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JOINT STANDING COMMITTEE ON TREATIES

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JOINT COMMITTEE ON TREATIES

Monday, 18 June 2001

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

Senators and members in attendance: Senators Bartlett, Coonan, Ludwig, Mason and Tchen and Mr Baird, Mr Byrne and Mr Haase

Terms of reference for the inquiry:

Kyoto Protocol

WITNESSES

Committee met at 9.09 a.m.

WATSON, Dr Robert Tony, Chairman, Intergovernmental Panel on Climate Change

ACTING CHAIR—I welcome members of the public and the media to this hearing into the Kyoto Protocol on greenhouse emissions. I also welcome our witness, Dr Watson, to the hearing today. 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 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. Dr Watson, do you wish to make some introductory remarks before we proceed to questions?

Dr Watson—The choice is yours. I can either summarise very quickly some of the key findings of the IPCC or I can immediately go into answering questions. The choice is yours.

ACTING CHAIR—Just as a framework, depending on the consensus of the other members, it would be useful for you to provide a synopsis of the findings.

Dr Watson—Okay, let me spend maybe five or seven minutes summarising the key conclusions of the IPCC. I will quickly go through the three working groups. Working Group I, which looked at the science of the climate system, concluded that the earth has warmed over the last 100 years by about 0.6 degrees Centigrade, which is about one degree Fahrenheit. We noted that the last two decades, the 1980s and the 1990s, were the warmest of the last century. We also noted that the last 100 years has been quite unique in the last 1,000 years; that is, the increase of 0.6 degrees Centigrade has not been observed in the proxy record for temperature in the last 1,000 years.

We have also seen significant changes in rainfall: some parts of the world have become wetter; some much drier such as northern Africa and southern Africa. But even in the United States, where there has been a slight increase in rainfall, what we have most noted is an increase in heavy precipitation events that leads to the risk of floods. There has been an increase in sea level of 10 to 20 centimetres. We have noted that most, but not all, non-polar glaciers are retreating and the extent and thickness of arctic sea ice is decreasing in summer. We have also seen some ecological changes. We have seen that bird migration patterns are changing, that birds are laying their eggs earlier and that the growing season in Europe has increased by about 12 days in the last 30 years. This is good for agricultural productivity in Europe.

We have seen an increase in economic losses due to extreme weather events over the last 50 years. What we also know is that we humans have increased the atmospheric concentration of greenhouse gases that warm the atmosphere and sulfates, which are aerosols that cool the atmosphere. When we try and look at the observational record for temperature for this last 100 years, we cannot simulate the observed increases in temperature by natural phenomena alone; that is, changes in solar output and changes in volcanic activity. However, if we do model the systems taking into account not only natural changes but also human induced changes—that is, changes in greenhouse gases and aerosols—we get quite a good correspondence between the observed change in temperature and that we simulate. That led the IPCC to one of its most important conclusions, that most of the observed warming of the last 50 years is attributable to human activities.

The key and second question then is: what about the future? We have taken into account, through socioeconomic models, potential changes in population, changes in economic growth, broad changes in technology and how the world may govern itself. All of these socioeconomic models, when coupled with climate models, suggest there will be an increase in the atmospheric concentration of the key greenhouse gas, carbon dioxide, over the next 100 years. The pre-industrial level of carbon dioxide was 280 parts per million. Today we are at 360. The models project that by 2100 we will have between 540 and 970 parts per million. This would then lead to a projected increase in the surface temperature of the earth of 1.4 to 5.8 degrees Centigrade over the next 100 years, which is 2.5 to 10.8 degrees Fahrenheit. We also note that most land areas will warm more than the global average.

Precipitation will globally increase. However, there will be increases in some parts of the world and decreases in others. But, again, we believe there will in most areas be an increase in heavy precipitation events that lead to an increased risk of floods. Sea level is projected to increase by somewhere between eight and 88 centimetres by the year 2100. But we believe that in most parts of the world there will be an increase in extreme weather events—heatwaves, heavy precipitation events, floods, droughts, fires and pest outbreaks—and we believe there will be an increase in tropical cyclones of both wind intensity and precipitation intensity.

The key question is: why do we care? The key reason we care is that we believe that climate change will add a stress to already stressed water systems, agricultural systems, natural ecological systems, human health and human settlements. In general, there will be some beneficial effects of climate change but, on balance, there will be more adverse effects than beneficial effects and the large majority of the population of the world will experience these negative effects of climate change.

The types of negative effects that we are projecting are that, for almost any change in temperature, there will be a decrease in agricultural productivity in the tropics and subtropics. For small changes in temperature, we actually expect an increase in productivity in the mid and high latitudes but, once we go above about two to four degrees Centigrade, even in the mid latitudes we expect a decrease in agricultural productivity—and that would include Australia as well as the United States.

We believe that many of the arid and semi-arid areas in the tropics and subtropics today will become more arid in the future. This is indeed the place—or these are the places—on earth where we already see significant problems with water resource management. We believe that many natural ecological systems will be threatened, especially coral reefs—particularly important in Australia with the Great Barrier Reef—also many of the mangrove systems and many both tropical and boreal forest systems.

We believe there will indeed be potentially an increased exposure to vector-borne diseases, such as malaria and dengue fever in some of the tropics and subtropics, and an increased incidence of exposure to water-borne diseases such as cholera. We believe that tens of millions of people are at risk of being flooded due to heavy precipitation events if you live in a river valley or due to sea level rise if you live in a coastal region.

Overall, the common conclusion is that developing countries are the most vulnerable to climate change, and the poor within developing countries are indeed the most vulnerable. Many

developed countries—some of those in Europe, the USA and almost certainly Australia—would probably benefit economically from a small change in climate. Once we go above two to three degrees Centigrade, though, many of those countries will start to see negative economic effects.

Just to summarise very quickly with respect to mitigation of climate change, in order to stabilise the atmospheric concentration of greenhouse gases, it would require all countries, certainly all regions of the world, to reduce their emissions. That clearly goes beyond the current Kyoto protocol, which only requires emissions reductions from developed or industrialised countries. To reduce greenhouse gas emissions significantly will require different patterns of both energy production and energy use. We note in the IPCC that significant technological progress has been made, however, in the last five years—wind turbine technology, hybrid cars, fuel cell technology and even the potential to trap and store carbon dioxide underground, which of course is particularly important for the coal industry.

From a technological standpoint, we believe that half of all global emissions that are projected to increase between now and 2020—that is, roughly the next 20 years—we could actually gain at net negative costs and the other half of the projected increases at about $100 or less per tonne. However, I have to stress quite carefully that these technological possibilities will not be realised without looking at the policies in the energy sector and overcoming barriers to the diffusion of technologies into the marketplace, and those barriers do at times come with costs. It will also probably require increased research and development and clearly effective technology transfer north, south and south-south. Clearly, forests and agricultural lands offer significant potential to sequester the carbon. So not only is it potentially a reduction in emissions but also we see forests, agricultural and pastoral lands given significant potential to sequester carbon—something, again, that could be of importance to Australia.

One could ask: why could there be some reductions in greenhouse gases at negative costs? There are market and institutional imperfections such as subsidies. Indeed, one of the most interesting things to note is that China have had significant economic growth in the last five years but, in that same time frame, they have actually reduced their emissions of carbon dioxide and other greenhouse gases, partly due to a reduction in their subsidies for fossil fuels in China and partly because they have closed down a lot of small and medium sized enterprises that were highly polluting and clearly were not very economical.

Secondly, one can actually also realise what we call win-win situations or synergies. There are some polices and technologies that can simultaneously reduce greenhouse gas emissions and also improve local and regional air quality. This could be particularly important in some developing countries where the local air quality is extremely poor—many Asian cites in China and India, as well as Latin American cites such as Mexico City.

One of the key questions often asked is: what would be the cost of compliance with the Kyoto Protocol? There is significant uncertainty in these economic costs. The macro costs suggest that if a developed country or an industrialised country had to take the hits or take all the reductions domestically—that is to say, no international trading—we would project a range of 0.2 to two per cent of GDP annually. If, however, there was annex B trading—that is, article 17 trading primarily, of course, with the former Soviet Union—one could roughly halve those costs to a range of 0.1 to one per cent. We also noted we could reduce those costs much further, if they were models only with carbon dioxide in them, by using the sinks to absorb carbon and to use

the clean development mechanism—that is to say, project based trading—with developing countries.

Lastly, my point would be that the costs of stabilisation increase as you go to lower stabilisation levels—that is, they increase from 750 to 550 parts per million—but there is a significant increase when you go from 550 to 450. The reason is that, if the world were to want to stabilise at a level of only 450 parts per million of carbon dioxide, it would mean that one would have to have global emissions peak within the next 10 or 15 years and decrease lower than today's level within about 25 or 30 years. The only way one could do that would be premature retirement of existing capital stock, so the economic costs rise quite significantly.

In summary, it is quite clear that the earth's climate is changing. We cannot ascribe all of those changes to natural phenomena. Indeed, we believe that most of the changes are due to human activities. We do believe that significant temperature changes are inevitable in the future without climate change polices and that, while there are some beneficial effects of climate change, most of the effects are adverse both in developed and in developing countries, especially for temperature changes that are greater than two to three degrees Centigrade. There are technologies that can be used relatively cost effectively to reduce greenhouse gas emissions, but it also has to recognise there would have to be significant changes in the policy machine. Thank you very much, Mr Chairman.

ACTING CHAIR—Thank you very much for those remarks.

Senator MASON—Good morning, Dr Watson. In some ways I feel I have an advantage because I have not been to that many meetings where we have discussed Kyoto, and perhaps therefore the issues that I remember are still fairly clear in my mind. Assuming you are right on the science—and I am sure you are—the issues that remain are these: the developing countries are remaining outside the regime, President Bush has announced that he is reluctant to engage in the regime and yet there is a push by many in this country that Australia entertain the obligations of Kyoto. The analogy that I am thinking of is a bit like unilateral disarmament. I am wondering why Australia should take up Kyoto obligations when the United States is unlikely to and the Third World is also unlikely to. That strikes me as the fundamental question.

Dr Watson—Let me be very careful and preface my remarks by saying that the IPCC itself, while it puts together policy relevant material, is not policy prescriptive. So the IPCC per se, and therefore me as Chairman of the IPCC, has no direct position on whether governments should or should not ratify the Kyoto Protocol.

Senator MASON—I understand that.

Dr Watson—Let me make a few comments, however. A very unusual situation occurred on 18 May, when 17 national academies of science around the world, which did not include the US, sent a letter to *Science* magazine. In that they said three things. Firstly, they strongly endorsed the process of the IPCC as coming up with credible science; and, secondly, they endorsed the findings of the IPCC. But the third element was very surprising in that, as 17 academies of science around the world, they felt very strongly that effectively the time for action was now. While the IPCC has not made any comment on the politics, 17 academies—and

I do believe it included Australia, but I do not have the list in front of me—did argue that, while there were some scientific uncertainties, the time for action is now.

The US National Academy of Sciences released a report in the last two weeks, again broadly endorsing the IPCC process and the conclusions but not commenting on the policy. With respect to the policy, you are absolutely correct to say that developing countries are currently outside the regime. But I would stress the word 'currently'. There are two comments I would simply place before you for consideration. Firstly, it is quite correct that, to ultimately stabilise greenhouse gas concentrations, it will require action not only by the industrialised world but also by developing countries as well. That is quite clear. Scientifically that is indisputable. The issue I think before all governments is simply one of equity, and that is a simple realisation that greater than 80 per cent of all of the anthropogenic greenhouse gases in the atmosphere today have come from the industrialised countries. And, secondly, even though growth will be larger in developing countries, one still has to recognise that the per capita emissions in China today, for example, are between one- sixth and one-eighth of the USA, and India is also probably less than one-tenth of the USA. I do not have the numbers relative to Australia and I apologise.

It is really a question of differentiated responsibilities and whether the industrialised countries should at least take the initial steps, recognising they have greater institutional, financial and technological capacity and greater know-how. This is a question I think all governments, including Australia, just have to think about. I would argue that the Kyoto Protocol would not be effective, obviously, without the United States because it represents 25 per cent of the world's emissions for only five per cent of the population. So a protocol without the US will clearly, even amongst the industrialised countries, not be as effective as one would like it to be. While I cannot tell you whether Australia should ratify the Kyoto Protocol, I do believe some of the equity issues should at least be taken into account. The only other comment I could make is that many of the senior politicians in Europe are arguing that Europe will indeed ratify the protocol. They believe climate change is an important environmental issue, and someone has to take a leadership role.

Senator MASON—Dr Watson, you just touched on my second and probably final question. Just going to the science for a second, you mentioned that the United States emits 25 per cent of the world's greenhouse gases. Scientifically speaking, is the Kyoto Protocol still worth pursuing without the United States?

Dr Watson—Again, there is no simple answer to that for the following reason: the Kyoto Protocol itself will make only a very small difference in the projected changes in climate over the next 100 years. The reason for that is very simply that much of the projected growth in greenhouse gases is indeed projected to come from developing countries. In fact, many people have argued: is the Kyoto Protocol an effective instrument with or without the United States? It is quite clear, as I have said, that with the Kyoto Protocol there will be only a small change in projected temperature over the next 100 years. But what the Kyoto Protocol does is that it starts to send a signal to industry as well as to governments that one is going to have to look at the energy systems of the world to have more efficient production of energy, to have more efficient use for energy and to put polices in place that can stimulate these more environmentally friendly technologies in the marketplace. So Kyoto itself—even if ratified by all industrialised countries, including the US—will only be one small step on a relatively long journey towards the ultimate stabilisation of greenhouse gases.

Senator MASON—Given that we have three-year terms in this country, Dr Watson, that is an interesting way to finish. Thank you.

Senator BARTLETT—In terms of the work that the IPCC has done—and you mentioned before that the time for action is now—is there an outline of what most effective, immediate types of action should be taken to reduce emissions as quickly as possible in terms of technology shifts, energy usage shifts and those sorts of things? I realise it has to be action across the board, but are there key priority areas in terms of action?

Dr Watson—As I said, the IPCC itself does not actually say what should be done, although we point out what possibly could be done if governments wanted to take those steps. We actually point out that there is no simple answer to this and that one does have to look across a very wide spectrum of possibilities. If one were fossil fuel, clearly many countries of the world have very inefficient power plants, so just increasing power plant efficiency, such as going to cogeneration, could be extremely valuable. Where a country has the option of switching from coal to natural gas for a new power plant, it would have the same energy probably cheaper and with roughly half the emissions through using natural gas rather than coal.

Where it is possible, clearly there would be a benefit in trying to stimulate the renewable energy sector. Some countries have a high wind regime, so wind power is particularly attractive; other countries have high amounts of sunlight, so solar energy is relatively attractive. But quite often renewable energies are a at disadvantage compared with fossil fuels because, in many countries of the world, fossil fuels have subsidies and tax breaks. So one almost has to firstly say, 'Have we got a policy regime that allows modern renewable energy to penetrate the marketplace?' Some countries in the world, such as Denmark, the United Kingdom and Germany, have actually said, 'We have put a challenge in front of industries. A certain percentage of the energy will come from a renewable, even if it is slightly more expensive, because it is a cleaner form of energy with less local air pollution, less regional air pollution and less global warming.' So they have tried to stimulate competition within the renewable energy sector.

It is also very important to note that, as I said earlier, not only can we reduce emissions to help to protect the climate system but also we can have better land management. We can, in certain parts of the world, slow down deforestation which is occurring. That is not just in the tropics; even within northern Europe and the US there is still some level of deforestation. We can improve forest management practices and agricultural management practices, and arrange to sequester carbon in the soil. So, to be quite honest, there is no single thing I would argue that one should do. Each country would have to look at its opportunities. Australia, with a very large land mass, may well want to look at reforestation even when it is shrub grass—it does not have to be large trees. I would argue that each country would want to look very carefully at its energy sector and at its land sector to see what technologies may be available for the efficient production of energy. But one has to see if the policy framework is appropriate to get these new technologies into the marketplace.

Another issue is the use of energy. What we pointed out in the IPCC is that there is great potential for more efficient transportation—both more efficient cars and more efficient land use planning around cars. So the transportation sector has great possibilities. In the United States, I can say that all the new advances in technology have gone into heavier cars and bigger cars, not

into using more efficient transportation. Secondly, if we look around buildings, we find that effectively there is a great potential to make buildings much more efficient through better glazing and better fibre for better insulation. In addition, the instruments inside, such as the computers, airconditioning systems, heating systems and refrigerators, all have great potential. While I would like to give you a very simple answer that this is the highest priority, what I would say is that every country has to look very carefully at where it uses energy and how it uses energy and has to examine both the technologies and the polices.

Mr HAASE—Dr Watson, thank you for the opportunity we have to speak to you in this regard. My first question goes back to the basic data that you are using for the determination that we have global warming in the last 50 years caused primarily by man's contribution. I would like you to react to the charge that, as the temperature recording points increase around the world and increasingly there is a higher proportion of those recording sites located in countries with a low and questionable level of technology, does this cast any shadow over the accuracy of the averaging of global warming? Would you answer that for me initially? Then we can go on from there perhaps.

Dr Watson—There are several things when we look at the temperature record. First, are all of the instruments adequately calibrated? The scientists that actually do the analysis try to look very carefully at issues such as temperature calibration and they do believe that the temperature record, the thermometer record, around the world is valid. One of the other key issues of the thermometer record is the so-called urban heat island effect—that is, are we really just seeing a rise in temperature because many of these thermometers are stationed in large cities? They may once have been in farmers' fields, in small villages or in small towns, and now they are in the middle of the city. You get the so-called urban heat island effect. All I would say is that the scientists who analyse these records look very carefully to try to make sure that not only are the individual sites well calibrated but also that they can subtract out the so-called urban heat island effect. What gives one some confidence that they have done this fairly well is that the trends they are seeing in those thermometers in cities, once they have subtracted the urban heat island effect, are the same as those that we are now seeing in the larger scene outside of the cities.

Also we have seen an increase in not only the surface temperature of the oceans but also the inner ocean. The inner ocean at some depths of many hundreds of metres is also starting to warm up. I believe if you look at the complete ensemble of the ground based data—you will probably ask me about satellites in a minute, so I will answer when you ask me—oceans and land, the scientists who have done this very careful analysis in several countries of the world are quite convinced that they are seeing a real increase in temperature.

Mr HAASE—Thank you, Dr Watson. I did not hear what it was I was probably going to ask you. Would you care to repeat that word please?

Dr Watson—I mentioned the satellite data records. Some of the sceptics have argued—and totally legitimately—since 1979, when NASA launched a series of satellites called the MSUs, that the satellite observational record has shown very little increase, if any at all, since 1979. The satellite data record is totally global: so why do we have confidence in the ground based data and how can we explain away the satellite data? There are two comments I would make. Not only did the IPCC do a very careful analysis of the ground based data but the US National Academy of Sciences looked at this very carefully about a year ago. They brought together

scientists who looked at the ground data and scientists who looked at the satellite data. They concluded that there was no reason to doubt the ground based data. In other words, the surface data is good.

Now the question is: is there an inconsistency in the satellite data? The answer is that the satellite data is in reasonable agreement over the land areas of the mid and high latitudes, but there is clearly a significant difference over the tropical and subtropical oceans. So there is clearly an area of the earth where we do not have a good correspondence between the satellites and the ground based data. It is the tropical and subtropical oceans. They tried to see if they could fully explain this discrepancy, and the answer was that they cannot. It is indeed one of the unanswered questions of science about which we need more information.

They could explain possibly some, maybe even half, the difference. That is to say, the middle atmosphere, which is where the satellites measure—the satellites do not measure the surface; they measure five-eighths of a kilometre above the earth's surface—may respond differently to both greenhouse gases and the so-called volcanic emissions that have come out from places like Mount Pinatubo and El Chichon. They may respond differently to the change in stratospheric ozone layer that has an effect on the temperature of the troposphere. So they could give some explanation for some of the difference but not all of it. Hence, as I say, there is no reason to doubt the ground based measurements, but there is reason to continue to ask the question: why does the satellite data not agree as well as we would hope with the ground data? That is clearly one of the unanswered questions that we need to continue to research.

Mr HAASE—Thank you for answering that question. This is the next area that I would like you to speak on: to combat the global warming situation and to put in place some of those mooted solutions, in your opinion, does it mean overall a reduction in the global standard of living, if you like?

Dr Watson—I tend to be a technological optimist and I believe that, if the Kyoto Protocol were to be ratified, it would stimulate far more action in research and development in both the public sector and private sector. So my personal belief is that it would not reduce the quality of life or the standard of living. If we look at a few of the other big international environmental issues that have taken place over the years, one of them would be the issue of stratospheric ozone depletion.

When the argument was that fluorocarbons and bromine containing compounds were destroying ozone, many in industry argued that to eliminate the use of these long-lived fluorocarbons would be unbelievably expensive and possibly there would be no solutions at all. Once the Montreal Protocol was ratified and then later the London amendments, the Copenhagen amendments and the Vienna amendments, we found that actually living up to the phase-out of the chlorine and bromine containing compounds was much cheaper than any of the projections. That was because we allowed industry to be innovative and to find the cost-effective solutions. Secondly, when the United States decided to desulfurise, the original costing of how much it would cost to take the sulfur out of the power plants was a very high number. It turned out, again, that once we allowed industry to be innovative using new technologies, bringing the coal from where they wanted to buy and sell the sulfur credits, the costs were about a factor of 10 lower than anyone had projected initially. When I read the IPCC—I am not a technologist, I have to be honest—I tend to believe that we will see relatively

reasonable solutions. But my view is that we must allow industry to be innovative because industry will be the solution to this issue in the long term.

Mr HAASE—Thank you. I have one final question. I do not profess to know your specific background and expertise but I am personally interested in the value of tidal energy as a power generator. I wonder whether you could comment on what will become the global acceptance of tidal energy and how you suggest we might overcome the public reluctance to go down this path due to the very high capital cost and the apparent tendency to overlook the very low operating costs. Your comments, please?

Dr Watson—Just as a matter of interest, I am an atmospheric chemist and my real research area of expertise was actually understanding stratospheric ozone depletion, especially the ozone hole over Antarctica, which is real close to you guys. Tidal energy is not one of the forms of energy that we spent a lot of time on in the IPCC. To be honest, I would have to go back and understand why. I have heard lots of people say there is great potential in tidal energy but I am not an expert in this area at all, so I cannot comment on the difference between high capital costs and low running costs. However, what I can do for you is to pull out the latest thinking from the IPCC about what we have said about tidal energy. To me, it seems like it has great potential but, again, I am not an expert on this. Let me go back into the IPCC document, look to see what we have said, see whether there are any other pieces of literature that I can find and make sure they get to you.

Mr HAASE— I would very much appreciate that.

Senator TCHEN—Dr Watson, before I ask you any questions, I ought to clarify the point which Senator Mason made in his initial question. I think the reality is that Australia has been moving fairly deliberately and voluntarily towards meeting our Kyoto obligations. The sticking point at the moment is whether we should bind ourselves to the Kyoto Protocol by ratifying it, thereby tying ourselves to some of the matters that are not yet specified. The main argument is on that point.

You have been asked a question about sceptics on the IPCC report on global warming. Can I firstly ask you to put on record your response to two particular criticisms that a number of witnesses have put to this inquiry? The first is that the IPCC assessment had been exaggerated so that the funding for atmospheric science and the IPCC will be preserved. The second criticism has been that this whole global warming agenda has been driven from a political basis and in particular by the Europeans. Can you comment on those two particular criticisms?

Dr Watson—Yes. I have often heard this argument that the scientists are exaggerating the global warming threats for the continuation of funding. I personally do not believe that. As you may know, I am testifying here as the Chairman of the IPCC and I am currently Chief Scientist at the World Bank, but my previous position was actually in the US government overseeing basically a $US7 billion program on environmental issues. I truly do not believe that the academic community is pushing the issue of climate change just for funding. There are dozens of other interesting scientific or environmental issues that they could be studying. I truly do not believe that the scientific community is just trying to continue research funding.

The interesting thing would be that, if the governments around the world were to start to take the first steps to limit greenhouse gas emissions, it could have exactly the opposite effect on funding. That is, many governments around the world may believe we have solved the problem now so we do not need to put so much money into the research. So I would argue that, if the scientists have done a good job of persuading governments that this is a serious issue, it could actually reduce their funding, and what they should have been saying is, 'There is a lot of uncertainty and we should just continue studying it, rather than some of them arguing poor relation.'

With respect to the IPCC, it hardly has a budget. Literally every expert who takes part in the IPCC is a volunteer. There is not one person, including me, who gets one single dollar from the IPCC. I do most of my work in the evenings and at weekends, and the World Bank subsidises my travel time basically. So there is no sort of salary for anyone associated with the IPCC, except for the secretariat. The total budget of the IPCC, our trust fund, is about $US4 million a year, although it varies from year to year. That pays for developing country experts' travel and it pays for the plenaries. If this were an idea for keeping IPCC going, we are doing a real bad job of getting a lot of money. It must be my poor chairmanship.

On the political bias of Europe, I do not buy that one either. Let me put it this way: more than 50 per cent of all the research funding is actually in the United States. The United States through the National Academy of Sciences had some of the very earliest national assessments of the state of science and was pushing this whole issue of global warming at least as early as any of the European scientists, let alone scientists in other parts of the world. So from the standpoint of who has said that global warming is at least a serious environmental issue that needs to be studied and that it is up to governments where there is action, I would say the push has been just as much in the United States and Canada. Australia has been funding climate research for a long period of time. So I do not see what I call a political bias in Europe.

There is at this moment in time far more of a drive for action in Europe than there is in some other parts of the world. I think that is a very fair statement. I would make the comment that the one thing I find very interesting is the number of very large multinational industries that are also arguing for action and that have actually committed themselves to voluntary action. There are probably between 30 and 40 very large multinational companies around the world that have actually bought into the science of climate change and have actually stated that they will either live up to the obligations of the Kyoto, with or without governments, or even exceed them. They include Shell, British Petroleum, Lucent Technologies in the USA, Du Pont, Toyota and some very large European companies. So the interesting point is that the push is not just from the European government; some of the push at the moment is from American industries and Japanese industries that have actually said, 'While we recognise there are still some uncertainties in the science, we believe the overall conclusions of the IPCC are valid. Therefore we need to start to act.' I would argue that it is not a political bias from Europe, to be quite honest.

Senator TCHEN—There are also two commonly occurring criticisms which are more science based, and I wonder whether you could comment on them. The first one is that the scenarios provided by the IPCC are basically modelling scenarios or modelling outcomes and that there is insufficient rigour in the science applying to these models. That is the first criticism.

The second one is that global warming and cooling appears to be a natural cycle and the most we can say about the current warming is that it is an out of sync cycle. The question is whether it will reach stability at some point in the near future and then drop back again so that there is really no long-term extreme warming in sight. Can you comment on those questions? Finally, if you feel like it, can you make some comment about the possibility of nuclear energy as a non-global warming energy source?

Dr Watson—I am glad you gave me the easy ones, especially the last one. Let me start with the last one. Again, that is clearly what I call a sociopolitical decision; that is, it is up to governments and civil society to decide whether nuclear energy is or is not acceptable. From a perspective of climate change, it is a clean form of energy—no question whatsoever. However, you know as well as I do, the key question is: will it be publicly acceptable, either nationally or internationally, due to the safety of the reactors, the safety of the disposition of the waste and whether or not there would be a potential loss of fissile material into the hands of terrorists? They are the three key issues. The fourth key issue is cost, and that is: how do you effectively do the life cycle costs of nuclear energy? It depends what your discount rate is, because there is a big difference in what you think the clean-up or the waste disposal costs are when you effectively retire a nuclear plant. But, from a climate perspective, it is obviously a much cleaner form of energy than any fossil fuel energy. It goes along with the zero carbon or low carbon emitting technologies. There is a little bit of carbon used in cement and stuff like that in the buildings.

On the first one, the scenarios, when we project the climate into the future, there are two types of projections we need. The first is: what will the emissions of greenhouses gases be? The second is: what are the implication applications of those changes in greenhouse gas emissions? The first part of it is a socioeconomic model. That is, you have to make assumptions about, one, what will the population of the world be between now and 2100; two, what will economic growth be between now and 2100; three, what are the likely changes in technology and the diffusion of those technologies into the marketplace; and, four, how will the world govern itself? None of us has a crystal ball so we use the best estimates, a wide range of estimates, for all four of those key determinants.

As for population, as you know, we have six billion people today. We assumed a low value of seven billion people in two of our four story-lines, we assumed 10 billion people in one, and 15 billion people in a third. On economic growth, again we do not know what it will be averaged over the next 100 years. So we ranged the economic growth from two per cent per year up to 2.8 per cent per year, which is likely to cover the range over the next 100 years, obviously with regional variation. The same with the population: it was not done globally; it was done region by region as well.

We made some assumptions about technology. There is plenty of coal in the world, especially in the United States, Russia and Australia. There is at least 300 years worth of coal under any scenario, so we ranged from heavy use of coal to the very light use of coal, not because of a climate perspective but because of local air pollution and acid deposition. We assumed there would be heavy use of renewables in some of the outcomes and very little use of the renewables in others—again, not because of climate but because of local and regional air pollution. We also made some assumptions about how the world would govern itself: would it be a homogeneous world versus a highly heterogeneous world like today? So we put all those uncertainties into our

model and we came up with plausible emissions of carbon dioxide. So there is a very large range of uncertainties. It ranges from, in the year 2100, possibly as low as five billion tonnes per year—we currently put in just over six billion tonnes per year from fossil fuel use alone—all the way up to about 30 billion tonnes. We recognise that there is significant uncertainty in what the emissions of carbon dioxide and other greenhouse gases are. That is one set of uncertainties.

The second set of uncertainties is the climate models themselves, so we project the future with this wide range of greenhouse gas emissions into our climate models. The biggest uncertainty in the climate models is the role of clouds and the role of aerosols, and they control what we call the climate sensitivity. Our projections at the end of the day are that by 2100 the world is likely to warm by between 1.4 and 5.8 degrees Centigrade. In that very wide range, half of the uncertainty is in the socioeconomic driving forces of population, economic growth, et cetera, and the other half of the uncertainty is lack of knowledge about climate sensitivity.

But the one very important thing to note is that, even in a world of a very low population of seven billion people, even in a world with low economic growth and even in a world with low climate sensitivity—so it is low, low and low—we still project on the low end 1.4 degrees Centigrade temperature increase over the next 100 years, which is much higher than anything seen in the next 10,000 years. If, on the other hand, we have high, high and high, we get the 5.8 degrees. The central number, which is not necessarily the best number because we do not know what the best guess of population is, is around three degrees Centigrade. So many of the models are between 2½ and four degrees Centigrade. Some are lower; some are higher. That explains where what I call the projections come from.

With regard to the issue of global warming versus global cooling, obviously over many tens of thousands of years we go between a glacial period and an interglacial period. In the last 400,000 years, we have probably had about five glacial periods and five interglacial periods, so roughly one every 100,000 years. We are currently in a warm period; we are in an interglacial period. Therefore, by logic with the world left to itself, the next period would be obviously a glacial period. But we do not know whether that will occur in 1,000 years, 10,000 years or 100,000 years. When we go into glacial, the temperature difference tends to be three to five degrees Centigrade. What we are worried about, however, at the moment with the effects of humans is that we could well be seeing—as I have just said, and I hate repeating myself—an increase from 1.4 to 5.8 degrees Centigrade in the next 100 years. So whether or not we go into a glacial period in 1,000 years, 10,000 years or 100,000 years, the key issue is how climate will change in the next 100 years and how that will affect what we humans care about—water, food, coral reefs, sea level rise, et cetera.

Senator TCHEN—Thank you, Dr Watson.

Mr BAIRD—Firstly, congratulations on what has been a very interesting and comprehensive review. We have very much enjoyed it. There is just one question from me, and that relates to Australia's position and challenge. For those of us who sit in what is very much an energy intensive, driven economy, with heavy dependence on minerals and transformation in the aluminium smelter area and in power generation, and with the major development that we have in the North West Shelf in terms of gas production, and where other counties are exporting their energy intensive activities to Australia, it puts us in quite a challenging position in terms of the

Kyoto Protocol. I wonder whether you have words of advice to give us as we face up to that, in particular what impact significant changes would have on our own economic growth.

Dr Watson—To be honest, I have not spent enough time looking at the Australian economy to make anything of a sensible comment. Therefore, it would be inappropriate for me to guess. One of your other major emissions is from sheep and cattle—that is, methane emissions. From what I understanding, there are some significant advances in science by Australian scientists that may be able to reduce emissions from sheep and cattle. Also, if indeed you do have potential for better forest management and better agricultural management, that again can help Australia. Lastly, you would then look at your energy intensive industries. You certainly have got very energy intensive industries. So I think the question is: to what degree do you have any options of more efficient power plants—I am sure yours are some of the most efficient in the world—and is there any opportunity to go to natural gas rather than coal, which is a significant advantage?

I have to be candid with you. I have not looked at your economy well enough to make a sensible comment, so for me to give you an off-the-cuff comment would be inappropriate. But you can look at sequestration of carbon in effectively forest land, agricultural land and range land. You can look to see whether you can reduce your methane emissions from sheep and cattle. Lastly, one would then say, 'Okay, what would we have to do in our production of energy as well as our use of energy?' Again, there may be some leeway in more efficient use of energy in households, in transportation, et cetera. But, as I say, one would have to do a very careful analysis.

ACTING CHAIR—We have about one minute left. I am wondering if you would like to make any final comments for this particular hearing.

Dr Watson—Clearly, each government has to make its own decision. It is clear that, unless there is over the next numbers of decades concerted action to reduce greenhouse gas emissions, we do project significant changes in climate with—on average—adverse effects. There are two comments I would make. The first is that uncertainty can go in two directions. That is to say, we could be overestimating the impact of human activities on the climate but we could be underestimating it as well. I have a hard time being complacent and hiding behind scientific uncertainty.

The other issue is the time scale. We can wait for better knowledge and wait to see if our climate does change because of human activity, and say, 'Boy, we don't like this changed climate, let us slow down and reduce the CO_2 emissions and other greenhouse gases,' but the time for recovery of the climate system is not decades; it is actually centuries to millennia. We have one example of where it was centuries, and that is the Antarctic ozone hole. In there it is not, of course, a climate issue; it is a chlorine and bromine issue. We waited to prove that the Antarctic ozone hole was due to humans and, even now that we have completely banned all of the long-lived chlorine and bromine gases, the Antarctic ozone hole will be here for at least another 50 or 60 years. The climate situation is very similar with very long-lived gases like carbon dioxide. One could argue that we could wait for perfect knowledge and wait to see if we humans are changing the climate but then, if we do not like it, we cannot reverse the damage very quickly. I think that is something that has to be taken into what I call the policy equation.

ACTING CHAIR—Thank you very much for your evidence, Dr Watson. We face, as you probably appreciate, very difficult political constraints dealing with this issue. Your evidence today, particularly from my perspective, has been extremely valuable. I would like to thank you for taking the time out to give us the benefit of your wisdom on this issue.

Dr Watson—I appreciate the opportunity to testify; thank you very much.

Resolved (on motion by **Mr Baird**):

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

Committee adjourned at 10.04 a.m.