T R A N S C R I P T

LEGISLATIVE ASSEMBLY ENVIRONMENT AND PLANNING COMMITTEE

Inquiry into Tackling Climate Change in Victorian Communities

Melbourne—Tuesday, 10 March 2020

MEMBERS

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Mr David Morris—Deputy Chair
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WITNESSES

Professor John Donald, Interim Head, School of Life and Environmental Sciences, and

Dr David Halliwell, Industry Professor and Director Research Partnerships, Science, Engineering and Built Environment, Deakin University.

The CHAIR: Welcome to the public hearing. Before we begin there are some important formalities that I must outline. All evidence taken today will be recorded by Hansard and is protected by parliamentary privilege. This means that you can speak freely without fear of legal action in relation to the evidence that you give. However, it is important to remember that parliamentary privilege does not apply to comments made outside the hearing, even if you are restating what you have said during the hearing. You will receive a draft transcript of your evidence in the next week or so for you to check and approve. Corrected transcripts are published on the Committee's website and may be quoted from in our final report. Thank you for making the time to meet with the Committee. Could each of you please state your full name and title before beginning your presentation.

Prof. DONALD: Yes. Thank you for having us. My name is John Alexander Donald. I am a Professor at Deakin University and Interim Head of School of Life and Environmental Sciences at the university.

The CHAIR: Terrific. Thank you.

Dr HALLIWELL: My name is David John Halliwell. I am an Industry Professor at Deakin University and also Director of Research Partnerships.

The CHAIR: Fantastic. Over to you. Who is to go first?

Dr HALLIWELL: I am happy to kick off. I think we got our submission to you in time, so thank you very much for taking our late submission. We have really broken the submission up around two areas. One is what Deakin is doing internally within the business. I just note that as of last week our council met and our net zero target for 2030 has been moved to 2025, so we are well ahead of that target at the moment. I notice there is a carbon negative target now for 2030. I do not know what that number will be, but as of last week we have certainly moved that forward. A key part to that is the microgrid project, which is coming online this year on the campus down at Waurn Ponds. We have got about 7 megawatts of solar power that will be powering about half the campus, but there is also a range of other initiatives on campus, so I have outlined those in the report. I will not go through them all, but on page 2 there is a whole list of dot points in the bottom part of that page of some of the sustainability initiatives that have been initiated on campus. I was not planning on speaking more to that part of the submission, but I certainly welcome any questions if you have any.

The second part of the submission really relates to the research capability and capacity that we have at Deakin. We have certainly tried to highlight all of those areas that are working directly around climate change initiatives or where there is some ancillary or flow-on benefit to climate change as a result of the work that is being undertaken. We might just run through those areas, I think, and I might hand over to John for the areas that sit directly under his school. Perhaps I will hand over to you, John, for those paragraphs.

Prof. DONALD: My school undertakes a lot of research in the marine environment in particular and also in terrestrial environments and has climate change theory sitting behind it and also practice. In the marine environment we are very involved in a number of areas. We are very well known in the area of carbon sequestration. We have a large laboratory called the Blue Carbon Lab. Carbon sequestration in the marine environment to start off with is something I think that is very important in terms of future climate change management. It has a number of benefits. Firstly, to have a healthy niche or ecosystem for carbon sequestering is really important, but that actually has flow-on benefits in environmental conservation and also it is really critical in providing habitat for juvenile fisheries, so there are a number of flow-on effects. It is really important to have policies in and around near-shore ecosystem management because of that importance of carbon. We have a number of areas where we work in that space, particularly in the seaweed space. The sequestering of carbon is primarily related to what are called macro algae or large seaweeds as you would understand them rather than the so-called microalgae. The aim for the research is really understanding how these ecosystems absorb carbon, and so we have research teams that look actually at the net carbon absorption into these

ecosystems. The other part of carbon sequestering that is becoming increasingly relevant is also in freshwater ecosystems, and so we have actually got an extensive program looking at the role particularly of things like farm dams in absorbing carbon. So carbon is a big thing that we have.

We also at the university do a lot of work in modelling these impacts. So we have people who work on the ground, but we also have people who are very good at modelling long-term impacts of carbon management and ecosystem management. And it is all part of a sort of broad area that is referred to as ecosystem services. That I think is really critical for looking at the impacts of climate change.

The other area that is really important—that the university has a very strong team in collaboration with, actually, Melbourne and Monash—is coastal monitoring. So in terms of understanding the impact of climate change on sea level change, it is also relevant to understand what the geomorphology and the biology of the sea floor are. And so mapping Victoria's coastal environments has been a big project. And in fact I think it is getting to the point where there is going to be a continuous map of what the sea floor looks like, and therefore we could then understand, potentially, the impacts of climate change.

The other side of that in terms of coastal mapping is understanding the impact on urban environments, and so there is research now looking into basically creating a sort of a green barrier rather than a grey barrier; so it is looking at reef preservation. So we are working a lot in that space to look at how to protect communities from climate change. The importance of sustaining reefs is a really critical part of that, and to do that you need to understand what the reef looks like in the first place so you can model how it might change over time.

The other key area that my school is involved in is aquaculture. And we have significant expertise in that space, both in understanding the impact of rising temperatures on aquaculture practices—so we have a large amount of research now looking at the impact of temperature on aquaculture practices, and a lot of the projects are industry linked—and in looking at developing new farming practices to provide resilience for aquaculture.

Aquaculture, as you would be aware, is the key way of feeding the world in terms of seafood, going forward. Therefore, preserving the industry has benefit in terms of growing product, but also it is really important for regional communities in terms of sustaining farms, for example. We have projects with the abalone farm at Indented Head and we have new projects down towards Portland, with Yumbah. So making sure those industries are sustainable is a really key part. The work we do is focused on really developing new diets for them. The animals are under duress in increased temperature, and we are looking at how can we actually feed them diets that make them more resilient to temperature. So that is a big impact. I mean, if that extends beyond Victoria—so the work we do has application in other states, such as Tasmania, but rising water temperature is a big problem in Victoria as well. So it is well documented in Tasmania in terms of the salmon industry, but it also impacts on the salmonid industries in Victoria and also the abalone industry.

The other aspect that my school has, moving into more terrestrial environments, is that we have quite a lot of researchers who work in the area of bushfire, and so obviously that is very relevant in the current climate. So we have people who do on-the-ground research on the impacts of fire recovery and also modelling in terms of ecosystem impacts. And this is really relevant I think in environmental sustainability, because I think there have already been indications that, in post-fire environments in particular, pest species dominate compared to native species. From a botanical point of view weed species tend to be more competitive than the natural flora. So understanding post-fire environments and recovery in those environments I think is really important for really getting ecosystem repair, and we have significant expertise in that particular space. I think, as I said, it is very relevant in the environment that we are in, and there are already projects looking at the impacts of that.

The next thing that I will talk about is we have expertise in the alpine area. So the Alpine National Park is an iconic national park in Victoria in terms of regional development and is also important for people's health. Healthy People Healthy Parks is a Parks Victoria key policy. And one of our researchers is very active in looking at the thermal effects on the plants in the alpine areas. I think you might be aware that the alpine areas are under pressure from pest animals, in terms of horses and dogs and cats, but it is really critical that the flora is preserved as well, because it is key to the ecosystem. And so we have projects looking at the impacts of temperature change on the flora, and it is quite evident that temperature changes are having an impact on the ecosystem. So, again, it is the same as the marine environment in that essentially we are looking at what we call ecosystem connectivity and how all the parts go together.

Probably the last thing I will talk about in terms of our school's expertise is the modelling and policy development expertise that we have. So we have Professor Brett Bryan, who is a professor of global change and environment. He is very linked in to the United Nations s sustainable development goals and how they apply in this part of the world, and he has a lot of expertise in developing computational analytical tools for doing predictive science on the impacts of temperatures increasing. He is very well known in doing that, and he does have some focus in regional Victorian communities.

The last thing in terms of my school is that, again along the same lines in terms of theory and modelling, we have another researcher who works at a very big-scale level in terms of ecosystem preservation and again uses modelling to do forecasting—on how important is putting different criteria into looking at the impact going forward of climate change on ecosystems—and does that at a very big scale using modelling approaches.

So in summary I think we have in terms of capability within Deakin—and my school specifically—a really nice blend of hands-on, practical, industry-relevant-type research that links in to people who can do extensive modelling and predictive-type science based on current datasets.

The CHAIR: Okay. Maybe if we could have the opportunity to query John's evidence—I am assuming your topics are in an area that is different—if we could perhaps have 15 minutes, if that is okay, where we might quiz you, and then we will move to the second component of the presentation. I suspect your presentations are going to be quite different.

Just thinking about what you have said, particularly around the marine environment, Port Phillip Bay comes to mind. As you would well know, that was quite a degraded water body. We had commercial fishing, we had scallop dredging, and I suspect as a consequence of that the bay looks very different now in comparison to when European settlement occurred. Obviously we are no longer dredging. There have been attempts—I think reasonably successful attempts—to rebuild reef systems, and I assume seabed grass and other things are now starting to improve as a consequence of some of the decisions that have been made over the last four or five years.

Prof. DONALD: Yes.

The CHAIR: In a general sense, will that lead to Port Phillip Bay—the water temperature—being lowered as we put in place more marine grasses? Is there a tangible connection between marine bed grass or any other plant-based material and water temperature?

Prof. DONALD: So probably the impact is not so much on water temperature, but it is very positive for the other impact of climate change, which is carbon dioxide.

The CHAIR: Yes.

Prof. DONALD: So essentially seagrasses and algal environments—a healthy ecosystem—are beneficial in terms of carbon dioxide. The water temperature effects would probably be at a very proximal level, so maybe in terms of local currents. But water temperature seems to be primarily determined more by oceanic events than what could happen—

The CHAIR: Fish could get out of the direct sunlight, couldn't they, into the shaded—

Prof. DONALD: Yes. The bay is healthier for all the things that you mentioned, and that has net benefit in all sorts of ways in terms of fish nurseries, growing fish, sustaining recreational fishing in the bay and creating a healthy bay for the economy and enjoyment by people in Victoria. It also creates an environment where pest species are least able to have a negative impact. But those species can be pests but not invasive, so for example the sea urchin problem in the bay is being addressed because of the degradation of the sea floor. Sea urchins have taken over in many areas, and that is being addressed. Redoing the reefs could address the sea urchin problem. I think the temperature problem is, probably in the bay, more determined by the flows in and out of the rip than by the environment, but I agree about the point about having nurseries and ecosystems for shelter from sunlight and things like that.

The CHAIR: Okay, and is there any sort of mapping that has been put together in terms of where seagrasses once used to be, perhaps let us say at European settlement, that no longer have seagrasses? Is our understanding of how things have changed under the waterline as comprehensive as what our observations are historically above the waterline?

Prof. DONALD: Yes. There is actually quite a good catalogue of evidence about seagrass distribution in the bays, and I think in terms of seagrass probably Western Port Bay is more acutely affected by degradation of seagrass. There are significant projects we are actually involved in. We have a Melbourne Water funded project looking at seagrass restoration in Western Port Bay. There is actually—oh, right. So there are projects looking at restoration in different parts. I have just had it shown to me that it was actually in the brief about areas in Point Lillias, near Geelong. In terms of seagrass restoration, the bulk of the work seems to be focused on Western Port Bay. So to answer your question precisely, the department of primary industries and fisheries Victoria would have very good records of seagrass distribution in the bay that could be used to look at historical trends.

The CHAIR: So there are a couple of hotspots obviously that you have identified, but has that sort of historic mapping, historic footprint, been put together for the whole of the Victorian coastline so that we can see where there are areas where seagrasses have contracted, where there are areas where it might have in fact expanded? Is that work done at a thorough enough level that we have got a baseline that we can build from, ultimately with the opportunity of sequestering a lot more carbon in our coastal oceans?

Prof. DONALD: The seagrass issue is more prevalent in closed water systems, so the bays and the lakes. Along the actual oceanic coastline the issue about carbon and having healthy marine plants is more about algae, so the two have to be considered together. In terms of mapping along the Victorian coastline, there would not be a particularly strong historical dataset because the mapping is really based on technology. We do sea floor mapping from a boat, so the mapping is done in conjunction presumably with diving surveys, but there would not be, in my view, a particularly extensive dataset along the whole coastline. But I think seagrass meadows in lakes and bays would be better understood.

The CHAIR: Is that a particular problem? Does it matter that we do not have that historic data, or should we be trawling other—

Mr MORRIS: We should not be trawling.

The CHAIR: That is true. Should we be trying to find that data through other observations? Is that something that is worth doing? Is that a gap in the science that we should not really have that we do have, or do we just sort of accept it and move on?

Prof. DONALD: I think it is always good to know those sorts of things, but I have to say that I cannot tell you precisely along the whole of the Victorian coast whether that data exists. I think it is more likely, just repeating what I said before, that the data exists for the bays. So we could actually get a historical record of where we have got to and then the improvements are now being made through appropriate restoration projects.

Dr HALLIWELL: If I can offer a response as well, the other area to consider is around mangroves and the mangroves' loss of habitat through both the bays, because we know that there were mangroves in areas that there are no longer mangroves and it is probably not likely that we are going to restore those areas because of development. I think what the work is focusing around—this is all under this heading of 'blue carbon'—is what is the potential to lock up carbon in these coastal habitats and then the freshwater habitats as well?

I think in here Peter has given us some figures: 2.6 tonnes of carbon per hectare per year is one of the initial figures that he has put around how much carbon we can lock up in this blue carbon context, so I think probably a good question to ask is: what is the potential along our coastlines to lock up more carbon, and where are those locations where they are most likely to not interfere with the development that has already occurred along the coastline? Where are the opportunity areas?

The CHAIR: From Deakin's perspective, has that work been done? Let us say for instance around Port Phillip Bay, where we accept that there have been a lot of mangroves removed, but setting aside particular patches which might have some good remnant mangrove within them where we might encourage that

mangrove to migrate further along the coastline either side of it or whatever as an offset—has that been done to an extent? Because I suspect most Victorians would be completely naive to the fact that Port Phillip Bay did have significant mangroves around it.

Prof. DONALD: I think mangroves in Western Port Bay are probably more significant up around the top end of the bay. In terms of carbon, that would not make a significant impact.

The CHAIR: I was thinking more from an ecosystems perspective.

Prof. DONALD: Ecosystem is the key thing here. A healthy ecosystem contributes to the carbon offset but it also creates environments that create healthy marine environments.

Mr MORRIS: Can I just ask about, you talked about diet in agriculture, and Ag Vic were in this morning talking about similar tweaks for cattle amongst other animals. The question relates to what comes out the other end and effectively whether diet modification modifies the end product. I know with farmed salmon it is often said that you do not get the omega-3 benefits out of farmed salmon that you would get out of wild salmon and you have got higher omega-6. The names are about as far as I go in terms of the science, so do not think I actually know what I am talking about. But my understanding is that it is the pellet diet that effectively modifies the salmon so that the end product is not necessarily as healthy as a natural product. When you get into the area of modifying the diet in order to provide that capacity to tolerate heat stress, does that have any impact on outcome?

Prof. DONALD: Yes, it does, so this is actually quite a complicated science because to modify the diet of the salmon has impacts on flesh quality. Flesh quality is really a twofold thing. It is the way the flesh looks. Essentially if you look at salmon, they want them to grow reasonably quickly but they cannot grow too fast because it affects the meat quality. Salmon is one area, and it also applies in other aquaculture species such as abalone. The diet modification is a sophisticated piece of science because you are looking at maintaining the flesh appearance, the flesh quality and also the biochemistry in terms of the omega that you were talking about.

In terms of nitrogen, that is an issue in terms of what comes out the other end also in fish. In fact actually in Tasmania there is a new cooperative research centre, the Blue Economy CRC. One of its briefs is to get salmon farming offshore to minimise the local environmental impacts of aquaculture, but certainly nitrogen outputs from aquaculture practices are relevant in terms of the impact on the environment, and the EPA closely monitors that so people who work in aquaculture work under a licence to keep their nitrogen levels at below certain levels and you have to think about that in the diet as well.

The CHAIR: And potentially a nursery or an incubator for disease? You obviously put a lot of fish in this instance together potentially in a very close area, disease can be a problem which not only affects the salmon, it could also potentially have a consequence for other native fish in the area?

Prof. DONALD: Disease controls are quite strict, so for example you cannot bring salmon from Tasmania into Victoria because of disease controls. The major issue at the moment is susceptibility to disease based on temperature. That is one of the key issues, and this really became a big issue in Tasmania. The industry was set up in Tasmania with water temperatures at a certain level akin to North America but now they are getting water temperatures even in Norway that are too warm, so again a lot of the dietary modification is to sustain the industry through these difficult temperature times.

Dr HALLIWELL: I would just add around food conversion efficiency, when you look at agriculture you have got a much higher food conversion efficiency in, say, dairy cows or any cows where in a cow you can in theory optimise production of, say, milk in a dairy cow and minimise emissions at the same time, so it is kind of a win-win situation, but the overall food conversion efficiency will not be anything like what you get in a growing fish where you are getting much more efficiency, so when you are looking at emissions from these industries the emissions per food produced will be much lower in an aquaculture sense.

Prof. DONALD: Just the last thing I will say is that the aquaculture industry is a multibillion-dollar industry, so even small margins of improvement have significant economic benefit.

The CHAIR: I know we have focused a lot on John. David, did you want to add to that?

Dr HALLIWELL: I do not mind you focusing on John; that is fine. I will probably just point out a few other areas across the university. I probably should have said at the start that Deakin has four major faculties. We have the science, engineering and built environment faculty, and John and I are both from that faculty. We have a faculty of business and law, a faculty of health and a faculty of arts and education. There is work going on across the institution, and we have got a little bit of a bias towards the STEM areas, which is relevant today, but there is other stuff going on that is in the policy space and the like. I am going to just touch on a few of the other areas.

We also have a number of research centres. There is a Centre for Regional and Rural Futures, and there is a group there that is doing modelling right down at the farm level looking at impacts of climate change on an individual's farm, and it enables the farmer to go in and look at: 'What are the climate projections for what I can grow on my farm, what I can produce on my farm, as we move into the future?'. So it just helps with that longer term planning, and almost all of Victoria has been mapped in that way. Except for the Mallee and the north-east of Victoria, pretty much every other region has been mapped and that data is available.

The CHAIR: Is that data relatively accessible to catchment management groups, DELWP, local governments, farming groups?

Dr HALLIWELL: In fact it has been those three that you just mentioned—catchment management authorities, local councils or DELWP—that have funded that work. So, for example, Southern Grampians shire funded some work in their region. Actually they produced a really nice video they put on their site for their local constituents to have look at, and with the model, if you are a farmer in that area, you can click down right on your farm. You can also do little simple things like work out the area of a paddock or an area and things like that, but in a more sophisticated way you can look at suitability for various crop types as we move into the future under different scenarios.

The CHAIR: So could that potentially be adapted to—I am not a vigneron, but at the moment my farm produces this particular variety of grape, so I click on that and bring up that, well, I should be growing this other type of grape. Is there a way in which we can kind of toolset that information up to enable people or farmers to be literally making assessments as to particularly longer term crops like wine or apples or pears or whatever so that they can say, 'Okay, I need to change variety to continue to do the same type of farming on my farm'?

Dr HALLIWELL: The short answer is yes, and I think where you see that play out is more in the corporate farming sector, where they are looking across the country now at where their businesses are going to move in the generations ahead and buying up land with a view to doing that. So if you are an individual farmer with a farm in a fixed location, then that is a constraint you have got to work within, but if you are a corporate farmer and you own 20 properties across the country, then we are already seeing, for example, nothing to stop the beef farmer from moving cows from one part of the country to another if there is drought in one region and there is grass in another region, rather than moving the food to the cows. So it is definitely happening already, and you are seeing it. I think insurance firms often lead the way in this space when they are looking at risk, because it is essentially what their business is about. They are the sort of tools they are using, but in a short- to medium-term sense it is more about climate variation on farm for a farmer. So it is not about climate change and what it is going to be in 40 years; it is how am I managing my business over the next three or five years. So it is a slightly different slant on a longer term trend, but we are certainly seeing it in the corporate space. Some of the vineyards are moving south and even down to Tasmania.

The CHAIR: Or changing variety.

Dr HALLIWELL: Absolutely.

The CHAIR: And some of the things like wine, walnuts—any of those more tree-type products—they live for 60, 70, 80 years, so you want to be making those judgements for a long time, not just for the short-term crop.

Dr HALLIWELL: That is correct. I mean in the dryland areas you see that more so, because in the irrigation areas it really comes back to the price of water and the value of the crop. So we have got a group up in the Riverina in New South Wales that work in irrigated agriculture up there, and if the price of water gets above a certain amount, you will not have rice farmers anymore because they just cannot afford the water. So

you are seeing cotton essentially taking over in that area. But again, when you are growing an annual crop it is an easy thing to modify your farm business, but if you are growing trees—and I think the bigger concern right through the Murray-Darling is all the tree crops that are growing, so almonds, walnuts—all these sorts of plants require water every year. I do not know if anyone has done the mass balance on how much water all those plants need every year regardless of whether it is dry or wet, but I suspect we are right on the edge in terms of whether we can sustain the growth in some of those tree-type crops that are going in up there. Whereas if you are just putting rice in and you decide, 'This year I won't do that because it's not economical to do that', you can get away without it for a year and you might grow something else or you might just harvest your farm for food for other farmers or whatever. So I think there are some bigger issues there which are beyond the Victorian sort of boundary.

Mr FOWLES: Thanks, David, and thank you for the summary of all the areas in which Deakin is operating. It lines up pretty neatly with the main challenges before Government at the moment, I think. I wanted to ask you about the economic development opportunities in the regions, and tell me if you are not that close to what is being done in this area. I thought it was interesting that the project focused on the Great South Coast. You spoke about renewables, particularly around generation, transmission and storage. These are things that we have taken a lot of evidence on. These are challenges that have been responded to in terms of legislation quite recently as well. Can you expand a bit on what those opportunities are and how Vic Gov can assist in those opportunities coming to fruition?

Dr HALLIWELL: Sure. The project that really generated that whole area of work was around Geelong initially. It was called *Geelong Economic Futures*, and that report is available. The whole philosophy behind that was to look at what are the large-scale economic development opportunities in the regions, and our thinking was that people do not tend to think big enough to attract the private sector investment into the regional areas. So if you are talking about a $1 million or a $5 million or a $10 million project, that is not attractive to a superannuation fund. They will say to you, 'We're managing $80 billion, so unless you have got a project that is worth $300 million, we're not interested in even looking at it'. The whole philosophy behind that project was: what are the big-scale opportunities that would be attractive enough with a bias towards attracting private sector investment?

In Geelong there were five areas identified, some of them close to home for us. One of them was around commercialisation of carbon fibre, and from Deakin's point of view that resulted in the LeMond bicycle deal—I think about $40 million or thereabouts. Others were at Avalon, for example—a freight precinct in Avalon. I am certainly of the view that it would be more productive for Victoria to have a port down there and not in the heart of Melbourne. I perhaps will not talk about that today, but I think that there are some opportunities there. And one was around animal health labs and creating a more South-East Asia business hub for that sort of biomedical space, because when you look at the Geelong region the animal health lab is one of the truly unique things we have in that region. There are only about five of those kinds of facilities around the world, and so that is not easily replicated. One of the things we have identified is the bigger business opportunity around that centre.

So then what happened was the councils in the south-west saw that report and really liked that approach and wanted us to do something similar down there, so that is what happened. That report is actually not released yet. It is a final draft report; I have seen a copy. But certainly one of the opportunities was around renewable energy down there. There is already, you know, some major industry down Portland way. And one of the other areas was around agriculture. John mentioned Yumbah Aquaculture, and they have got some pretty big expansion plans which will have a significant effect on the Victorian aquaculture industry if they go ahead.

But the philosophy behind it was really: what are the big opportunities that will attract private-sector investment at scale into the regions? And organisations or institutions like Infrastructure Victoria and Infrastructure Australia, when you look at the reports that they put out they largely focus on the capital cities. Almost all of their projects are in the capital cities, and part of that is they just do not have the on-ground sort of intelligence to know what the competitive or comparative advantages are in some of those regions. It really requires input from the people who live in those regions and sort of know what the opportunities are. So the whole philosophy behind that approach was to go and talk to a whole lot of those business leaders, community leaders and people who have a vested stake in that region. That is what happened with Geelong and the south-west project and a

little bit up in the Goulburn Valley as well, which resulted in what is currently a draft report but I am sure it will be a final report in the not-too-distant future.

Mr FOWLES: Yes. If you would not mind sending the Secretary a copy of the report when it lands, that would be great.

Dr HALLIWELL: I think we can do that. Yes, that is fine. I would just note that we have had really good support from Regional Development Victoria—Phil Currie, for example, from RDV. So, with the Geelong Futures project, to start off with we did not engage Government. There was probably a sense amongst the project team we could be a bit more nimble without engaging Government to start with, but once we got that first report out and people saw the value of the approach I think everybody just wanted to jump on board.

The CHAIR: I just have one sort of manufacturing-based question. So, carbon fibre I think in many ways is replacing aluminium across the globe. It is as strong if not stronger and it is lighter, and that tends to lead to better performance, whether it be for bicycles or aeroplanes or wheels or whatever. That in itself will lead to lighter bodied vehicles, which will I suspect lead to lower fuel profiles for the use of those vehicles. Can you just highlight to the Committee some of the work you are doing in that space? And I have a follow up question. Obviously there are some limitations that have historically existed with respect to battery technology and what Deakin is doing in that space, in terms of all of the applications of batteries—from cars to batteries that support electricity grids. What is some of the work that is being done in those two spaces?

Dr HALLIWELL: I will not be able to cover in fine detail some of that stuff, because some of it sits in our Institute for Frontier Materials, where there is quite a large battery team. They call themselves the BatTRI-Hub group—the battery research team. I will start with carbon fibre. The main competitive advantage we have with carbon fibre is we have been able to lower the cost of production per kilogram of carbon fibre. I think we are closer to 50 per cent of the global production price of carbon fibre, and that is why we were able to license that technology to LeMond for that bicycle deal. That is part of the reason why Carbon Revolution, which is now ASX listed and is still on our campus, spun out of the university. The other reason from their point of view is that they could make a one-piece carbon fibre wheel and nobody else was doing one-piece. That means a lot less unsprung weight in vehicles, which means more fuel efficiency, better handling and so on. So, carbon fibre is fantastic whenever you need strength and light weight, but it does come at a price and that is still the challenge. I think roughly the cost of production of carbon fibre is about a third labour, a third input material and a third energy—roughly those are the numbers.

Mr FOWLES: So how is it that they are half of the global standard?

Dr HALLIWELL: Because when you look at commercial carbon fibre production lines, they are made to make a particular part or a particular widget. At Deakin we are lucky enough to have a full-scale production line and a quarter-scale production line, but essentially a carbon fibre line is just a series of ovens and furnaces that run along. You just run a strand of polymer through and it comes out the other end as carbon fibre through various heating processes. Because it is set up with a research bias, we can adjust the temperature and optimise the run and the input materials and all of those things that in a commercial sense it is difficult to do because you cannot maybe adjust all of the temperatures and the run times and all of those things that we can do.

The CHAIR: You tool up for a purpose, and if the purpose changes a bit it gets hard.

Dr HALLIWELL: That is right. So we have just been able to optimise, through PhD projects and the like, that production process which has really dramatically reduced the energy input into the process and decreased the time it takes to actually make it, so that is where we have really made the saving.

The emerging area now is—and I am sure you have heard of it—the circular economy sort of phrase. The Institute of Frontier Materials' whole strategy now is really centred around this circular economy theme. Where we see that intersecting with carbon fibre and some of the work that is happening in the nutrition space is that a lot of waste materials from agriculture are fibrous materials. So we are looking at those fibrous materials now and saying, 'Can they be inputs into things like carbon fibre, these synthetic fibres that we are producing, and are they cheaper inputs as well?'. Because, as I said, about a third of the cost of making carbon fibre is buying the raw material, which largely we buy from China still—probably not at the moment, but ordinarily. If we can reduce the cost of the input material, then that will again bring the price of carbon fibre down. So businesses

like Carbon Revolution at the moment make a great product but it is still an expensive product. It is really only on your higher end vehicles. I think probably the Ford Mustang is the cheapest of vehicles it is on at the moment. It would be great if you could have that on your Hyundai or your Toyota Corolla and that sort of thing, because it would really drive efficiency in the handling of those cars. So to push the price down further, if you can come up with a much cheaper input material, that will make a big difference. If you can again be more efficient with the energy use through the process, that is a big difference. The labour cost is relatively fixed, but if we can do it faster, then we can make some—

The CHAIR: Automation, perhaps automating—

Dr HALLIWELL: That is right. So there is a lot more happening with carbon fibre, and we have a lot of businesses come to Deakin. Derek Buckmaster, who runs Carbon Nexus, is right across the fine detail of this, but a lot of people come to us to make very small volumes of particular carbon fibre material. There are a lot of different starting polymers that you can use to test. On the quarter-sized production run they might just make one spool of carbon fibre and then we put that through a whole lot of physical testing to see if it meets the specifications they are after, and if it does, they will scale it up and make more of it, and often they will take that back home wherever they are from and produce it at mass scale. So that is the carbon fibre stuff. I guess I am just highlighting that there is a lot more going on there that I am not across the detail of, but our competitive advantage is our ability to drive the cost down through optimisation of the production process. That is really it in a nutshell.

On the battery side of things, and again I am probably a little less familiar with this area, as I understand it the research has moved away from just looking at things like lithium batteries, which are pretty well investigated, to looking at energy storage as a broader theme, so not just batteries per se. Sodium batteries is another area of research for that group, which is also a much cheaper form of battery than a lithium battery and brings some of the same properties as a lithium battery, so lightweight and better storage and—

Mr FOWLES: Sorry, did you say sodium?

Dr HALLIWELL: Sodium.

The CHAIR: As in salt?

Dr HALLIWELL: As in salt, yes. So there are other ways that you can chemically store energy, and that group is looking at other ways of chemically storing energy beyond—lithium is the big thing at the moment—

Mr FOWLES: I thought the trend was towards the lighter element, that they were looking at helium batteries and the like rather than elements at the other end of the spectrum.

Dr HALLIWELL: I do not know that there is a helium battery. That is a noble gas so I do not know that there is storage in helium, but—

Mr FOWLES: Maybe it was one of the other ones.

Dr HALLIWELL: We are certainly looking at hydrogen, and I did not mention this earlier but there is the Hycel project, which is in here, down in Warrnambool, which is I guess I would call it in phase 1 at the moment, looking at having a testbed for the use of hydrogen in heavy vehicles, and also we are looking at potentially running our Warrnambool campus in the longer term on hydrogen instead of natural gas. I just had a meeting last week with a research team from across the university looking at what are the opportunities that we see around this site that we could demonstrate—

The CHAIR: Is that because the campus is relatively close to the source of renewable energy? Because hydrogen, if you generate it from coal, is not particularly climate friendly. If you generate it from renewable energy, then potentially it is very climate friendly.

Dr HALLIWELL: That is correct. So how you generate it is a good question, but there is a lot of technology out there to generate hydrogen. The focus of the research at Deakin is not about generating hydrogen, because lots of people are doing that, but the intent is to generate hydrogen from renewables, so from solar and wind, and then—

The CHAIR: Tidal, given that Warrnambool is on the coast?

Dr HALLIWELL: At this stage we have not looked at tidal. I know there was a tidal project down that way. I do not know that Deakin was involved with that, but I know there were some challenges with that project—

Prof. DONALD: There was a wave. Some years ago there was a business set up to look at wave energy, and that was not sustainable.

The CHAIR: Okay.

Dr HALLIWELL: But certainly we are looking at solar and wind to generate hydrogen as a renewable way of generating hydrogen and then using hydrogen as an energy source. Within the vehicles it is not a combustion process. I have forgotten the term they use, but it is essentially like a type of battery. It is a chemical reaction that occurs with hydrogen. I am sorry but I have forgotten the name of it. It is a membrane process anyway, so it is a hydrogen electrolytic membrane process that converts the hydrogen into electrical energy, which is a far more efficient way to go from hydrogen gas to energy rather than a combustion process. There is a lot of research going into these cells, and I think they call them PEMs but I have just forgotten off the top of my head the acronym.

What we are really looking at is the use of hydrogen, including things like the safe use of hydrogen—protocols around using hydrogen, how to integrate it into a heavy vehicle. We have got Kenworth on board as a partner. How can we use hydrogen in a heavy vehicle? There are hydrogen vehicles around the world already, so there are a number out there, and the amount of hydrogen that the vehicle needs to carry for the equivalent distance, say, compared to diesel is a much smaller volume. There is a lot of energy in hydrogen. That is the hydrogen work that is happening, which is really just in the very early days. Quite literally last week we had our first round table with the research team to sort of nut out some of those ideas.

I am sorry I cannot give you too much more detail on the battery group, but I am not across the fine detail of that. But there are 30 or 40 researchers at Deakin within the Institute for Frontier Materials, and that is their sole focus. The lead researcher for that group is Professor Maria Forsyth, who I am sure would be happy at any time to give you a briefing on that in some more detail.

The CHAIR: Terrific. I have run out of questions. Three of us have Deakin University campus very close to our seats, so we are very grateful for a fourth.

Mr FOWLES: We are very invested in your success—in Burwood, Box Hill and—

The CHAIR: South Barwon. Thank you for your time. We very much appreciate it.

Committee adjourned.