

REPORT ON PROCEEDINGS BEFORE

**LEGISLATIVE ASSEMBLY COMMITTEE ON TRANSPORT
AND INFRASTRUCTURE**

**ELECTRIC BUSES IN REGIONAL AND METROPOLITAN PUBLIC
TRANSPORT NETWORKS IN NSW**

At Sydney on Friday 20 March 2020

The Committee met at 10:30

PRESENT

Ms Robyn Preston (Chair)

Dr Marjorie O'Neill

Ms Eleni Petinos

Mr Gurmeh Singh

LARISSA CASSIDY, Manager of Policy, Electric Vehicle Council, affirmed and examined

BEHYAD JAFARI, CEO, Electric Vehicle Council, affirmed and examined

The CHAIR: Welcome to the second day of our public inquiry into electric buses in regional and metropolitan public transport networks in New South Wales. Members, witnesses and those in the public gallery, we ask anyone who is feeling unwell or has returned from overseas within the last 14 days to please leave the hearing room now. In today's hearing we will hear from witnesses from BusNSW and Transport for NSW and academic experts. A number of participants will be taking part in the hearing via teleconference as well.

I now declare the hearing open. The witnesses before the committee are from the Electric Vehicle Council. Do you have any questions you would like to ask about the hearing process?

Mr JAFARI: No, thank you.

Ms CASSIDY: No.

The CHAIR: Would you like to make an opening statement?

Mr JAFARI: Yes, please and I will be brief. First of all, thank you for inviting us here. It is a great time for a person in my position to be addressing the Parliament on electric buses. What we have seen from both domestic and international projects is that the time for electric buses has well and truly arrived—it actually arrived some time ago. We have seen a number of projects occurring in Australia and globally where electric buses are now showing that, when transitioning technologies—so moving from diesel buses to anything else—compared to diesel, hybrid electric buses outperform already, based on both economic and environmental outcomes.

The biggest driving force in helping achieve that is that there are certainly challenges, obstacles, uncertainties when doing any technological transition, and certainly there are here as well where there are large pieces of infrastructure that need to be changed. The solution has always been a firm direction given by the ultimate decision-maker—in this case the government—to say that we do want to achieve this outcome, we do want to reach eventually full electrification but we want to begin the electrification of our bus fleets today.

What we have found as a result is that all of those uncertainties and obstacles have always found a solution—in fact, not only have they been solved but every time that solution has developed new practices, new business models that provide even further economic benefits as well. There are some key points to note in addressing this transition. One is that we are not just talking about changing the drivetrain from diesel to LPG, for instance, but talking about a technological transition. Inside of that we would like to call electric vehicles a convergence technology, so there are uncertainties that can be met through coordination and certainty provided by governments. I will not speak too much on coordination, but in other presentations you have heard, and quite commonly you have heard, that people who have been in manufacturing and operating buses for a very long time now need to understand electricity grid infrastructure. There are people who provide that electricity grid infrastructure and they know the answers to their questions, but they similarly have questions about operating and manufacturing buses as well.

Providing that coordination role, which is a job that we already do as the Electric Vehicle Council and we would encourage the New South Wales Government to join us in doing, is to have a holistic plan to transition. We find there are no obstacles that are insurmountable. That is why we have seen that we have electric buses operating here but, when we look at markets like California and the UK, we have hundreds of buses in operation already today. When we look to China, which is a very different case again, we have a bit over 400,000 electric buses in operation. It is something that is possible. You can begin transitioning right now and it is very important to set a long-term plan as well to transition your entire fleet out into the future.

The CHAIR: Thank you very much. Ms Cassidy?

Ms CASSIDY: No, that is all fine.

Mr GURMESH SINGH: Yesterday, we heard from witnesses and I would be very interested to hear your take on pedestrian safety when it comes to electric vehicles in general, with a particular focus, obviously, on buses.

Mr JAFARI: Yes, certainly. When it comes to electric vehicles, both for light vehicles and buses, there is a lot of standardisation being created right around the world in how to solve this problem, noting there is a very real both public space amenity benefit and an economic benefit to reducing noise from vehicles, then ensuring that people who are hearing or vision impaired are not negatively impacted by that. Really what we are starting to see is that we can manufacture acoustic sounds that mitigate that issue without creating unnecessary sounds. How

can we enjoy more of our public space? How can we have buildings and land use closer to the roadside? That is possible because we have less sound overall and that sound can be either integrated into other things—so for the vision impaired you may have tools and services available to you and you can integrate directly with that or be able to create a sound that is heard by people directly on the roadside but, for instance, not somebody living in an apartment 200 metres away from the roadside.

Ms ELENI PETINOS: In your opening remarks you mentioned the technological transition that would need to happen. Do you want to expand on that for the Committee?

Mr JAFARI: Yes, absolutely. What we hear quite often when, for instance, a bus provider is seeking to transition to electric, there can be a very simple transition that occurs at the pilot stage. If you are operating two to four buses, you require some level of charging infrastructure and you can trial out and operate well enough. But if you then look to transition to 20, 40, an entire depot of electric buses, the questions start arising around how to upgrade the facilities at my depot to allow for enough charging to be able to occur. Also, what other opportunities are there? There might be the ability to use those batteries when they are not being used for transport purposes to provide vehicle-to-grid services and make additional money out of that, whether that is the bus operator themselves or whether they are providing that to another service provider. You might ask: what grid upgrades are required leading into the depot and then the grid connection for the depot itself?

Again, what we have seen time and again—for instance, in projects around California—is that those upgrade costs are actually far lower than usually expected. They are very localised and we can use far smarter solutions as well. We are not talking about needing—I am going to throw a few numbers—500 kilowatts and then getting a 500 kilowatts connection into your bus depot but being able to do some level of on-site generation, storage and then charging your buses from the on-site energy products that you have as well. Of course, if you are a bus operator or a bus manufacturer it is quite likely that you are not interested in doing all of the work on the energy side, so you are looking for partners who can provide those solutions and monetise those solutions and then allow you just to operate a bus fleet.

We are beginning, particularly here in Australia, at the very early point where the uncertainty that we see is that we know we need to think about all of these things. Very importantly, it touches on why that certainty is necessary or the direction from government is necessary, saying that for the last few decades we have been making money just by operating a diesel bus network and we can make money out of an electric bus network as well, but unless someone tells us to transition to electric, what is the point? There is a lot of extra work that goes into it for the same outcome, as far as we are concerned. The direction helps, but also being able to provide those linkages across. There is a lot of education required on both sides. It is right there in the name, the electric vehicles on the electricity side; on the vehicle side, these are industries that are speaking to each other for the first time.

Ms ELENI PETINOS: Does the Electric Vehicle Council have a preferred type of charging infrastructure? Would you prefer at stop or at depot or at the end of the trip?

Mr JAFARI: We are agnostic based on what works for that location. There may be some of your routes where having on trip works better, some that at depot works better. What we really look to prioritise when it comes to developing policies or tender documents is allowing for the flexibility for outcomes to be produced in electrification and the benefits of electrification, whether they are in industry, development, public health or reducing the economic cost of running that bus network. There are new technologies that are now available in the market, but I think the part that is really evolving constantly is the business models that people use in the deployment of those technologies—so not hamstringing people to a preferred way of doing things, but instead allowing them to not only reap the benefits of, for instance, reducing the cost of operations, but also requiring them to do so when that is available.

Again, usually the challenge is not that the case for the electrification of the bus network does not stack up; the challenge is that it requires additional effort and resources, and unless there is a particular reason for all the players to go through all of that effort, it can be left undone.

The CHAIR: Thank you. Picking up on what you were talking about with the different models that could apply, if you had an existing bus depot and you needed to retrofit that depot, is there a need for a larger space to do that? How easily would that be adapted? Change is very confronting for some industries. Having gone down a particular path for the past 40 to 50 years or so, how do you get them to embrace that and what sort of change would need to happen to retrofit an existing depot?

Mr JAFARI: What we have found to be successful in the past has been, for instance, models where government has provided some form of best practice guidance that shows, for instance, the bus operator who is putting together a tender or putting together a business plan to electrify their fleet what questions they should be asking. Most of the concerns are just, "I don't know what I don't know, and how do I go about fixing this problem?"

The CHAIR: There is a fear factor?

Mr JAFARI: There is a fear factor. Of course, usually the first and most common place people go to for answers is someone who is trying to sell them something. There is a lot of uncertainty around, "Is this the best product or is this the best product?" when someone is trying to sell something. There should be some level of guidance on how things should work, what they need to consider and what they need to go about doing. Again, this is, in a more limited capacity, the work that we do in the marketplace. We do not offer any products. We are a not-for-profit, so we can provide some of this information back. Then we can start to provide some of the linkages with the people who do have those answers who are looking to make similar investments. There are—and we are seeing this here in New South Wales with the bus tender process—partnerships being formed. It is not about lumping it on the bus operator and saying, "You now have to go out and understand electricity infrastructure and solve all of that." Instead it is about saying, "Why don't you go and partner with somebody who wants to provide that part of the service to you and give us, as the customer, a turnkey solution that allows for this electrification to occur?"

Dr MARJORIE O'NEILL: We have been speaking a bit about convergence technology and the challenges that come with a new logistics model and how that works when you have different people. But in the case of something such as a power outage, what backups would be needed—or do you see would be needed—to ensure that buses can continue?

Ms CASSIDY: I think a really important thing we also need to think about is how to engage with the utilities. Their advice is very much to engage them as early as we can in the planning process so that they can start to think about these things and plan accordingly. In terms of power outages, I think the roles of many depots around the world are also utilised in backup storage. But certainly there may be contingencies that need to be considered. In the same sense, fuel security is currently an issue for diesel-powered buses. The same considerations need to be made.

Mr GURMESH SINGH: Earlier you both said that you are technology agnostic, but I would be interested to hear your thoughts on hydrogen fuel cell technology and what that will look like in the next two decades?

Mr JAFARI: What I would say is that while we are technology agnostic, we are investment biased as long as we are talking about people looking to actually deploy the technology. We do less work, I suppose, in the academic and research and development space. We have 60-odd members who are looking to roll out products in Australia and it is about what we can do to help them get underway here, noting that Australia is further behind. We are seeing—again, with some uncertainty—some further development around what role hydrogen will play in heavier vehicles. There are time frames there of 2030 to 2035. There is some increasing level of certainty there, but what we certainly know is that we can start today with electric buses. Our concern is that we will see something that is a bit further off and decide to wait a little while longer. We cannot give you, when it comes to looking for breakthroughs to occur in the hydrogen space, a "you can do this by 2034 and then transition this amount of your fleet." It is important to continue watching and monitoring the technology as it develops and then start to consider how to plan forward.

Ms ELENI PETINOS: I would like to ask about the benefits of transitioning to electric vehicles. I know your submission does touch on elements other than the green arguments, as such. That is something I would like for you to flesh out for the Committee today.

Mr JAFARI: Certainly. Ms Cassidy, would you like to touch on public health?

Ms CASSIDY: Certainly. Outside of the green or carbon emissions angle, diesel and petrol powered vehicles also emit other dangerous emissions into our streets. Transitioning to electric vehicles removes the exhaust emissions. There is a major benefit in removing a lot of these dangerous emissions from the air, which generates public health benefits. That is a really important angle to consider. We did some work recently that looked at electric vehicles generally and quantifying the benefits that transitioning to electric vehicles could provide New South Wales. It looked at the Sydney, Newcastle and Wollongong regions and found that for each electric vehicle that could replace a normal internal combustion engine, New South Wales will save at least \$2,400 in health costs. We aimed to quantify that and link it in to the public health system to show what that would save us and how we can start incorporating this sort of thinking into weighing up the benefits and quantifying the benefits of electric vehicles. There are a number of other benefits.

Mr JAFARI: I might just touch briefly on industry development. You can appreciate that for a group of people like us, it is the main prize that we are trying to chase here. What we see in particular is that when it comes to heavy vehicle manufacturing, it makes a lot more sense to do that domestically in Australia. We already have some level of bus assembly component manufacturing and manufacturing occurring here. But inside of this

transition—and this is why we have so many markets around the world that are accelerating what they are doing—it is worth noting that this is the time to try to land that further investment. If we are looking to manufacture electric buses, both for Australia and across the Asia-Pacific region, some of the decision making about where to put that plant equipment is occurring right now. Certainly with servicing the Australian market and deciding where to put that plant somewhere in Australia, there is an opportunity there.

What you will hear frequently from those manufacturers is that what they are looking for more than anything else is certainty of demand. They are looking for a large offtake for everything from battery manufacturing to battery assembly, electric bus manufacturing and electric bus assembly. They can put it anywhere they like as long as they know there is going to be a customer that is asking for more than two to four pilot stages and that there will be a few hundred buses to sell.

What you will also hear from people, however, is that as every state eventually moves on to the issue that you guys are talking about now, they will not be able to pick up and move to every state every time. It is going to land in one place. The advice we give there is that what is needed is to go first and go big. It needs to be a big enough order to land the investment in the first place. I will make it clear that we travel around the country and say this to every other state as well. There is a winner takes all prize to be had right now. You can sort of land those sorts of things here in New South Wales, but they could go elsewhere. But once they are built, they are certainly going to stay put.

The CHAIR: Thank you. You have talked about the benefits. I am wanting to look at the barriers that electric buses might present. There may be reduced limits for passengers because of the weight of the batteries. Can you comment on that?

Mr JAFARI: Where we have been able to work with jurisdictions to do pilot programs—and I will speak about heavy vehicles a bit more broadly because some of the issues impact buses—we have looked at the impacts it has on payload. Whether it is carrying cargo, garbage or passengers, it is a payload issue. There has been a decades-long discussion among operators of heavy vehicles and road authorities around what weight is correct. Given new technological advances in things such as asphalt and other things, there is a question about how much more we can carry. Of course, there is a cost trade off there as well, and if heavier vehicles are creating more wear and tear but are then providing other benefits, how does that balance out and are we getting more than we are spending? What we start to look at, particularly in the pilot stages, is our opportunities to provide waivers to lift the amount of weight that an electric heavy vehicle is able to carry.

It chips away at some of the inequality that exists. For instance, something like 20 to 25 per cent of that gap is based on the fact that an internal combustion engine truck or bus is weighed when it is empty as opposed to when it has a full tank of diesel inside of it whereas that does not make a difference when it comes to electric batteries, it weighs the same. It helps to chip away at some of that by giving it a higher weight restriction. And then the rest of that as well is, at this early stage, by providing that temporary waiver, it lets us do a bit more study and research to see if yes, we are sure it is going to have greater wear and tear on the roads, but given the other benefits it is providing is it worth spending that additional money on having to upgrade roads occasionally more often to get the public health benefits and all the others that we would like.

The CHAIR: Thank you. Ms Cassidy, did you want to add to that?

Ms CASSIDY: No, I would just add that in terms of some international examples, we are seeing that sort of approach taken throughout the world. As I understand, California has an approach where it is sort of staged; they have given electric buses a higher weight limit, and then the city of Paris has also given a one tonne additional limit to electric buses.

Dr MARJORIE O'NEILL: In addition to those weight limitations, are there any other key learnings that we could take forward from other places? In terms of other jurisdictions, if we were going to roll this out what would be the key takeaways ?

Mr JAFARI: I was actually thinking about this in terms of the recommendations that we have made. What I would say is there are quite a number of smaller barriers in place, smaller challenges and obstacles to face and then a few larger ones as well. The overall way that these get summed up is that the plan to transition to electric buses cannot just be a process that is done with bus operators and bus manufacturers; it does need to be one that is holistic and has all the relevant stakeholders around the table. That is where we find that the sheer magnitude of small obstacles are able to be overcome because they turn out to be uncertainty as opposed to obstacles. The type of questions that are asked here is that I am not sure if the grid can handle the capacity of electrification of bus fleets. That is because that is somebody who does not come from the electricity background and it seems like a huge insurmountable issue, but in fact it is not. You get an electricity expert around and they can explain why it is fine and in fact provide a benefit for that.

The other major point that then is required is setting that very certain goal of we do want to achieve full electrification, we do have interim targets in place. Where we have seen it fail in several jurisdictions both here and globally has been when it has been a preference or an option, of that you can try to electrify your fleet, we will allow for it to happen. It is recognising the what you are asking is for the manufacturer of the product, the electric buses and new technology have lower profit margins for the operator of the product, they have to do a lot more work to get the exact same outcome. You are asking people to do a lot more work, make less money, just for the option of making air cleaner for the people of New South Wales that they do not get any money out of. Again, it is giving them that certainty that they need to do it and once they know that they need to, the answers there for them.

Dr MARJORIE O'NEILL: A supplementary question from that: Who do you see as the major stakeholders in this?

Mr JAFARI: Ms Cassidy, I think you already touched on some of that.

Ms CASSIDY: Yes, definitely the utilities. Ausgrid, Endeavour Energy and Essential Energy as the grid operators. We know that the impact is going to be on the local grid infrastructure. It will depend on the charging model selected but certainly land holders and the land agencies. There might be additional land required so it is good to engage with them early on. Obviously the transit operators and the other energy service providers as well. The ones that have these smart charging technologies and products should be engaged.

Mr JAFARI: I was just going to say on how do we engage with each of those, take the approach of the transit operator, this is a goal that we want to achieve. Let us help you achieve it by bringing other parties to table. Again, I am going back to my point of where we have seen this process fail has been, "You guys go off and see if you can do it or not." Of course they will absolutely run into an obstacle. There will be obstacles and challenges but for them that can mean they stop. Whereas if it is a driven process that says, "We have to overcome these things. Let us help you in doing that." Them being able to begin, whether it is grid operators, intermediaries who will build you the infrastructure and deal with the grid operator for you, charging infrastructure providers—being able to bring all of those parties in together, you can find a solution to every problem.

Mr GURMESH SINGH: In terms of the challenges we are likely to face bringing electric buses onto the grid, what are the different challenges that might occur in regional New South Wales or regional Australia as compared to the city?

Ms CASSIDY: In terms of the regional versus metro outlook it probably depends more on the capacity of the grid at the location that you are looking at irrespective of whether it is regional or metropolitan. In areas where there is less grid capacity we will be looking at in the first instance seeing where we can manage the demand more than in the end instance investing in this grid infrastructure. That is probably more relevant as to a regional metropolitan take on it. Obviously the options for whether you look at a depot or en route charging might also be a factor of if you are metro or regional as well, but I think it would probably need to be more of a case-by-case example rather than regional versus metro.

Mr JAFARI: Some of the broader issues that you may imagine may be obstacles that are more sentiment based. What we usually hear is how people feel as a larger country. Range may be an issue where, particularly for what we call managed fleets like this, we know exactly how far the bus goes and what capacity, what range the vehicle has so we find them not to be issues. If we are talking about coaches that drive long distances, that can be a different story and that is maybe a path that is further down, maybe a role played by hydrogen, of tour operators going from Sydney to Western Australia or wherever else. Particularly, whether it is in a regional area or in a metropolitan area, those buses are going along a discrete route and we know exactly what they are able to provide. Even where we find that an electric bus may not be suitable for that site today, that is where that longer-term planning comes into play as well. As the technology continues to either become more efficient, get longer ranges or come down in price, it will be able to serve that tomorrow. Being able to hit those switchover points ensures that the local operator there is following up on that point, so if in two years' time you found that the technology has improved but they have not adopted it you can go and provide some oversight and ask why not?

Ms ELENI PETINOS: I just wanted to follow up on some of the comments that were made about manufacturing before. It is something that we touched on with other witnesses on Wednesday. In regard to any local component target, which we spoke about on Wednesday in respect to some of the other states having targets on the sourcing of local components being used as part of that manufacturing process in their state, do you have a view on whether a target is appropriate and if so what sort of target would be sustainable to the industry?

Mr JAFARI: I would say receiving a benefit out of some level of work manufacturing is certainly possible. We usually try to look at this from a point of flexibility but then provide some weighting and some benefit so if you get somebody with zero per cent, somebody with 10 per cent and somebody with 100 per cent,

you are able to provide some form of input there and recognise it. Whether that is based on if they cost more or are they at cost parity, that is where we usually look at it in terms of fleet transitions. If two side-by-side are at cost parity for instance, so everything else is equal, the electric one should win. Similarly, if everything else is equal the one with more input, whether that is doing local manufacturing or providing other services to the community here in New South Wales, those people should win. As we say, some of these are people who are developing new plants and equipment in manufacturing, some of them are already located in Australia, but because of this transition they will require some level of investment to change over their product lines anyway. It does provide that one-off opportunity for them to say, "Since we are going to do it, would it be more advantageous for us to set up somewhere new as opposed to upgrade our existing facilities."

The CHAIR: Thank you very much for appearing at the public hearing today. We may have an opportunity to put further questions to you in writing, would you be happy to accommodate that?

Mr JAFARI: Yes, absolutely.

Ms CASSIDY: Yes.

The CHAIR: We request that you respond within seven days of receiving that question in writing, if we need to do that. Thank you very much for appearing today.

(The witnesses withdrew.)

LUKE TODD, Managing Director, Nexport Pty Ltd, sworn and examined

The CHAIR: Mr Todd, welcome. I thought I would ask you if there are any questions on the procedure before we go any further. Is there anything you would like to ask us?

Mr TODD: No.

The CHAIR: Would you like to start with an opening statement?

Mr TODD: Yes, I would, thank you. First of all, thank you to the Committee for organising this. We, as an industry, value the opportunity to communicate with the government and speak about electric vehicles and the transition that is taking place at the moment. Personally, I have operated electric buses in Australia since 2014. I have actually operated larger fleets of electric buses since 2016. I have been operating the electric vehicles that we are now talking about for mass rollout for some years, so I speak with great confidence about what electric buses can deliver. I can also talk about some of the challenges that were faced in the rollout of those vehicles. But, fortunately, I have been at the front edge of the technology and have had the opportunity to operate vehicles in Australia, so I believe where we are heading is a very strong direction to a new technology that will deliver very good outcomes for the state. This is a great opportunity to communicate that and some of the experiences that we have had.

The CHAIR: You must be excited about that.

Mr TODD: Yes.

The CHAIR: It has been a while.

Mr TODD: It has been a while, so it is very much appreciated.

Dr MARJORIE O'NEILL: Thank you, Mr Todd, for coming and for your submission. I want to unpack and know a little bit more about your involvement in the trial in the inner west. In particular, what do you see as being the key learnings from it?

Mr TODD: I had a hands-off involvement with the trial in the inner west, because this was during the start-up of my new business. I had transitioned from one company to another and that trial actually took place during that transition. What I have seen as the benefit of the trial is that it was the first real opportunity for the government to see what electric buses do. The work that I had done previously was largely around airports, and there was some questions around whether an airport operation is similar to a city operation. The key benefit, to answer the question, realistically is that it was the government's first opportunity to have the raw data and see what the trial of electric buses would deliver in real government contracts.

Dr MARJORIE O'NEILL: So that has been the opportunity. What have you seen as the key learnings from it, in terms of takeaway?

Mr TODD: I think some of the key learnings have been that the range of the vehicles has actually exceeded the expectations of what was anticipated to be delivered. I believe you would have seen the data that has come out of the trial. The operator had a certain level of expectation as to how far the bus would travel and how long the bus would run per day on the capacity of batteries that were on board. The main learning, I feel, has been that the buses have outperformed the expectations. We have also learnt through that trial, I think, some of the driver interaction outcomes of the electric vehicles and the benefits of the electric vehicles. Through my experience, every driver that has driven an electric bus generally is reluctant to go back to a diesel bus because it is an easier and more comfortable environment for the driver to operate in. I think that has been a learning from this process with the region 6 trial.

I also feel there were some learnings around the capabilities of the vehicles. The region 6 area is quite a unique area in that it is quite steep in some parts. There are a lot of sharp turns. There are a lot of the ride-over roundabouts that you may not see across the state. So there were some good learnings around what the buses that they were operating—or they are operating—could do, and some of the height of the actual vehicle—like, the ground to the base of the bus height. One of the adjustments that was made, just as a technical answer to the question, was that the ride height was adjusted slightly to accommodate the drive-over roundabouts, just to make it a little bit more easy for the bus to traverse that area. So I think there was some good technical learnings, but generally the main learning was that the buses not only met the brief but exceeded the brief to a high standard.

The CHAIR: I just wanted to pick up on some comments you made about the driver experience, because at the previous hearing on Wednesday we had comments to the opposite of that. I am really interested to learn what particular features they found more beneficial for them and what they enjoyed more and why you think that they might want to transition to electric buses, as opposed to what they are driving now.

Mr TODD: A couple of the learnings that I have had through the time is that the bus itself is not vibrating all the time. A diesel bus is in a constant state of vibration because there is a combustion engine powering the vehicle. The bus, when it is at a stationery point, is completely still, just like a normal position that you would be in and not vibrating. Also, the foot acceleration and the way you drive a bus—so, for example, if you are driving a diesel bus you are constantly accelerating and then constantly pressing the brake, so you are moving your foot side to side on a regular basis. The best way to drive an electric vehicle is to utilise the accelerator and the regeneration that kicks in when you take your foot off the pedal. So if we are talking about repetitive strain injuries with leg action, in an electric bus you are virtually keeping your foot just in the one position going up and down through the space of a seven-hour shift. It is not left to right.

The CHAIR: I have not driven an electric bus. Have any of our Committee been in the driver's seat? So you have a brake?

Mr TODD: You have a brake. But if you drive the bus well and in the conditions that we have operated so far, the need of the brake is only to come to a complete stop. You are trying to maximise the regeneration, which puts energy back into the vehicle—

The CHAIR: With the accelerator pedal?

Mr TODD: —by using the accelerator pedal. That also provides a better passenger outcome as well, because if you are doing—

The CHAIR: Less jarring?

Mr TODD: Less jarring, exactly. We found in the surveys that we did with our staff who were driving and operating the buses that they just felt generally more at ease at the end of their shift—less stressful. It was very hard to measure that, so a lot of our feedback was just on surveys and interaction with our staff. But I think the measurable part was, as I mentioned, the number of drivers that switched over to driving electric buses—they were very reluctant to move back to a diesel bus because they just found it more comfortable as an overall experience.

The CHAIR: Just further to that, driver training for transitioning from current buses to electric buses. Do you see a particular time frame for that training period so that they are capable of moving to electric buses and working them?

Mr TODD: Yes. The time to train a driver that is an experienced diesel bus operator to an electric vehicle is realistically somewhere between four and six hours of both theoretical and practical driver training. Then you can obviously have more training as you go along but within that four to six hour period, the majority of basics and increased performance out of the vehicle training is met. One of the benefits of the training is that the higher the calibre of driver, if they are driving the vehicle well and using the accelerator as I have previously described, that will actually increase the range of the vehicle which enables the vehicle to perform at its designed

specification. If you drive an electric bus like you drive a diesel bus, you may not get the full use of the new technology.

The CHAIR: Thank you. Ms Petinos?

Ms ELENI PETINOS: Thank you for your time this morning Mr Todd. I wanted to ask about bus manufacturing in New South Wales which I understand your submission has touched on briefly. In your opinion, how can we support bus manufacturing in New South Wales?

Mr TODD: As I have submitted in our proposal, we have committed funds—both ourselves as Nexport and also BYD—have committed funds to establish a bus assembly leading into manufacturing plant in New South Wales. That site will be a research and development facility. We believe that the next generation of electric buses can be designed and engineered out of New South Wales and that is what we are focusing on. So it is not just manufacturing but it is about research and development. With our connection and relationship with BYD, the facility that we intend on building is heavily focused on research and development and the connectivity with the best minds in this space—being largely out of Asia—and connecting that technology to bring the best technology that is available globally into New South Wales to develop the next range of electric buses.

As far as manufacturing itself, I believe that government realistically can support manufacturing the best way by guaranteed orders for somebody that is bold enough to actually establish a facility in New South Wales. I personally do not have the view that a content percentage is a good path to go down. Reason being, having observed other states and other jurisdictions that have done that, it traps the procurement process to a certain technology or a certain vehicle-type. Maybe using historical outcomes, that has kept the technology from evolving the way it might have done in other countries more quickly than what Australia has done.

I do not support a content percentage but I do support the government engaging directly with companies that are willing to invest money into the state and looking at guaranteed orders. So for example, if the government knows that they are buying—or it has budgeted to buy—300 buses in a 12-month period, why not sit down with a company that is going to set up an established facility in the state and put in a guaranteed order so that company has the confidence and comfort to invest into that facility because they know they are not running a high risk profile all the time of having to wait for uncertain orders. Hopefully I have summarised my views on that.

Ms ELENI PETINOS: Can I just pick up on that? If I understand correctly, part of the argument being put by some of the other witnesses as to the content percentages and how they are working in other states, is that it facilitates the growth of further industry in whichever state we are talking about. So if we are to remove any suggestion of content having any level of percentage in this state, so that we can build on or not limit the evolution of technology, how do you guarantee the growth of jobs in industry in any part of the state?

Mr TODD: It is a good question. I do not think there is a way of guaranteeing that. I think it would just be through the natural process of, if you establish a factory in a certain jurisdiction, you are likely to utilise the facilities that are around you naturally. It is a good question. I do not have a specific answer as to how you would guarantee that. I think also there has been some adjustment to—selectively choosing my words—what actual content has been delivered historically, locally and whether it has truly been a full content locally. So I cannot answer that with a specific guarantee but my belief is that if you establish a plant, and we are looking at regional New South Wales as well so we are looking at Nowra as being—

Ms ELENI PETINOS: That was my next question.

Mr TODD: —where we are looking at. So it would just be natural—

Ms ELENI PETINOS: Sorry, did you say Nowra?

Mr TODD: Nowra, yes. It would be a natural flow for our business to look at what resource we could utilise locally. That would obviously encourage and stimulate local growth without any guarantee of needing to do a percentage because, back to my belief, if you set a percentage of 20, 40 per cent—whatever that may be—the manufacturer is always trying to find ways of justifying their percentage. That would just be the natural outcome of that business. They know they have to meet a certain target and they would find ways to do it. I do not believe that is the best outcome. I think the certainty of that operator, that they know that they have the order and they look to engage as much with local facilities and supplies as possible.

Ms ELENI PETINOS: So let the market decide and let the local operator make the best decisions about what is geographically viable?

Mr TODD: That is 100 per cent correct. For example, if we are looking at windows or seats for example, if we can procure seats from Brazil, China or wherever they may be made, for a certain price and we have to ship them in and they cost a certain amount but a local supplier has the capability to skill up and build a local seat that

matches the overseas product or potentially is better, obviously just natural flow would direct us to that local supplier because they would be more directly, geographically, close but more so just more at hand to provide that after sales service content. I think what you have said is let the market dictate and I think that would be the best outcome.

Ms ELENI PETINOS: Thank you.

The CHAIR: Deputy Chair?

Mr GURMESH SINGH: I noted in your submission that electric buses would be ideally suited to regional areas. What other factors might we need to consider for electric buses in regional areas?

Mr TODD: Infrastructure obviously is key for regional areas. On infrastructure, in many ways in regional areas, it is actually easier to look at alternate solutions. Previously Behyad Jafari had some comments on regional infrastructure. In my view, in a regional area you have the opportunity to look at some direct source energy opportunities. We are currently talking with one entity about putting in Australia's first direct source energy bus trial which is utilising solar, direct into solar batteries, the batteries hold the solar that is captured and when the bus returns in the evening, those batteries put the energy into the bus. That is a completely off grid scenario. In regional areas, those opportunities—because you have a bit more space to put in some more solar panels and a bit more room in general—and technology advancements are able to be enacted. That is one thing I would see for regional opportunity.

Dr O'NEILL: We have heard from other witnesses around the use of the acoustic vehicle alerting systems to improve safety, particularly for those who are impaired. Do you have any thoughts about this? Particularly the inner west trial, this is not on.

Mr TODD: No.

Dr O'NEILL: I am interested to know your thoughts on this.

Mr TODD: My thoughts on this holistically is that in many ways it is defeating the purpose of one of the benefits of electric vehicles if you were to reintroduce some sound to offset the sound that you have removed. I would just take one step backwards on this answer. If we are looking at a city like Sydney, the volume of sound that is coming from the whole fleet of buses is quite staggering. So you walk down George Street or any area, and if you focus in on the noise, the vast majority of noise that you will hear is either construction or buses. By introducing electric buses as a city-wide exercise you will be removing a large amount of ambient noise that is currently there and people do not realise just how noisy it is until we actually take it out.

I spent a large amount of time in a city called Shenzhen in China, which has now got a full fleet of electric buses. You walk through the city and you do not hear or have that same rumbling noise that you have from diesel buses. When you train your ear to that, you notice a significant difference. That is my base: it is a good thing to remove the noise in the first place, but then when we need to look at it is safe to do so, especially around impaired situations, I think we need to have an open discussion and see what is the best way forward.

I think there is a wider problem in general at the moment with people wearing headphones and looking at mobile phones that also needs to be addressed in concert with this discussion. Because it is fine for us to introduce a noise, whether that is a ringing noise or some humming noise, into the vehicle but the wider problem in the community at the moment is people not being observant of the environment around them. I think there is a good discussion to be had. There are technologies that we can introduce into the vehicles, such as a bell or some ambient noise but in theory you do want to get the noise down because it has much, much greater benefit by reducing the noise.

I do not have a perfect solution as to resolving the problem because if you put a bell noise or something then you need to start to think about when do you want that on? Do you need that running all the time? Do you need that only when you are approaching a red light and the vehicle is coming to a stop? There is a whole variant of factors that would need to be discussed. But my personal view is that I think it would be better to not go down the path of mandating or needing some additional noise or alert back into the vehicle. I would look at other ways of just driver training and looking at community interaction with how they interface with roads in general.

Dr MARJORIE O'NEILL: I have just one more question. Has Nexport at all had any dialogue or interaction with groups like the Disability Council or Vision Australia to get their feedback?

Mr TODD: Not as yet, no, we have not.

The CHAIR: That was something that we heard on Wednesday's public hearing—representatives from, I presume, hearing and blind groups that would struggle with something that I think is a great feature with electric buses, the silence.

Mr TODD: Yes.

The CHAIR: Have you looked at the possibility of apps rather than fitting something on the bus that could actually alert a waiting passenger, who is vision impaired, where the phone might vibrate or it might speak to them through headphones?

Mr TODD: Yes. To my knowledge there are apps that are working and in development for that type of awareness. I cannot speak as an expert on that technology but I have seen and spoken to people that are developing that type of technology. In the absence of having spoken to the vision impaired society, I would welcome those discussions so we could find a solution because I do not think there is a perfect outcome just as yet. It is a conversation that needs to be had as part of this transition to electric vehicles.

Ms ELENI PETINOS: I also want to go down the path of talking about the silence of electric vehicles.

Mr TODD: Yes.

Ms ELENI PETINOS: We have covered the app component as being a potential solution for communities who are reliant on noise as a way of interacting.

Mr TODD: Yes.

Ms ELENI PETINOS: But one of the other witnesses put to us on Wednesday that the lack of noise emitted from the vehicles was an impediment for drivers because they found that pedestrian behaviour changed so they felt that it was less safe to drive an electric vehicle, and further to that that it was too onerous on drivers to constantly need to manually ring or signal as a form of alerting pedestrians. Have you found that manually needing to signal is too onerous for drivers? Would that be a potential solution if we wanted to maintain the quieter nature of all-electric vehicles?

Mr TODD: There are two parts of my response to that. First of all, I do not believe that a manual ringing or some artificial noise is a good direction to go down. So, yes, I think that would be onerous on drivers if they had to do that, if they had to enact their core driving responsibilities and then in addition be observing pedestrians and trying to work out who is about to cross or who was not listening and ringing something. That would be clearly an added task that you would not want to place upon a driver.

But the key part that I would like to answer is the buses that I have delivered to the country so far have now reached four million kilometres of operation since 2016 and in the driver interaction that I have had, which is many hundreds of drivers that have been trained on electric buses, I have not had any feedback that they found it harder to drive an electric vehicle and have any added need to concentrate or avert or sway away from passengers. From my personal experience, which is extensive, I have not seen that or had that feedback at all.

Ms ELENI PETINOS: Do you think that perhaps—you touched on this earlier—we need to work on a public awareness campaign if we were going down this path to generally look at modifying the nature of pedestrian behaviour generally, not only in relation to potential e-vehicles but being on phones and just the general nature of pedestrian behaviour at present?

Mr TODD: Yes. I think there is definitely a need to address general pedestrian behaviour more broadly in society. In regards to the public awareness campaign, yes, I think that would be a very wise move. I noticed that the recently introduced light rail in the eastern suburbs has had a public awareness campaign. I forget the slogan: look up, trams about, or something like that, so that would definitely be a worthwhile exercise. There are also other ways that we could look at introducing new alert measures. For example, as a pedestrian, when you press, as you know, you have a bipping noise when people are allowed to cross the road safely when the roadway is green. There could be technologies that we could look at to similarly introduce at bus stops, for example, to alert when a bus was approaching and look at ways of introducing new sounds or new technologies that were not deployed on the bus itself but into public infrastructure such as bus stops or areas where buses congregate.

Ms ELENI PETINOS: Thank you.

The CHAIR: Would you like to make a closing statement?

Mr TODD: No. I would just once again like to thank the Committee. Obviously I am a passionate advocate for electric buses. I have had the opportunity to operate them in fleet size and I have seen the benefits both environmentally and economically so I think the path that the government is heading down is a very prudent path. I would like to be involved in ongoing discussions to see how we can adopt what the Minister has put out there as a target to transition the full fleet. I once again thank the Committee for having these discussions.

The CHAIR: Thank you, Mr Todd. If there is a need for the Committee to send you a question in writing, would you be willing to respond to that?

Mr TODD: Of course.

The CHAIR: And within seven days?

Mr TODD: Yes.

The CHAIR: Thank you, and thank you so much for your time. We appreciate your contribution.

Mr TODD: You are welcome. Thank you.

(The witness withdrew.)

(Short adjournment)

MICHAEL LI, Senior Project Manager (Cities and Policy), ClimateWorks Australia, via teleconference, affirmed and examined

The CHAIR: We have Mr Michael Li on the phone. It is Robyn Preston, the Chair. Welcome, Michael. Before we start, are there any questions about the hearing process that you would like to ask?

Mr LI: No questions from me. Thanks.

The CHAIR: I have our Committee here with me here. I would like to introduce their voices to you, seeing that we are doing a teleconference. To my left I have the Deputy Chair, Mr Gurmesh Singh.

Mr GURMESH SINGH: Good morning.

The CHAIR: To my immediate left I have Ms Eleni Petinos.

Ms ELENI PETINOS: Good morning.

The CHAIR: To my right I have Dr Marjorie O'Neill.

Dr MARJORIE O'NEILL: Good morning, Mr Li.

The CHAIR: We also have several staff members in the room, including our Committee director.

Mr LI: Thank you.

The CHAIR: Thank you, Mr Li. Do you have an opening statement you would like to make?

Mr LI: I do. On behalf of ClimateWorks Australia, I would like to thank you all for this opportunity to take part in today's public hearing. From a climate change and emissions perspective, this hearing is timely, given the New South Wales Government recently released its *Net Zero Plan Stage 1: 2020–2030*. Unpublished analysis that we have done recently at ClimateWorks projects that a rapid transition to electric vehicles over the next decade plays a key role in transitioning to a net zero emissions cost to the economy. Transitioning to electric buses for regional and metropolitan public transport networks supports to some extent all four priorities of the stage one net zero plan, but in particular priority one, which is to "drive uptake of proven emissions reduction technologies" and priority four, which is to "ensure the NSW Government leads by example."

Electric bus trials already underway in New South Wales show that the technology and industry are ready to expand electric bus roll-out. A 2019 study by the International Energy Agency found that around the world policies and targets are essential to stimulating demand for electric vehicles and enabling investment in energy infrastructure to support vehicle charging. We are excited about the potential opportunity for New South Wales to use these procurement processes and purchasing power to drive this change to lower cost and larger social and economic benefit. Thank you. I look forward to responding to questions.

The CHAIR: Thank you very much for that opening statement. I will call on our Deputy Chair, Mr Singh, for a question.

Mr GURMESH SINGH: Thank you, Madam Chair. Michael, would you able to please tell us more about the use of hydrogen and battery electric vehicles as part of the mix of fuel sources in public transport networks?

Mr LI: Yes. With the advent of battery electric and hydrogen vehicles coming into the transport networks, they will most likely be both needing to play a role in transport networks in the future. From the research that we have been doing, both from scenario analysis and modelling that we have done and also research shows the experience of these technologies around the world is that they are likely to play a complementary role. In

particular, what we found is that it is generally accepted that battery electric vehicles are more likely to be applicable for smaller and shorter-range vehicles, particularly passenger vehicles. That would generally include buses as a part of that category, whereas it has been found that hydrogen vehicles are more likely to play a role in applications where there are larger distances and larger ranges needed because of the trade-off between range and that leading to larger battery sizes. Also, where there is rapid refuelling, that is required as well. So we would see hydrogen potentially playing a role in applications like in potentially long-distance freight where there are heavier payloads that are required, where battery electric vehicles may not be the most economic way of meeting those ranges.

Ms ELENI PETINOS: Good morning, Mr Li, and thank you for making yourself available this morning. Can you please comment on the potential use of electric buses in metropolitan and regional areas and the issues that need to be considered before rolling them out across the state?

Mr LI: Yes. There would be distinct considerations for metropolitan and regional applications for electric buses. Some of those will be related to electricity infrastructure, the availability of electricity and the strength of the electricity grid at the location. That would vary for different locations such as between metropolitan and regional areas around different parts of New South Wales. That would need to be a consideration.

Also, I guess, the availability of depots and en route charging opportunities between metro and regional areas will need to be considered as well. Finally, I would say that the range issue as well in terms of potentially the different ranges of different bus routes between metro and regional areas, but also equally within metro and within regional contexts would need to be considered in the determination of what sort of technology is appropriate.

The CHAIR: Thank you. It is Robyn Preston here. In relation to batteries for electric buses, we have heard from other witnesses about the ability to recycle those batteries to other areas but once that life span has expired and the battery needs to be disposed of, what are your thoughts on the best practice of doing that?

Mr LI: That is an issue of ongoing conversation within the electric vehicle industry. It is a rapidly evolving one. Just late last year globally the World Economic Forum agreed to best practice standards and best practice approaches to dealing with the whole-of-life issues around batteries, including both upstream in the supply chains and where materials are procured from but also what happens with them at the end of life. There are examples around the world of where batteries for buses but also for battery electric vehicles in general, including passenger vehicles, including cars, have defined application to be reused when they reach the end of their useful life in a vehicle—for example, in a building, in a house or maybe in commercial retail applications.

There are some examples of 7-Eleven stores in Japan where they are using old battery electric vehicle batteries to run their refrigeration systems. There are examples of manufacturers around the world that are looking at how they can use the recycled components that are in batteries once they reach the end of their useful life in building applications to feed into new batteries being produced. It is an ongoing conversation globally across the supply chains—different parts of the battery supply chain—to try to play their role in managing those end-of-life impacts.

Dr MARJORIE O'NEILL: Mr Li, you have spoken about the need for infrastructure requirements but you have also touched on policies and targets that are essential for a transition. Is there anything else that you think that New South Wales needs to do or should be doing to support the uptake of electric buses? Is there anything in particular you can think of that might even be quite specific?

Mr LI: Yes. I guess there are a range of complementary issues and challenges and barriers to electric vehicle, electric bus uptake that would need to be addressed in complement to a specific target on procuring electric buses. These are challenges that could be addressed within procurement processes and standards that New South Wales implements and run in parallel with its electric bus procurement target. One example of that would be some of the issues that have been mentioned earlier in the hearing around the safety issues of buses interacting with pedestrians because of their silent nature.

But also complementary standards and investment strategies around our charging infrastructure as well because currently in Australia, what we have found from our research, is that there is actually uncertainty about who is responsible for funding, building and operating charging infrastructure in Australia. So if the New South Wales Government would complement any procurement target for electric vehicles, electric buses, with programs to potentially plan for and invest in potentially charging infrastructure, or at least some sort of standards for who takes responsibility for that, that would help to address some of the barriers and challenges that are faced in the broad uptake of electric vehicles.

The CHAIR: Thank you. Deputy Chair?

Mr GURMESH SINGH: Just changing tack a little bit. What factors should be considered when transitioning to electric buses for passengers with a disability?

Mr LI: Those accessibility considerations, probably specific considerations around them are probably a wider scope than we have looked at from an emissions perspective. But I guess some of those considerations that have been discussed before around managing interactions of electric vehicles generally with pedestrians with vision impairments would be an important consideration. Those are factors that could potentially be considered in standards or procurement rules that are put in place by the government to make sure that those are addressed.

Ms ELENI PETINOS: Mr Li, your submission clearly focuses on the environmental benefits of the introduction of electric buses. Are there any other benefits of electric buses that you would like to add for the Committee's benefit?

Mr LI: You are right in noting that. At Climate Works Australia—it is in our name now—our primary focus is on emissions.

Ms ELENI PETINOS: Completely understood.

Mr LI: Some of the other benefits that we have found in our researching experience of electric buses around the world and in our suburbs are around reduced costs, improved air quality and also the opportunity to support local industry. If I start with the reduced cost. There is analysis—quite extensive analysis—mainly out of the United States by Bloomberg New Energy Finance that finds that even based on today's prices, electric buses are already cost competitive with conventional diesel buses when considering their operating lifetime because of their lower operating and maintenance costs.

Even though upfront electric bus costs remain high today, it is predicted that by 2030 even the upfront costs of electric buses would be comparable with diesel buses because of the fall in battery prices. But even based on today's upfront costs, that study found that over the lifetime of an electric bus it can be cost competitive with operating a diesel vehicle.

In terms of air quality, obviously removing diesel buses from the roads would eliminate that source of nitrogen monoxide emissions which has been known to result in poor health outcomes. The Electric Vehicle Council mentioned their study on health benefits earlier today. There is also another study from New York City that found that replacing one diesel bus with an electric bus would save \$150,000 per year in reduced health care costs. So it is a pretty significant saving in terms of public health.

In terms of local industry, there are some examples in Australia of organisations like Precision Buses and Volgren that have just started their journey, their transition towards manufacturing and assembling electric buses, I think in Volgren's case using components that are manufactured in China but assembling them in Australia which tells the story of potential support of local industry and support of local jobs in the state.

Ms ELENI PETINOS: To follow up on that if I may, do you have any views on whether or not there should be a local component target as part of any contracts that may be awarded in the future should electric vehicles proceed as a more regular part of the transport mix in New South Wales?

Mr LI: That is probably more of a question to the broader economic policy beyond our environmental considerations that we have looked at. I would say that if those sorts of standards help to improve the economic viability, it will improve the case for introducing electric buses and rolling out electric vehicles which, from our modelling, is key to reaching net zero emissions, then that should certainly be considered. But we do not have any specific recommendations on what that would look like and what is appropriate.

Ms ELENI PETINOS: So in effect, you are keen to see it proceed. What we decide to do in that space, you do not have any specific recommendation as to manufacturing or components or any of the economic modelling, just a general message to us about the necessity to introduce electric vehicles in New South Wales?

Mr LI: Yes, that is right. There are obviously enablers to that, part of which would be the opportunity to grow local industries and that is the key enabler for a lot of the transition to net zero emissions that we are finding beyond even electric vehicles. We see the importance of supporting those broader enablers but we do not have any specific recommendations on what they should look like.

The CHAIR: Mr Li, I am interested to hear your opinion on my question. It relates to the current system where buses we use attract a tax for fuel and how you see that may be interpreted with a new fleet of buses with electric operation?

Mr LI: It is a great question and I guess it is an issue that impacts on the broader transition to electric vehicles beyond electric buses, that broader kind of fuel excise and taxation issue. Again, we do not have any specific recommendations on that. We do recognise that there are some pieces of research by groups like

Infrastructure Partnerships Australia and the Grattan Institute around pricing mechanisms that can support transitions in our transport system and better manage our transport infrastructure. One of the trends they look at in research is around the transition to electric vehicles and reduction in fuel excise. But from our research and from the analysis that we have done, we do not have any specific recommendations around what the mechanism might be for managing that shift from a petrol-based, diesel-based fuel excise to a potential alternative.

The CHAIR: Thank you. Any further questions from the Committee members? Do you have a parting comment that you would like to make, Mr Li? We have no further questions from the Committee.

Mr LI: I guess I just want to reiterate our support and excitement for this process from an emissions perspective and from an environmental perspective and we look forward to seeing how the conversation progresses.

The CHAIR: Thank you for participating today. We may send you some further questions in writing. Your replies will form part of your evidence and they may be made public. Would you be happy to provide a written reply to any further questions if that does happen?

Mr LI: Yes.

The CHAIR: Thank you and we ask that if that is the case that you respond within seven days of receiving that written question.

Mr LI: Yes, that is fine.

The CHAIR: Thank you very much for your participation today. You may now leave the conference call.

Mr LI: Thank you.

(The witness withdrew.)

(Luncheon adjournment)

GUY MARKS, Principal Investigator and Lead, Centre for Air Pollution, Energy and Health Research, via teleconference, affirmed and examined

ANNA NADOLNY, Research Officer, 100% Renewable Energy Research Group, Australian National University, affirmed and examined

KATELYN MARIE PURNELL, Centre for Energy and Environmental Markets, University of New South Wales, affirmed and examined

IAIN FERGUSON MacGILL, Associate Professor, Joint Director (Engineering), Centre for Energy and Environmental Markets, University of New South Wales, affirmed and examined

The CHAIR: I invite the witnesses to make a brief statement of up to two minutes. I have three members with me in the room. Do you want to make a statement?

Ms PURNELL: I am a Phd candidate at the University of New South Wales and my interest is in electrified transport and how it impacts the electricity grid. I am here today with my colleague Dr Iain MacGill and we are representing our centre that looks at energy and environmental markets. We would like to commend the New South Wales Parliament for this initiative. We are in support of electrification for New South Wales bus fleets for a myriad of different reasons which are outlined in our proposal that I will not go through right now. But something that was not mentioned in there is, in a general sense, electric buses give us opportunity to reframe the discussion around electric vehicles being something that only the elite driving Teslas in Sydney can afford. Moving towards electro mobility is for everyone.

Our key point in our submission is that we need to co-ordinate the two planning regimes of the electricity and transport sectors in a way that we have not done significantly before. Battery electric buses are a new major load in our distribution grid and it could add 0.50 per cent to 4 per cent each year in the annual electricity demand in New South Wales. But noting that this is a transition and it will happen over a number of years while we are also transitioning our electricity grid to more and more renewable energy. There are some challenges, of course, but we do not see them as insurmountable. But we would like to highlight the need for communication between the two sectors in order to plan charge scheduling design and coordinate the location of the depots and the charging infrastructure.

The CHAIR: Dr MacGill?

Dr MacGILL: I am one of two directors of the Centre for Energy and Environmental Markets. One is from engineering, which is my background, and one is in the Australian School of Business, but we work in an interdisciplinary way. We work with other faculties: Arts and Social Sciences, Law, Built Environment. Our aim is really around clean energy transition in market-oriented energy sectors, such as New South Wales and Australia and most places. We work right from the engineering through to policy. The key part of this, of course, is even in market oriented energy sectors, the thing we know is that government direction is so key. They are too important to just to leave to markets. We are seeing some other areas right now as well.

We focus very much on the integration of renewables. Electrifying the bus fleet in New South Wales is really an enormous opportunity to help us better integrate renewables. It comes to the point made by Katelyn Purnell, and I suspect Anna Nadolny will also make, that you can do this well or badly and the results of carefully integrating electro mobility—buses, vehicles and more—with higher penetrations of renewables can be a very powerful synergy. If we get it wrong, as is always the case, we can just be making difficulties for us down the line. A key part of our challenge right now is just to make sure we get it right. We, and other groups, really see that as a key role that we are hoping to contribute if the New South Wales Government takes this forward.

Electric buses would, sort of, fall under what I guess we would call distributed energy resources. They are big vehicles. They have quite significant battery storage in them. They are quite significant demand, particularly, as you may have seen in our submission, we talk about charging need for depots and so on. But they fall into distributed resources and as such they are really part of a broader picture as one in four households in Australia put a photovoltaic [PV] system on the roof and a growing number put in batteries and we see in industry, commercial places all looking to increase the flexibility with which they take electricity. Electric buses are an enormous flexibility option. They have got large batteries. We have got a sizeable fleet and the way we use them can be very positive in helping us manage growing renewable penetrations.

Finally, we do not do a great deal of work in transport. We do have links to the through electric vehicles. There is a smart transport group at the University of New South Wales and we do work with them in the electric vehicle space. But for broader matters around energy security, I am certainly hopeful that you are hearing from panellists who are dealing with this — obviously COAG is actually meeting and fuel security is one of the topics - and electric buses present fantastic opportunities there. And then more broadly again, it is just great to see this meeting still proceeding. Time management is everything. We are always telling our students, "You have got to keep working on the important even when there is urgent or else the important but less urgent gets dropped." So it is great that this work is continuing, I think that is fantastic. It is obviously an important fit within the broader New South Wales Government plans that we have seen announced recently which are really looking to take a leadership role. We are learning many lessons from COVID-19, but clearly one of those is the role that government can play in providing leadership.

Ms NADOLNY: I work as a research officer in the 100% Renewable Energy group at Australian National University [ANU]. We look at not just electricity but also the next steps after that including the transport industry, everything; even looking at new feedstocks instead of fossil fuels, moving to hydrogen, moving to other bits and pieces like that. I would like to completely agree with what Ms Purnell said about making electromobility more open to everybody, this is really a question of equity not only from a health point of view but also sharing the benefits of the electric transition that we are seeing. Solar and wind photovoltaic costs have fallen so dramatically over the last decade that we are at a point where new build solar and PV is competing with new build coal and other fossil fuel plants. We are at a stage where we can see a future national electricity market that is entirely renewable for a similar cost.

Our research group at ANU took our model of the national electricity market and put in all land transport to be electrified and saw that there was really not a significant increase in electricity price at a wholesale level, and that if we were to use the demand management and new technologies we could bring that price down even further. I would like to highlight that Australia's liquid fuel security is not in a very good position. We currently import more than 90 per cent of our liquid fuel and so we are very dependent on other countries and the broader international market. We also can see a future where all of the refineries domestically will be closed so relying on those supply chains means that our prices are dependent upon international events, but also dependent upon what other countries are going to be doing in the future. For example, Singapore has just announced in February that it will be looking at not having any internal combustion engine vehicles by 2040. That includes all of the used stock and it will be interesting to see the impact that that then has on our fossil fuel imports given that so much comes through Singapore.

Professor MARKS: I am Guy Marks. I am here in behalf of the National Health and Medical Research Council Centre for Research Excellence on Air Pollution, Energy and Health Research. I personally am a

respiratory physician and an environmental epidemiologist, so you can imagine we have been living in interesting times starting with the bushfires and now with COVID-19. Lots has been happening but I also am pleased to see that this inquiry is still continuing. We come from a health background to this and the major point of our submission is really that there are co-benefits of the transition to non-fossil fuel-based sources of energy for transport including buses. Those co-benefits include improved air quality. We want to commend the concept of moving to electric vehicles including electric buses and point out that it is not just the carbon pollution reduction benefits that are achieved but also the improvements of air quality.

Any reduction in particulate air pollution, any improvement in the air quality can be predicted to have substantial benefits for health including reduced mortality and reduced hospitalisations for heart disease and possibly also of lung disease. Of course those benefits are contingent on the source of electricity being a non-fossil fuel-based source of electricity as the other speakers have mentioned. We need to make sure that we are not simply transferring air pollution from the streets of the city to the areas where electricity is being generated by coal-fired power stations.

There are other benefits of course of bus-based or large vehicle-based transport. One of those is less vehicle kilometres travelled in total. It actually also probably increases the extent to which people walk and do physical activity because if you are taking a bus as opposed to a private vehicle you are more likely to have to walk at least some distance and that physical activity also has health benefits. There are a range of health benefits that can be expected to follow from this initiative and we support it.

Dr MARJORIE O'NEILL: My question is firstly to Professor Marks but I would also welcome contributions from the other academics in the room. We have heard that the energy sources from electric buses is an important consideration not only in terms of pollution and the overall health benefits. In your submissions you make particular mention about a correlation between investing in electric buses and physical activity. I would like to hear more about this and your views more broadly as well.

Professor MARKS: I would not necessarily link this to electric as opposed to other buses; it is a question of as opposed to private vehicles. As I was just alluding to, I think the issue is that if people are using public transport they have to at least walk to the bus stop rather than just down to the garage. So it is likely that there will be increased physical activity and that increase in physical activity is likely to be of benefit, but I do not think there is any mechanism by which the electric vehicle buses as opposed to other buses will increase physical activity. I am sorry if that was misleading in the report.

Ms NADOLNY: I would suggest that there would be an improvement with electric buses as opposed to conventional buses because of not having the diesel fumes that you need to walk through in order to walk to the shops. It would make me more likely to walk to the shops rather than doing bigger shops fewer times a week. It does make the streetscape so much more pleasant if you do not have the noisy buses—and let us be honest, the smelly buses—to walk past. I think personally—and this is anecdotal rather than a proper study—that there could be an increase in physical activity.

Dr MacGILL: The way that we talk about it and are modelling in our group is that we use the term "electromobility". It did start with electric vehicles, that is personal passenger cars, and now obviously we are seeing great activity, like commercial fleets and buses are seen as a real opportunity. But electromobility really does go down to those scooters and beyond, which New South Wales is currently thinking about what the rules might be for them. What we could envisage in the future is electric buses as part of a broader electromobility, where people might be using scooters or who knows, my students like the electric skateboards, to actually be feeding into public transport. In some ways, that certainly may assist in the use of electric buses and public transport more generally. As for the health impacts, there is a bit of tension there, isn't there, between having your scooter carry you effortlessly to the bus stop versus actually pushing, but it is part of this broader story. I think it is potentially going to be quite complex, but in the general sense, getting people out of their cars is a good thing.

The CHAIR: I am just going to ask Ms Purnell for a comment on that question.

Ms PURNELL: Just a small comment relating to the cross-modality of transport. This is not particular to electric vehicles but while we are procuring new buses, putting bike racks on the front or the back of buses like they do in Canberra might add to that cross-modality, and if it is a bicycle rather than, say, an electronic scooter, that might help the physical activity.

Mr GURMESH SINGH: I found that to be really interesting, considering you are right that in Queensland the electric scooters seem to have a far bigger take-up because they are unregulated up there. Do you think looking out 10 or 15 years that we might see far more people using those point-to-point, individual types of transport? Will that perhaps see a reduction in the need for as many bus routes as we have now, where people might be able to do the first three or four kilometres of a journey on an electric scooter whereas to walk that

distance now might be too long of a walk, but if you had an electric means—and therefore improving public transport?

Dr MacGILL: It is difficult to know how this will all play out. I think perhaps I, and I imagine some of you, may have visited cities where those scooters seem to be everywhere right now.

Mr GURMESH SINGH: Brisbane.

Dr MacGILL: Brisbane and through Europe. We will see how that plays out, but it certainly speaks of an opportunity, does it not, where we do move to being able to go further distances on small private transport to then use shared transport. How exactly it plays out I do not know, but my suspicion is those scooters are only getting cheaper and better with longer range, but unregulated is probably not the right way to do it because people soup them up and things like this. We need to make sure that vulnerable footpath and other users of public space are protected. But yes, there is a big opportunity here, is there not, to re-envisage the way that we do transport in an urban environment.

Mr GURMESH SINGH: It is what Segways were supposed to do when they first came out. That was their marketing.

Dr MacGILL: They were \$14,000 and weighed more than you could lift. We have moved in very positive ways since then.

The CHAIR: Would the other two ladies in the room like to comment?

Ms NADOLNY: I have seen charts showing the uptake of electric bicycles, rather than electric scooters. They are just going all over the place, especially in Europe. That might be the mode that sees more growth, because they are a bit more robust, they can handle different terrain a little bit more easily and they are also—I am not sure, but they seem more safe. I have not seen any statistics on that. That might be another way in which the electric transition really takes hold. That would be more comfortable to traverse four kilometres on, rather than a scooter or skateboard.

Ms PURNELL: I agree with what these two people have said. Back to your original comment, though, about whether that will displace bus routes, I would argue that public transport is absolutely vital for society, particularly for people who have mobility issues and cannot use these more small mobility measures, and also as a provision for wet weather. Personally, I will not ride a bike in wet weather; I know some people will. I believe there is always a very strong argument for public transport.

The CHAIR: Another issue that I have seen is that pedestrians feel they have a right of way on a footpath, so they feel that electric scooters are encroaching in that territory as well, and the safety of elderly people with walkers and canes and prams as well. There are issues about sharing the pathways that we have to deal with. Professor Marks, did you want to make any further comment on that?

Professor MARKS: No, I do not think I have anything more to contribute on that point, thank you.

Ms NADOLNY: Could I please make a further point?

The CHAIR: Yes please, Ms Nadolny.

Ms NADOLNY: Just on what Ms Purnell was saying about wet weather, there is also the changing climate to be aware of. If we are having more hot days then it might not be physically comfortable to take a scooter to the train station instead of taking a bus. Rather than taking away bus routes you might need to increase them so that people can safely travel around the city.

The CHAIR: Thank you. Professor Marks, it is Robyn Preston here. We talked about accessibility for different people. I am looking at the opportunity to cater for disabled, vision-impaired people who have made submissions and have spoken at this public hearing only on Wednesday. I would be interested to hear the comments and thoughts of each of the witnesses in relation to how electric buses could provide safe passage for those who are vision-impaired, because they raised the issue of not knowing when the buses were approaching because the buses were so silent, or which buses. Some drivers in trials had turned off any notices when they were on the bus about which bus stop they were approaching. There were issues that were raised and I would be interested to hear from the witnesses today how they think that might be dealt with.

Ms PURNELL: I do not have a lot of knowledge in this area, for starters, but reading through some of the submissions that were quite excellent from the vision-impaired groups they were suggesting that there is some kind of sensor technology that might be able to alert people at a bus stop when a bus is approaching, which seems reasonable. Unfortunately I cannot really comment further than that. As for announcements on the actual bus, I was lucky enough to be on an electric bus the other day and it had an announcement system about which bus

stop you are approaching, just like in the new light rail, which seemed to work quite well. I note that our current bus stock does not have any announcements at all.

The CHAIR: Thank you. Would any other witnesses in the room like to comment?

Dr MacGILL: I might just make one comment, which is that we certainly see the quietness of electric buses as an advantage, but you are absolutely right—as were those submissions—about the potential safety implications of it. I think what we are seeing with the introduction of electric buses elsewhere is it is also a chance to revamp the smarts in buses as well. It does not need to be an electric bus to be providing the sort of information that Ms Purnell was saying they now do provide, but revamping the fleet is an opportunity to do that. We are certainly seeing in China and elsewhere that of course you add these smarts. It is part of re-envisaging the way buses operate. But yes, we will need to get that right.

The CHAIR: And the issue with people on their smartphones and looking down at their mobile phones as well—not just vision-impaired?

Ms NADOLNY: I have not seen any data on this, but it does seem sensible to have some sort of noise on the bus itself that was low enough that it would not impact people in a residential setting but it was such that vision-impaired people could hear it as the bus was travelling down a street or what have you.

The CHAIR: Thank you. I invite Professor Marks to comment.

Professor MARKS: Again, I do not think I have anything useful to add to that. I think obviously it is an issue that needs to be addressed by those who have expertise in that field.

Ms ELENI PETINOS: Good afternoon everyone, and thank you for making yourselves available this afternoon and for your submissions. Just having a look particularly at the submission from the Australian National University, I was interested in just fleshing out a little bit more information about the electricity grid and your comments that we require a new flexible load. We have dug into a lot of comments quite a bit, but we have not explored this one perhaps as much as you have got in your submission. Would you like to share some of your observations with the Committee?

Ms NADOLNY: New wind and solar, whilst being quite easily predictable, is not very flexible in terms of when it is generating and when it is not. It is very helpful for the grid to have load that the market operators can say, "Now is the time to charge, now is the time to switch on, now is the time to switch off as well", so that those new renewable generation technologies can make up a larger percentage of the overall generation whilst taking into account the limitations that they have. Having a load that you can switch on and off in that way also means that you do not need to install as much storage, which can often be quite expensive for the grid. We had an image showing the generation in South Australia, which is the huge increase in solar energy that is generated during the middle of the day. That generation kind of suppresses what the market operators are seeing in terms of the load on the grid. That can get quite difficult as that load approaches zero or even negative loads. In order to run our grid we do need to be moving towards more dispatchable demand.

Ms ELENI PETINOS: Did any of you have any specific comments around hydrogen and the availability in the market of hydrogen as a fuel source compared to other forms of electric energy?

Dr MacGILL: If I might, but I would also like to provide a quick comment on that. The utilisation of our electricity networks is a really key opportunity, because we have demand that only runs sometimes. The demand that applies to our network is quite peaky and that means there is actually a lot of available capacity on the network as long as we add new loads, such as electric buses charging, at the right time. That can be around what other loads are doing, not the evening peak when everyone is getting home and starting to cook and so on but also with PV during the day. Already we are starting to see issues with PV generation on rooftops and the challenges it is raising. Seven megawatts of load is a really valuable opportunity to balance supply and demand. Just as a rough order of magnitude, for 1,000 electric buses, the battery storage in them is more than the Tesla big battery in South Australia. This is quite a substantial resource potentially we are talking about. It is a big battery—it is 1,000 smaller batteries, but it is a big battery overall. In terms of hydrogen—

Ms ELENI PETINOS: Before we get to hydrogen, whilst I am very interested in hydrogen, you made an observation that made me think about charging infrastructure. Because you are talking about the peak in the grid at various points of the day, does that mean that you would have a preference for certain types of charging infrastructure over others—say, at stop or at destination charging as opposed to depot charging, which may coincide with peak periods in the grid ordinarily?

Ms PURNELL: I think the answer is not immediately clear, which charging regimes and whether we go 100 per cent charging depots or whether we go a mixture of opportunity charging at stops or terminals, as you said, or fully opportunistic charging. As others have discussed, we want to be moving charging demand outside

of the peaks, so outside of the four p.m. to 10 p.m. window and the morning peak as well, and moving it into the middle of the day or to overnight. With depot charging we can definitely do overnight if we have some kind of control management or we incentivise them with tariffs. With charging in the middle of the day, they might also be incentivised by tariffs, but perhaps there is opportunity for opportunity charging as they travel throughout the day or, indeed, as the technology gets there, putting photovoltaics directly on the bus. But that technology is not quite there yet.

Ms ELENI PETINOS: Can we go back to hydrogen before I share with my colleagues?

Dr MacGILL: It is interesting with hydrogen transport, because there was a lot of discussion—I am old enough to remember the late 1990s, when it was all going to be hydrogen-fuelled cars and fuel cells and so on. I think what has happened in the two decades since is batteries got better faster than hydrogen did. Having said that, hydrogen has been making steady progress in technologies for making it, storing it and utilising it. I think there is pretty broad agreement now that there are some areas of transport where batteries may struggle—long-distance freight being a very obvious example—and where hydrogen might be a particularly good energy storage technology. It is important to note that you can burn hydrogen directly in combustion engines, but now the thinking really is, if we are talking about hydrogen vehicles, they are really electric vehicles with hydrogen on board as well and a fuel cell. Let us see how those two options play out.

There are some things we are pretty sure batteries will not do well—long-distance freight, shipping would be problematic—and you could envisage a strong hydrogen role there in the medium to longer term. There are other things where batteries look pretty good, and we will need to ask the question: would we want to take on the additional complexity of adding hydrogen?

The CHAIR: Professor Marks, would you care to comment?

Professor MARKS: Again, I do not think I have anything useful to comment on this.

Ms NADOLNY: Just in terms of hydrogen and costs coming down, we may find over the next decade or two that other uses, such as feedstock for industry and particularly ammonia, and also hydrogen for our steelmaking without the use of fossil fuels, will mean that the costs to produce hydrogen, to store it and to transport it might come down. Then hydrogen fuel cell vehicles may become much more competitive, but as it is batteries are the go.

Mr GURMESH SINGH: I just want to expand on that topic. Some of our witnesses on Wednesday mentioned that hydrogen seems to be where the future is going but that will not be for another two decades or so. Where do you foresee the race between batteries and hydrogen looking 20 years out?

Dr MacGILL: It is our usual challenge of trying to get a sense of what technology is going to look like in 20 years. If we go back to 2000 and try to get a sense of what we see now, the iPhone was in 2007—was it not—and we see that it can move very fast. The thing with hydrogen pretty clearly is that what we would call the round trip efficiency of modern batteries is far better than hydrogen, turning electricity to hydrogen and then hydrogen back to electricity. It is much more efficient with the batteries. For short-term storage, if we are talking about storing hours of energy, I think batteries definitely have that. For longer term storage, if we look at Europe, they are looking at trying to store renewable energy seasonally between their very extreme summers and winters. That is not a job for batteries and so hydrogen storage is seen as a really great opportunity there and the storage is much lower cost than the batteries for that period.

It is going to depend on a wide range of factors. I think Ms Nadolny's point about integrating hydrogen into, let us say, regional development more generally and the whole range of applications we already have for hydrogen—making fertiliser, making explosives, formic acid and a wide range of other uses—that is a really interesting opportunity. Then you could envisage we will have a hydrogen energy sector and an electricity energy sector and we will be seen working across both of those sectors. That is going to be great, obviously. It is going to give us much more flexibility in the future about how we might choose to do all the things we want to do.

The CHAIR: Ms Purnell, would you care to comment? I want to give everyone the option.

Ms PURNELL: Thank you, I appreciate that. My take on hydrogen is that it is something to keep an eye on, but for right now, if we are considering transferring our fleet, electric is the go, as other panellists have said. Even if in, say, 10 years hydrogen becomes very, very attractive, I do not think having battery electric buses that we implement now will be a sunk cost. They will still be great technology and they will still be in service. Then, if we are flexible enough with our planning, we can introduce hydrogen. I think that would be best.

Mr GURMESH SINGH: Just to be clear, my question was not around one versus the other for now. As governments, we are looking a decade or two out and I can see that there would be a transition. Both are electric vehicles and it is just a power source. I just wanted to add that clarification.

The CHAIR: Ms Nadolny?

Ms NADOLNY: I do not have anything to add at this stage.

The CHAIR: That is fine. Professor Marks, would you care to comment?

Professor MARKS: No, nothing from me.

Dr MARJORIE O'NEILL: Can you comment on the differences, challenges and opportunities for metropolitan and regional areas in terms of the transition of buses? We have touched on things like regional development. Is there anything more broadly outside of that?

Ms PURNELL: I think you would have to look more in depth at the different transport patterns of buses in different areas. If we talk about the cities, I think that cities are a great spot for electric buses because we have a lot of stop-start driving and high duty cycles, which make the electric technology almost perfect. In regional or rural areas, the bus might travel a much longer distance. In buses, the battery capacity can range between 100 kilowatts-hours and 400 kilowatts-hours. We have a wide range. We might start looking at different buses with higher batteries or different ways that we can schedule these buses so that instead of the bus driver getting a 15-minute break every X amount of hours, there is a slightly longer break, so you get more charging in. But I think you would have to dive into the detail for specific use cases to make a good comment on that.

Ms NADOLNY: It would also depend on the specific town and the specific region. For example, Tingha in north-western New South Wales would have a very different distribution network, and probably also uptake of solar PV, amongst the residents than, for example, Armidale or Tamworth would. That would have a big impact on the decisions that you would make and whether you would need network augmentation in order to be able to charge the bus, and also what extra generation capacity you might need to keep it going. Then, of course, there are the variable distances between the different regional routes and whether or not they are travelling on the highway. The speed would impact the necessary battery size.

Dr MacGILL: I think one of the things is that diesel buses work very well on the open road but do not work particularly well in cities. Professor Marks may want to pick up on this, but the air pollution benefits are clearly greater if the buses are being deployed in more built-up environments. I will just make one more point. I think there are some great opportunities to show regional leadership. We see particular towns taking something on. You could really envision a strong community engagement driving that forward. But I would say that when you are bringing new technologies in, there are sometimes advantages to making sure that you are fairly close to infrastructure in the sense of expertise and so on. There are some advantages to not bringing new technologies out in the middle of woop woop just because there is a learning curve as people work out how to make it work, get parts, get supply chains going and get people trained up. That might be another factor. Having said that, there is an extraordinary flexibility to this. The experience we are seeing with electric buses is that there is a very high level of reliability; the same thing we have seen with electric cars. They go to the service and they refill the washer fluid or something. There are some opportunities there. But the range is a very big issue, as well as the duty cycles.

Ms PURNELL: I just want to make the distinction between buses in regional towns versus buses that transverse between regional towns. I was in Broken Hill last weekend. It is a fairly small town and geographically, it is completely isolated. But the bus service within that town pretty much stays within the town, which is six kilometres by six kilometres. In that case I see no difference between putting an electric bus in there versus putting one in the city. There might actually be some co-benefits for the electricity sector. Thinking through the New South Wales Government plan for renewable energy zones, particularly in regional towns, suddenly we are going to have a lot of new generation in places that did not traditionally have a high load. If we increase the load by putting in electric buses or otherwise, we might actually be able to improve the utilisation of the grid in those areas.

The CHAIR: Thank you. Professor Marks, would you like to comment?

Professor MARKS: I just echo the points that were made. The co-benefits for air pollution are going to be greatest in built-up areas where the buses are travelling near where people live. In more remote areas those co-benefits will not be so great. Of course, the carbon pollution reduction benefits are not related to the urban environment. But the co-benefits to air quality and health will relate to the proximity to where people are living. That will include, as has been mentioned, regional towns. But not, perhaps, travel between towns.

The CHAIR: I hear you. Thank you very much. Are there any more comments on that from the witnesses?

Ms NADOLNY: The noise benefits might actually be higher in regional areas. For example, in my hometown of Armidale, it is almost shocking when a car drives past, let alone a bus. So that benefit—

The CHAIR: Resonates more?

Ms NADOLNY: Yes.

The CHAIR: I wanted to look at a practical situation. Let's say we had an electric bus with a very large battery capacity that had been used during its run and needed recharging. What amount of time would a vehicle like that need to be charged for?

Ms PURNELL: Of course, that depends on the battery size, how much it was used and what kind of charging infrastructure you use.

The CHAIR: I accept that.

Ms PURNELL: I have got the chart somewhere. If we are talking about the slow charging for the 22 kilowatt rate, it could be six to 10 hours to do a full day's route. But that is considered fairly slow in terms of electric bus charging. Something more suitable might be 50 kilowatts, which would be half that time—so three to five hours. Indeed, there is rapid charging from between 100 to even 300 kilowatts, which could take well under an hour.

The CHAIR: Based on that, it is important to establish acceptable charging stations that could cater for different levels of ability of charge.

Ms PURNELL: Yes. It also comes back down to how you design the schedule for each bus each day. If you want the bus to be able to run at full capacity all day you might have to use some of those fast chargers that are over 100 kilowatts. There may be opportunity chargers along the route. If you have buses that have less overall distance to cover in the day, you could get away with slow charging them overnight. That is potentially kinder on the grid. But it really depends on the individual bus route that you electrify.

Dr MacGILL: Buses are pretty good for holding batteries because they are big. You can put a lot of batteries in them. In some ways it is an economic trade-off when it comes to how much you spend on batteries and how much flexibility you get for that. Having said that, because of the nature of the way buses get used, the depots and the routes—they are not going to disappear somewhere there is no charger—we can design quite carefully around the route. That tends to say that you can perhaps go with smaller batteries than with, by comparison, cars. It is a bigger battery but compared to the size of the vehicle it may be smaller.

With the charging, the modern chargers can be extremely flexible so if you have got time you can charge slowly and if you are in a hurry then you can charge faster, and of course if we are thinking about a depot or something there are multiple buses so we are thinking about the way there are multiple buses and the way they might be charged in parallel at the same time, or slowly, or really bringing some vehicles back to full charge very quickly. We have got a lot of opportunity to really do charging in the way that is most valuable to us, that works best for the buses' role as transport, but also for the grid. That flexibility is very valuable and it may change over time. We can envisage that we are going to end up charging buses differently when it is sunny to when it is not sunny. It is entirely conceivable.

Ms NADOLNY: I completely agree with everything that the panellists have said and would add that there is even flexibility in the future as battery technology improves to, say in 10 years, to take those batteries that have been used out of the buses and leave them as stationary storage that can then be recharged. At that point you would put more cost-effective new batteries into the vehicles and that would then mean you would not need to augment the network in that area but you would be able to do fast charging straight to the batteries in what could be quite a cost-effective design. I think BMW, Nissan and other companies have been doing that with their electric passenger vehicle batteries already. There have also been ferries in Norway that use a similar set up. There is so much flexibility here.

The CHAIR: Professor Marks, would you care to comment?

Professor MARKS: Nothing further from me.

The CHAIR: I might ask if Ms Petinos would like to ask a question and I will give the option for answers to Professor Marks first.

Ms ELANI PETINOS: I might go to the deputy chair because I know he is very keen for a question.

The CHAIR: We will see if Professor Marks would care to answer the question. Let us wait and see.

Mr GURMESH SINGH: Over the past 18 months or so the state government has been trialling driverless buses. We had one in Coffs Harbour, we had one in Armidale as well. I am keen to hear everybody's thoughts on whether they think electric buses will make the transition to driverless buses easier and how that might happen?

Professor MARKS: Thank you for giving me the opportunity but I am going to pass on it.

The CHAIR: You might care to wait for the others to answer and you can respond after that.

Mr GURMESH SINGH: I thought this one might be for Dr MacGill.

Professor MARKS: I will answer questions about health but I am not so good on the technical questions. I will be very happy for the other panellists to answer those questions.

Dr MacGILL: I will make a quick start. We are seeing greater automation in petrol vehicles right now with adaptive cruise control and lane departure. These are steps on the way to driverless vehicles which are happening with internal combustion engine vehicles. Having said that, I think electric vehicles are a more straightforward path for bringing automation even further. They have more flexible drivetrains, so they are easier to start and stop and they are built from the ground up with a sense of electronics and so on. They are tending to be set up in ways where there is already very advanced control to protect the battery and manage the great power that the vehicles actually have. I think that is an easier fit but it is not to say you cannot do it with internal combustion engines.

The CHAIR: Thank you. Are there any other comments from our witnesses?

Ms NADOLNY: In Tesla cars, some of them alert the service technicians when something has gone wrong inside them and arrange their own service times, so things like that you can see really working quite well with driverless buses. The other big benefit is if having driverless buses meant that the price for transport were to decrease and then the demand were to increase it would mean that we would not have the pollution that would be associated with petrol and diesel vehicles.

Ms PURNELL: And if we can get some of those autonomous features like cars have, particularly around safety, that might go hand-in-hand with the solution for the visually impaired and audio impaired.

Ms NADOLNY: And also greater uptake of cycling, whether it is electric or human cycling.

Mr GURMESH SINGH: Define cycling?

Ms NADOLNY: I just mean more people would be comfortable with cycling if they knew that there was a sensor; that the bus would not hit them or would have a lower probability of hitting them.

The CHAIR: Professor Marks, do you want to add to those comments or are you happy to leave it?

Professor MARKS: I am happy to leave that.

Mr GURMESH SINGH: Other witnesses that we called on Wednesday were talking about a lower lifetime cost per unit when we are looking at buses. Does anyone care to comment or add their thoughts to that as well?

Dr MacGILL: Again, these sorts of assessments do have us looking forward to what diesel might be costing into the future and what electricity might be costing into the future. I think the key thing with diesel and fossil fuels more generally is just a huge uncertainty. Prices are collapsing at the moment in the oil market but who knows where it is going to go if we are looking out 10 to 20 years and these are substantial assets when we are buying these vehicles. In terms of where electricity prices might go, I think there are two factors there. One is, as Anna Nadolny flagged before, the falling cost of renewables means that electricity pricing is sort of moving a bit towards that there are going to be times where it is very cheap and, there are going to be times where the sun is not shining and the wind is not blowing, where it could be quite expensive.

If you have got a flexible load like an electric bus, that for you is money because your flexibility means you can buy electricity cheaper than people and other consumers who are not flexible. It is fair to say the electricity costs of electric buses are going to be very competitive loads and they are going to be able to get very good deals out of an electricity industry with lots of renewables. That is one factor but not the only one of course around the life-cycle of the battery. The battery life is an issue that we are still really coming to terms with, although there is value in batteries which may no longer be suitable for a bus but could still be suitable for another role. The evidence seems to be we have spent over 100 years getting diesel engines more reliable, efficient and less likely to break down but they still do. The evidence seems to be we could probably get higher reliability and lower servicing needs with electric vehicles, which is not to say we will necessarily get them right immediately, but if we think about the number of parts, the complexity and so on I think there is a good opportunity to have lower running costs.

Ms PURNELL: A small comment, slightly tangential, but if we can also start some kind of knowledge sharing between the bus operators who have done trials to spread the knowledge of how much these buses actually cost to maintain that would be insanely useful to the industry and to academia.

The CHAIR: Thank you very much for coming in today and for coming on to the phone call, Professor Marks. There will be an opportunity if the Committee wants to ask further questions to send those to you in writing, are you happy to respond to those?

Dr MacGILL: Yes.

Ms NADOLNY: Yes.

The CHAIR: We ask you to respond within seven days of receiving those. Thank you so much for coming in. It has been really insightful.

Dr MacGILL: Thank you for the opportunity.

Professor MARKS: Thank you for the opportunity too.

(The witnesses withdrew.)

MATT THRELKELD, Executive Director, BusNSW, sworn and examined

JOHN KING, President, BusNSW, sworn and examined

The CHAIR: Gentlemen, thank you for joining us this afternoon. We appreciate you coming in person. We have cleansed and sanitised the tables for your own personal hygiene, and we are maintaining safe distance and practising good social distancing habits. Is there anything that you would like to ask about the procedure today before we start?

Mr THRELKELD: No.

Mr KING: No.

The CHAIR: There may be questions as we move forward. We have an opportunity now for opening statements. Would both of you like to make an opening statement, or just one? And could they go for around two minutes, please?

Mr THRELKELD: Yes, I am happy to. Good afternoon. My name is Matt Threlkeld. I am the Executive Director at BusNSW. Mr King is a bus and coach operator and is the president of BusNSW, and he has been involved in an electric bus trial. For those who may not know, BusNSW is the peak body for the New South Wales private bus and coach industry. We represent around 400 bus and coach operators across New South Wales and 100 industry suppliers. Our mission is to foster the efficient and sustainable growth of public transport in New South Wales and to promote the benefits of bus travel. Our members provide bus services under Transport for NSW contracts in the Sydney metropolitan and outer metropolitan areas, and also in New South Wales rural and regional areas. We also represent long-distance tourist and charter operators, who are obviously doing it very tough at this point in time.

BusNSW generally supports the transition of a diesel fleet to electric or zero emission, based on the health, environmental and economic benefits. We believe that this transition should also include a reduction in the maximum age of the fleet from the current contractual maximum age of 26 years down to somewhere around 18 years. We note that contracted operators are required to procure buses from the Transport for NSW bus procurement panel, which means that operators can only select electric buses, potentially, that have been approved by Transport for NSW. Whilst electric buses will be charged at depots in most cases, we certainly have a view that there is a need to consider opportunities for charging of electric buses en route, possibly using pantographs.

Aside from the energy supply issues, we think one significant issue that the industry is currently assessing—and I think this is still being worked through—is the question of who pays for infrastructure that is required to charge electric buses at depots. I should note that, I think, in most cases bus depots are owned by the private bus operator. If operators are to pay, I think there is a need for long-term contracts that allow for the amortisation of those significant costs. On the other hand, we understand that if government pays for that infrastructure, there will be some expectation for long-term access to a bus depot, which may involve a lease arrangement. I think the impact of this may play a part in the upcoming tendering of the Sydney metropolitan bus contract, which needs to be considered. I might just add that I think these types of complicated issues are generally best dealt with through negotiated performance-based contracts. Electric vehicle technology is certainly changing rapidly and BusNSW recommends that government adopt an agile transition strategy and that this should include proper engagement with the bus industry. We are happy to take any questions from the chair or the Committee.

The CHAIR: Thank you. Mr King, did you want to add anything further to that comment?

Mr KING: No, that covers it.

Mr GURMESH SINGH: Can we hear from the two of you what you think might be needed to retrain the drivers in the bus driving sector to transition to electric buses, and any experiences that you have had to date on that?

Mr KING: I will answer that because I have actually been involved in it. It is quite different. It is not just the actual driving of the vehicle; it is the performance on the understanding of the regeneration of power on the operational side of things, but also on the day-to-day operation of pre- and post-departures and arrivals, and how you charge the vehicles and what procedures have to be put in place. We do have experience on that process and where we may give on a diesel bus a 10-minute start and a 10-minute finish, that was pushed out to a 30-minute start and a 30-minute finish. So there will be a cost adjustment to those sort of processes.

Mr GURMESH SINGH: Sorry, can you just explain what you mean by the start and finish—

The CHAIR: If you could elaborate?

Mr KING: Sure. At the start of a shift if the driver starts at 9.00 a.m. to depart the depot to go and start the journey, we normally give a 10-minute pre-start to that. There is a procedure they have got to go through. But with the electric bus, we needed to do more than that because you have got to unplug the charger before you leave, you have then got to secure that charger before you get into the bus and there is another procedure to start the electric bus different than what it is if you start a diesel bus.

The CHAIR: What is the procedure for a diesel bus when you start?

Mr KING: A diesel bus is fairly simple because it is already parked ready to go. You get into the vehicle. You do your pre-departures, make sure that all your lights and everything work. Then you start the vehicle and you drive away. Whereas with an electric bus, it is a procedure of starting. So you have got to pull the charger, you have got to secure it and sign off that you have secured that charger. Then you get into the bus and start your pre-departure on that process. When you start an electric bus, it takes about four minutes for that to go through its checks before it will actually let you start the vehicle up. It is added cost to the operation.

Mr GURMESH SINGH: So before you continue for the rest of your answer, do you think that half an hour will reduce as people get more used to the start-up procedure? Or is that going to stay at about that half an hour level?

Mr KING: As you streamline systems and the technology grows and gets more developed, it obviously will decrease. But in our experience that is what the process was.

Mr GURMESH SINGH: Thank you. Sorry, we did cut you off halfway through your answer.

Mr KING: No, you are alright.

The CHAIR: Did you want to continue?

Mr KING: No, I am fine. That covers it.

The CHAIR: Any other comments, Mr Threlkeld? Would you like to say anything?

Mr THRELKELD: No. I think Mr King has covered it. He has had that firsthand experience.

The CHAIR: It is good to talk to someone with a practical experience of this in the trials.

Mr GURMESH SINGH: You mentioned in your answer that the buses are actually different to drive because they have got those regenerative properties. Could you elaborate on that a little bit more as well?

Mr KING: So in our training packages, where you have been a bus driver for many years—and I am a bus driver—to drive a diesel bus is typically your foot down, driving very aggressively in a way to get to the end destination, and not really concentrating on the process of what is driving that vehicle, be it fuel usage. Whereas electric training, it took us a while to get the drivers right, and I can give you some statistics on that. It is about take the foot off, not the foot on, and how you actually drive that process differently when you are an actual driver on it. It will get better as more vehicles come onto the networks to actually train and get the drivers to understand the process. If you look at the statistic side of things, the best driver we got out of our trial came back with 38 per cent charge and the worst driver came back with 27 per cent charge. So it is about who trains to go up a hill at less speed than what you would normally do it, to what you are generating coming down the hill.

Mr GURMESH SINGH: Thank you.

The CHAIR: Ms Petinos?

Ms ELENI PETINOS: Good afternoon gentlemen and thank you for making yourselves available. I also wanted to pick up a little bit on the training element, which I note is in your submission since Mr King is actually a bus driver. Other witnesses have pointed out to us throughout our inquiry that there are significant differences in the operation of the electric buses but further to that, due to the silent nature of the electric buses, that in their experience they find that pedestrians interact differently with the electric buses, and they feel as though the silence or lack of noise emanating from an electric bus means that there are associated pedestrian safety issues which the bus drivers feel. Do you have any comments on that? Have you found in your experience that pedestrians do interact differently with electric buses, and if so, would we be looking at— or rather instead of giving you what I would like to say, what would you recommend as ways to address that if you believe it is an issue?

Mr KING: It is an issue and in our trial—and we have given this report to Transport for New South Wales—in our trial we found when we operated between a place called Nowra and Kiama on the south coast, we were going through a little town called Berry and we were finding that we were having that same issue, which was obviously a training thing for our drivers because of the stress of an incident. What we did do with the company that we actually trialled with was put a geofencing environment in place. So if you came into a 50 kilometre zone there was a chime that used to ring as the bus went down through that geofence. So it came into the 50 kilometre zone and every one and a half minutes you would hear the chimes, just like a bell chime. Then when it got out of it, they would turn it back off again. We did get some community reaction to that because at 5.00 a.m. in the morning they were not wanting to listen to a chime.

Ms ELENI PETINOS: It was not a favourable community reaction, I think.

Mr KING: Yes. So there were some adjustments to that to say that at 5.00 a.m. in the morning we may not have needed the chime but we had to train the drivers differently to be more aware of things. There is technology for that to happen and we achieved that and we are quite satisfied with the outcome.

Ms ELENI PETINOS: Can I ask about this chime concept? We put something similar to another witness that they would be required potentially to manually make a noise and it was suggested to us that that is too onerous on drivers. So the chime that you are referring to, were your drivers manually turning it on at the beginning of the process, and it would run for that time slot, or were they manually chiming at each 50 metre interval, whatever you suggested?

Mr KING: So there were two options. We originally started with the manual process that the driver would just chime it as they went. We found that was causing a little bit more grief because one driver would and one driver would not. So we gave them the option that it would come on automatically at a geofenced point and go off at a geofenced point that they could actually, if they were in between a chime and there was someone they thought potentially may come to harm, they could manually just flick that chime.

Ms ELENI PETINOS: Could I put to you how you feel about the need for a public awareness type campaign about pedestrian interactions generally? Should we proceed with electric vehicles given that a lot of pedestrians now get distracted by phones or headphones and other things going on in their lives as opposed to focusing on the traffic in the manner they would have previously?

Mr KING: Having nine grandchildren, I can understand your comment.

Ms ELENI PETINOS: I openly walk around with headphones all the time. I am not passing judgement on this.

Mr KING: No, not at all. It is something that any sort of new technology coming forward or transport modes that we are going to come into—and you have got that with the light rail up and down George Street—that awareness is something that we have got to publicise. Everybody has got to understand their obligation to the new technology that is coming into our industry. It will be a government process with the operator to actually make sure that communities understand their obligations to what a safe workplace will be for our employees.

Mr THRELKELD: Can I just add that certainly from an industry point of view, there would be a need for a public awareness campaign similar to what has just happened with the light rail. That is certainly something that already happens in terms of the Be Bus Aware campaigns that are run by the NSW Centre for Road Safety and is supported by the bus industry. It would be ongoing. It is not something you can do when we start to see more electric buses in the network. It will be something that will probably go on forever given that need to just make people aware of those risks.

The CHAIR: And electric cars as well.

Mr THRELKELD: Correct.

Mr KING: Absolutely.

Ms ELANI PETINOS: Absolutely. One of the other issues that I wanted to flesh out was how the trial interacted with people with a disability. We have taken evidence from some of those advocacy groups in relation to the fact that because the vehicles do not emanate the same level of noise as the buses on the roads at the moment, people in those disadvantaged groups were interacting what they believed to be differently with the electric buses as opposed to ordinary buses. Was there any part of your trial which looked to overcome some of those problems for people with a disadvantage, or did you notice that it was an issue which you became aware of and which you feel as though we would need to address moving forward?

Mr KING: We did not experience any issue with any disability advocates in our trial. It was only good comments about how quiet and how smooth the vehicles were. That is from people with wheelchairs or disadvantaged in eyesight. We have no problems at all with it, and nor did they.

Ms ELANI PETINOS: And what about the deaf community?

Mr KING: Not a problem at all because they are timetabled and that is that, so on our trial we had the app going so that they knew when the bus was coming, where they were pulling up at a bus stop—none at all. Sorry, we do not have that problem with our diesel fleet either.

The CHAIR: Vision impaired might appreciate a diesel one because they are relying on sound.

Ms ELANI PETINOS: Yes, but if there are multiple buses pulled into the one station or the one bus stop at the same time, how does a commuter who has low vision for argument's sake know which bus to get on? If noise is part of how they ordinarily would identify things and your vehicle does not have noise, how do they know which bus to get onto?

Mr KING: If you are talking about a major bus stop in Sydney, they are typically looking at the destination signs. They are not listening for a vehicle coming forward if they are sight impaired. If they are deaf, then it is the same issue: they are looking for the destination signs. We have gone in a world of standard livery in our society these days in the bus industry and everybody is relying on the signage and/or the technology of apps. Does that answer your question?

Ms ELANI PETINOS: It does. I do not know that it quite alleviates my concerns about vision impaired people being able to identify the bus because they cannot read the signage. There is a scale in terms of what vision impairment means for different people, but I appreciate your comments.

Mr THRELKELD: I think it is obviously a different experience for them and there is probably some reliance in terms of the driver and when the bus actually approaches that stop, then gets to the stop, and then the doors open that would allow them to understand that the bus has arrived. So there probably is a need for some communication. Obviously this is new and it probably comes back to the original question around the driver training and something that will need to be addressed moving forward with this new technology.

Ms ELANI PETINOS: Do either of you have any awareness around some of the emerging technology in terms of apps which potentially could be integrated to alert the passenger directly as to what is in front of them or is about to arrive in front of them?

Mr THRELKELD: Not in detail, but we do know that there is technology out there and from what I understand it uses beacons, and for a customer that is vision impaired a bus can potentially send a signal to that customer where there may be a vibration on a smart phone for example, that would give them some notification in terms of the impending arrival of that vehicle.

Ms ELANI PETINOS: Would BusNSW consider that as something appropriate to look at integrating, or do you believe that the system works appropriately at present?

Mr THRELKELD: Yes.

Ms ELANI PETINOS: And you would not need to go to that extent?

Mr THRELKELD: No, no. I think it definitely should be given some serious consideration. We have an associate member, a supplier to the industry, who is involved in that type of technology, so I think, from what I understand, they have certainly had some discussions with government and not just in relation to electric buses but to any bus to improve that experience for people that may be vision impaired.

Ms ELANI PETINOS: Thank you.

The CHAIR: I just want to follow on in relation to Ms Petinos' questions going forward. If a vision impaired person is taking a bus, currently how do they know what bus stop at which to alight or leave the bus and

get onto their preferred route and their destination? What is the procedure now on board when a bus driver is there?

Mr KING: I can answer that. In the Illawarra, we run the network. We run something like 212 vehicles. We have a program with the blind society of the Illawarra that they come to the depots and we actually understand that process of what they have got to do, how they load a bus, where they have got to get on and where they have got to get off, but typically they would then connect with the driver and we would in our documentation to the driver say, "You may have at this bus stop a vision impaired person that will need assistance." Typically, though, most of the vision impaired people are very, very smart and they understand where, how and why they want to travel and we do not have any issues with it. But if they feel that they need some assistance, they come to the depot, we show them how to load, how to offload, if they need assistance with the ramps, and that just follows through into the network and training.

The CHAIR: We had some comments from witnesses on Wednesday that were from that group and they talked about going forward with electric buses; that it would be ideal if there was an automatic announcement of a bus stop on approach; that they do have that sort of thing in the Sydney Metro North West, for example. Is that something that you think would be of value in an electric bus?

Mr KING: It is of value in all buses. The more we can give our community, the more we will get them out of the car and onto the vehicle. That is just a sales pitch. But at the end of the day, the more we can give them, the better it is and the technology is there today.

The CHAIR: Thank you. Just one other question: in relation to the drivers who have driven the electric buses, and you have been involved in that, could you give me an idea of the experience they have had and the feedback you have got in relation to them thinking it was either a good or a bad experience, and roughly the percentage that say thumbs up or thumps down, please?

Mr KING: One hundred per cent said thumbs up.

The CHAIR: Okay.

Mr KING: Much better work environment to work with.

The CHAIR: Why was that?

Mr KING: More silent, the customers were more comfortable in those particular buses because of the noise factors. Overall, it is a positive experience for the commuter and the worker. Typically this is because of the new technology that is out there. We are driving brand-new technology that they have not been used to.

The CHAIR: And they were happy to embrace that learning, though?

Mr KING: Absolutely, absolutely. We had them lined up.

The CHAIR: That is good to hear. Thank you. Mr Threlkeld, did you wish to comment?

Mr THRELKELD: No. I think that has probably covered it.

The CHAIR: Thank you. Enough from my questions. Dr O'Neill?

Dr MARJORIE O'NEILL: We've spoken quite a bit about the driver experience as well as the need for the noise emitting that you have learnt from the trial. Are there any other key takeaways from the trial that you would like to share that would be an important learning?

Mr KING: Absolutely. In our trial, we were the first bus operator in Australia basically, certainly on a contract run in rural and regional, to do this trial, and we wanted to just get the learning as to what we needed to do going forward. I suppose the biggest learning we had—and I can give you the data—is to run a diesel bus it is \$140 for that particular shift and it costs us \$28 in power, so significant savings. We only use one millimetre of brake linings in 38,000 kilometres, which is a good answer for safety. The reason we did that is coming back to the driver training to make sure that they regenerate the power. They are being trained to do that.

I think the other process in the sense of savings, though, was all about the community expectation of getting people back onto the buses and paying their fares so that we get that disparity between government funded and getting some fares back, and we had some great numbers coming back onto the buses because they wanted to experience something different. That may be a short-term goal or long-term vision. Who knows?

In the sense of the problems we had putting it in, it took us 18 months to get approvals to put a power station in our depot. Then we had to spend quite a lot of money to actually get enough power in the depot to run that bus.

The CHAIR: Can I just interrupt to ask the authorities that you were waiting on approval for that?

Mr KING: It was a whole range of them from the power companies to Transport for NSW. It was just something new we brought to the country, as such. Without taking up too much time, the statistics showed that if we put a power charger in our depot it could run at 430 amps, which could charge the bus in 20 minutes—from dead flat empty to full. Because if it went over 100 amps we become a power station with a different world of regulation, we had to wind it back under 100 amps, which then took seven and a half hours to charge that bus. We put it in there as operational understanding to how we actually could run 20 or 30 buses in a bus depot, which is probably going to say you cannot because the power supplies to the rural and regional depots and even some of the metro depots are just not there.

The CHAIR: The drain. So that is something going forward that would have to be considered in the long run—the sustainability.

Mr KING: Especially government investment in that. We need to do on-road charging, which we cannot control, and a certain amount of depot charging and finding that fine balance to keep the buses on the road because if you bring the bus back to the depot every time, it grows the cost to government of operating that fleet.

Dr MARJORIE O'NEILL: I have another question. Would you mind providing just a little bit of insight into what you think is needed to be able to retrain service staff in particular. We have spoken a bit about bus drivers and what is needed but the other side of it is maintenance and service of this new technology.

Mr KING: It is a totally different world to what we have been used to. I am a motor mechanic as well. To go and service a vehicle with an industrial engine with a gearbox and differential—we can train people to do that in four years. Typically they would be fairly competent. When you are taking it into this new world—we sent one of our guys over to China to be trained—you have to be training a lot of people in a different mindset. One is that you stick your finger in that red hole and it is going to hurt you; two, to be able to have an understanding of what actually drives the power through to the drivetrain coming from the batteries on the roof. It is a different world of training and it is something that our industry is not ready for. I do not think any industry is ready for it and we need to start that ball rolling if we are going to start rolling these fleets out.

The CHAIR: Thank you. Mr Threlkeld, would you like to comment at all?

Mr THRELKELD: Only to say that there needs to be some work done in this particular area. We are involved in a committee for transport and logistics that provides advice around training requirements under the vocational education and training program. It is certainly something that is being looked at in terms of the changes to skills that will be needed into the future as a result of the transition to electric vehicles.

The CHAIR: Is there any further discussion from the Committee? Mr Threlkeld and Mr King, thank you so much for coming in today in person. We do appreciate your presence here.

Mr KING: Can I just sum up one thing, though?

The CHAIR: Please.

Mr KING: Bearing in mind that buses we get today —this is where I think we have to drive it through as industry—buses that are being delivered today are still going to be on the road under the current environment with Transport until 2045.

The CHAIR: That is a good point to leave us with.

Mr KING: I thought so.

The CHAIR: Just before you go, if the Committee members have any further questions and they send those to you in writing, are you happy to respond?

Mr KING: Absolutely.

Mr THRELKELD: Yes, sure.

The CHAIR: We would ask that you respond within seven days. Gentlemen, thank you for your company.

Mr KING: You are very welcome.

(The witnesses withdrew.)

(Short adjournment)

ELIZABETH MILDWATER, Deputy Secretary, Greater Sydney, Transport for NSW, affirmed and examined
STEVE ISSA, Acting Executive Director, Services, Greater Sydney, Transport for NSW, sworn and examined

The CHAIR: Welcome. Thank you to my guests, Ms Mildwater and Mr Issa. Before I start, is there anything you would like to ask us about the procedure this afternoon?

Mr ISSA: No.

Ms MILDWATER: No.

The CHAIR: I might introduce the Committee members to you. On my left is the Deputy Chair, Mr Gurmeh Singh. On my nearest left I have the Parliamentary Secretary for Transport and Infrastructure, Ms Eleni Petinos. To my right I have Committee member Dr Marjorie O'Neill. I also introduce to you our Committee director Bjarne Nordin. Thank you for coming this afternoon. We really do appreciate you coming in person. It is great to be able to interact face-to-face with our witnesses for this particular public hearing, this being our second day. There is an opportunity to you to make a short, two-minute opening statement, if you would like to. Would either of you like to do it?

Ms MILDWATER: Yes, I might. Thank you, Madam Chairwoman. This Committee is really timely and relevant for us, so thank you for giving us the opportunity. As you are probably aware, transport is in a period of immense growth, change and disruption. In Sydney especially, there is a significant part of our growth coming from our infrastructure spending and massive expansion in public transport. This has meant we have achieved some great things in public transport. For example, between 2015 and 2019 there was a reduction of 13 per cent in vehicles entering the CBD in the morning peak, and a corresponding 14.7 per cent increase in public transport into the CBD.

We have a mature, multimodal network providing more than 800 million customer trips every year. In the past five years the number of trips on the New South Wales rail network alone has increased by over 100 million to over 400 million trips per year, which represents a 30 per cent increase in patronage. On buses we have had a 40 per cent increase in patronage over the same five-year period. But while growth has been immense, as you might imagine there are a couple of challenges that go with that.

One of them is in the form of disruption, which comes in many forms. Ultimately, technology is the one that it mostly presents in, but that presents new opportunities as well—new ways to travel, plan journeys and provide services to customers. People are more mobile and interconnected than ever. The second challenge for us has been the challenge of achieving mode shift—moving more people onto public transport and out of cars, particularly cars with one person. For us buses are really key here. We think we can get a lot more people into buses in the Greater Sydney area over the coming years.

These challenges also, of course, present opportunities. We are well aware that the choices we make now will enhance the productivity, liveability and sustainability of communities well into the future. The Government's target of achieving net zero emissions by 2050 and a 35 per cent reduction in emissions by 2030 is clearly targeted at the liveability and sustainability aspects of our communities. At Transport, we are contributing towards achieving this by targeting to move away from diesel technology and into zero emissions technology in buses. It ties into a number of policy conversations both in the state and federally. Removing diesel buses and having a fleet of buses that run off the electric network has clear health and environmental benefits for the people of New South Wales.

Our submission gave an overview of how we are doing that but I will touch on some key themes that I know have come out in the submissions over the past couple of days. There is considerable work underway with industry and how to help develop our future road map for delivery. This includes the NSW Electric and Hybrid Vehicle Plan and the Connected and Automated Vehicles Plan. They set the strategic direction for five years to maximise community and customer benefits. The electric and hybrid vehicle plan included an action plan to trial zero-emission buses with a view to testing the operational, technical, functional, customer experience and environmental performance of those technologies. As part of the new Transit Systems contract for region 6 in Sydney's inner west, we have been trialling four electric vehicles. They have the capability to travel up to 350 kilometres a day on a full charge.

We have been talking with industry about the challenges of this for some time, and as the Committee heard on Wednesday, fundamentally, the experience of leading cities around the world demonstrates that a transition to zero emission buses is possible, but it does take time and it requires partnership with industry. We have been engaging with stakeholders, including via a market sounding that we started last March and we want to continue to work with the industry on the key questions like: how to make buses more accessible and safe?

How we help industry adapt gradually over time and how do we send the right signals from government? And what kind of approach to ensure sustainable and reliable partnerships with our energy sector? These are matters we are working through. We are looking forward to feedback from the Committee and your final report, which we think might address some of those things.

We operate over 8,000 buses including in the communities across Sydney and the outer metropolitan areas so we do see that we have a real obligation to improve the health and environment of the city. My colleague Barbara Wise could not be here today, but in relation to regional, she is the person who manages buses in our regional areas. Unfortunately, she could not attend. We also operate 3,000 buses across regional areas, servicing major regional cities in particular. There has been a significant uplift in new buses across regional New South Wales as well as part of our rollout of seat belts on school buses programs. In the process of doing that, we have been able to roll out cleaner and more efficient vehicles.

Close to 1,000 of the buses on the roads in regional New South Wales are less than five years old. As the fleet is relatively young, it is likely to take longer to turn it over to zero emission buses than it will take in the cities, but it will happen. The considerations that need to be given to introducing widespread zero emission technology in regional New South Wales are similar to those in Sydney but we intend to apply the learnings we make in Sydney first before we roll out to the regions. Vehicles do need to be tested in different operating environments. We do intend to keep making public transport better for our regional customers, but the Sydney environment is where we have started testing mostly.

We are committed to providing reliable, safe and accessible public transport services for our customers everywhere. Taking the lead from others around the world also allows us to adopt best practice and learn from other jurisdictions. It allows us to be fast followers, if I could say that, and our plan is to understand the experiences of similar deployments and implement the lessons while again focusing on safety, accessibility, reliability and cost. We have made a very strong commitment to the community and industry of our intentions to transition to zero emissions technology. We hope that enables industry to have confidence to invest and continue to develop the technology and deliver buses that meet the needs of our customers. We will be happy to take specific questions on any aspects of that.

The CHAIR: Thank you, Mr Issa, do you need to add to that?

Mr ISSA: No, thank you.

Dr MARJORIE O'NEILL: Firstly, thank you very much for coming in today. There is currently a trial underway in Sydney. What can you tell us about that trial in terms of any key learnings about it? I have asked that first. I will have a follow-up question.

Ms MILDWATER: Okay. I might actually throw to Mr Issa for the detail of that because overall the trial is actually going much better than we expected. There are four buses required as part of the region 6 contract but then Transit also introduced a fifth bus, a Yutong bus, that had started in Nowra and brought into region 6. The feedback from both customers and drivers is pretty good. I will invite Mr Issa to maybe talk a bit more.

Mr ISSA: Thank you, Ms Mildwater. As Ms Mildwater indicated we started a trial last June-July of all electric buses in the inner west and in August we added a fifth bus, so we had four BYD buses and one Yutong bus. Those buses have been in service now since July and August last year. Overwhelmingly the trials have been very successful. What we have learnt across that trial is that the buses themselves are travelling a variety of different routes. As part of that trial, what we have done is to look to plan and test the buses in different environments. How do we take a zero emission bus and adapt that to a Sydney environment? The inner west is a perfect arena for that—topography, geography, climate, hills, lots of congestion, traffic—so that gives us a really good platform on which to trial these buses in a Sydney environment.

Through that exercise we have been running buses on the route 389, so Bondi Junction to Pyrmont; route 431, Glebe Point to Martin Place; the 433, Balmain to Railway Square; the 447 Lilyfield to Leichhardt; and the 470, Lilyfield to Martin Place. More recently we have been running that on the M50 to Drummoyne. So we started the buses on smaller routes to make sure that we could prove the technology and we had confidence that when the buses left the depot, they could perform their trips and come back with enough supply.

The CHAIR: When you say smaller routes, what was the distance roughly?

Mr ISSA: Approximately 100 kilometres, initially. So 100 to 150 kilometres on a trip for a day. Overwhelmingly, they are doing approximately 200 kilometres in a day and they are coming back with approximately a 50 per cent charge remaining. So they are going out for 12 hours at a time, in some instances up to 16 hours, and returning with about 40 per cent to 50 per cent charge remaining. What we are finding is that driving in the Sydney environment, with the stop-start, the regeneration from the braking is actually recharging

the batteries circa 35 per cent. So along the trip, when they leave and throughout the journey, they are adding 35 per cent charge back into the technology, which means they are getting longer journeys.

The drivers are really enjoying them. The customers love them. We know that it takes time to bed the services in and we have trialled them in really hot weather, when the air conditioning is higher, because that also creates a charge, and we have trialled them in wet weather in different topographies. Overwhelmingly it is going extremely well. We are overwhelmed with the results. The operators are overwhelmed with the results: they exceeded their initial expectations. We are building confidence with that. But what it has really taught us is that we can do an average day's bus trips with a full charge and have confidence that the buses will go out, deliver those services and come back. To date we have not been caught short with the power supply or charge or any of those issues. They are still coming back with approximately 50 per cent battery charge, which is a very positive outcome for us.

Two hundred kilometres is approximately what an average bus in region 6 in the inner west would do in a day and it is doing that quite easily, with spare battery to go. From a performance, from a ride-ability, from a driveability but also from the question around will the battery last for a day, they are going very well.

Dr MARJORIE O'NEILL: One of the things that has been raised from different witnesses over the course of days is around the need for noise-emitting devices. Even the witnesses who were doing a trial down around Nowra found that they had to put on a device. I am aware that in the inner west there are actually no noise-emitting devices at all on the buses that are being trialled. Has there been any feedback specifically about that and the need for anything around that? I am just interested.

Mr ISSA: We know that internationally electric buses have been rolled out more broadly. Hundreds of buses have been ordered in Berlin, hundreds of buses have been ordered in Los Angeles, London has over 200 buses in operation today with more on the way and in Europe, in Paris, I think they ordered 100 buses in 2019. One of the advantages we have is that we can tap into the lessons of other jurisdictions like ours who are operating in similar environments like ours and also who have similar customer challenges and customer service provisions that we do. More recently the United Nations [UN] put out a policy position in terms of a regulatory framework around what we call the acoustic vehicle alerting system. That has been adopted through the UN and is now a standard that will apply to those vehicles.

Transport for London is looking to actually take that one step further and trialling how they can make that more standardised across their bus fleet so that you have a similar type bell arrangement. That is a recent addition to the framework. What we know is that as this technology evolves, those lessons will be incorporated into the design of the vehicles and they will be rolled out more broadly. The buses at the moment in the inner west are not fitted with those but they are working to do something manually as an initial provision, but we are working through how we can do that more long-term, systems-wise. In London they are automated at the moment and in Europe they are automated, so we are working through some of that.

Dr MARJORIE O'NEILL: Just to clarify, Transport for NSW has received no feedback at all from disability groups or disability advocacy groups regarding that?

Mr ISSA: Actually, I will have to take that on board. I might be wrong on that. I will take that on board. I think they are fitted. I will have to take that on notice to be honest, to be sure, but I do not believe or I am not aware of any feedback. But I will take that particular question on notice, if you do not mind.

The CHAIR: Ms Mildwater, did you want to add to that?

Ms MILDWATER: No. I was just going to say the same. We were talking before—I think we might have had one complaint about an electric bus all-up.

Mr ISSA: Potentially one.

Ms MILDWATER: But, no, we have not had significant feedback. Like we have not had feedback to that extent.

The CHAIR: Are you aware of any users that are vision impaired at all? Has there been any feedback from the drivers?

Mr ISSA: Sorry, in terms of?

Ms MILDWATER: Accessibility?

The CHAIR: Just accessibility—any feedback from the drivers of users who might be vision impaired and there is a problem?

Ms MILDWATER: Giving negative feedback, no.

Mr ISSA: No, not from the drivers themselves, but then we will double-check. We think there may have been one customer who has raised it but we will double-check that. We think there is one.

Ms ELENI PETINOS: For the record, the peak advocacy groups appeared before the Committee last Wednesday. They submitted to this Committee that they had not formally participated in the trial. I appreciate you are saying you are willing to take this question on notice, but they are in agreement with you that they did not formally provide any submission or request to Transport for NSW.

Mr ISSA: Or opposition.

Ms MILDWATER: If we were rolling out—having learnt the lessons—take it to the next phase, we always work with disability groups before we roll out a new service. That would be the time now we would get the feedback. We have heard about the new technology. Before we went further we would engage them to find out what their feedback is.

The CHAIR: Discussions amongst the Committee and witnesses in relation to that have made suggestions for apps that might be used as well, and also a public awareness campaign, for these sorts of vehicles because we have got electric cars as well, and you have got people on mobile phones and head phones as well. So there is a lack of audibility when they are not impaired but they are creating that barrier themselves. Following up from that, have you looked at ways that other countries are dealing with this issue of awareness and arrival and departure at bus stops for those with disabilities and how they handle that?

Ms MILDWATER: I think some of the things Mr Issa talked about are probably where the industry is going with those audible changes to buses. So if they got implemented as standard we would follow standard as well. I do not know whether you are aware of any other things?

Mr ISSA: That is actually the path we are heading down—audio vehicle alerting system. More recently, the federal government's infrastructure and transport committee that met in June last year set the framework for vehicle design guidelines. In New South Wales we have a framework called Australia's design rules and those design rules apply to buses, trucks, cars and they are looking at actually adopting those guidelines as policy for designing vehicles in Australia. As those become guidelines and policies that become minimum requirements for buses in the future, that is one way that our bus customers will be able to tell that the bus is arriving at their stop. However, we will continue to look through the technology that we can. So apps and other technologies as they come on board, but the biggest thing that people are doing internationally is around the audio as buses arrive.

The CHAIR: One of the matters that came up in the discussion with the vision impaired group was about the announcements when they are on the bus, often approaching a bus stop and where it is. That seems to work with the Sydney Metro Northwest at the moment, where if you are approaching another station it will announce it. Is that something that could be considered?

Mr ISSA: Yes, that is a new requirement. So all our new buses and fleets actually have that on them as we renew the fleet. So that will be a requirement of any new bus we buy and that is a requirement today. As we roll out newer buses throughout the fleet, the passenger information displays and the audio announcements on the buses will be standardised across the bus fleet for any new purchase. So that is actually a requirement of our current fleet as we move forward and it would be a requirement of the new zero emissions fleets.

The CHAIR: With the current fleet, is there an ability for the driver to turn off that announcement manually as they approach a stop? The vision impaired group said that was happening and so they missed the opportunity to get to the stop because it was not announced.

Mr ISSA: I will take that on notice. We are happy to follow that one up.

Mr GURMESH SINGH: Given that electric buses can weigh more than traditional diesel or gas buses, have you had any feedback from local governments around wear and tear on roads or anything of that nature?

Mr ISSA: I refer to the Australian design rules which articulate the width, height and size of buses. Regardless of whether it is a diesel, hydrogen, electric or hybrid bus they have to fit within those guidelines. It is more around how the bus is designed and the size of the bus and regardless they have all got to fit into that. If they do not meet those Australian design requirements then they are not certified and they cannot be purchased to be used within Australia or New South Wales. We have an envelope around the weight of the bus so it should not really change the wear and tear on our roads because it fits within that envelope.

Mr GURMESH SINGH: Yesterday the Committee got some feedback about electric buses potentially being three to four times heavier than a regular bus. Is that your understanding?

Mr ISSA: No. So it is not our experience or our understanding. It is not what we are experiencing with our trials in the inner west. The batteries are somewhat heavier. But that is accounted for in the design of the bus

and there is an envelope that the bus has to fit in, in accordance with National Heavy Vehicle Regulator. They are federal guidelines.

The CHAIR: Is there a tonnage limit as well?

Mr ISSA: That is my point.

The CHAIR: Does it reduce the number of passengers because the batteries are heavier?

Mr ISSA: It could, depending on the way the bus is designed but as that is evolving they are designing the buses differently to accommodate for the weight of the battery. It was no different, if I may, when we first saw compressed natural gas [CNG] buses come out. Initially when the CNG buses came out to Australia the gas was a little bit heavier than the diesel component and over time they designed the bus to accommodate that difference in weight. But they still fit into the design envelope and requirements. From a road perspective the weight should be no different.

Mr GURMESH SINGH: Thank you for that clarification because the Committee heard conflicting evidence about that matter.

Mr ISSA: It is all in the federal guidelines.

Ms ELENI PETINOS: I am interested in manufacturing in New South Wales. Some witnesses before the Committee have indicated that they believe that switching to electric vehicles in New South Wales would provide the opportunity for a local manufacturing industry. They have, however, been quite uniform in their evidence that they do not believe that a local manufacturing industry could survive without a directive or a clearer indication from government as to a desire to proceed with electric buses moving on into the future.

With that in mind, do you believe it is possible to give industry enough surety, should the government decide to proceed down the path of electric vehicles, to encourage them to support industry in our state? Further, do you have any views on whether there should be any local component mandate as part of any potential contracts, which I understand are currently occurring in both South Australia and Victoria?

Ms MILDWATER: I am not sure that we are the right ones to talk about whether there should be mandated different components. But I suppose from our point of view what we would like there to be is a diverse industry like, as in sustainable supply with diverse suppliers so not to be entirely reliant on, for example, one overseas flow. That is not good for us. And so we do recognise the need to give industry strong signals. I suppose we have started by giving that sort of high level strong signals, so hopefully they have got the message we are serious. We followed up, when we launched the bus franchising also being quite, in our face-to-face meetings, strong about our wording. We understand what we need to do now is follow through with some really definite plans, and so the next piece of engagement will be through an expression of interest process to try to work out our existing manufacturers and others who can partner together to start doing trials.

But the other piece of it that we are trying to do is, obviously, we are not going to turn a fleet over in a couple of years. This is a process that takes years so hopefully it does give the industry time to get ready to gear up and build. We are aware some local industries are already doing that but we want to give them time as well to do that and it is in all of our interests. We have given a high level signal. I think we could, maybe as we do some more work with industry over the next few months of the rest of the year, we might be able to be a bit more granular about that in terms of what the definite plans look like.

In the immediate term, we have certainly said we are going to put another 10 buses into Randwick. We are hoping to be able to make some more definitive announcements over the coming months that will strengthen that signal. We are very aware that industry needs to really understand it is a firm commitment. We are trying to be firm. We are saying we are committed to zero emissions so that gives the direction. At the moment electric is probably the only technology that is really ready to go on that front. There is also potentially hydrogen coming down the track, so industry might gear up for that down the track but electric is their focus immediately.

Ms ELENI PETINOS: The comments around hydrogen have been optimistic and, I think, reflect your comments around it maybe being down the track. My perception, at least, is that there is a reluctance to invest in, again, an emerging technology that they have no surety over its use to the same scale as something else. The message to the Committee has definitely been about receiving signals as to what government would like to invest in, moving forward.

That takes me to the second thing which probably has been spoken about significantly over the course of the inquiry, and that is the mix of the grid. I appreciate that you are not in the business of delivering electricity to the state or configuring the grid itself. Did you have any comments for the Committee around if there are any observations around preferred types of charging—whether it be at stop, at depot or any other configuration—and

any learnings which you may have from trials or other types of infrastructure which the department has rolled out in the past?

Ms MILDWATER: It is probably a combination of learning from both what we are doing at the moment, but also from some of the things that came out of the market engagement last year, which I might give Mr Issa a chance to talk about. When we did the market engagement last year, we had electricity suppliers involved and since then Mr Issa and his team have been talking with them. I think you did articulate there are a few ways of charging and we would like to investigate all of them.

The other thing to say is in depot charging, we would like to explore pulling off the grid: installing solar panels in depots to perhaps produce our own power there. Something else that has come to light is being able to use batteries in the depots, including batteries that might have had some life on a bus and then using them in the depot to charge and recharge buses—something Mr Issa can probably talk more about. We also have had insight into the fact that where you put the charging is a very local issue that we will need to investigate. It is not like we can just sit here and say the grid is the grid everywhere. What we now need to do is look at particular locations. So, for example, we are looking at Randwick. We need to talk to the supplier about Randwick.

Mr ISSA: As Ms Mildwater has indicated, in terms of the grid and infrastructure it is a very local conversation with network suppliers around particular locations and the capacity and how much they can accommodate. Generally speaking, our experience and international experience is that the buses are doing 350 to 400-plus kilometres a day with a single charge. In most Sydney environments, that would exceed the demand for a single day's travel. So it provides us some flexibility with the way we manage our fleet and the demands on the grid and how we deliver charging to that fleet. In region 6, speaking locally around that particular trial, that means that we can charge overnight, when demand on the grid is lower. It does not require opportunity charging halfway through or at a bus stop or at a train station, to your question, because the buses are leaving with a full charge but they are returning with a half charge—with a 50 per cent remaining charge. That means that because of the regeneration of power along the trip, the need to charge the bus is not as high overnight. They are only topping up 50 per cent, so it is not like we are taking every bus and charging it 100 per cent overnight.

Our operators are talking to energy providers, and we are talking to energy providers about what that looks like at individual locations and individual depots. We do know that internationally and locally we are looking at what we can do with solar panels on roofs of our depots, what we can do with—as Ms Mildwater has indicated—batteries, and what we can do with a number of different technology types that are quickly evolving. If we look at the battery technology itself, it has evolved significantly over the years and will continue to evolve and provide greater flexibility for us.

We know that where we are today in our commitment to zero-emission buses, quite loudly, converting the whole Sydney fleet over time is a quite significant announcement. That will mean that with what we are doing and what international players are doing around the world, such as Los Angeles, London and Paris, the industry itself will invest in new ways of delivering that technology. They will invest in new ways of capturing other power sources, particularly renewable, and that will allow us to learn and partner with them to achieve that so we can deliver the power we need where we need it, which is a very important consideration for us.

So we are confident that it can be delivered. We have to partner, as we have talked about, with industry to deliver that. We need to look at every location specifically and understand what redundancy they have in power. It may not even be a grid issue. We know, for one example, it is just the local power connection at the depot that needs to be upgraded because it was not designed to accommodate that much power, but the grid itself has plenty of capacity. Until you get to that sort of level of detail and understand that, you really cannot answer those questions. That is what we have to do side by side.

Based on our trials and based on what we are seeing overseas, in the Sydney environment we are confident that a bus can do most of a day for most of the trips and still come back with plenty of charge left on them. There might always be an exception to that where we have to work around that, but the whole point of the trial and staging it is to trial that in different environments. That, for us, is working really well and so we are seeing lots of positive outcomes.

Dr MARJORIE O'NEILL: One of the things we have explored and that has been discussed quite extensively is the retraining of staff for electric vehicles—on one hand, the retraining of bus drivers, but also as well the service staff around that. Do you have any insights or thoughts about the best ways for achieving that and retraining not only existing staff, but as this becomes an emergent new area, how that should be achieved?

Ms MILDWATER: We probably have not developed training ourselves. We have not got to that extent. But I guess the context would be every different type of bus on the network—and there are lots of them—actually needs particularly the mechanics and the service staff to retrain a little bit anyway. Also, when you think back to

the introduction of gas buses, they have had to retrain already there for a different sort. So I guess we have a lot of confidence that they can do it. It is just about the process of putting it in. It would not necessarily be for us to run that training. We would obviously be very supportive, but we are thinking there is actually no impediment to it because it happens quite regularly at a smaller scale and has happened at large scale before.

Mr ISSA: To add to that, across our fleet we have a number of different suppliers and different models. Every particular bus, either the mechanics of the bus or the way the driver drives the bus is different. Over the years drivers and mechanics were trained specifically on a bus and they familiarise themselves with a bus on where the steering controls are, the brakes, the indicators, the emergency buttons, and likewise for mechanics. As those buses are rolled out, our operators partner with the suppliers and develop training packages to get those services in and make sure those staff are trained and fit for purpose. We have a bus operator accreditation scheme; BOAS is a framework which applies to all bus operators in New South Wales. As part of that, there is a framework which requires a comprehensive safety management and training program to make sure that that is delivered.

In terms of this particular technology, like every other bus that has come out, there will need to be specific training material developed. That was done for region 6 and it was also done on the south coast when Premier did their trial of an electric bus. As the technology progresses, we will work with industry, we will work with BusNSW, and we will work with operators to develop that. But the operators themselves will work with the suppliers of the buses to make sure they are fit for purpose—what do we have to do to maintain this bus, how do we drive this bus, how do we charge this bus. It will be upskilling of the mechanics and the maintenance staff to do that. Just like Ms Mildwater indicated, be it a compressed natural gas bus or be it a diesel bus of some other sort, we have had to do that along the way. We have confidence in our operators that they can do that and they have done that successfully in the past.

The CHAIR: Did you want to make any further comment?

Ms MILDWATER: No.

The CHAIR: I had a question in relation to the percentage of the current fleet that is less than five years of age. What percentage would you say that was?

Mr ISSA: Less than five years of age? I know that the fleet has an average age of 11 years. I can take on notice less than five years. What I do know is that we have until recently bought approximately 200 buses a year across Greater Sydney.

The CHAIR: Yes, that was my reasoning for that question because you have got at least a couple of hundred buses that are new—less than five years of age. The lifespan of those buses would be expected to be what?

Ms MILDWATER: It can be 18 years to 25 years. It is quite a range but it can be a long time.

Ms ELENI PETINOS: Notwithstanding that, though, would it be fair to say that, in the department's view, the potential introduction of electric buses would not mean that you are going to disregard every other bus in operation?

The CHAIR: I was about to say that.

Ms MILDWATER: No, that is why we are emphasising this is a rolling period that will take time—

The CHAIR: Correct. That was my next part of the question: the transition.

Ms MILDWATER: Hence we are giving industry time to develop. But as a practical matter you would not turn the fleet—you cannot anyway, because you could not order that many buses. But yes, you would transition buses out as it made sense. It does not mean you would wait until 25 years for every bus, but certainly the ones that are new you are not going to—

The CHAIR: No. So what you do have is current stock that is of an acceptable standard for some time, which would allow you to transition into that electric buses mode—

Ms MILDWATER: That is right.

Mr ISSA: Yes.

The CHAIR: —without the panic of the fleet having to be depleted totally because it has run down.

Ms MILDWATER: That is right, yes.

Mr ISSA: Yes.

The CHAIR: Just from your observation and looking forward, what would be—without having a crystal ball—a transition period for something to move into, say, a 50-50 split between the electric buses and current bus fleet?

Ms MILDWATER: That is the question that we are working on and still working out. It is why in particular we want to do this next piece of trials with different types of industry in different places. We actually do not have an answer to that question at the moment, because it is balancing up the realistic—what industry can do, the life of the fleet that we have got, good use of taxpayer money, getting the right length of time out of the current buses—but also trying to be as ambitious as we can.

The CHAIR: And further trials will help you come to that decision?

Ms MILDWATER: Yes, they will, because also as industry develops there will be more suppliers. We do have to balance what is possible with supply. We are confident that the sort of trials that we want to run out over the next year or so industry will be able to meet, but in that time they will also be able to gear up a bit more. Yes, sometime relatively soon we will have to work out what that transition period is, but we are still working it out.

The CHAIR: Judging from the feedback we are getting throughout this hearing the experience has generally been very good with the electric buses to date in the trial.

Ms MILDWATER: Yes.

Mr ISSA: Fantastic. The customers love them. The customers love them and the drivers enjoy driving them, so they are running terrific.

The CHAIR: Deputy Chair, did you have another question?

Mr GURMESH SINGH: I did. With the introduction of more and more electric vehicles on our roads, and especially buses, how have the emergency services reacted to that and are there any safety protocols or regulations that may need to change if we have more electric buses on the road?

Ms MILDWATER: In relation to emergency services?

Mr GURMESH SINGH: Yes, so basically previously people might have been trained to fight a petrol or diesel fire—

Ms MILDWATER: Yes, that is true.

Mr GURMESH SINGH: —and now we have electric fires, or the potential for it.

Mr ISSA: I think from a safety perspective over the recent years we have been doing a lot of work to improve our bus safety. If I start there, we have done a lot of work to improve the levels of safety within the bus, the level of fire-retardant material in the bus and also bus fire suppression. All 5,000 buses across Greater Sydney have fire suppression to help minimise safety incidents and to enhance customer safety. We work with the emergency services and they also have a view of the Australian design rules to make sure that they can respond. As every bus comes on board, be it diesel, be it gas or electric, we work with them. There are less combustible parts in an electric bus because you do not have the compressed natural gas and you do not have the diesel tanks, which rupture and create other things. We have worked with them closely, as we have for all new modes to be rolled out, and we have not had to date any negative feedback or significant concerns raised.

Ms ELENI PETINOS: As you are aware, we are inquiring into the impact of the introduction of electric buses not only in metropolitan areas but also in regional areas. Do you have any insights and observations that you would like to share with the Committee about the potential differences in the introduction across the two distinct areas?

Ms MILDWATER: Some of that goes to range and geography.

Ms ELENI PETINOS: I appreciate you cannot comment specifically without having a static example of each, but just in terms of the general factors that would need to be considered, and if there are any considerations you think that the Committee needs to take on board, when making recommendations.

Mr ISSA: I think from a recommendations perspective, obviously our regional services are much longer. They run longer kilometres. We know that in the trial on the south coast they split the route up in two and they ran a trial, a diesel and an electric bus, so that they could actually compare the two services and they found that comparable—the electric bus did quite well.

From an infrastructure perspective, and from a deployment perspective, I think it comes down to what is the local network from an infrastructure, electricity-supply perspective in the regions, the length of the trips that

they can undertake, and is there a need for opportunity charging or charging at locations where a coach may terminate at a major interchange, for example, and then turn around and come back again. Because the trips are longer, we would need to look at some of those infrastructure considerations around in the regional sense.

Having said that, again, we are getting 300 kilometres to 400 kilometres on a bus, but given some of those trips are longer in distance we would need to understand what that looks like. But again, in terms of—we talked about the infrastructure itself: it would be a local, tactical conversation about what that looks like. If we were looking to run buses for 500 kilometres or 600 kilometres or run buses on a long, long trip it may be that they require some midpoint charging. It would be no different to any other electric vehicle. As we look at electric vehicles more broadly across the network and we look to roll out electric vehicles—so light commercials and sedans—across regional New South Wales, and more broadly across New South Wales, they would also need opportunity charging along the way.

In considering the provision of opportunity charging for light vehicles and light commercial vehicles we would need to ensure that we have an eye to electric buses so that we could capture the whole market, not just a commuter or a family taking a trip along the Pacific Highway or the Princes Motorway. It is around provisioning for those sorts of services and understanding, I think from a consideration perspective, understanding how we cater for that where the depots are probably a little bit further away for charging.

Ms ELENI PETINOS: One witness earlier today suggested that perhaps in more rural and regional communities that are set up with existing wind infrastructure, was the example given, that there might be an opportunity to enhance the use of that type of energy in those types of fleets as distinct from the city fleets. Is that something that you may have prior awareness of or do you have any thoughts?

Mr ISSA: I think it is really important that we articulate that we are fuel agnostic. If it was water, if it was wind, if it was solar—look, it is the grid. How it is generated, we know that once it is converted into electricity we can use it to charge the battery of the bus and we can use the bus. Absolutely, if there is provision for solar, if there is provision for wind then we would be more than happy to tap into that. I am sure Ms Mildwater will add to this. We are looking to how we can do that more broadly across Transport for NSW. Again, even at our bus depots we would in the future look at how we can maximise solar panels and other things to capture solar and turn that into energy to create the power. Regardless of how we can get that, absolutely, if it is wind, if it is water or whatever it may be, the bus just requires access to that infrastructure and it can charge.

Ms MILDWATER: I suppose there are probably just two aspects to that as well. There is the low-emission type of energy, but the other thing that we bear in mind is the contingency planning and if there is a diversity of power sources—what I was saying before, for example, having batteries in the depot—that does give you some contingency. If something were to happen to the grid you have got an alternative power source. Same if there was wind power: it would be an alternative power source.

Ms ELENI PETINOS: That aligns with some of the testimony that was given earlier today. I was just trying to flesh it out so that we have comparative points for later.

Ms MILDWATER: Yes, it makes sense.

Ms ELENI PETINOS: Chair, do you want me to go again?

The CHAIR: Yes, please. I am enjoying the questions.

Ms ELENI PETINOS: I am sure that you are. There is potentially a question around who would pay for depot infrastructure and the upgrade to that. Does the department have a view?

Ms MILDWATER: It is something we are pretty aware of because depot infrastructure is necessary. I suppose, at the moment there are mixed ownership arrangements of depots. Some of them are ours and some are owned by private operators. It is one of the things we have signalled as part of the renewal of all the contracts, because we are looking at all 14 contracts over coming years. Potentially in the longer term it is obvious we can upgrade depots that are ours. It also potentially makes the market more open if depots are commonly held. But we are still really looking into that.

One of the things that will come out of the request for expressions of interest we are about to do, where we are asking existing operators to partner with industry, is we would expect that would be one of the things they will bring to us—what depot infrastructure is needed and how that would be funded. Obviously, the STA depots are ours and we will pay for that infrastructure, but in the other depots we have not landed exactly what the model would be, other than recognising that upgrades will be needed. One last thing is that, potentially, as the city goes further out west with the Western Parkland City, we are probably looking at completely new depots in some places as well.

The CHAIR: And you have new airports there.

Ms MILDWATER: Yes, so we would build from scratch there. In some cases that is actually a little easier.

Ms ELENI PETINOS: Can all existing depots be adapted for electric buses?

Ms MILDWATER: I do not know that we have actually looked at every single one yet. Probably some of the operators are better placed to answer that. I would think that is something they will tell us during the next process we are about to go through.

Mr ISSA: I think it is more of an issue of the supply, be it solar, wind, water. For the grid, it is more a question of how much power they can source that is the consideration in the transition. Principally, can they use battery? Can they use solar? Technologically, there should be no reason why they cannot. It is more about what is required to do that work and understanding the local environment. We know the operators are actually having conversations with their local suppliers and operators who supply them the buses to understand that. They are making those inquiries themselves, so there should be nothing to prevent them. Quite simply, it is electricity and nothing more than that.

The CHAIR: Just picking up on that point, do you think there needs to be a standardisation of equipment for charging so that different companies with different models of buses—and cars also—have the ability to use and adapt to those charging ports?

Mr ISSA: It is a good question. What is occurring at the moment is operators are creating their own charging. If you buy a particular bus, it comes with the optional charger that is designed for that particular manufacturer. But there are also universal chargers that you can buy more broadly that can service the buses. We are seeing some standardisation as we move forward across the different charging technologies. One of the things we need to be cognisant of is that this is really evolving technology. It is very much in its infancy. As an infant product it started with a very bespoke-type charging system that the particular manufacturer designed for. As they become more standardised, and they start to service large parts of Europe and now Asia, they are looking to more standardisation across that. Yes, the buses do come with a particular brand of charger, which the manufacturer has produced, but you can buy multipurpose chargers that you can use across a number of different fleets, which I suspect over time will become more popular because, if I am an operator with a multipurpose charger, I can use that potentially on a number of different buses.

In terms of the technical requirements and whether or not a charger for a bus, for example, can charge a light vehicle, I could not comment on that. But I do know that the battery technology and the charging technology for those buses is evolving and there is some standardisation coming. But you can always get a specific type of charging system for that. It may be that operators will make their own decisions around what they prefer and how they prefer to set their business up, which is what they should be doing, but that is evolving as we speak.

The CHAIR: Further to that, in relation to the battery itself, what we have heard over the last two days of the hearing is that there is an opportunity for the battery to be recycled and reused in other ways. Moving forward from that, when it gets to the end of its actual life expectancy and that has now expired, has the department a view on what happens to batteries then?

Mr ISSA: I think at this stage, no. We are still working through that. To your point, and I know others have provided evidence at hearings, what we are seeing internationally is that they are being repurposed to store power locally at depots as contingency or as supplementary but also to capture solar power. They are being connected to solar panels on roofs and companies are then capturing solar, storing it in their batteries and using them to charge their fleet. In terms of the very end-of-life product, we will have to work through policy positions around recycling and disposal, as we would with the department of environment. We are definitely cognisant of our environmental footprint. It is just something we have not landed yet because it is very early in the process.

The CHAIR: Yes, it is all part of the mix.

Mr ISSA: It is, absolutely.

Ms ELENI PETINOS: Ms Mildwater made comments in her opening remarks about the importance of the digital disruption that is happening as a result of emerging technology. Has any thought been given to, or are there any opinions about, how the evolution of technology, in a digital sense, can be used to enhance the customer experience with that in relation to electric buses and their rollout in New South Wales, particularly with respect to people who may be experiencing disability with either their sight or hearing?

Ms MILDWATER: There are probably a couple of aspects and I think Mr Issa referred before to apps under development. The other piece with the electric buses is a bit like where some of our train fleet have gone.

They now have very sophisticated monitoring systems so that in the control centre they can essentially see everything that is happening on a bus. It is taking live all the stats of what is happening on a bus and predicting how it is going, seeing if something is going wrong, monitoring it and dealing with it from the control centre. Although that might not seem to have a direct customer impact, what it does do is make it more reliable and help the customer centre to hop onto something if it is going wrong. From the maintenance side, they are getting pretty sophisticated and approaching where the trains already are. In terms of the apps for accessibility, I will ask Mr Issa to respond.

Mr ISSA: Internationally there are some apps currently under development and we are watching that closely. We are a follower in this space, so we are leveraging off what is being done internationally. We talked about the AVAS-type technology that will help people understand the bus is there and what is around them. That is for all our customers and there is an audible noise for customers. We have talked about the passenger information displays and the announcements for our mobility impaired or vision impaired or hearing impaired customers on our transport network. As they arrive at a bus stop they can hear a bus coming and they can understand the bus is arriving. There are apps currently in development around the world that will hopefully allow customers to know from a technology piece that gives some indication. We are watching that very closely.

What we have also found is that with our movement from a turn-up or timetable-type service to a turn-up-and-go service, the actual arrival of a bus to a timetable is occurring regularly. From a customer perspective, more buses are arriving more frequently. That means that reliance on a timetable is less important. We are seeing that particularly in Greater Sydney. We will have the technology around allowing customers to be aware that a bus is approaching and the new technology around making announcements on buses that they are approaching their bus stop, so they are aware that they should get off at this stop. We are monitoring what is happening around the world with apps. We are bringing the products from an app perspective but also from a bus perspective closer together to try to meet those customers' needs and make them more accessible but also make sure that our customers are informed. We are learning in that space, like the rest of the world, and we will continue to drive ourselves to improve those services and make sure we meet those needs. It is a very dynamic environment.

Ms ELENI PETINOS: I believe that was specifically raised with us about the Halo app, unless any Committee members want to correct me? Is the department aware of that particular app, and is there currently any interface between the department and that app?

Mr ISSA: Yes, we are aware of the app. I will have to take it on notice as to whether we are talking with them.

Mr GURMESH SINGH: I want to touch a bit further on the charging infrastructure and how that might be made more uniform. I know we spoke about this a bit earlier, but if we have 10 different bus companies running all over the state, does it make sense, in your view, to have uniform charging in case we need to move buses around the state in cases of emergencies like we are seeing now?

Ms MILDWATER: That is a good question.

Mr ISSA: In their infancy the buses themselves were having—should we get to a point where we have uniform charging? Absolutely. It needs to be, regardless of the technology, something that can charge a bus simply. In Europe that is where they are heading with the current stock design standards. Because we are early in the process, we have not specified any particular requirement at this stage. But we are still developing our requirements. But we do have universal chargers available today on the market that can be used across multiple buses. It is getting there. Because the buses are new, it is a new technology and they are evolving, that is where it is heading. But absolutely, we should have consistency and ease of use for all operators across the state.

Mr GURMESH SINGH: In other jurisdictions is the push towards uniform charging market and industry led or is it government led?

Mr ISSA: I will take the question on notice, but I think it is a combination of both industry and the market.

Ms ELENI PETINOS: To provide further context on what Mr Singh was referring to, some of the submissions have asked the Committee to consider whether tier 1 providers should be responsible for the charging outlets to ensure that there is uniformity.

Mr ISSA: Tier 1 bus providers?

Ms ELENI PETINOS: They say tier 1 providers.

Mr ISSA: We will have a look at that. From our perspective, having a consistency of supply will be important at some point.

The CHAIR: It makes sense.

Mr GURMESH SINGH: Another bit of context is that at the moment electric passenger vehicles are coming into the country and every single manufacturer seems to have a different charging port. One of the beauties of petrol and diesel is that any manufacturer can go to any service station and refuel, which is not the case for electric passenger vehicles at the moment. I do see that as an issue moving forward.

Ms MILDWATER: It is something we would obviously need to address. If the industry does not naturally move itself then we would need to make sure there were universal chargers, because, as you mentioned, although they are depot based, we do move fleets around in emergencies or if we need contingency planning.

Mr ISSA: The universal chargers are there. But over time it will evolve to a common platform.

The CHAIR: Does Transport for NSW have an opinion on the fuel excise tax that is currently on the fleets with diesel and the lack of tax with electric buses, as such?

Ms MILDWATER: I do not think that is something that either of us would have an opinion on, no.

The CHAIR: Safe answer. I just wanted to throw it out there. It is not within the confines of this particular hearing, but it is something that has been raised. Would you like to make a closing comment?

Ms MILDWATER: I suppose I would just reiterate that we are quite enthused about the opportunity to move to zero emissions, but we do understand that there are a lot of questions and challenges. We look forward to hearing where you land and what the recommendations are.

The CHAIR: Thank you both for appearing this afternoon.

Mr GURMESH SINGH: And thank you for coming in person.

The CHAIR: Absolutely. We really appreciate the face-to-face meeting so that we can pose further follow-up questions. There may be an opportunity for the Committee to ask further questions, which we would write out and send to you. Are you happy to respond to those questions?

Mr ISSA: Yes.

Ms MILDWATER: Yes.

The CHAIR: That would be part of your submission as well, and would be made public.

Ms MILDWATER: Yes.

The CHAIR: We would request a response within a seven-day turnaround. Thank you very much for coming.

(The witnesses withdrew.)

The Committee adjourned at 16:20.