions and participated in a number of others, I have experienced discussion of the common

agricultural policy many times. I found that platitudes were plentiful and action was difficult. However, the Andriesson Agreement did provide us with some encouragement and we have seen movement. It has been slow, but perhaps Australia has been unduly ambitious in seeking to have a purity in international trade that is inherently unlikely because people tend to look after their own interests. The problems of the common agriculture policy are perhaps a distance away from this energy question but we have certainly had our difficulties as a nation.

CHAIR—Do you think perhaps that expecting something of the largest emitters of greenhouse gas who are not parties to the protocol is the same sort of yearning for purity that is present in asking us to sign up to this agreement and meet targets when those large emitters of greenhouse gases are unlikely to? Indeed, why should the efficient emitters of CO_2—Australia could count itself as one compared with India or China—give up our capacity or our emissions and allow them to migrate to jurisdictions that will not be a party to the treaty in order to deliver the competitive benefit to your industry?

Mr Rae—I do not think the question as asked is capable of being answered. If I may, I will rephrase it a little and try to answer it.

CHAIR—Sure.

Mr Rae—There is a general acceptance that there can be substantial economic benefit which can come to Australia in accepting two things. One is a higher profile in relation to the information technology areas generally and the participation of that aspect of the new economy. The second is that there can be considerable trade and economic advantages which can come to Australia as a result of participating in the eco-industry opportunities. There is worldwide acceptance that the information industry and the eco-industry are the two major growth areas in the world. I would hope that Australia could take advantage of both. If we can take advantage of both, we will not be seen in a position of being disadvantaged by adopting these policies, but advantaged by them.

CHAIR—The proposition has been put to us before that, if we were to mandate an increase in the cost of emissions within Australia by signing up to this—and you foreshadow that where you say the increasing cost of emissions in the next decade will increase the viability of your industry; that is obvious—and if, in a sense, we tax the carbon emitters, then, ipso facto, whether it is by a mechanism like these bills in the Senate or a more simple carbon tax, investment capital will flow to your industries within this jurisdiction. But, in terms of the processing industries—smelting, for example—that the Allen Consulting Group pointed out are migrating to jurisdictions that do not have those same costs on carbon emissions—India, China, Indonesia and the United States—then , in a sense, we lose those industries and those jurisdictions gain them. All we are left with is taxing ourselves to shift capital to your industry where the smelting and the processing that we now enjoy will simply go elsewhere. The burden of proof, I think, still rests with you to prove to us that OPEC, without Saudi Arabia in it, which would be the protocol without India, China and the United States, would still leave Australia in a sustainable position. I do not think the burden of proof is yet discharged. You have to do more than this to prove it because you are asking us, representing these areas, to voluntarily cut our incomes. Those graphs that we saw from Allens—

Mr Rae—Were nonsense, if I may say so, with all respect to them.

CHAIR—You are asking us to shut down some industries and, in effect, develop yours.

Mr Rae—They were two years out of date and acknowledged to be graphs which did not take into account any of the positives and showed only the negatives. They were a nonsense. They are being brought up-to-date. I would very much like the opportunity to see them when they are brought up-to-date and then comment on them. It may well be that we have something relative to comment about. Those graphs were the sort of thing which I think has been misdirecting the debate in the past couple of years because there has been so much change that they have not taken into account.

CHAIR—We will need another round, in the sense that they foreshadowed another report. I feel that you still have to provide more analysis and detail to prove to us that your uptake of capital and development of jobs will replace and increase what meeting those Kyoto targets would reduce.

Mr Rae—Yes. This was where I felt that the European Community's analysis of the study of EU eco-industries' export potential and the final report in relation to that would be of considerable benefit to you. A tremendous amount of analysis has been done there of how that can have a growth effect on the European economy, which has many similarities to ours in trade disadvantages and the potential of loss to the United States or to China. I am more than happy, if we have a further opportunity, to direct attention specifically to doing some work in relation to questions that you have raised.

CHAIR—You have to prove the case. The burden of proof from our point of view, if we are to ratify this treaty, is whether or not it is in Australia's interest. Treaties come along at a great pace—some very small but some enormous like this. We find ourselves cast in the role of hearing evidence to prove that it is in Australia's interest. The consequences from meeting the targets, which ratification must mean—it is no good ratifying it and then just disregarding the targets—are dire for some parts of Australia but perhaps good for others. We need a fairly reasonably standard of proof before we recommend anything like ratification. We had better adjourn here. Thank you kindly. We must have you back for some more debate about it.

Mr Rae—Thank you for the opportunity.

Resolved (on motion by **Senator Tchen**):

That this committee authorises publication of evidence given before it at the public hearing this day.

Committee adjourned at 4.56 p.m.