T R A N S C R I P T

STANDING COMMITTEE ON THE ECONOMY AND INFRASTRUCTURE

Inquiry into electric vehicles

Melbourne — 9 November 2017

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Witness

Dr Julian de Hoog, Honorary Research Fellow, Melbourne School of Engineering, University of Melbourne.

The CHAIR — Dr de Hoog, thank you for joining us and welcome to the public hearings of the Economy and Infrastructure Committee. The committee today is hearing evidence in relation to the inquiry into electric vehicles, and the evidence is being recorded. All evidence taken at this hearing is protected by parliamentary privilege; therefore you are protected against any action for what you say here today, but if you go outside and repeat the same things, those comments may not be protected by this privilege. Could I ask you to state for the record your name, your position, the organisation that you represent and the suburb or city in which you are based, and then give us a 5 to 10-minute introduction. We will then open up to questions.

Visual presentation.

Dr de HOOG — Thanks for having me. My name is Julian de Hoog. I am an honorary research fellow at the University of Melbourne. I am based here in Melbourne, postcode 3010. I am going to talk to you about research we did over the period 2012 to 2015. It was a three-year research project looking at what impacts electric vehicles would have on our electrical networks. That is my area of expertise; that is the main contribution I see myself as being able to give to this committee.

I did bring slides, but it is a bit of an academic presentation. They are more there to provide support if there are some questions that come up. I think it is probably easier if I just talk to you directly about the findings.

It was a three-year research project we had, and there were two main goals. The first was to understand: if people start to buy electric vehicles and start to plug them in at home, what kind of impacts will they have on our networks, specifically residential networks? The second goal was: if these impacts are bad, what can we do about it? How do we shift the timing of electric vehicle charging so that we mitigate these impacts? To do that we first built up relationships with network operators — AusNet, United and Ergon Energy in Queensland — and worked with them to build up some example networks for which we got data on people's typical demand. We used state government transportation surveys to understand how people use their cars, how far they travel, what times they arrive at home and what times they would be likely to plug in their electric vehicle and so on. Then basically we had models of several typical electrical networks and we played around with them a bit. We went through a whole validation cycle which included peer-reviewed research to make sure that these were accurate models of what really happens in real networks.

That meant we could start to add vehicles here and there, add one vehicle to a network, add two, add 10 — however many we wanted — and start to discover what the actual impacts would be. The main impacts we anticipated were obvious, I guess. First of all, I want to emphasise that an electrical vehicle is no different from any other electrical appliance you might use, like a washing machine or a split system; it just draws electricity like anything else. The only difference might be that they might charge at high rates for quite long periods, depending on how long you have travelled and, as you would expect, people will plug them in when they arrive home, and that is typically in the evening. That is peak demand. So you are already running all kinds of other things, so they actually contribute to peak demand.

If people start to plug in all these electric vehicles, the potential problems are: first of all, you get all this extra demand in the network, which means there is extra demand on the transformer and on the cables, and that could be a problem. The second thing is, as you have more electricity being drawn through these networks, the voltage is affected at individual houses. So every house is supposed to have a voltage of around 230, but if people start to put more load on the network it can drop. It can be higher at times, but it could drop low, and if it drops too low, that is not great. That negatively affects things you might own in your house. The third is that the networks need to be balanced. Most networks have three phases. Each house connects to one, and if a lot of people on one phase start to buy electric vehicles, you start to unbalance networks and that in turn leads to problems of voltage and so on.

After we did all these studies, we found that typically in Australian-style networks, which would have maybe 50 to 200 houses connected to one transformer, the first problem is low voltage. That is usually a problem before you have issues with the transformer and the lines. It depends on where the neighbourhood is, how far people have travelled — so how much they need to charge. It depends on the season — summer or winter — and it depends on the day of the week. But looking at all kinds of different scenarios and different types of networks we found that typically the first problems start to occur at around 10 per cent uptake. It depends very much from network to network; this is not a blanket statement. But in general when every 10th house starts to plug in an electric vehicle, that is when you may start to see the first problems, and the first problems are typically around low voltage.

Maybe I will do just one example slide here. One other finding was that individual houses have very different levels of sensitivity. Some houses are no problem — you can plug in an electric vehicle anytime you like, even at peak demand — but other ones are much more sensitive because they are far from the transformer on a heavily loaded phase. That means that they are already at a low voltage. If they plug in electric vehicles, that means more current flows through the heavily loaded phase, which means more imbalance, which means more voltage issues.

One kind of fun experiment we did was say, 'What if we put one vehicle in the most sensitive location; how many vehicles is that equal to in the more robust locations?'. You can add 10 or 20 vehicles in the good locations and have the same impact as adding one vehicle in a bad location.

Ms HARTLAND — Can you explain why?

Dr de HOOG — Yes. Am I okay to stand up and point?

Ms HARTLAND — Yes, please.

Dr de HOOG — If this is a typical network, triangles, squares and circles represent which phase each house is on. When you see your lines going down the street, you will see four. They are phases A, B, C and neutral. Every house is connected to one of those phases. Typically networks are pretty unbalanced in Australia. There is a story that when they add a new house, it is easiest to go to the closest line, so you end up having this imbalance.

As current travels down the network, you have losses as you go. The voltage here will be high, here it will be lower, and here it will be lowest. But current travels back through the neutral, and if you have more imbalance, you have more current, so you have more losses. The further you go from the transformer, the lower your voltage. Then if it is on a highly balanced, highly loaded phase, you create more imbalance, which makes the voltage drop even more. Basically this one is very sensitive, and these ones are pretty safe and pretty robust. In fact — it is getting a bit technical now — you can actually add vehicles to the lightly loaded phases, and because you are rebalancing the network, you create opportunity for more vehicles to charge.

The point of all that is to say that there are some issues of fairness house to house, and the first issues will be around voltage. The first problems, like I was saying, are anticipated at around 10 per cent uptake. There are ways you can solve that. There are low-cost ways that you can rebalance the network so that you can then solve some of these issues.

Then as you start to get to higher and higher uptake levels — 15, 20, 25 or 50 per cent — that is where we went into the second phase of our project, which was to say, 'What can we do about the timing of this charging to improve all of this?'. Being an academic project, we found the optimal way to do this, but basically there are simple ways to shift vehicle charging. Maybe I will bring up one more slide.

Here is just an example of the timing of charging. Every horizontal line represents one vehicle profile, and green and orange mean the vehicle is at home. White means the vehicle is away from home. You start at 8 in the morning, and a lot of vehicles are away from home. Then they start to arrive. Orange means how long they would need to charge to go from whatever level or state of charge they are at to 100 per cent. Some vehicles have only travelled a short distance and do not need to charge very long, but other ones have travelled a long way and need to recharge for 2, 3 or 4 hours to get to 100 per cent.

If you plot it this way, you can see that all the charging is likely to overlap right around peak time — 7.00 p.m. or 8.00 p.m. — if everybody plugs in as soon as they get home. But then there is all this flexibility where the cars are at home and where they are not charging. It is an obvious idea, and we all realise this, but this really visually emphasises how much flexibility we have. There is so much spare capacity to charge these vehicles and still have them fully charged when people actually need them in the morning.

I guess that is the main point. Basically there are fairly simple ways to shift that charging. If you do it in the optimal way that we developed, we can get uptake levels of 80 per cent, so almost every house in the street could have a vehicle, and as far as the network goes, we could handle this uptake.

Regarding the mechanism of allowing that to happen, I think the technical side is there. It is certainly possible to control this charging. There are many easy technical ways to do it, and the real questions are around the regulatory frameworks that incentivise it and allow it to happen.

The CHAIR — Are you suggesting, looking at that, that half the people should get up at 3 o'clock and turn their car on?

Dr de HOOG — Well, I would not ever expect it to be something that people would have to do themselves. I would expect it to be a charge provider — like we had one already speak today — or the retailer or whoever manages this for you, in the same way that we have the timing of hot water being managed today. Technically it is certainly possible, and it is just the case that we need to have the incentive for somebody — whatever retailer or whatever service provider the home owner signs up with for their charging — to do this. For them the incentive needs to be there to do it as well; they need to be charged more if they are charging at peak and be charged less if they are charging overnight. My main expertise and contribution, I think, is more around the impact on the network side of this, and I think the key things are that there may be some minor problems in the short-to-medium term, but based on the research we have done we do not anticipate there to be a huge negative impact on electrical networks in the short to medium term. If everybody starts to buy them, then things might start to happen.

The CHAIR — Right. Well, thank you for that. I was going to ask you about that peak and off-peak issue, because clearly if this thing does take off and a lot of people have electric cars that they plug in, off-peak will become peak, surely, and that will impact costs and charges from electricity companies, I would imagine.

Dr de HOOG — Yes, so it becomes part of a bigger energy and network question. The networks are built around peak demands, that is where all the costs are, so how do we get people to shift their demand patterns in such a way that we do not all use electricity at the same time? Like I say, it is a broader question — it is not just electric vehicles; it is the way we use energy at home, demand response programs — I think there are certainly ways to do it. One of the mechanisms is to change the way that we pay for electricity — this has been a big discussion for a couple of years now — so that people get charged if they contribute to peak demand. I think that would certainly be a big incentive to get people to not use electricity at peak time.

But to get back to the question, would it lead to a new peak overnight? I think you would have to have a lot of electric vehicles to lead to a peak overnight. I have seen demand data where you see a peak go up till sort of 6.00, 7.00 or 8.00 p.m. and slowly drop down, and then it jumps up at 11 because that is when people go from their peak to off-peak rates and everyone runs, certainly, their hot water systems, their pool pumps and all those kinds of things. It is usually not as high as the main peak, but you do see this jump. I think there is a risk, if it is managed poorly, that if electric vehicles get a cheaper rate at 1.00 a.m., suddenly they will all kick on because of whatever timing mechanisms exist, but that is, again, something that can be solved. That would need to be done together with the network operators, but it is not that difficult, really, to adjust the timing of the start of these charging systems so that you do not get these crazy ramp rates and these crazy peaks.

The CHAIR — I am asking people to look well into the future today, to 20, 30 or maybe even 40 years down the track, when we may have a situation where the overwhelming majority of people will have electric cars. How much more power will we need at that point than we have now?

Dr de HOOG — Can you give me 10 minutes and I will get back to you? I will do a back of the envelope. I think it depends on where you are. People in the outer suburbs will commute much longer distances than people from the inner suburbs and so on. One EV that travels —

The CHAIR — As a state, though, how much more power, how much more electricity, will we need to produce for the added demand of electric cars in those numbers?

Dr de HOOG — Well, one EV, if it goes a long way, is like a small house in terms of its consumption, but I cannot think of an exact number, because then you are looking into population expansion and all sorts of things, and so I do not have an exact —

The CHAIR — So down the track, as I say, we could easily be looking at 2 million small houses.

Dr de HOOG — Yes.

The CHAIR — That is quite an extraordinary extra demand on the grid, I would have thought.

Dr de HOOG — Yes, it certainly is.

The CHAIR — Fascinating. But not even looking that far down the track, could the extra demand lead to blackouts given we are looking at potential blackouts this summer? Could the added demand placed on the grid by electric vehicles lead to blackouts — even localised blackouts?

Dr de HOOG — Well, if the timing of electric vehicle charging coincides with existing high-demand periods, which are heatwaves, late afternoon and early evening, then that would certainly put an enormous demand on our networks. But if we shift that timing, then in our research we found, like I just said, that we can accommodate quite large numbers of electric vehicles in our networks with pretty minimal requirements for network upgrades.

Mr LEANE — Is there a household electrical item that you could compare to an electric car charger as far as the current that it draws, like an air conditioner or —

Dr de HOOG — Sure. So for an electric car it depends on what kind of charge you have. I am not up to date with the latest charging technologies, so maybe somebody else can provide more info on that, but certainly when we were doing this work we were assuming that they were charging at 3 kilowatts. At the time, slow charging was 3 kilowatts and fast charging was 6 kilowatts. So 3 kilowatts would be like a little fan heater, which can draw 3 kilowatts. Air conditioning split systems can typically draw about 3 kilowatts. Big ones might go up to 5 kilowatts or 6 kilowatts, so it is like quite a large split system. But the difference is that many of these other household loads, such as a washing machine which might be 3 kilowatts, would run for maybe an hour. Air conditioners will cycle on and off. With an electric vehicle, you turn it on and it charges, and it charges at that rate for quite a long time, so it is a very continuous, high demand.

Mr LEANE — I am probably not up with the research you did, but I think there is an argument around electric cars if the charge is supplied by a coal-fired power station. I know there is an intention for renewables to kick in. You have not got exhaust from the back of your car because you are driving an electric car, but there would be increased pollution from the power station if you were to charge your car at 3 kilowatts at night? Has there been any research around how much more environmentally friendly an electric car is?

Dr de HOOG — Yes. Some colleagues of mine at the University of Melbourne, even before I joined the university, did some work on that where they looked at small vehicles' and large vehicles' impact on the environment and small diesel and small petrol versus electric. So if you are charging an electric vehicle from coal, your emissions — I forget the exact numbers; we would have to dig them up — is roughly equivalent to a petrol-powered vehicle in terms of the total lifecycle emissions into the environment, the difference being that they are not in the city, so you are not emitting in the city. So it improves air quality in the city. But the obvious benefit of electric vehicles is that you have flexibility, so you do not have to choose coal; you can choose renewable. You choose whatever electricity source you want. As our energy mix evolves over the coming years, and I do believe it will be going more in the direction of renewables, at that point the comparison gets better and better in terms of the emissions for electric vehicles.

Mr LEANE — Fantastic. Thanks.

Ms HARTLAND — There is a lot of talk about whether we will be able to meet the electricity supply. It sounds to me that what you are saying is with good planning in five, 10, 15, 20 years we will actually be able to manage the numbers of electric cars that are likely to be coming onto the market.

Dr de HOOG — With good planning, the right regulatory environment, and certainly discussions with the network operators enabling these mechanisms we need to shift charging — if those kinds of things can be enabled — then yes, I think there is a very good chance that we can handle large numbers of electric vehicles at minimal extra infrastructure cost.

The CHAIR — Thank you very much indeed for joining us today. We do appreciate your time and your contribution to our deliberations. There will be a transcript arrive at your door within two or three weeks. If you could just check that and let us know if there are any glaring mistakes, that would be a marvellous thing. Thank you very much indeed. We do appreciate it.

Dr de HOOG — Thank you very much.

Witness withdrew.