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Proof Committee Hansard

**HOUSE OF  
REPRESENTATIVES**

STANDING COMMITTEE ON INDUSTRY, SCIENCE AND  
INNOVATION

**Reference: Long-term meteorological forecasting**

TUESDAY, 30 JUNE 2009

SYDNEY

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**HOUSE OF REPRESENTATIVES**  
**STANDING COMMITTEE ON INDUSTRY, SCIENCE AND INNOVATION**

**Tuesday, 30 June 2009**

**Members:** Ms Vamvakinou (*Chair*), Fran Bailey (*Deputy Chair*), Mr Bidgood, Mr Champion, Mr Cheeseman, Dr Jensen, Mr Johnson, Mr Ramsey, Ms Rishworth and Mr Symon

**Members in attendance:** Mr Ramsey, Mr Symon and Ms Vamvakinou

**Terms of reference for the inquiry:**

To inquire into and report on:

Long-term meteorological forecasting with particular reference to:

- The efficacy of current climate modelling methods and techniques and long-term meteorological prediction systems;
- Innovation in long-term meteorological forecasting methods and technology;
- The impact of accurate measurement of inter-seasonal climate variability on decision-making processes for agricultural production and other sectors such as tourism;
- Potential benefits and applications for emergency response to natural disasters, such as bushfire, flood, cyclone, hail, and tsunami, in Australia and in neighbouring countries; and
- Strategies, systems and research overseas that could contribute to Australia's innovation in this area.

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**Committee met at 8.57 am****RENNIE, Mr Graham, Manager, Flight Dispatch, Operational Policy and Industrial Affairs, Qantas Airways Ltd**

**CHAIR (Ms Vamvakinou)**—I declare open this public hearing for the inquiry into long-term meteorological forecasting in Australia being conducted by the House of Representatives Standing Committee on Industry, Science and Innovation. The inquiry arises from a request to this committee by Senator the Hon. Kim Carr, the federal Minister for Innovation, Industry, Science and Research. Written submissions were called for and 33 have been received to date. The committee is now conducting a program of public hearings and inspections. This hearing is the sixth for the inquiry.

I welcome our first witness today, from Qantas Airways Ltd. Although the committee does not require you to give evidence under oath, I should advise you that these hearings are formal proceedings of the parliament. Consequently, they warrant the same respect as proceedings of the House itself. It is customary to remind witnesses that giving false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. We thank you for your submission and now welcome you to make a brief opening statement before we proceed to questions.

**Mr Rennie**—Thank you. I have managed the flight dispatch, flight planning, tactical and strategic areas for many years—15 in total. In the past week I moved into a new capacity as principal adviser, global operations development. I am here as an operational person, not as a meteorologist or a scientist. I am here to give the operational perspective for Qantas and how we see the importance of met in the future. To give a bit of background, Qantas is one of the world's leading airlines in terms of operational activity with meteorology, including meteorology with volcanic ash. We are very active and enjoy a collaboration with the Bureau of Meteorology unlike any other country in the world. We have developed this collaboration with the bureau over many years and we enjoy this two-way activity. Globally, we also have close collaborative ties with IATA, the International Air Transport Association, and ICAO, the International Civil Aviation Organisation. We are innovative, with the World Area Forecast Centre, and Qantas was instrumental in improving the resolution for the world area forecast that is produced by Washington and the UK daily—it is now four times per day. We have been instrumental in improving both spatial and temporal resolutions.

We understand that meteorology is not a perfect science, and since we have understood that we are much better at it. Operationally, Qantas has a met department, which is not unusual in aviation among airlines, but these days our model is quite different, whereby the meteorology department within Qantas adds value. It is a very integrated department within the Qantas integrated operations centre and it emphasises the importance that we place on meteorology and the environment.

Regarding the future, we see meteorology being absolutely instrumental in the way that we progress. There is improvement in efficiency—and safety of course—and, from an air traffic management perspective, it is going to be vital. At a recent meeting with the Federal Aviation Administration in the US, where we were talking about the next air traffic management system, they produced documents stating that they have measured the current delays in airspace and that

the cost to airlines is upwards of US\$28 billion, of which they consider that two-thirds is avoidable. What this means is that they have put in a huge effort within the national met authority and other authorities in the US to improve this aspect. We are right there with them.

In terms of the next air traffic management system, which will be global and starts in 2015, we will be having what are known as business trajectories, where aircraft will receive a trajectory in 4D—that is, 3D plus time—and included in that is the weather. So, when we produce a trajectory within our operations office and that is accepted by air traffic control, that will take into account the weather. So the products and the accuracy we require will need to improve. From an air traffic perspective, with the congested airspace today and what is projected, they see it as the only way to reduce separation standards so they can manage the airspace. It is that important. Qantas as an airline have measured the environment very closely and we see it as being fundamental to improving safety; efficiency—fuel saving to the industry; and, of course, CO2 emissions.

**CHAIR**—On the issue of the products, in your submission you said:

Qantas develops probability forecasting products to ensure that operational efficiency is maintained in a range of circumstances.

Can you tell us what type of products you are developing and what type of circumstances they are being applied to. Are these products applicable to other industries?

**Mr Rennie**—The probability forecasting is really central to the future. A meteorologist, when he develops a strategy for a forecast, works in probabilities. Nothing starts and ends just like that. It is worked up in terms of probabilities. We learned in the 1990s just how important probabilities were. We developed a product in Australia called Code Grey and if you look at the aviation weather site today you will see Code Grey. That is a probability forecast for long-haul flights into Australia. It was developed by Qantas with the bureau and everyone can use it. It is simply a probability of the alternative scenario occurring rather than the forecast. The forecast may say one thing; this is the alternative scenario. When we are managing the risk of getting an aeroplane in it is very important that we understand that risk.

**CHAIR**—Are you being pre-emptive in the way you approach this?

**Mr Rennie**—Exactly and it is being pre-emptive in terms of fuel policy. This is not a safety aspect; it is simply an efficiency aspect. There is a probability of an alternative scenario occurring in X amount of hours, therefore should we or should we not take that into account? We put that through a risk filter and come up with an answer to that. It is not precise but what we have done since then is to improve the way that we manage risk at both destination and en route.

We have developed a product internally called OpRisk whereby we look at all of our forecasts, all of our destinations, in the light of probabilities. We may have a low pressure system or we may have a perfect day forecast, but what is the alternative in that time frame? In other words, we are looking at forecasts over maybe 24 hours but we are really looking at the half an hour when that aeroplane gets in so that is what we refine that OpRisk to. It is simply a refinement of that forecast. When you consider our global operations we look at one-hour fly-in and also at 16-hour fly-in. They are quite different in the way they have to be managed in terms of the

environment. If you look at the back end of the forecasts, the accuracy drops off to a level whereby we must take account of that by measuring that risk. That is exactly what we do.

We forged products with Weathernews in Japan for Japanese arrivals. We found that in Tokyo there was consistently low-visibility weather which had not been forecast. For years we carried additional fuel. We forged a probability forecast with Weathernews. They have an independent look at the forecast at a very precise time, and at the forecast at the alternative airports, versus the official product from the Japanese meteorological authority and they give us another scenario. We measure that scenario in terms of risk. Since we forged that we have saved a lot of fuel and we have not had one failure—touch wood. We have had that now for five years.

**Mr RAMSEY**—A failure is where you are getting low on fuel and you have to divert.

**Mr Rennie**—Exactly. In this case it is very costly, obviously. We look at it in terms of misses, or failures, and false alarm rates. Unfortunately, at the moment the false alarm rate is quite high with probability forecasting. So that is where our efforts are going at the moment. We also have a probability forecast with the UK Met Office for low-visibility arrivals into London and Frankfurt. In terms of verification of the product, they have a very high success rate. When you consider operating an aircraft, a flight crew have to be recently trained in low-weather minima and autolands. If we have a pilot that is not recent then we can only approach in much higher minima. Therefore, in low-vis ops we cannot make an approach, so we have to divert until that weather becomes good. We can now look at probability forecasts up to three days out and measure the risk of each flight.

We also have probability forecasts with HKO of Hong Kong. Hong Kong airport is significant in the level of turbulence and windshear that it experiences. It is also subject to cyclones and high winds. So we have a probability of crosswind coming across Lantau Island and creating windshear across those approaches. We have spent a lot of time with the HKO in developing products with them, particularly with the probability forecasting. Our probability forecasting is now with the WMO, which is the World Meteorological Organisation. They are the chief scientists of the world, and they work out all the equations and so forth. They are now seriously looking at probability forecasting. It is the future. The FAA and Eurocontrol have recognised that probability forecasting is the future—and how each airline then measures that risk.

**CHAIR**—This is a product that Qantas has developed.

**Mr Rennie**—Yes.

**CHAIR**—Is this a world-leading innovative approach?

**Mr Rennie**—Yes. We use probability forecasting more than any other airline.

**CHAIR**—Why don't other airlines emulate that type of product?

**Mr Rennie**—Good question. It is a question I ask myself.

**CHAIR**—I might change my attitude towards flying forever after today.

**Mr Rennie**—Regulatory rules require fuel policy. Qantas is very adept at flying long-haul operations and our fuel policy reflects that. In terms of our rules, we have a lot of flexibility with our fuel policy. To keep that developing, we do not needlessly carry too much fuel—in other words, you have perfect weather and you have very long alternates. Australia is not endowed with lots of airports, particularly for large aeroplanes. It is very costly to fly across the Pacific and carry Melbourne, Brisbane or Adelaide as an alternative airport. From a 747 perspective, to carry such an alternate across the Pacific would cost in the order of five to six tonnes of gas. That is a lot of money every day, four times a day. So we have a fuel policy that we tailor to that flight. It is well within the CASA rules, obviously. It is not a safety issue; it is simply that we can forge such policies.

In Australia we are not endowed with airports. It is a unique operating environment in that—at night, for example—we do not have a lot of ATC at airports; we do not enjoy that. And there are very strict rules for flying, whether it be twin jets or ETOPS rules. So we work very closely with CASA in forging fuel policy and the operational rules.

So we need to be smart. Other airlines that carry lots and lots of fuel around the world do not necessarily have to be that smart. But, as the FAA found out when they provided relief to their airlines to do this, in terms of the US carriers, they now operate across the Pacific in much the same way as we do. So we have a meeting of the minds here, certainly with American airlines.

**Mr RAMSEY**—Can I ask a question from personal ignorance: what is your alternate on Jandakot Airport?

**Mr Rennie**—I do not know. In terms of Jandakot, because we do not operate there, in terms of heavy metal, I cannot say. I can tell you about Perth or anywhere Qantas operates, but unfortunately—

**Mr RAMSEY**—What happens in Perth? Where are your alternates?

**Mr Rennie**—In Perth, we have alternates for the 737 and that size aeroplane. We can go to Kalgoorlie, Geraldton or further up north, or down south to Albany. For the 767 and 330s, we are more restricted, but we have Kalgoorlie, and then we go up to Learmonth. For the 747, it is Learmonth, before Adelaide.

**Mr RAMSEY**—Not close, is it!

**Mr Rennie**—Not close!

**Mr RAMSEY**—Boy oh boy, that is a lot of fuel.

**Mr Rennie**—That is exactly right. And when you look at the cost of fuel and the emissions, unless we had got very smart with how we operate, and we measured that risk, we would be in a much worse situation today.

**Mr SYMON**—I have lots of questions. Unlike other witnesses to this inquiry, your organisation appears to have a reach, obviously, into a lot of other countries' met systems. Everyone we have heard from until now has come up and spoken about the Australian Bureau of

Meteorology and CSIRO and various other things that we do here. My question is: in regard to the information you receive from Australia compared to other countries in the world, is the information you get here of a higher standard or a lesser standard? Are there places that do it better than we do?

**Mr Rennie**—Yes. When we look at weather, we have to look at the conditions. Not being a meteorologist, I may not be able to answer all of that question. We certainly measure forecasts around the world, and we have some verification internally. We certainly push very hard ICAO and the bureau of met and other met authorities to introduce verification. Verification is a key to improving the accuracy of their forecasts. We find, for example, that forecasting in Australia is generally quite good—as a general statement. What we find, though, is that forecasters can be overconservative, for example. We need to improve verification to identify that.

On fog forecasting: we find that, in Australia, fog is obviously very disruptive. It is incredibly disruptive. We need to improve on that, but we are no worse and no better than any other country. And that is because Perth may be harder than Sydney for forecasting fog, for example. So you cannot take it from one country to another; it is really one location. In terms of Perth fog, we have had several workshops in the last 12 months on how to improve. Obviously, when you mention Jandakot or Perth, there is an element of it being over on the other side of the country, and you do not always have those alternates. And we do not want to be diverting en route, which is what we would do if there were unforecast fog.

We need to understand the probability of that forecast fog occurring in a 12-hour time frame. For our flights from Japan that arrive in the early morning, knowing about the fog at four o'clock in the morning is no good, because we are already up there. We need to have an understanding of the possibility of something occurring. If it does take us by surprise, which it has and it can do, then we simply divert en route—we end up in Darwin or wherever. However, that is not quite the aim of what we are trying to achieve.

If we get there and it is below minimums then we will divert early anyway, because it is better to divert early, tank up and then fly on. But, unfortunately, there is a high false-alarm rate with fog forecasting at any time. You may say it is forecast over six hours but it may only appear for half an hour. That is the issue. So we need to continually evolve products with the bureau that say, 'We have a long-term forecast, or a probability forecast, and this is now what we are doing, in the now-casting sense,' so that, if it is going to appear at three hours, then we have a high predictability of that actually occurring so we can do something.

**Mr SYMON**—I would like to switch questions completely now and ask you about timetabling and scheduling and how that is affected with long-term forecasting. Obviously, it is a question of resources as to how many hours you can keep a plane in the air per day, and you need to set your schedules quite some time in advance. How much of a factor is the long-range forecast in that side of the operation?

**Mr Rennie**—Let us look at long-haul operations—say, from the US to Australia. If we see that there is a high probability that a 747 is going to end up in Brisbane, for example, because there is a very, very good chance that fog will appear, then we know where flight crew are. The flight crew that actually end up in Brisbane, if they do end up in Brisbane, can elect to fly on, if they are within hours. They may be out of hours, which means they cannot, of course. If they are

within hours then they may elect to fly on. If they are not, our crewing department will know and will have, on standby, a flight crew ready to operate that aeroplane.

**Mr SYMON**—I probably have not got my question across properly there. Let us say, for instance, you were thinking of setting up a new route from Sydney to—who knows where; let us say somewhere in Mozambique. At that stage, when you were thinking about that, the long-term forecast would, I would think, have to come in there to say, ‘How long is the flight going to take?’ ‘What are the conditions we expect over the next year?’ and ‘How will it affect our baseline?’ Surely that is looked at, at some level?

**Mr Rennie**—That is a good question. Within our department now, that is exactly what we do. Whenever we look at sectors—and we are continually looking at sectors, whether they be ‘what ifs’, or ‘proposed’, or whether we are actually going to do it—we have a level of sophistication. We have within our computer statistics on winds—12 months of statistical winds. We know where we can access climatology, which is what is going to happen in 12 months at that airport. There is a big drive now to look at the actual time of day.

**Mr SYMON**—So that is the fourth dimension again.

**Mr Rennie**—Yes. There have been instances, in the recent past, whereby we have said to the commercial area that it is not the best to operate into that airport at this time of day, because of high fog rates or whatever so that, from a commercial aspect, it is simply not viable. We look at that and then we have that picture out. We are going to Mozambique, so we understand the possibilities—what we are likely to receive 12 months a year. Then we ask: ‘What are the alternates?’ ‘What is their climatology?’ ‘What is the en route climatology?’ So then we turn all that into what we call load planning and we say to our commercial area, ‘This is the load for this aeroplane.’ They may say, ‘Let’s try it with a different type of aeroplane,’ and we will do exactly the same with that. We will come up with a load plan, so it is a route and a load plan for that service. They will then do a business case on whether or not Mozambique is viable.

**Mr SYMON**—I have one last question and it is only a short one. Do you share information with the Bureau of Meteorology? You obviously get information from them. Do you collect information for them as well?

**Mr Rennie**—Absolutely. Operationally, sharing of information is widespread. There are very few barriers to that.

**Mr SYMON**—Do you share it with other airlines?

**Mr Rennie**—Yes, and that is within Australia and globally. It is not a commercial aspect. There are some commercial aspects to what we do and we do not share those. That is obvious. But in terms of how we operate there is no barrier there.

**Mr RAMSEY**—Graham, you spoke earlier about US\$28 billion for the US industry in in-air wastage time, or something or other—I do not know how you described it but you know what I mean. I presume that is an annualised figure, is it?

**Mr Rennie**—Yes, it is. There were other numbers that were produced by the FAA which came up with higher numbers because they actually broke them up into the effect to the airlines, the passengers and other factors. It came up to about US\$42 million.

**CHAIR**—Million or billion?

**Mr Rennie**—Sorry, billion. That is the second time I did that.

**CHAIR**—It is just that the difference is—

**Mr Rennie**—I cannot comprehend those numbers! They actually broke it up. It was a greater number. So \$28 billion was a reference to the loss for airlines. There are many factors: your inconvenience, for example. If you could not make it today with your flight in, what was that inconvenience to you? How do you put a dollar on that? That is the hard bit and that is the number that is not really in there. It is really about fuel, crew costs and CO2 as well.

**CHAIR**—Does it have a relationship to the price of air fares?

**Mr Rennie**—I do not know.

**CHAIR**—I was wondering. If you develop efficient forecasting systems and less fuel, you might—

**Mr Rennie**—It is a cost-based business, absolutely. Our call is all about meteorological accuracy. If we were 100 per cent accurate every day in forecasting around the world, I can assure you our fuel bill would be hugely different.

**Mr RAMSEY**—One of the primary focuses of this inquiry is seasonal forecasting. I am wondering whether there is any advantage to Qantas in having better seasonal forecasts. We understand it affects the tourist industry—a wet English summer might stuff up Wimbledon and the Ashes, for instance—but is there any advantage in Qantas actually having better seasonal forecasts or does Qantas just keep filling up the jets and then, when one does not fill, do a cancellation?

**Mr Rennie**—I guess, really, if you have a schedule then you have to go to that schedule, regardless. What we are about operationally is to ensure that in safety and efficiency we do the best we can. I think all organisations these days are getting smarter, in terms of what you are saying there. There is so much intelligence that floats around. For example, in our industry, in terms of seasonal forecasting, we have cyclone forecasts and we know each season for the Pacific what the forecast is for the cyclones for that season, for the next 12 months. I look at that and we pass that information around. We discuss it. We say, ‘Okay, we can expect more in Australia, fewer in Australia, more in the western Pacific, more in Japan or more in Hong Kong’—whatever. That allows us then to be better with our planning. These days everything we do is about planning. In terms of the strategic planning, it allows us to have that in place.

**Mr RAMSEY**—Effectively, what would that mean? If you know that you are going to have more cyclones down the east coast of Australia, it is all well and good to say you know there are

going to be more, but you do not know what dates they are going to be on. How would that change what you do in an operational sense?

**Mr Rennie**—If we were going to have, for example, an increase in cyclones in the western Pacific, which is basically an ordinary scenario for us, we would either put in extra routes or we would do exactly what we have just recently done, and that is to introduce user preferred routes into that area. In terms of air services, Qantas and Australia were at the forefront of developing the current air traffic management system. That allows us in the Pacific and Indian Oceans—and soon in Australia and the Tasman—to use user preferred routes. Right now, when you go from Sydney to Perth, you go on an airway. There is a chart that has all these lines, but with user preferred routes the lines disappear, fundamentally. We can operate where we want to operate in terms of the winds and the restricted areas within the normal operational boundaries. So we can now optimise our flying, reduce our fuel and so forth. If we are going to have more cyclones we need to get smarter on how we plan for cyclones. So we are making improvements to our planning system and saying: ‘We’re going to have more cyclones within a certain time frame. How do we operate around that?’ We are now doing mathematical calculations in terms of free flight to actually motor around that type of environment much better. It is the same for volcanic ash.

**Mr RAMSEY**—Does that have any implications for safety?

**Mr Rennie**—It improves it. That is what we are all about.

**Mr RAMSEY**—I mean there must be a compromise somewhere in abandoning the traditional flight paths, where we know the traffic is.

**Mr Rennie**—Because user preferred routes are at random, it is in fact safer in that sense. We have operated user preferred routes across the Pacific, from the US to Australia, and from Sydney to Buenos Aires and South Africa, for quite a few years now. If you are talking about randomness, it has allowed the separation standard to be reduced to levels that are really world beaters and world leaders. That is the benefit of the current air traffic management system, which was tested in the Pacific throughout the nineties.

**Mr RAMSEY**—So why have we persisted so long with the traditional flight paths?

**Mr Rennie**—Because of traffic. Between Sydney and Melbourne we will always have a line. There is no benefit in using user preferred routes between Sydney and Melbourne, because if you were to random-route between Sydney and Melbourne you are almost certainly going to come up with the same line. When we operate from the east coast to the west coast, Broome or Alice Springs, we will have a user preferred route, and Airservices or ATC will agree to that. We will file it and they agree or they disagree. From an air traffic management perspective, the other aspect of that is that we can now do dynamic airborne re-routing in the Pacific area, whereby as soon as we get a wind update we can improve the flight. We simply re-run that flight plan from a certain position and uplink that straight into the flight management system of the aircraft, and then we can operate that route on an improved basis. If that tropical cyclone slows down or speeds up, we can motor around it again.

**CHAIR**—That was very interesting. Thank you very much.

[9.35 am]

**WHITAKER, Mr Richard, Meteorologist, the Weather Channel**

**CHAIR**—Although the committee does not require you to give evidence under oath, I should advise you that these hearings are formal proceedings of the parliament. Consequently they warrant the same respect as proceedings of the house itself. It is customary to remind witnesses that giving false and misleading evidence is a serious matter and may be regarded as contempt of parliament. Thank you for your submission and I welcome you to make a brief opening statement before we proceed to questions.

**Mr Whitaker**—Thank you for the opportunity to address you. By way of background, I worked for the Bureau of Meteorology for 31 years before joining the Weather Channel in 2004. I am head of meteorology at the Weather Channel. The Weather Channel is part of a number of ways in which weather is communicated to the public. It had its roots in Australia way back in 1877 when the first weather map was produced in the *Sydney Morning Herald*. In 1923, the first weather forecast information was transmitted by radio. The beginning of television in Australia was in 1956 for the Olympic Games and weather forecasts were then issued on television. In the mid-1990s, we had a complete revolution with the birth of the Internet which gave a whole new dimension to issuing weather information.

In 1999, in response to a perceived demand from the public, we began a specialist weather channel which was part of the subscription television network of Australia which is disseminated to urban Australia through Foxtel and to rural Australia through the Austar networks. This is a specialist channel that concentrates purely on weather and we have an agreement with the Bureau of Meteorology under which they give us their products and their data free of charge in exchange for us distributing the information. In this information we cannot differ from the bureau; our agreement specifies that our forecasts must be the same as the bureau's, so we give the same information as the bureau but we attempt to value add to the information. As an example, if the forecast is for a shower or two then we will say things like, 'mostly in the afternoon and we think we might get one to five millimetres'. We try to add a little more detail to the basic forecast.

That is where the Weather Channel sits. We have a close relationship with the bureau. We also have a close relationship with many users of weather information in Australia. It has been estimated that about one-fifth of our economy is weather-sensitive in some way. This includes, obviously, things like agriculture. We have just heard the representative from Qantas give us a good rundown on just how weather-sensitive their operations are. Then there are all sorts of aspects of the construction industry, such as pouring concrete and when to start building, which are weather-sensitive. I mentioned agriculture and more specifically there are things like when to plant, when to irrigate and all sorts of expensive operations. In television and advertising, if a film crew is on location in the morning and it rains, this can cause expensive delays, whereas if the day before we can confidently predict it is going to rain, we can cancel the shoot and save a lot of money in that sort of decision-making. Really weather forecasting is a very big part of our economy even though it is hidden in many ways.

At the Weather Channel we are very interested in trying to get the information across to the public in various ways. We have specialist presentations for agricultural Australia. We have general forecasts for the general public and we have warnings. Whenever a severe weather warning is issued—it may be a severe thunderstorm warning, a gale warning, a strong wind warning or a fog warning for road weather alerts—by the bureau we get them out as soon as possible thereafter. We try to react very, very quickly to all those warning situations. Basically we try and provide another way of getting information out very rapidly to the public.

I mentioned the internet earlier. This has had an enormous effect on meteorology because we now have access to mathematical simulations from all over the world. Indeed, one of the bureau products, called Water and the Land, which is a very good product, is in fact an amalgam of meteorological simulations from, I think, 10 different weather services around the world, including the US, Japan, Germany and I think Europe as well. Various simulations all combine together to produce this product. The internet has made all this available. It has had an enormous effect on meteorology and really it has helped to improve many aspects of weather forecasting.

The actual process of weather forecasting has changed enormously since I have been involved. I began in the early 1970s. Mathematical simulation of the weather was in its infancy and, as forecasters, we did not take it very seriously at all. Now, with the advent of more powerful computers and also improved mathematical simulation of our atmosphere, it is the first thing we look at—the mathematical modelling of the atmosphere—for the forecast for the next seven days ahead. The forecasting of things like the development of east coast lows that used to be very difficult, if not impossible, back in the 1970s is now routinely possible out to seven days ahead, at least, through the mathematical simulations of the weather. As an example, with the *Pasha Bulker* disaster on the coast a couple of years ago, in 2007, the east coast low that caused that was very well forecast about five days previously and all the other ships in the area had left the danger zone. Through other causes the *Pasha Bulker* was caught. That was a very good illustration.

It is very hard to put a value on weather forecasting but, when we compare weather forecasting today to past times when there was no weather forecasting, you can get some idea. Back in 1857 there was a terrible disaster just on the front doorstep of Sydney—it was the wreck of the *Dunbar*, a sailing ship which had come out from the United Kingdom and had been three months at sea. It arrived at Sydney Heads one particular night. We think there was an east coast low there but there was no weather forecasting system or gale warnings or anything at the time. They tried to get through the heads in big seas but they ran onto the rocks at South Head and lost everybody aboard. That sort of shipwreck was quite common 150 years ago when there was no organised meteorological service. In more modern times, in 1918, a very large and destructive cyclone hit Mackay. There was no warning and no satellite photographs, and there were no organised teams of meteorologists looking for cyclones. That cyclone impacted very heavily without warning on Mackay.

Of course, now we have systems where cyclones are identified a long way out to sea through satellite photography. Their path is mapped through simulations and warnings are issued well in advance. This sort of technology and effort certainly saves Australia a great deal of time and money. The Weather Channel is, we hope, part of that by distributing information from the bureau. That is where I am coming from.

**CHAIR**—Thank you. Mr Whitaker, I just want to take you through some of the comments you made initially. I am a bit intrigued, and I am sorry if my questions sound a little bit ignorant. In relation to the Weather Channel, it actually distributes the information given to it by the bureau. You made the comment that you actually value-add to the forecast with your predictions, so if there is going to be rain then you say it will be in the afternoon and maybe it will be five points or whatever. Where does that value adding come from and how is it that it does not come from the bureau but that you can do it? I am just wondering what is going on there.

**Mr Whitaker**—I am talking now of my time in the bureau, which was in 2001, so things may have changed. But back in those days there just was not time to include that sort of detail. The bureau is responsible for a vast amount of forecast and warning information all around Australia as well as aviation—all the route forecasting for aviation—and shipping forecasts. With the sort of detail we are talking about, there just was not the time. That was the situation in 2002; it may have changed now. At the Weather Channel, of course, that is one of the things we try and specialise in. So that is where that comes from.

**CHAIR**—You specialise in actually filling in the detail of the picture.

**Mr Whitaker**—Joining the dots, yes.

**CHAIR**—I wanted to ask what you considered Australia's strengths and weaknesses might be in relation to long-term meteorological forecasting.

**Mr Whitaker**—That is a very big question. It is not just Australia that is grappling with this, but other countries all around the world. The mathematical simulations I spoke of work very well out to about seven days ahead and you can run them out to 14 days ahead as well. These are called initial value simulations. They look at the atmosphere now and they give what the highs and lows are all around the world and put them in the computer which has all the equations of motion that govern the atmosphere. It works out what the situation is now and what it will be like in 24 hours, 48 hours et cetera. Millions of calculations are required, so it requires huge supercomputers to do them. If there is a small difference in initial conditions—let us say the high is put into the computer as 1,022 hectopascals instead of 1,020 hectopascals—then after seven days there might not be a big difference but after 14 days that little error will start broadcasting outwards.

**CHAIR**—Of course.

**Mr Whitaker**—So, up until recent times, long-range or seasonal forecasting up to three months ahead has only been done via statistics rather than using the process I have been describing which is called dynamical modelling. It uses a statistic based system which is what the bureau is using for seasonal forecasting now. Having said that, there are now developments under way which use dynamical forecasting further and further ahead. As we get more automatic weather stations, more satellite information and more powerful computers we will be able push that envelope out further using dynamical modelling.

What I have just described is actually called a chaotic system, which is extreme sensitivity to initial conditions. Sometimes, if we vary the initial conditions by a small amount, after four or five days it will not produce much of an effect. However, under slightly different circumstances,

even after four or five days, it can produce a whole cascade of different effects. This is known colloquially as the butterfly effect. It is theoretically possible for a butterfly to flap its wings in Brazil and precipitate a cascade of events that results in a cyclone developing off the coast of America. It is mathematically possible but on whether it is in reality, opinion is divided.

**Mr SYMON**—That is all very interesting, thank you. We have recently been talking to both the bureau and CSIRO about their dynamic forecasting models. I would like to go to your criticism of the statistical model, especially in your submission where you have one report by the *ABC* on 25 March this year which, if read casually, gives the opposite picture. There is a particular line in it saying that there is a fifty-fifty chance that temperatures will be warmer. You could actually say anything on that basis.

I take your criticism that it is not in a format that the public can readily digest or understand and, if it cannot be understood, then it is not of a great deal of use to many people. I see where you have put in your submission that this type of information, if it is going to be put out as a long-term or seasonal forecast, needs to be in a format that Joe Public can use and appreciate. Have you got some ideas of how that type of information, whether it comes from historical data or a dynamic model, could be better presented so that the average person on the street could understand it?

**Mr Whitaker**—Yes, I guess that is getting to the crux of the whole thing. At the Weather Channel we use a particular product, the Seasonal Outlook service, and we tend to avoid fifty-fifty-type situations because they are so difficult to explain, particularly in a 30-second grab. Also, they are particularly difficult to explain in newspapers. I think the way the bureau explain them on their web site is the best way of doing it because they really go into all the nuances and the detail. It is a very difficult situation to explain.

What the bureau is trying to get across to the public is perfectly legitimate, in that if you use these forecasts, say, for a 10-year period, you are going to come out in front. If you are just going to use a forecast once then it is like backing a favourite at the racecourse; favourites do not always win. If you use these forecasts on a regular basis then you will come out in front and that is a difficult thing to get across, particularly in newspapers that are after a snappy headline. That can change the whole meaning of the product underlying it. It is a challenge; I have made a couple of suggestions about rebadging it.

I would certainly like to emphasise the fact that we think it is a very, very useful product. I have mentioned a success story in 2003 where rural Australia planted on the bureau's seasonal forecast, to the great advantage of the nation afterwards. We had an excellent crop, so there is a very good example of prudent use of the product. But it is a difficult product to use and I think many farmers actually use it through agricultural consultants, and they talk about it in detail. It is a product that is very difficult to use for the mainstream media.

**Mr SYMON**—The successful example that you used from 2003 was quite a high probability. I think, again, someone that is not versed in the science can read that and say, 'That's not a bad bet,' whereas if it is fifty-fifty they might say, 'That's pot luck.'

**Mr Whitaker**—Yes, that is very true. In fact, at the Weather Channel we take that sort of line. If there is a low-shift situation we do not really cover it much, but if there is a strong situation

we will give it coverage. There was a very recent one: the bureau issued on 24 April the May to July outlook and it had areas of 60 per cent chance of exceeding average rainfall over north-east New South Wales and south-east Queensland, and they subsequently had all those floods. That was another example of a very good product. We tend to find it is more useful when there are strong shifts, rather than when it is fifty-fifty. In fact, I am not sure whether we even issue a fifty-fifty type situation.

We are very aware of rural distress too. We talk to farmers on a regular basis and many of them, of course, are doing it very, very hard and headlines like 'El Nino' and 'Drought looms' cause genuine distress. We have been aware of suicides, because people thought there were impending droughts over the last decade or so. So how this information is presented is a very serious issue.

**Mr RAMSEY**—That reminds me of a comment I made at one of the pre-hearings. The bureau was saying how important its forecasts were for farmers' state of mind. I said, 'Do you realise how much it rips the guts out of a farmer when you forecast good rains on 1 September and they don't arrive?' So it has both positions. You were just talking to Mike about the farming question with regard to the 2003-04 wheat crop. One of the questions I have about statistics is: do you actually have the figure about whether to increase plantings? That is a more pertinent point. To say that we had high production is an indication that the year was good; it is not necessarily an indication that farmers made the decision to go and plant more on the strength of the forecast.

**Mr Whitaker**—That is true. I am relying on the last page of an article that was written by the regional reporter Daniel Lewis in the *Sydney Morning Herald*. In the article 'Farmers bet Australia's biggest grain crop on rain', he mentioned:

Farmers in northern NSW have started planting what may turn out to be Australia's biggest grain crop as weather forecasters predicted the recent rainfalls there would continue.

It also says:

Weather forecasters say there will be a 60 to 70 per cent chance of above-average rainfall—

and that it looks like the El Nino was over. I relied on my interpretation from that article. So I have not got a figure for you.

**Mr RAMSEY**—It is a reasonable story but it does not really tell the full story.

**Mr Whitaker**—True.

**Mr RAMSEY**—As a farmer, while I recognise the difficulties with the wording in the forecast, I think we actually have become quite familiar with the bureau's language on this and that most farmers do understand what they are saying. There has been criticism for years through various groups that we work in, and I think our knowledge of it has grown. As an ex-weather forecaster—I hope that is not too derogatory a term to describe you with—do you have frustrations with the models that the bureau is using? We had a few answers in evidence that the bureau has all its eggs in one basket with POAMA and that perhaps there is not enough outside

scientific input to question that model and to test it. Do you have a high level of faith in the model that the bureau has chosen to pursue or do you think it should be looking at other resources as well?

**Mr Whitaker**—Yes. The bureau models are certainly world class. There is no doubt about that. I mentioned the Water and the Land product, which is the rainfall and temperature product. That is an amalgam of weather models from all round the world. There is a tendency now for meteorological services to combine resources. The European Centre for Medium-Range Weather Forecasts is made up from several countries in Europe that have combined resources. They have their own computer and they are actually combining resources from several countries to produce a model which is available to all members. It has been suggested that the World Meteorological Organisation move in that direction too so that we in fact have a big world model and that other national weather services can have smaller, detailed models coming in off that. That could be the way it goes. I think the bureau at the moment do have information coming in from other parts of the world. At the Weather Channel, we are about to use models—we are purchasing information from the ECMWF and we are actually getting a great deal of information from there as the basis for our television graphics and to accompany the forecasts we have from the bureau.

**Mr RAMSEY**—For instance, yesterday we heard some evidence that Japanese models were not concurring with the Australian models on predictions for current seasons. Do you have the ability at the Weather Channel—you cannot change the bureau's information; you have to present that as is—to present an alternative view of that or is that rolled into something?

**Mr Whitaker**—We will say that. We certainly present the bureau's product as our product, but we will mention on some occasions that some of the models are different and that there is a certain amount of doubt in this forecast or we will say that all the models are singing the same song—they are on the same page—so we have a high degree of confidence with the forecast. We do make comments like that.

**CHAIR**—As there are no further questions, Mr Whitaker, I would like to thank you for your submission here today.

**Mr Whitaker**—Thank you very much.

**Proceedings suspended from 9.56 am to 10.15 am**

**GOODRICH, Mr David, Managing Director, Firewatch Australia Pty Ltd**

**CHAIR**—I now call the representative of Firewatch Australia Pty Ltd to give evidence. Although the committee does not require you to give evidence under oath, I should advise you that these hearings are formal proceedings of the parliament, consequently they warrant the same respect as proceedings of the House itself. It is customary to remind witnesses that giving false or misleading evidence is a serious matter and may be regarded as a contempt of parliament. We thank you for your submission and welcome you to make a brief opening statement before we proceed to questions.

**Mr Goodrich**—Thank you for the opportunity to present to the standing committee. I represent a company that owns some technology that can detect bushfires before the human eye can see them. This technology is terrestrial, that is, land based; it is not satellite based. It provides the ability to monitor broadacre landscapes 24 hours a day, seven days a week, which a satellite system does not. Obviously a satellite goes over once every four to eight hours, so there is a fair amount of time that lapses between each pass, and a fire, should it so desire, can get away in that time. Our technology is interesting in that it was developed by the German aerospace institute for the NASA Mars Pathfinder mission. Our technology is not a camera, per se; it is more of a scanning technology because the German aerospace institute's technology was required to scan the surface of Mars in order to determine where the Pathfinder vehicle should be put down. One of the spin-offs, as NASA has done in the US, is that it tries to use the technology and these huge technological endeavours for the benefit of mankind more generally, and a German technology company acquired the exclusive patented rights to the scanning technology to monitor bushfires.

Why is this important to your committee? I would be very happy to answer any questions. However, as an introductory point of view our system is not a stand-alone system; it is not the only answer to bushfire detection or bushfire fighting. Our technology is an input into a 21st century way of thinking about detecting and managing bushfires in our ever-drying climate with less rainfall every year. Australians love to live in and around the Australian bush; it is part of our psyche, really. If we are going to make that a safe and acceptable thing for us to continue doing, I think we need to think a bit more comprehensively than we have in the past in respect of the way in which bushfires are monitored.

Our technology is made up of two main components. The first one is what looks like a camera that sits up on top of a tall mast, on top of a fire tower or a telecommunications tower, which rotates by itself automatically every six minutes, 24 hours a day, seven days a week. It has night vision so it can see at night when the human eye cannot see, and it can detect the difference between 16,384 shades of the colour grey. I did not know, prior to owning this technology licence, that there are even 16,384 shades of the colour grey, but there apparently are.

**CHAIR**—That is a very specific number; 16,384.

**Mr Goodrich**—Yes, this is a computer based technology, so everything with computers is about specific things. That is a very good point, Madam Chair. However this enables the technology to detect the difference between bushfire smoke and cloud, or mist, or fog or a

backyard barbecue, because the grey shade of backyard barbecue smoke is different to that of a eucalyptus tree burning or the Australian bush burning. It is a very high technology system that can deliver real-time information into the hands of the people who we entrust in our community to keep us safe, which are the emergency services authorities.

The technology—and this is where it may link into the standing committee—takes inputs from all kinds of meteorological resources, being wind speed, wind direction, humidity levels and, if there is such information available, soil moisture levels. As a result of taking in those feeds, Firewatch can alert the firefighting authorities to what direction the fire is going in, what size the fire is and exactly where it is, down to the nearest one metre, so the right resources can be sent to the right location in the shortest possible time, ensuring the utmost safety of those volunteers, primarily, who serve our community so faithfully, to the maximum possible capacity, instead of sending them out on an investigatory mission not knowing what exactly they will find when they get there and not being sure that they have the equipment that they need when they get there to fight that fire.

Whilst this technology is absolutely state of the art, I am sorry to say it is not new. It has been around for the last eight or nine years. There are 156 cameras in Germany. Installations are either underway or in testing mode in the United States, Portugal, Spain, Estonia, the Czech Republic, France and Greece, to name a few. So it really is tried and tested. The results from the German firefighting authorities are plain: the area of forest fire burnt since Firewatch was installed there eight or nine years ago has reduced by 92 per cent.

**CHAIR**—Yes, I saw that figure. It is quite staggering.

**Mr Goodrich**—It is not an evolution in bushfire detection but really is a revolution. From our point of view, we are really interested in sharing knowledge of this technology with everyone who is interested. I know that Fran Bailey is visiting Germany as we speak to get a firsthand understanding of this technology. She obviously was and is significantly impacted by the devastating effects of Black Saturday and she is interested in trying to make a difference, which is a fantastic thing for all of us. In summary, this technology is available, it is cost effective in terms of its implementation, it is reliable and, from the perspective of saving lives and property, it has the potential to have a massive impact.

Importantly—and I do not know whether this is an area that this committee looks into—from a greenhouse gas perspective, Firewatch has the ability to minimise the amount of greenhouse gases emitted as a result of bushfires. I do not know whether the standing committee is aware of the reports from the CSIRO which stated that the Black Saturday fires emitted the equivalent of one full year of industrial greenhouse gas emissions in one fire event. Currently, under the Kyoto protocols, as I am sure you are all aware, bushfire emissions are not counted. There is every indication, however, that in future versions of Kyoto, whatever they look like and end up being like, bushfire emissions will be counted; hence they will have a real cost to our economy and not just to our planet. The ability to detect and extinguish bushfires from an environmental and a cost perspective for future generations of Australians is massive using the Firewatch technology. I thank the committee for allowing me to present this morning.

**CHAIR**—Thank you very much. Our deputy chair is on her way to Europe, and Germany in particular. I assume Firewatch is not being used anywhere in Australia at the moment.

**Mr Goodrich**—We have found the implementation of this new technology a rather frustrating process. Our initial approach was to speak with the people who were on the front line of fighting bushfires to discuss with them and share with them the potential positive impacts that this technology could have upon their operations and their performance. It is unfortunate that we have been unsuccessful in convincing the emergency services authorities to embrace this technology. We do not blame them. They have constrained budgets. I think the question is why.

**CHAIR**—I was going to ask you why.

**Mr Goodrich**—There are two reasons. One is constrained budgets. They operate under the same conditions that we all do particularly in this economic climate. But the second one, and it is a little bit more concerning, is the operational methodologies and thinking applied in these organisations. I am generalising and I do not wish to paint everyone with the same brush, but generally speaking, as has been indicated by some of the testimony in the royal commission into the Victorian bushfire tragedy, there are some operational issues which exist in most emergency services organisations, which tend to constrain the embrace of new technology. There is a desire for more trucks and more helicopters and water bombers—the big toys of course. I am not saying that they are not necessary. However, once you need those toys, it is too late.

**CHAIR**—So the emphasis would be on acquiring the equipment necessary to fight the fire rather than acquiring the equipment necessary to detect and potentially prevent the fire.

**Mr Goodrich**—Quite so.

**CHAIR**—Is it a massive cost to install a system like this? Do you have any idea of how much it would cost?

**Mr Goodrich**—The costs depend upon the extent of the network so it is very difficult for me to say precisely. I would not want to mislead the committee in terms of cost, but I can assure you that the cost of installing a comprehensive network of firewatch cameras in and around the urban fringe, as a starting point, of our capital cities would be infinitesimal compared to the cost in terms of loss of life, loss of property, loss of natural environment—and flora and fauna—and, in the future, the potential costs associated with greenhouse gas emissions, which would absolutely dwarf the cost of installing a comprehensive network of detection technology.

**CHAIR**—So there is no figure. I appreciate what you are saying though in terms of costs.

**Mr Goodrich**—In terms of a figure—

**CHAIR**—Computer specific.

**Mr Goodrich**—To install a single camera is a very expensive way to approach this and it is not our proposal. Our proposal is that we actually install a network of cameras across this vast land of ours. We propose that we do not charge the government anything in terms of capital costs but that we provide an information service that various government agencies across state, federal and local levels contribute to, hence sharing the cost. However, our organisation would be responsible for the financing, installation, upkeep and ongoing maintenance of this network and, provided we have a long enough lease term, we could amortise those costs over the life of the

technology. The technology is constantly being updated from a software perspective and so it would make much more sense that the owners of the technology and the developers of the technology retain the obligation to keep the technology current. So from a capital perspective the cost would be nothing. There would be some small costs associated with towers in things, which are not in our ownership, but really the bigger picture issue here is to provide real-time information to enable detection to happen at the earliest possible time and the extinguishment of fires before they become fire fronts and get out of control and become major life and property threatening issues.

**CHAIR**—This system is obviously a detection device and it is programmed in that way. Is it also reliant in any way on broader weather forecasting and seasonal forecasting? There are lots of issues we are looking at in terms of getting accurate forecasts that can pre-empt perhaps a fire hazard. Is this system at all reliant on any of that information being fed into it, or is it a stand-alone detection process?

**Mr Goodrich**—The system is stand-alone, but it is able to take and receive its inputs from a variety of meteorological resources and sources. The more of those resources and sources and the higher quality of those resources and sources, the better information that can be delivered from Firewatch itself. The system is automatic. I can provide the committee with some pictorial evidence, if that would be useful.

**CHAIR**—Yes, that would be useful.

**Mr Goodrich**—I am happy to table it. This one shows our recent trial in the San Bernardino Valley in California in the United States. Unfortunately, these photos are in black and white; I did not have the colour printer running this morning.

**Mr RAMSEY**—Shades of grey.

**CHAIR**—Very true.

**Mr Goodrich**—If you flick through that stack of photographs, you can actually see what the screen in the control room looks like. It is real-time and you will see there is a camera. When the system automatically scans and detects a bushfire, it puts a box around it and gives exact coordinates. Then the operator can disconnect the automatic rotation and ask the camera to go back to the exact location of that alarm and focus on it, and stay on it and watch it, and monitor whether it is someone burning off a car in the middle of a bush track or a real fire, or some registered back-burning operations that they know about, and they can release the alarm signal. The automatic nature of it takes away the human error that can come from the current 19th century systems and technologies that are employed by the good Samaritans phoning in a bushfire or phoning in saying, 'I think I see some smoke over the back of yonder and I think it is a bushfire.' The consequential costs associated with sending out resources to check out those things or putting a plane or a helicopter in the air are enormous.

**Mr SYMON**—You mentioned there are 156 stations in Germany, which, according to my very rough maths, covers about 100,000 square kilometres. Obviously, it would be a much larger venture to undertake in Australia.

**Mr Goodrich**—Yes.

**Mr SYMON**—How do these monitoring stations communicate (a) with each other and (b) with a central reference point?

**Mr Goodrich**—That is an excellent question. Your calculations are roughly correct. However, the amount of area monitored by each camera station or each installation obviously depends upon the topography of the area that it is installed in.

**Mr SYMON**—I take it there would have to be an overlap for your triangulation purposes as well?

**Mr Goodrich**—Exactly; a small overlap. I can actually show you in this document a pictorial representation of what that overlap looks like. However, no camera, no technology, can see through a mountain. If there is a mountain in the way, it might not be 700 square kilometres of coverage because of the topography. The system itself is a self-powered, so the remoteness of the locations does not impact the operational capability. It is a combination of solar power with battery packs and hydrogen fuel cells, depending upon the weather and how much sunlight. In Australia we are blessed with abundant sunshine, so we would probably not need the hydrogen fuel cell technology except for in the most southern parts of the country. In terms of the way they communicate, obviously if you are close to a network point then that is better. However, if you are absolutely remote then we use satellite technology to beam the signal up to a satellite and then take it down to a terrestrial land point again and feed it into the broadband system or the telephone system. That then connects to the control point. The control points can be anywhere—any state or any country, or you could be sitting at home set with a laptop computer—it is that flexible.

**Mr SYMON**—I suppose that was my point: the communications side of things. Going back to the Victorian bushfires and Black Saturday, one of the first things to get knocked out was the mobile phone network. A lot of people found they could not get onto it because it was that busy. If you had a monitoring service that could not actually log onto a signal, maybe in an area like Victoria satellite might be the way to overcome that.

**Mr Goodrich**—I think most of the emergency services networks are very secure and very robust networks compared to the mobile phone networks—they have to be. Police, ambulance and fire brigade operate off their own networks in every state and territory. I believe there is currently a tender out at the moment for private organisations to deliver those services. We would think it would be appropriate to utilise those emergency services networks as opposed to the standard mobile phone network for exactly the reason you mentioned. This information is so critical at critical times that you do not want to depend upon mobile phone towers and mobile phone networks that do get congested at peak times.

**Mr SYMON**—Just onto another technical issue you have there. The scan time takes seven minutes to complete its 360 degree.

**Mr Goodrich**—Actually it is six minutes now; it has just been fixed.

**Mr SYMON**—All right, six minutes. Is there a reason it takes that long? Are there advantages to it being a shorter duration?

**Mr Goodrich**—The technology that really delivers the genius of this system are the operating system and the central control station. That central control station is where the analysis happens, where the data gets collected and where people get to make decisions on what to do. The camera itself is just a data collector. We are trying to scan a very, very large area—a 10 degree slice of a 360 degree revolution—and it takes a certain amount of time for each slice to be fully analysed and for all the data, which is quite a rich data stream, to be fed into the system. With a 10 degree slice happening 36 times it takes six minutes in order to do that. Six minutes is not a very long time, I think you will appreciate, when you compare it to six or eight hours with a satellite going over.

**Mr SYMON**—I suppose I am just running that further. In your submission, in relation to the German ones, in some cases the cameras detected the fires even earlier than human observers.

**Mr Goodrich**—Every time. At night-time definitely the human eye cannot see anything. In the daytime—and what we are talking about is the comparison with manned fire towers—it is very, very difficult for a manned fire tower to maintain concentration at a peak level for a sustained period of time, so the amount of human error that is possible and happens in manned fire towers is significant. Whereas from a technological perspective it is irrelevant. In terms of Firewatch delivering its product compared to a manned fire tower, there is no comparison really with the 19th century, ‘Let’s put a person up there with some binoculars and hope that the fire is in front of them rather than out the back at the time they are looking at it.’ By the time the human eye sees it, Firewatch—and I think it is in that submission that I passed across the table—sees it significantly earlier than the human eye can see it.

**Mr SYMON**—Thank you.

**Mr RAMSEY**—I am from South Australia, David, and I do not think we have any manned fire towers in South Australia any more. Do we in the rest of Australia?

**Mr Goodrich**—They are manned during peak fire season times. But there are not that many. That is a fair comment.

**Mr RAMSEY**—So there is not a significant saving to be made there?

**Mr Goodrich**—Not from a human perspective. In Germany the type of forests they have tend to mean that they have a lot more fire towers. The level of population they have in Germany is significantly greater than we have, from a density perspective, in Australia. So they had a more significant manned fire tower system in place than we do. We have a couple but not significant numbers, according to my knowledge anyway.

**Mr RAMSEY**—In that light, given that you found it difficult selling it to emergency services, what about the forestry industry, has there been interest there?

**Mr Goodrich**—We believe there would be interest across a range of stakeholders once the network was in place. But it takes a lead agency or a lead political initiative to get it in place or

to be the almost the head contract with us, if you will. Then the expenses, I am absolutely certain, could be defrayed by selling the information to forestry companies, to local councils and to state government agencies like Forests New South Wales, who are themselves forestry businesses. Environmental agencies like National Parks and Wildlife for instance and other government agencies I think would also share it. We have had meetings with pretty much all of those agencies particularly in New South Wales. When you try to say, 'Hey, who is going to be the lead agency?' it is universally true that the fingers go pointing in opposite directions because nobody is able to take that lead, and hence we have gone nowhere over the last two or three years.

Our proposal is to ask the federal government to take the leadership on this issue and make this investment as a nation-building project. It would dovetail beautifully in with the National Broadband Network because we could tap into that from an information dissemination perspective. But it would provide future generations with the sense of safety that we all want if we live in the bush. I do not know whether any of the members live near the bush, but I do and I love it. To say that you cannot do that I think would be something that most Australians would find unacceptable.

**Mr RAMSEY**—This is once again on a localised issue but it is my thought that the South Australian emergency services are better funded than perhaps some of their interstate counterparts because we have—with great political pain—an emergency services levy there. We have a full government dedicated radio channel now that has been laid out and better funding. Particularly in the Adelaide Hills, I would have thought that this would be excellent technology. Have you tried to sell your wares there?

**Mr Goodrich**—We have not. We have been focusing on the New South Wales and the ACT market. It was unfortunate that we received our first inquiry from the Victorian CFA six weeks before the tragedy earlier this year and it has gone no further. That is due to the same reason I mentioned with respect to separate government agencies not wanting to be the first cab off the rank, so to speak. State government would like the federal government be the first cab off the rank. It is our great desire that Mr Rudd see the benefit of at least trialling this technology in Australia. I cannot believe that there is not an initiative to at least try it. I do not know why it is but every country that we sell this technology into seems to want to have their own trial. That has been the case in France, Spain, the US and Portugal. Even though it has been installed and working for eight or nine years in Germany and you can go there, as Mrs Bailey is doing, and see it working, each country wants to have a trial. We have not even had that in this country and that seems inexplicable. We are hoping that at least there is some investment in the desire to try this technology out and to see its benefits for today and the generations to come.

**CHAIR**—The technology has been in existence you said for some eight or nine years. Is that correct?

**Mr Goodrich**—It has been installed for some eight or nine years. It has been in existence for some 20 years because of the pathfinder mission. It has been installed and operating as a bushfire detection network in the Brandenburg province in Germany for the last eight or nine years. I also have some letters from the French official firefighting authorities talking about their experience of testing this equipment. I table those recommendation letters as well. These are not private organisations that are signing off on the technology. These are government agencies

equivalent to our own state government and federal government agencies that are signing off that this technology is something that has value and is to be implemented.

**CHAIR**—It seems like a very practical and specific infrastructure. Our committee is looking at the various dynamic modelling systems of forecasting and all the issues related to that and perhaps even the related costs to try to get some sort of accuracy for weather forecasts that might prevent bushfires and floods and things. It seems to me that there is a system that is already there. The detection itself may be sufficient and maybe the emphasis should be on installing devices that can detect and therefore prevent rather than perhaps focusing on trying to get a dynamic modelling system that may give some picture of whether there is going to be a high fire danger or whatever. What would your view on that be?

**Mr Goodrich**—My view on that is that I am not saying Firewatch is the whole solution. It is part of the solution, but it is part of the solution that is currently not being investigated, not being embraced, because of existing bureaucratic systems that are in place. There is no doubt that having accurate weather forecasting is a good thing. Nobody would say anything to the contrary. But the only way to stop bushfire from impacting on life and property and, in future, greenhouse gas emissions is to detect it when it occurs. No-one knows when it will occur or where it will occur. That you cannot predict, particularly when arsonists are involved. But what you can do is provide blanket coverage with proven 21st-century technology to, as soon as the fire starts, detect it and notify the appropriate authorities to enable them to put it out. The only way to save life and property in respect of bushfire is to put it out. Of course preparations have to be put in place to minimise the risk associated with bushfire. Part of that is great information forecasting. Part of that is back-burning and equipping the general public with the appropriate tools, resources and knowledge to know what to do to protect their properties, to maintain their properties and to save life and property, but ultimately what you want is to know when a bushfire has started, before it becomes a major problem. You want to be able to go directly to it, to as near as one metre, with certainty as to what is happening there and put it out. That is what Firewatch can deliver, has been delivering over the last eight years in Germany and is delivering in almost a dozen countries around the world at the moment.

**CHAIR**—Thank you. That is very interesting. Thank you for bringing it to the attention of the committee. That is certainly something that we had not anticipated. Fran has spoken about it, so it is very good to finally hear from you. Thank you.

**Mr Goodrich**—Thank you for having me.

**CHAIR**—Will someone move to accept exhibit No. 1 and exhibit No. 2.

**Mr RAMSEY**—I so move.

**Mr SYMON**—Seconded.

**CHAIR**—Thank you.

[10.56 am]

**WERNER, Dr Christian, Managing Director, Weather Risk Management Services Pty Ltd**

**CHAIR**—I welcome the representative of Weather Risk Management Services. Although the committee does not require you to give evidence under oath, I advise you that these hearings are formal proceedings of the parliament and, consequently, they warrant the same respect as proceedings of the House itself. It is customary to remind witnesses that the giving of false or misleading evidence is a serious matter and may be regarded as contempt of parliament. We thank you for your submission. I now invite you to make a brief opening statement before we proceed to questions.

**Dr Werner**—Good morning. Thank you very much for the invitation to participate in the hearing today and make a submission to this I believe long overdue inquiry into the services rendered at the moment by the Australian government through its arms of the Bureau of Meteorology and CSIRO. I will provide you with a brief background. Weather Risk Management Services provides consulting services to weather and climate sensitive industries here in Australia and overseas as well. We generate the products that the Bureau of Meteorology and CSIRO are producing and far beyond. It is not just season outlooks but very detailed risk assessments. That is basically how we have built over the years our reputation here and abroad as well.

What the public and you may have heard presented already by various eminent scientists in Australia, especially by the Bureau of Meteorology and CSIRO, is a little bit of what is possible. There is far more possible than what is in the public arena. I do not really want to criticise the government, but because it is a large organisation it just takes longer to adjust and bring forward the latest knowledge and techniques to provide products and services on which we can then base business decisions. Basically our business on a daily basis is to provide such information to weather sensitive industries here in Australia.

Looking at the terms of reference for this inquiry, you would be targeting more the tourism and emergency services but there are whole other sectors of the Australian economy that may be affected by weather. There are the farmers, the commodity traders—maybe through the AWB—the national electricity market and the Victorian gas market which are highly weather sensitive. For example, tariff case submissions depend on some historical analysis as well as looking forward. If a vertically integrated energy business—and we have some of those in Australia in Victoria and here in Sydney—were charged with acquiring a hydrogenerator, how would they go about that, for example?

We are participating in these sorts of risk assessments with significant value at risk: we are talking about hundreds of millions if not billions of dollars either on the traded national electricity market on a daily basis, in Australia or abroad, or in these large-scale acquisitions. So a lot of human activity and business activity depends on reliable and trustworthy short- to long-term meteorological information, therefore it is absolutely pivotal. I hope that this inquiry comes up with some recommendations at the end of the day about how we move forward from here. If we were just to continue with business as usual then we might give \$100 million for a new

computer and a few more resources, but what would we really gain? Would we actually have the products which enable us to make sound economic decisions within an uncertain environment? Uncertainty was, is and always will be part of the decision-making process and of scientific processes as well. Again, Weather Risk Management Services is sitting right at the interface when it comes to discovering the latest science and then applying it in the business arena. I think that is one of the things which is still missing because the climate scientists are in one camp and very often when it comes to the application of their latest findings too much time goes by before they are published. When do we get a new, more powerful computer so we can tackle these grand challenges of science and engineering?

Climate and weather forecasting is a grand challenge. The National Science Foundation in the US recognised in the 1990s that one of the grand challenges to human survival on this planet was to master and understand how the climate systems work, otherwise we would not know what is happening in 10 or 20 years. Through the IPCC mechanisms we have some understanding, yet it is currently taking too long before new results are publicised and are being applied in the business arena. Then we hear in the news that some of these findings are already superseded by observations, which is very scary. So time is really running out. We should not rush through this, but we have to change a few structures, I believe. We have the building blocks already, but we have to arrange them in a clever way to move forward.

**CHAIR**—Thank you. I have a couple of questions but we will go first to one of my colleagues.

**Mr RAMSEY**—Dr Werner, are you saying that the technologies are there but that, to your mind, the bodies that control the technologies are being overly cautious and wanting to test them to the nth degree before they are making them public?

**Dr Werner**—There are various approaches to how to go about this, to be more cautious, and obviously everyone would not just be using a better version of a model, for example. Maybe I should take one step back. We have various ways of going about addressing and solving the current challenges of long-term meteorological forecasting. You have probably heard already that we have all these different highly sophisticated tools. Then we have great believes in two camps, the statistical models and the dynamical models, so that is what the inquiry is now about. So we already have these tools, and you would have heard or read about the different levels of skill or fidelity in terms of how they perform. Again, there are different ‘believers’—sometimes things develop into a religion for some people within the scientific environment because there is a lot of funding at risk, let alone their positions or jobs. We have to develop an objective approach to this. What is really available? How do we go about this? Maybe we need to look overseas at the way it is structured and funded as well.

To answer your question, yes, the building blocks are already there. We do not need to be overly cautious; it is more like we are being a little bit protected here in Australia as to how the funding is being done. We already have the building blocks, which were developed in the seventies and eighties. The Bureau of Meteorology, as you may have heard or read, was absolutely leading in this and we had absolutely great scientists. We still have some of those, but they are reaching retirement age. There was very little done throughout the 1990s in terms of nurturing young scientists going through the universities here in Australia and having broader-scale funding—not necessarily more, just not only for greenhouse, for example. That was the big

buzzword in the 1990s and there was very little research funding available in Australia for aerosol particle research, for example. You may have heard or read about that; it is now a big thing in the IPCC. One of my PhD supervisors was involved in that. But there was virtually no funding at all for that here because the big focus was on greenhouse, with millions of dollars committed to that.

As for these building blocks, it was very tough for me in the 1990s, when I was studying towards my PhD, to get any funding to actually do this. As it turns out, yes, it is a big thing now. Air pollution and volcanic eruptions all play a role. Yes, we do have these different building blocks here as well but we have to make some more publicly available, so it is something like open source rather than spending a lot of money—and we are spending tens of millions of dollars. There is building a new model, for example, and if we use a dynamic model rather than a statistical model. We are spending a lot of money and it is sort of reinforced. But there are other opportunities to participate in this. As I said earlier on in my opening brief, we are running out of time. For example, three months, six months or 12 months in the business world is a long time, and it is so even with the climate because changes are happening very rapidly. We do not have all the tools to master this but we have got some building blocks. We have got what I call the passion and the persistence to tackle these problems successfully. Yes, we do have the building blocks but we have to rearrange them as to the way we are doing business in a climate sense, otherwise we will see a repeat of the 1990s, for example, whereby one group will get a lot of funding. In the university sector, for example, there are a lot of young brains just scraping by with very small funds. Sometimes you do not necessarily need big funds, but that is just the way it is organised. You may have already heard that there are collaborations. But given the way I see things evolving here in Australia having those is not enough. I went through this; it is very tough out there.

There is a big thing to develop this new earth system simulator. There are different European countries developing it. There is already a lot of open source material as well. Maybe Australia needs to go down this path and provide some funding for infrastructure whereby young scientists and established eminent scientists here in Australia can participate in this and really make a quantum leap forward. That is very important, because time is running out here in Australia. We would not like to see a repeat of the bushfires that we had recently in Victoria, for example. If the population and emergency services had been alerted earlier, we may have been able to prevent some of the deaths and casualties and loss of property which occurred unfortunately during those bushfires.

**CHAIR**—If I could interrupt you for a minute, Dr Werner, the previous witness was from Firewatch Australia and he was talking about a device that has been developed and installed in Germany and other parts of the world. Its practical application is to actually detect fires well before a human eye can see them. The question I want to ask you is what I asked the previous witness. It is really about funding, isn't it? I think a lot of what you are saying is about that and about this issue of time running out, which goes to the core that either we do not have the human resources available or we are not cultivating them in enough time. Is that right?

**Dr Werner**—Yes.

**CHAIR**—That is in order to be able to do that. We are aware that we are falling behind in this area, because we were told that yesterday.

**Dr Werner**—Correct.

**CHAIR**—You made the point about, and you drew the example of, the Victorian bushfires and said that if we had better systems of forecasting there may have been a different result. My question is: would something like Firewatch be sufficient as a detection device to deal with the issue of climatic conditions that could lead to a high fire danger and catastrophes? Otherwise, is it the actual detection process and forecasting the place where you spend the money to develop expertise and precision? Do you see both working together?

**Dr Werner**—It think it is probably about the last point. They have to work together. It is all about how information is exchanged—and this is very important—freely. So it is not about firewalls or about a cone of silence being put around experiments. People talk about the technology—and you may have heard or read about it—and say the new forecast models are experimental. That is how it all starts, with some research, for example, but it is all about information and how information is exchanged so we should not charge just one organisation or one body with having the sole purpose of monitoring and providing.

At the end of the day, somebody has to have the legal right to make an announcement, such as: ‘This is what we believe is happening this summer.’ Weather Risk Management Services cannot issue a fire warning. You may not like what I am now going to say but, from July last year, we knew about the drought conditions leading up to the bushfires. We knew about the heatwaves. Over the last two summers, the southern states have been having significant heatwaves. We knew about that in the previous July-August period. Again, the way information is exchanged is not part of our business. The technology is already there. We are operating in different spaces.

**CHAIR**—You have the capacity to be aware of those conditions?

**Dr Werner**—That is correct.

**CHAIR**—But you are telling me that you could not disseminate that information?

**Dr Werner**—That is the way our business model is structured. Who would support our research into the conditions leading up to heatwave activity as such? It is my understanding that, by law, the Bureau of Meteorology, emergency services and CSIRO are charged with this research in Australia. My previous point was: it is about how information is exchanged. For example, there will be one organisation, and so again it boils down to funding. We do not receive any federal funding to do any of our research. Funding of our research is based purely on a fee structure. We charge our clients here and overseas to provide them with operational services, risk assessments. Some of this in-house money will be spent on research, because we cannot spend any time on writing grant applications to do something. That takes too long.

**CHAIR**—What did you do with the information you had in relation to the possibilities of what happened in Victoria?

**Dr Werner**—It was provided to our fee-paying customers.

**CHAIR**—It was provided to fee-paying customers?

**Dr Werner**—Yes. The Australian government or any of the state emergency services are not part of this. Yes, it was sold privately. For example, I would have conveyed to friends in Victoria that there was an increased risk of bushfire this coming summer. With reliable long-term climate forecast information, it was not too difficult to figure out that that was going to happen. It was not just the temperature; it was a straightforward meteorological event. My understanding is that there is another inquiry into the bushfires in Victoria. I am not following that inquiry closely at all, but we—

**CHAIR**—It is actually a royal commission.

**Dr Werner**—Sorry. I am looking to it. Again, we already have these building blocks but we have to sit back and think: how do we actually do business in Australia? We have to do it in a smarter way. So how do we exchange this information? I do not receive any state or federal government funding. For example, I have customers who pay a fee to obtain certain information about heatwaves. Heatwaves in the southern states would indicate an increased airconditioning load coming up in the summer. This is basically what happened in the previous two summers. The interest was in that, and a by-product of it would obviously be bushfires. Bushfires also impact on the hydro catchments of AGL and Snowy Hydro. If you have a bushfire going through those catchments, it changes the catchment's characteristics and that can have an impact on the availability of electricity during critical periods.

So, again, the building blocks are already there. The way that we exchange information has to change in this country, because it is basically one of the road blocks. I would be unfair to my customers, my clients, who are paying a lot fees to obtain such sensitive information, if I exchanged it when we do not have any formalism to do so. It is not my bad intention to withhold information. It is basically a business case as such. So how do we do business in Australia? Are we actually allowed to exchange information? How do we cooperate with the Bureau of Meteorology, for example? The Bureau of Meteorology is allowed through various acts to issue the warnings, whereas we as a privately owned business and, as I understand it, other providers in Australia are not in a position legally to issue warnings. We may burn somebody. So there has to be a better formalism as to how we exchange this information.

**CHAIR**—How do you see that 'formalism' for an exchange of information? Would you sell your information to the bureau? How would you see it working? How would it happen?

**Dr Werner**—That would be one avenue to pursue. We are generating this information after having assessed that it fits the purpose of providing quality, long-term forecasts. That would be one mechanism by which to proceed. We incur a cost to generate this information. We are not obtaining this information from a third body. We are actually generating in-house short-term to long-term assessments. So there is actually a cost to our business.

**CHAIR**—You would sell it to the bureau.

**Dr Werner**—That would be one mechanism of doing it. If you asked me obviously we felt bad about this, what was going to happen in Victoria, but my understanding is some conflict of interest with the Bureau of Meteorology if I would have issued a press release, for example. I do not know what the full legal ramifications are if all of a sudden Weather Risk Management Services starts to issue warnings.

**Mr RAMSEY**—Given that you predicted a high risk of fire because it was going to be a hotter than average summer, did you have the ability to predict the extended heatwave as such? I think we had 14 days, which was unprecedented at that time of year. We have had that large blocking high sitting there maybe a month later, maybe six weeks later, but at that time of year we had never experienced a high, in recorded history at least, that had blocked the weather up for that long and allowed the northerly infeeds to continue day after day after day over a two-week period. Did your model pick up that there was a high risk of that occurring as well, or were we just looking at the hotter summer with higher fuel loads?

**Dr Werner**—The short answer is yes, we knew about it. The mechanisms for this last heatwave are slightly different and somewhat more concerning, because the heat in the interior of Australia normally during the summer period, looking at heatwave activity in South Australia and Victoria, is such that most of the hot air is sourced from northern Western Australia or the northern parts of Australia. This time the heat was actually sourced from the central parts of Australia and northern South Australia. Very scary. I have seen it in some of the climate change simulations that the centre of the heat has actually moved further down, so the actual source of the hot air was much closer to the impact area. You needed much less to tip it over basically and produce this heatwave activity. To answer your questions, yes, we did.

**Mr RAMSEY**—So that is a more northerly airflow than we have had before, or is the pool of air it is sourced from closer, so it is hotter.

**Dr Werner**—Both. First of all the air was sitting there and the meteorological or synoptic situation was such it was not plucking in, and once it plucked in through the northerly winds and was north-westerly or northerly or even slightly north-easterly, north-north-easterly winds, it just kept rolling. Then when you have a stationary weather pattern you can have a day and night when you have warm invective, so transport of horizontally dry and warm air into the target area. Then you have the fuel load, which was another tick, and we had an ongoing drought with reduced soil moisture. So you have got to pick all this up. So when you do the modelling the way business is done currently it is unable to do this because we are providing seasonal outlooks in a three-month block and a lot of things can happen. Is it going to be warm or hot at the beginning, in the middle or at the end or for the whole block? It gets very blurry. It is a statistical techniques so you are looking for analogues. We never saw this before and we have to come to grips with this. There is going to be more of this. I am not painting this as climate change is going to happen or climate change is something that is happening in 2050 or 2100. Climate change always has happened, is happening right now and will happen again. There is no such thing as an upper limit. So we can get a heatwave again where we sustain temperatures in the low 40s to mid-40s. There is nothing speaking against this. We have seen it and it is possible, and we need to have tools which can simulate this and pick it up on the extreme days. On one of the days we were only 0.3 degrees out in Melbourne, for example, when it reached more than 46 degrees. It was reasonably easy to predict these sorts of things when you have the right tools. You have got to have the right tools. It is like as a carpenter you have to have sharp tools basically.

**Mr RAMSEY**—Even if a public body buys the information, it is how they change public behaviour as a result of it. What happens is that next season we will see people in Victoria being very conscious about their fire prevention measures. Over an extended period of time looking back to the Ash Wednesday fires in south-eastern Australia over 30 years ago, people were very

good at looking after their properties and you could give the mornings but over a 30-year period that collective history disappears and people go, 'Oh yeah, they warned about a hot summer last year and we never got burned out.' It is very hard to keep warning people that they are heading into high-risk seasons and actually get them to do something about it. That is not your problem, but it is a question of how you influence public behaviour with the information you have at your fingertips.

**Dr Werner**—That is a very interesting point. It is basically a level of general education when it comes to meteorology or weather and climate in general. Comparing Australia with different countries, the US, for example, appear to be much more educated, if I can use that word. Therefore, they are more aware of it. Maybe the Australian psyche is, 'Mate, we'll be alright; no worries.' People living in those really beautiful places forget about other terrible bushfires in Australian history for history. When it comes to weather, people very often forget quite quickly. We had a lot of brush there. We need to step back and look at volatility. We need to start—maybe through the Bureau of Meteorology—an education campaign of some kind that is part of the Australian education system.

We are living in the driest inhabited continent on this planet. We have deserts in the interior; we just live on the fringes. We need to teach people about the risks. People forget about these things. They think: 'Real estate prices are going up. We have beautiful views.' They are living in the middle of nowhere and that is highly dangerous. People living in those places need to take certain precautions so as to prevent this sort of thing from happening again. We cannot prevent these bushfires; we cannot prevent these meteorological situations—well, we can, but that is a different story to do with climate change. We have to take onboard the education of the public and tell them what the risks are and that it is an ongoing issue. We have to treat it in the same way as AIDS or as the swine flu virus and educate the public. Education about meteorology should be an ongoing process: these are the key points and this is what it means. It should not just be on a web site, because not everyone logs onto the Bureau of Meteorology's web site. It is very important, especially for people living in the high-risk areas, not to become complacent.

**CHAIR**—On the issue of educating the public, it is quite clear to me from talking to people that a lot of people do not have any confidence in weather forecasting. The attitude of, 'She'll be right, mate,' may be based in the fact that people believe that the forecasters do not know what they are doing. Can you comment on that?

**Dr Werner**—Yes. Unfortunately, when you look at the forecasting track record, it is somewhat true. In science, especially the meteorological science or atmospheric physics, there is a lot of skill involved. The forecasts can perform reasonably well. But if you are interested in a particular day—such as today—and ask, 'Do I need an umbrella to come to the inquiry today?' I see all the clouds out there. The Bureau of Meteorology is telling me that it is going to be 23 degrees or 24 degrees. Again, I must apologise; I do not want to bash them up or criticise them. But they are basically the main source of information in Australia. They do not have a terribly track record. We have to change this. We need to present information in a different way so that the lay person can understand it. That is our job as well.

As a qualified person with a PhD in theoretical physics specialising in numerical weather prediction modelling, I could go all the way and people's eyes would just glaze over. Nobody would listen. They would say: 'Look, mate, I don't understand this. I have to make a decision

here. I have to purchase so many megawatt hours for summer. Should I do this, yes or no?' It has to be brought down to a level that is easy to understand. It is a large challenge to visualise it. We have on our hands a multidimensional problem. There is not just temperature; there is humidity, soil moisture, the role of clouds and rainfall. We have all these difference indices. It is a zoo of indices and terminology. But we have to start somewhere. We need to produce an information pack that explains what things basically mean.

Yes, it is true that the track record has not been good, so there is distrust. We have to build trust and maintain it on a daily basis. Yes, sometimes we can get it wrong, but I have to get it right more than 51 per cent of the time otherwise I would not have a business. It is very important to build this up, and you can only do it over a long period of time. I have been involved in this for a long time already. The other things that you have to have are passion and persistence—and what people call a thick skin as well. You have to really stick it up. You cannot give wishy-washy forecasts. We cannot predict what will happen on 25 March next year—we cannot do that—but we can provide possible scenarios. We have to move away from the notion of uncertainty and move into the arena of risk. Knowing the risk means that at the moment we probably know most of the underlying distributions of what may happen. Uncertainty means that something is completely unknown or ambiguous. We have to deal with this.

At the moment, looking through the scientific literature, you find people use, in an interchangeable way, 'risk' and 'uncertainty'. For a risk manager in the energy market they are two separate shoes altogether—or pairs or whatever. This is what it comes down to again. You can hide very quickly: 'I was uncertain; that's why I got it wrong.' But at the end of the day they have to make a decision. The public has to make a decision too: do we have to evacuate—yes or no?

It is a process which may take a few years. We have to gradually build up this trust. We have to run education campaigns, maybe in the school, to throw in a few more things. The other thing is that here in Australia—I obviously come from Germany—the education is slightly different. Again, that is where it is coming from—there is a long history. Whereas in Germany you can study meteorology or atmospheric physics—it is a completely encapsulating degree at the university—here it is seen as mathematics or physics. It is just a sideshow type thing. I am not saying that meteorology is not a great thing to study in Australia; you can still do it, but it is completely different. In the United States you can study just meteorology or atmospheric physics at a meteorology institute or department. By training I am actually an atmospheric physicist.

So you start from a completely different level and base of openness. That is missing here. And then you can see: you got this wrong so many times already. There was Inigo Jones. He got it right a long time ago—or maybe not. There are lot of things happening in the folk law as well. There are some private providers here in Australia too, but you have to start somewhere to build this trusting relationship again. And you have to take some risks. The risks are taken through the organisations of CSIRO or Bureau of Meteorology or maybe through some of the private net service providers taking some of the more cutting-edge building blocks and coming up with new ways of presenting the information to the public. So they say, 'Oh, it's actually much more possible.'

So we are not driving, anymore, in a Holden Kingswood SL—a 1970s or eighties car—because now we having much more sophisticated cars. It is the same when it comes to science

and technology. We now have these supercomputers. We do not have Crays any more. We have IBM or NEC supercomputers. We already have all these building blocks and we have to move forward. But we have to move quickly as well, because one summer goes by and another summer goes by and many more things can happen.

**Mr SYMON**—There are several things I would like to pick up on there. I note in your submission that you talk about publicly available seasonal forecasts and how they are based on statistical models. But also, as you have just been talking about, there is a lack of ‘user friendliness’—if that is the right way to put it—in getting the information, even if it is based on the old models or on a new dynamic model, to the end user. And we have heard from a witness this morning on the same subject. Do you have any ideas as to how that message could be put across in a way that an interested user—Joe Public; maybe a small business operating in the construction industry—could be able to understand it and use it?

**Dr Werner**—That is a very good question, because at the end of the day we always have to look to the end users. So we are not doing it just because we love to do meteorology. At the end of the day—and you see this in all the funding reports and submissions—it has to benefit someone. On a daily basis we have to demonstrate and prove this.

And tomorrow is another day. Just like in a football team you run out and try to score again. It is a completely new day. You are not necessarily starting with a clean slate but you have to think, ‘How do we make these people some money?’ For example, for a construction business, looking at a three-month period is just too blurry. It is basically like taking off my glasses—or somebody else’s glasses—and trying to drive on the F3 Freeway. Not only would it be against the law, because I have to wear my spectacles, but it would be all blurry. So you cannot really make a decision. It is very uncertain.

For example, in the construction business—and, yes, in the past we worked with construction businesses here as well—if they take a roof off a data centre or a bank here in Australia we work with project managers and engineers. Engineers are a different breed to scientists, because with scientists there is always some fuzziness, uncertainty or risk around. With engineers they would like to know everything so they can calibrate and measure against something so that that they know the risk. So they know whether they have to put a tarpaulin on and what sort of tarpaulin, or whether they can proceed at all with the project on a given date.

So there needs to be a much finer level. There have to be different products. The current product is targeted at a very broad sector. From that alone it would blur, and obviously in a three-month period there are rainfall and temperature outlooks as well. Very often businesses are working on a quarterly or monthly basis, so you need a much finer temporal resolution in your products and services. Maybe you would like to issue probability distributions. You may have heard about it or read about it. There are ensemble techniques, which would be one way of assessing the risk around a certain outcome in temperature or rain or hail or snow. You are using these sorts of approaches, for example, where you would offer a probabilistic information type forecast but based on deterministic. Statistical lists are basically a data reduction technique. I have an example of 10,000 data points. What is a mean? What is the standard deviation? That is what you would be interested in. From there you would infer the most likely outcome—possibly.

This kind of avenue may work. You could say, for example, that in January, historically, so many thunderstorms occurred in Sydney or in Brisbane. Going through our dynamical forecast systems, we have generated various ensembles. Based on these ensembles we come up with these statistics, and they would be more detailed. As you get closer you would be zooming in. You would use different tools again to reassess the risk of the forecasts you have issued recently. In that seasonal outlook, you are getting closer to current days. You would have more information, closer information, but it does not necessarily mean, as you are getting closer, that your predictability will increase. That is not true. It is not true because there is generally a perception that I can predict the weather very well for today or tomorrow. There are a lot of examples where it is not the case and we would be much better performing further out—for example, if there were rainy periods or heatwave activity. So we have to disengage from this notion as well.

We have a lot of examples in our business and through our clients where we have predicted flooding and heatwave activity which occurred at the same time. For example, that happened in Queensland in the previous year's summer. So you have this issue of seasonal outlook and you are getting closer and then you would zoom in, literally providing a product. You would go back to the customer or client and say, 'We have to know this information. We will reassess the risk; it has changed.' So basically you have a sense of ownership. Again, I believe they are passionate and persistent about it, but it seems to be somewhat lacking. You have this sense of ownership. It is not just file and forget—you do something with it. That is what it appears like on websites here and overseas. So there has to be a sense of ownership as well. There are livelihoods at risk, businesses at risk, earnings at risk, capital expenditure at risk. There are a lot of things. That needs to be absorbed as well and not just said in the statement. We need to be fully aware of the implications. A more entrepreneurial approach to this may be the way to go in the future.

**Mr SYMON**—Thank you for that. You mentioned ensemble type forecasts. Again, going back to your submission, you say that the US National Centre for Environmental Predictions runs ensemble forecasts four times per day with 21 ensembles, resulting in a total of 84 ensemble member forecasts for the next 16 days. I take it the Bureau of Meteorology is not in that league, from what I have read in your submission, although I have not asked them about this. Could you fill me in on what you understand they do?

**Dr Werner**—Yes. I am obviously not fully involved with the current research activities in the Bureau of Meteorology. My understanding is there was always an attempt to do ensemble type forecasting in Australia, currently the PME model—the new seasonal dynamic model. But what they are doing is what is called the poor man's or poor person's ensemble. Basically you do a forecast, a straight dynamical forecast, say, for six months, assuming you have a seasonal forecasting system. Tomorrow you do another forecast and so on. After a week you would have seven ensembles covering six months out. You are moving forward in this window rather than having multiple initialisations. Based on your initialisation schemes for the ensemble forecast—with the National Centre for Environmental Prediction in the US or the European Centre for Medium-Range Weather Forecasts performing—you have multiple initialisations per given day.

The way it is done is that you change slightly the initial conditions. You can maybe change parameters within the model—physical aspects. There are different ways of doing this, basically moving forward. The more you have, basically a picture is forming. It is like having a box camera where you have one hole to look through, so you would not see much, like the eye of a

fly. If you had 100 holes in the camera you would see more. Take a chip in a digital camera where you are talking about megapixels—you can resolve much more. Resolution is almost everything, going down through horizontal resolution as well as having temporarily more of these ensembles because you have more of these risks addressed. Otherwise it is hugely uncertain.

**Mr SYMON**—Does that come down to a lack of resources in Australia or a lack of computing power or a lack of dollars? Otherwise, does it seem to be a preference for a different direction?

**Dr Werner**—It is probably a sort of a mix of all of the above. Predominantly, I would say—and I mentioned this in my opening statement—Australia used to have really smart people working in the field. One of my other PhD supervisors was Professor Lance Leslie, who was back then at the Bureau of Meteorology's research centre and was one of the best dynamical meteorologists Australia has ever produced. He was by training a mathematician. After he left the Bureau of Meteorology he became a full professor of the University of New South Wales. I had three PhD supervisors. He then moved on and went to the US. It is my understanding that Dr Bill Burke is still at the Bureau of Meteorology. He is another very eminent person.

Again, it was not nurtured but I do not know for what reasons, maybe funding or maybe there was an executive decision somewhere. It is not always an issue of funding; it is how the funding is delegated. There is the politics itself. Through the 1990s here in Australia the flavour of the day was CO<sub>2</sub> emissions, and how they impact on climate, and the greenhouse effect. There was very little on aerosols and very little on the radiative properties of the atmosphere. Only a few people on this planet actually built these models from the ground up and know how these models work. You can use them as a black box. It is like this: instead of sitting in your car today, you are sitting in a jumbo jet and you have to get back to Canberra and you think, 'There are a lot of buttons. How do I do this?' With these models there is a risk of misapplying them as well. Again, you have to buy this knowledge. It used to be that it was not nurtured. We have to get back to what we had before, because we are developing some dependency. Too much is depending on it. It is just handing out the funding dollars and getting a third-party model.

There are great models out there. It is basically about a mix of politics itself. Even if we do not see aerosol particles as a red warning indicator, it still needs to be funded—and the same with radiative properties. My background is specialising in radiative transfer and theory. Very few people are actually developing these new codes within these climate models and weather prediction models. When you look at some of them you see some of the codes are dating back to the seventies and eighties, so you should get a new shell. Say you drive a brand-new car but the motor itself, the radiance field, is a motor of the climate and weather system. If you switch it off it does not really look like a weather movement. Obviously there would just be darkness. But that is the motor itself and there is very little done, especially in Australia, to progress this further. My principal PhD supervisor was Professor Michael Box, who is now retired. He was the leading person in Australia when it came to the radiative properties of aerosol particles. He is now retired and there is very little happening as to these very important key issues, so very few people have an understanding of these models.

You may have heard or read that you can freely download a climate model. If you have a large enough work station you can run the model. It is already there and it does not cost you anything.

But you have got to have the knowledge itself. Otherwise it is like giving someone the keys but they do not know how to use the keys themselves. Funding is one thing but it is also about resources. But we already have the building blocks and maybe the way to move forward to make this a really clever country again in climate and weather research is by having a dual approach. We would still have the Bureau of Meteorology and the CSIRO but we would nurture by having outside arrangements like those that are happening over in the United States where you have an open-source and developed model, for example. From a risk management perspective, you do not want to put all your eggs in one basket. We are talking about maybe \$100 million in funding over, say, half a decade. We do not want to spend this money, so you have to have a dual approach to nurture this human capital. That is one thing Australia can become leading in. It is about not just being able to sit at an international scientific meeting but actively contributing and looking at our risk profile and exposure. I think that is really necessary.

**Mr SYMON**—Thank you.

**Mr RAMSEY**—Yesterday we had evidence from some people in the academic world who highlighted that universities had difficulty accessing the technology that the Bureau of Met and CSIRO have in their supercomputing facilities. They highlighted problems with that silo mentality, which is exactly what you were just saying about putting all our eggs in one basket. From what you have just been saying, I gather you would concur with that it is difficult for people to actually progress another thought process or another model in Australia because everything is targeted into this one area already.

**Dr Werner**—Correct, unfortunately. I wish I had a machine like the CSIRO has in Victoria. It is just great. But, again, you do not have to spend tens of millions of dollars on hardware. I also made the point in my submission that new technologies are emerging. We now have new hybrid cars, for example, which may run just on electricity and not on petrol anymore, so there is a different question about where the electricity for these cars comes from.

A classical computer uses a central processing unit, or CPU. That is the brain where all the calculations are done, and you have a few thousand of them in a supercomputer. They all need to talk to each other, so they are run massively parallel. Backdoor processors were the flavour of the day a few years ago, but now we have these massively parallel computers. They are all run together, with a computer code running, to solve all these complex equations to basically produce an outlook. But that is old technology that needs a lot of energy and has absolutely huge cooling requirements. Cooling is the single biggest issue worldwide when it comes to data centres and supercomputers—they run really hot.

New technologies are emerging, for example, in GPU, or graphical processing unit, computing. We recently went to an exercise with one of the larger international computer and supercomputer manufacturers, and we discovered there is a factor of anywhere between 100 and 1,000 in terms of cost and performance. The speed-up of some of the computational fluid dynamics code, which is the code of these dynamic models—computational fluid dynamics or hydrometeorological—is anywhere between 10, 50 and 100 times. That is already established and those sorts of benchmarks on this new type of technology are already freely available over the internet.

Again, we have to pursue these different technologies now. We should not take the supercomputer away, but we have to ask serious questions. Now we have to invest tens of millions of dollars and six months later the technology is already slower, and we have to solve all these problems faster and faster. So we need to address differently how we put in place, at taxpayer's expense, this very expensive infrastructure. We have to put these people together—computer scientists, not IT people but computer scientists, and atmospheric physicists, oceanographers and land surface modellers—to model the atmosphere, look at the ice shields and put this all together, and we need to have more access. But you are absolutely right—it is very difficult.

Back when I was studying and working at universities it was basically the universities' own resources that were used. Now I am running my own business successfully, and we run our own smaller supercomputing facility, so we are not accessing any of these facilities. You can do it smarter, and I do not have \$10 million to buy a nice fast computer!

**Mr RAMSEY**—Of course you have!

**Dr Werner**—We do not, and you have to do things smarter because you have to stretch the funding, although that does not mean they should be underfunded. We still have this pool of funding, but we need to ask: what do we do and how do we do it? That way we may lower the walls of these silos so that these young researchers can actually gain access. It is very difficult to get funding from the ARC here in Australia, but the attitude should be: 'We have this brilliant idea; why don't we give it a go?' That is how innovations very often come about—with contributions that seem like completely off the wall ideas. We would still go through a peer review process and that sort of thing, but we would be fast-tracking this rather than going through all the different funding. So you would have this idea and you would sit down with your PhD supervisor and say, 'I would like to try this.'

**CHAIR**—That came up yesterday—the whole issue of the structure and especially the ARC and the way they can be prohibitive to young scientists who may have different ideas and may think outside the square of what is acceptable thinking. I have listened to you speak. You have raised issues such as the human resource shortage, a diminishing capability and the fact that we once were at the forefront. We have heard before many times, especially in our previous inquiry on research, that Australia seems to be lagging behind where it used to be X number of years ago in a number of fields. Obviously, this area is one of them as well. Is the current establishment an inhibiting factor to encouraging new scientists? Or is it that they are just not available? Do they see no scope for pursuing the sorts of things they want to pursue here?

**Dr Werner**—It is difficult. Again, what you need is passion and persistence. It is very difficult. When I think back to the early 1990s, it was very difficult. You have to have a very understanding family and believe that eventually there will be a light at the end of the tunnel, so to speak. It is daunting as well when you know what the success rate is. But we have to step back and say, 'Australia is a small country, so there are limited funding resources.' I do not know what the entire science budget is—I did not read up on this—but let us assume it is \$100 million. It is like a \$100 million pie, so you have all these people to feed. You have to buy lots of things. Hardware is very expensive to buy. Any experiment in experimental physics is extraordinarily expensive. Just to teach physics is expensive, as is chemistry. You have to buy all the equipment.

People are going to get disenchanted if they do not have the passion and persistence. At the end of the day, only a few people really succeed and stay in the field, so we have to make sure that this is actually happening. We educated all these people to PhD level. A lot of PhDs get a lot of publications out and then say, 'No, I don't do meteorology anymore. I do computer code for an investment bank.' The talent is wasted. The talent is there, so we have to change a few things and put the passion back. That is a necessity here in Australia because we are hugely exposed to the elements.

Maybe we have to change the funding structure. One of my concluding remarks in my submission was that maybe we should have a special levy or tax where we raise extra funds through the normal taxation system. I know we are already heavily taxed, but maybe it could be just a dollar per person, to raise funds, to raise the level of awareness, and those funds could be put towards the further advancement of long-term meteorological forecasting here in Australia. That is very, very important, rather than saying, 'Okay, we already have the funding. Now we have to decide what to do with it. We have read the submissions. We have had all these public hearings'—like this hearing right now—'and now we will have business as usual.' A few things really have to change; otherwise we will just see a repeat of the eighties and nineties and we will not have gained anything. The only thing we will have done is to spend more funding—and we will have a new computer as well. So we can see this levy as a scientific stimulus which leads to a more prosperous Australia in an economical sense as well.

**CHAIR**—Thank you very much. You certainly have a lot of passion and drive. It has been a very interesting discussion. Dr Werner, thank you very much.

**Dr Werner**—Thank you very much.

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

That this committee authorises publication, including publication on the parliamentary database, of the transcript of the evidence given before it at public hearing this day.

**Committee adjourned at 11.49 am**