Energy Futures** – Coping with hotter summers: the challenge for our electricity system - **Melbourne 30 April

Climate change means that we are facing hotter summers. As homes and businesses switch on their air conditioners on a hot summer afternoon, power stations must ramp up production to meet the peak demand. The owners of the 'poles and wires' have been planning and building for years to ensure our power networks will cope. If any part of the system fails, blackouts can occur, with severe consequences for people and businesses.

With so much at stake, what can we learn from how electricity demand patterns have changed in recent years and what does this mean for the future of peak demand? How might our expectations or the power system need to change in the face of a changing climate? And how will the system cope when more of our power comes from wind turbines and solar panels, which cannot always operate at full capacity at the times when more power is needed?

On 30 April, as part of the 'Energy Futures' series, the Melbourne Energy Institute and Grattan Institute co-hosted a public forum on the future of peak demand in Australia.

Speakers: Lucy Carter, Energy Fellow, Grattan Institute
Lane Crockett, Executive General Manager, Pacific Hydro
David Karoly, Climate Scientist and Professor at Melbourne University
Julian Turecek, General Manager of Wholesale Market Operations at Energy Australia

LUCY CARTER: Good evening ladies and gentleman. My name is Lucy Carter. I'm the Energy Fellow at the Grattan Institute. On behalf of both the Grattan Institute and the Melbourne Energy Institute, I'd like to welcome you here this evening for this second *Energy Futures* lecture. This is the second in our series, this session being on the hotter summers and the future of peak demand. The format for tonight is I'm going to be doing a short presentation on peak demand, what is peak demand, what does it mean; we'll then move on to some brief presentations from the three speakers we have lined up for you this evening; and then we'll move to a Q&A panel session for the remaining 45 minutes. Before I get started, I would like to acknowledge the traditional owners of the land in which this event is taking place, that's the land of the Wurundjeri, and pay respects to their elders and families.

So, peak demand. As I said, the purpose of this presentation is really just to get us all on the same page about what we're talking about when we refer to peak demand and why that matters. So, just a bit of background on the electricity sector in general. When we talk about the electricity sector we're actually talking about a number of different component parts. We have power stations which then feed into a transmission and distribution network, which I'll refer to collectively as electricity networks, that then feed power on to end users. And then in-between we have retailers who are responsible for paying the power stations and passing funds along to the distribution businesses, who then pay transmission companies. Why it's very important to understand this is because in this market there are some aspects of this market that are regulated and some aspects of this market that are unregulated. So the retailers and the power stations operate in competitive markets, whereas the electricity networks operate in markets that are regulated, and that has quite significant implications when we look at peak demand and how it impacts particularly customer bills.

So, what is peak demand? Peak demand can be measured in various locations and it can be measured across various times, which can get confusing when people talk about peak demand as if it's a single figure that applies across the whole system. This is a scan of the Victorian market, so this is Victorian electricity demand for 2013, and you can see that circled point at the top there is the peak demand number for Victoria for this year. So on that day on the 12th March demand was a bit short of 10,000MW, so that's what we call a peak demand day for the year. That peak demand tends to be very closely correlated with weather, which is an important factor which we will get to a little bit later I believe. There are a range of factors which drive demand for electricity. Hot weather is a big one. You can see I've plotted that section there for summer, particularly where there's a sequence of hot days that's a contributing factor. There are a range of other factors which can often drive peak demand so, for example, it's more likely to occur on a weekday because more businesses are open; it's more likely to occur when school's back in as opposed to on the school holidays because that creates an additional demand. So it's not a single factor model, but weather is a large driver.

So, why does this peak demand issue warrant a lecture of its own on this fine Wednesday evening? When we build a power system it's a little bit like building a football stadium. One of the challenges with electricity systems is that often people aren't quite as familiar with these as they are as something like the MCG. So if you think about building the MCG, you've got to make a decision about how many people you want to fit in there and you've got to build a stadium that's big enough to accommodate that, and that's very expensive. So when we talk about our power networks it's a bit like saying how big do you want to build the stadium and you've got to build it that size to cater for your maximum crowd.

So our peak demand day is like AFL Grand Final day, that's when we have a situation where you've got to get maximum capacity in there. Unfortunately, unlike a football stadium where you can say we have 100,000 tickets available and if anyone else wants to come, too bad; in the power network we have a bunch of users connected to that network and those users will be turning things off and on, and if the network can't deal with that then there will be problems with the system, most of the time that means blackouts. And what we see there is that that capacity, so this large amount of capacity that has to be built in order to account for that fact that we have these peak days and we have these days where a lot of people are putting pressure on the system, isn't used very often.

So this is a bit like saying if we've got AFL Grand Final day, we also try to use the MCG for a range of other things, so we have cricket in the summer and football in the winter, and the idea of that is that you get paid based on the number of tickets you sell, not how big your stadium is. Again, there's a parallel here in terms of the electricity market. So most of the charges that people pay for energy are based on the amount of energy they use, not the size of the system that has to be built to supply that energy. So you can see here that if you look at the top 10% of capacity - so that's to meet the peak demand level just in this year within a 10% level – that's only used for a bit under 36 hours a year in 2013. So if you look at a longer time horizon, obviously those numbers get even lower. So basically we're building 10% of the capacity based on this year to be used in less than 0.5% of time throughout the year.

Now, on top of that we've also seen this marked change in the electricity sector over the past few years. You can see there that since the 1960s we had this steady run-up in how much energy are using – remember, that we're paying for the system based on the amount of energy - and then around 2009 that turned around and people are now using less energy. Now, this is a problem for two reasons: firstly, because it means that there's a smaller pool of energy to collect revenue from; secondly, because no-one really saw it coming. There were forecasts going back to, say, around

2009 where the view was that electricity would just continue its steady progressive march upwards, which is not what we've seen occur.

Now, going back to this original diagram and the power stations and the networks, this falling demand impacts different parts of the network different. So for the electricity networks, these are regulated business. That means that there's a fixed amount of revenue that these businesses are allowed to collect from customers every year. So these networks are allowed to increase the size of their networks or the capacity of their networks, which means building infrastructure in order to meet peak demand and then they're allowed to recover the cost of that investment, that's the regulatory model, plus a return on that investment. If there is less energy being sold that creates the problem that the same amount of revenue has to be collected over a smaller pool of energy, which means rising prices.

Power stations, on the other hand, operate in quite a different market. Firstly, power stations have the advantage that to some extent there is more potential to build dedicated peak capacity. So there are certain types of power stations that you can build which are cheaper to build but more expensive to run, are quite well-suited to meeting just this sort of peak capacity on a few days. It's not necessarily as easy to do that within the network system. The other major difference with power stations is that, for the most part, they're privately owned or at least they're not subject to this same regulatory model where they're entitled to earn a certain amount of revenue every year. That means that these businesses are exposed to substantial commercial risk. If there's excess capacity in the system that means the business is going to lose money, as opposed to on the network side where excess capacity in the system means lower network utilisation, power bills are going to go up.

Some numbers recently put out by AGL suggest that in the National Electricity Market (NEM), so that's the east coast market in Australia, there's around 9,000GW of spare generation capacity which is of a market of a size of about 45,000. So that's a significant portion of the market which we're saying, based on this falling demand, is no longer being utilised. Unfortunately, while demand has been falling, the data on peak demand is a lot less conclusive. Obviously we measure peak demand a lot less often because it only occurs, say, once a year. So these are annual figures. If you look at that 2009 forecast for where peak demand was going, the forecast was it was just going to keep ticking up year-on-year. If you look at the actuals there and then the revised 2013 forecast - these numbers are all for Victoria – you can see that we actually haven't got to those levels. This is particularly problematic because under the regulated network model, networks plan to build based not on what the actual maximum demand is, but what the forecast maximum demand was.

So I've got two plots up there. The red line shows year-on-year forecast maximum demand and the value of regulated assets projected in Victoria. So what you can see is there's a very close linear relationship there. Network values increase, which means the revenues they can collect increase based on the forecasts of peak demand. The other plot there is looking at actual maximum demand relative to the network values and you can see it's a much more varied plot, there's no obvious relationship there. Now, the implication of this – and this is national numbers and it does vary a bit between states – but we've seen network asset values increase by around 64% over the past seven years and, at the same time, electricity prices have been running up by 75%. So while there has been a lot of rhetoric around carbon pricing and the impact that a lot of renewable energy charges have had on pricing, and that undoubtedly has been a factor, but really in terms of if you look at the bulk of the network cost increases Australia-wide, this issue of networks and peaks driving more network investment has been a major contributing factor to rising electricity prices.

What we're also seeing are some changes in the way households use electricity and that is contributing to this problem of peaks being stable or possibly increasing, while electricity demand is actually falling. The figures on the left there are just an indicative idea of what we're talking about when we talk about air conditioning contributing to pressure on the network or solar contributing on the network. They're not based on actual data, but just to make the point that often air conditioners create problems because they dramatically increase household contributions to peak demand without actually increasing the total amount of energy that gets used. Solar panels often have that opposite effect where, if you can see that chart on the right there is from a feeder in Queensland where they have very high levels of penetration of solar PV, the peak demand level hasn't really fallen over the course of that day, but over the years the amount of energy that's being consumed during the day has been falling off dramatically. So what we see is the network still needs to be sized to the same level, but the amount of volume that you're recovering that revenue off has been declining. And one of the big arguments for looking at household demand – and obviously there's industrial demand and that's been a factor in falling energy demand – is that households actually contribute disproportionately to peak demand relative to their overall contribution to the power sector. So if you look at the average contribution of households to the total energy pool it's somewhere shy there of around 20% to 30%, but if you look at the contribution during anything above that 90% percentile, so these high demand periods, households are actually contributing more.

Finally, just some comments about the work that Grattan Institute have done on this and are continuing to do on this. We released a report in December last year called *Shock to the System* which looked at the implications of this falling demand and came out with these three key issues that need to be considered in terms of how to deal with this falling demand issue.

So firstly, is there an argument for cutting the value of network assets? So basically saying the value we're holding these at doesn't reflect the market value, they need to be written down. That is not necessarily a risk-free option because someone has to pay for that. Another option is to reduce unnecessary expenditure. We released a report in December 2012 which looked at some of these options around how you can reduce the amount that's being spent on networks so at least if you're in a hole on this one, stop digging. And the final point there which we're taking a much closer look at at the moment – we'll hopefully have some work out around June – is around network utilisation and specifically looking at household tariffs and the way that households pay for the use of the network and the way that household behaviour could be improved if households had better incentive for using the network more efficiently, which goes to not the amount that people have paid and not necessarily consumers paying more, but consumers paying tariffs that are more cost-reflective.

So, without further ado, there's my introduction to peak demand. We'll kick-off with our speakers. First up tonight we have Professor David Karoly. David Karoly is an Australian Climate Scientist and academic. He's an expert in climate change, stratospheric ozone depletion and climate variations due to the El Nino southern oscillation. Karoly has served as a lead author for the Inter-Governmental Panel on Climate Change and is a Professor of Atmospheric Science in the School of Earth Sciences at the University of Melbourne and the ARC Centre for Excellence for Climate System Science. He's also a member of the board of the Climate Change Authority. Could you please welcome Professor David Karoly?

DAVID KAROLY: Thanks Lucy and thank you for inviting me along. Usually when I do a presentation I have lots of graphs and what I'm going to talk about is so simple that it doesn't need a lot of graphs. In fact, it doesn't really need any graphs. And we've already heard that one of the big issues for peak demand in electricity is that it's closely related to high maximum temperatures. In many parts of

Australia we've got used to a society which isn't particularly happy with hot temperatures. 30 or 40 or 50 years ago we had buildings which were designed well with large eaves so you didn't need as much protection, or we coped better with hot temperatures. Now that we have fans and air conditioners and evaporative coolers we want to turn them on when the temperatures get hot in the daytime or we want to keep them on overnight, and that means that peak demand goes up.

So what I'm going to talk to you about is what has happened to high maximum temperatures in Australia, particularly in major cities in Australia, over the last 30 years and what's likely to happen in the next 30 years. And the simple answer is, as we all know, they've got more frequent. It's got hotter. Although our Prime Minister says that that's just part of natural variability, we live in the land of droughts and flooding rains. We've heard about that from Dorothea Mackellar for over 100 years and nothing's changed. I'm a climate scientist. The most recent assessment report from the Inter-Governmental Panel on Climate Change came out in September last year and it had a number of clear conclusions. It's also important to remember that the Inter-Governmental Panel on Climate Change and its key conclusions are accepted unanimously by representatives of 120 different governments unanimously, the United Nations rules, and so that generally means these conclusions are conservative.

So these conservative conclusions are that warming of the climate system is unequivocal. There is no doubt that the climate system has warmed over the last 50 years. It is extremely likely that human influence has been the dominant cause of the observed warming since the middle of the 20th century. No, it's not natural variability; it's us that have caused this warming in the last 50 years. And it's virtually certain – not 50:50 – it's virtually certain that there'll be more frequent hot temperature extremes over most land areas on daily and seasonal timescales. It's going to get hotter and it's already getting hot.

So what have we seen in Australia? Over the last 30 years there's been about a one degree increase in mean maximum temperature in each of the capital cities in Australia, particularly in summer. Melbourne has had more frequent hot days, days above 35 Celsius, as has Sydney, as has Adelaide. All the capital cities have had them. And one of the really interesting things is scientists like myself have been talking about this, it's happening or it's going to happen. Climate scientists have been making projections of hotter temperatures, more hot extremes, particularly in summer, for a long time. 50 years, about that, about 1980 was the earliest CSIRO climate change projections. What I did, foolishly, was try to look at these projections because a lot of these projections were originally "Oh, it's going to happen a long time in the future". Well, it's happening now.

What we decided to do was look at the projections from the 1990s for what was going to happen 40 years in the future. Well, it's already 23 years in the future. These are projections for 2030, projections for the number of hot days, days above 35 Celsius, in Melbourne. From the 1990s, the average number of days above 35 Celsius in Melbourne was 9.1 days. The 2030 projection was 11.4 days best estimate, range from 10.6 to 12.8, it spans the 90% confidence interval. We look at the average from 2004 to 2013. So that sort of middle is about 2010, so that's halfway to 2030. What's the change? 12 days is the average from 2004 to 2030. We've already exceeded in the average around 2010 what is the best estimate for the change in the number of hot days above 35 Celsius for Melbourne projected for 2030. We're close to the upper limit, the 90% confidence interval, the upper range for the projection.

In other words, often climate scientists, because of uncertainties, tend to be somewhat conservative. We are already getting more frequent temperature extremes than were projected for 2030 as the best estimate and we're projecting even greater warming in the future. This is data from Melbourne; we've got data for a number of other cities. It's true across the whole of southern and eastern Australia that the projections that were made by CSIRO for 2030 have been exceeded for the number of very hot days, for the best estimate. What do we expect in the future? Even more hot days. How do you cope? Well, you either use more electricity or you develop systems which can allow our modern society to cope better with very hot days, because there are going to be more of them whatever the government decides to do or not to do about climate change. I'm going to hand over to someone else.

LUCY CARTER: Thank you Professor David Karoly. Our next speaker is Lane Crockett. Lane Crockett is the Executive General Manager Australia at Pacific Hydro and has been responsible for managing its Australian business for more than five years. Lane is also a Director on the board of the Clean Energy Council. Lane has over 30 years of international experience in the energy sector in Australia, Asia the UK and New Zealand. He has worked in utilities regulation, managed the performance of electricity and gas alliance contracts, and has led engineering procurement and construction projects in the oil, gas and petrochemical industries. Could you please welcome Lane Crockett?

LANE CROCKETT: I'm going to use a number of slides because I'm going to start off with a case study, because we're talking today about how we cope with heatwaves and in particular, as Lucy mentioned before, about sustained heatwaves. So the first thing I'll do is go through a bit of a case study and look at how the electricity network performed, and then I'm going to have a bit of a discussion about the market response to times of high demand and look at also the impacts of renewable energy.

So, I'm going to look at a particular five days in January this year, I think anyone who lives here will remember well those very hot days. There were actually four days in Victoria in a row which exceeded 40 degrees and in South Australia there were five days in a row. And I am just going to focus on South Australia and Victoria because that's where the heatwave was sustained for four or five days in a row. You can see that, whilst we didn't hit new peaks, we did hit levels that don't get hit very often and, in fact, it's actually been several years since the last significant heatwave because we have had a couple of summers which haven't had that hot sustained weather. So I'm going to break down that week and look also how we've coped with a transitioning electricity network.

So what happened in the week? Firstly, let's look what happened on the supply side, how did the system cope? You can see from the table that there was over 1,000MW of thermal generation that fell off the network due to various technical issues, plus also one of the gas-fired generators in South Australia went offline for a day, and also Basslink suffered some issues as well which meant that a lot of electricity couldn't be transferred from Tasmania for part of the time. And I might just note that in the newspapers at that time, particularly the Murdoch papers, there was a lot of analysis after the week about the performance of variable generation, such as wind and solar, but nobody talked about the fact that the thermal generators didn't perform up to expectations. But the result from what happened was that there was no load-shedding in either state throughout the whole week. So that means that at no point was there a brownout because there was a lack of supply. There were some minor distribution-level issues but those are expected, but generally the system coped very well. So if you say during that very hot week, was it a pass or a fail for the electricity system? You'd say it was a pass.

So let's look in a bit more detail what actually happened. This is Victoria, it's a bit more traditional, you see the brown section at the bottom, that's the brown coal generators in the Latrobe Valley, and then above it you have the dark blue which is the gas-fired generation, and then the light blue which is the hydro power stations in Victoria. Then the white is the wind-powered generation, which is proportionately relatively modest in Victoria, and then the orange is imports from Tasmania and New South Wales, and then, finally, you can see on the top there that yellow slither, that is the solar rooftop PV which is obviously chipping away at the peaks there.

Now, this is much starker when you start to look at South Australia because South Australia has transitioned a great deal further as an electricity market. There's a lot less coal you can see, but there was quite a lot of gas-fired generation during that period. Now you start to see a state that has quite a lot of wind power and you can see the benefit of having wind power in South Australia, and then you can see some imports coming through from Victoria from time-to-time. And then, finally, you can also see the also significant impact from rooftop PV and you can see that in many cases it's really starting to take away the demand during those hot periods. You can see from this that in South Australia, for example, the variable generation from wind and solar actually had a significant impact in that market.

So let's now look at what was the price impact. Now, I'm going to compare against two other hot periods. February 2011. Now, this was mainly a hot period in South Australia, so it didn't get quite so hot in Victoria so you're not really seeing those high prices experienced here. But back in January 2009 we had very similar conditions, very hot conditions, both in South Australia and Victoria going over four or five days. Now, interestingly enough, three/four years later the average price during this very hot sustained high-demand period is lower and I'm going to explore a little bit why that's the case. And, in fact, very conveniently there was a study performed by Meridian which had SKM MMA analyse what was the price impact of having wind power in South Australia during that very hot week in January 2014? Now, this is not a very useful graph I guess, but it was all I could take out of the study. The blue is the actual prices and then the red is the modelled prices assuming there is no wind power capacity in South Australia. And you can see that the prices would have been much higher, in fact, they estimate that the wind power lowered the wholesale electricity price in Victoria and South Australia by 40%.

Now, what is becoming very clear is that the growing levels of wind and solar are depressing prices due to their very low marginal cost. The price of renewables has dropped to the point where it can displace existing thermal generation and provide a long term reduction in energy prices to consumers. Now, some might be surprised by this conclusion and I'm now just going to look a bit more about these price impacts on the retail electricity bill, because you see a lot over the last few years as a result of rising electricity bills that there's a lot of discussion about the impact on consumers.

Firstly, I'll just go through and provide some evidence that this is not actually a surprise, this is something that we do know about, it's already happening around the world in different places and has been happening in Australia for a little while. There was recently a report by Schneider Electric which was actually commissioned by large energy users and it showed that the retail electricity price is depressed in the medium to long term because of the renewable energy target. So pushing in more renewables is overall reducing the renewable energy target. Tim Nelson from AGL has already been talking about this for the last few years, and here's an example in Ireland where they're already seeing the price-depressing effects of wind energy there. And, interestingly, if you go to the US, there was a study that looked at 11 states in the US which have more than 7% of the generation there which comes from wind power and they compared the retail electricity prices relative to the average of the rest of the US states. And you can see there that states that have more than 7% wind energy had a very price-depressing effect on electricity prices there, whereas in other states over the five years they had an 8% increase in prices. So modest compared to what we've had in Australia recently, but nevertheless a marked difference.

Finally, today you may have seen some media, the Clean Energy Council launched its report that it commissioned from ROAM Consulting, an energy specialist. Now, ROAM Consulting have done some very detailed work on what is the impact of the renewable energy target on electricity prices between now and 2030 and what would be the impact of either raising the renewable energy target or removing it completely? And I've just got one example here which shows what the benefit is of the renewable energy target as it is today relative to completely removing it. And you can see that in the first few years there's a modest impost which, if you take the red line rolling through from 2014/15 about to 2017/18, that at that point the benefit of the depressed wholesale prices starts to kick in. And so you can see, this graph here is for your average residential household, 6.5MWh per year, but you can say that households will save around about $100 to $150 per year post-2019/20.

Now, it's more marked in some states relative to others and there's a great deal of information that comes from this report, but essentially what is going on here is that by having a renewable energy target we are pushing more renewables into the electricity system and that means that in the future we're not going to be burning gas to produce electricity and gas prices are rising considerably and already are. Yesterday I think IPART had a draft determination for household use of gas and that's going up 20% in one year. So there are very significant gas rises already and it's going to go up considerably over the next few years as we go to an export parity price.

So to conclude, more renewables are helping to meet high demand in sustained heatwaves and, at the same time, reducing the peak prices that would normally occur. And, in fact, transitioning to cleaner energy systems leads to cheaper bills for all consumers, large and small. Thank you.

LUCY CARTER: Thanks Lane. Our final speaker for this evening is Julian Turecek. Julian Turecek is the General Manager of Wholesale Market Operations at Energy Australia. He has two decades of commercial experience in the energy and greenhouse sectors having worked for major Australian companies such as BHP Billion and Origin Energy. His experience includes trading spot and contract electricity and gas; setting up Origin's carbon markets desk; working in policy and government affairs focusing on energy markets and climate change policy; four years in venture capital specialising in the clean tech sector; and, more recently, running the trading and marketing group at Loy Yang Power. Would you please welcome Julian?

JULIAN TURECEK: I wanted to start with some audience participation. On a quick show of hands, who would say they had a fair idea of how the NEM works? That's encouraging. Who would say that they've got no idea how the NEM works? Excellent, okay. So I will try to pitch this somewhere in the middle. I'll be relatively quick, because Lane's already talked to the case study that I was going to talk to so I can cut down on that element of the presentation.

How the NEM works in a nutshell. So the interesting thing, the unique thing about electricity is that you can't really store it in the large scale, so minute by minute, hour by hour we have to match electricity supply and demand. That's what makes it really interesting. So if the lights went off here or if the air conditioning came on or whatever, there'd be a generator somewhere in the NEM that was responding to that fluctuation right then and there. So how the NEM works is effectively all of the generators need to compete with each other. They put a bid into the market and the market operator stacks up all of those bids and where the demand at that time, at that five minutes, meets the sum total of what's stacked up, that's where the market clears. So when we talk about market price, it's the clearing level where demand meets supply, in a nutshell.

Now, I had a snapshot here but, even better than a snapshot is the live NEM. So on the screen what we've got there is what's actually happening in the NEM right now and you can see that every five minutes the market operator, AMO, is determining what is the price – and while I'm talking you might actually see it click over. The NEM is effectively an interconnected system from Port Augusta all the way up to Cairns connecting up all of these east coast states. Five regions, all relatively robustly, to some varying amounts of extents interconnection between those regions. There are many generators in each region trying to complete for the right to be despatched into the market to provide their energy into the market. So, for example, Energy Australia: we've got wind and gas assets in South Australia, the wind will be running now; we've got brown coal and gas running right now in Victoria; and black coal and gas plant running in New South Wales. So they're all bidding into that market and getting despatched.

Now, the red numbers are the price and the interesting thing about that is that all generators get paid that price and all retailers, or people buying load for their customers, have to pay that price. So that's the clearing price of power. Tonight it's a fairly benign day. As other speakers have mentioned, demand fluctuates over time. In the middle of an autumn evening there'll be a little bit of winter demand coming up, so those big blue numbers, so the 6,518MW in Victoria, that's the demand that we're seeing right now and, as you can see, it's just ticked over. So on a benign day like today the market is not in stress. There's heaps of supply, the market clears at the market clearing price and the prices are relatively stable. These prices also include the carbon price; all of the generators that have emissions are pricing in the price of the carbon charge into their bids into the market.

Now, the contrast between a market like what's happening at the moment and the market on a peak day is really quite interesting. So here's what the market looked like on the 16th January, the heatwave that Lane mentioned, at the half-hour ending four-thirty, which was actually five-thirty - the NEM runs in Eastern Standard Time. So at that time, Adelaide was at 43 degrees; Melbourne was at 39 degrees; and this was the third day in a row of temperatures over 40 degrees. So this is heatwave that you don't see that often. We were down to less than 10% reserve margin in South Australia and Victoria and there were constraints all through the network, transmission lines, both distribution and high-voltage transmission, all get thermally limited during these heatwaves. So, South Australia hit the market price cap $12,500MWh. That's a long way from the $60 you saw just before. So this is a market in stress and only just being able to meet supply and demand. Now, the interesting thing though was that all through that heatwave these kind of extreme half-hours only were hit on a small amount of occasions.

So just overviewing, if you'll allow me just to dwell a little bit more on the heatwave that Lane mentioned. In exactly the same week you can see we had temperatures over 40 degrees in Victoria for four days, we had maximum demands over 10,000MW compared to the 6,200MW that you saw just before. But the maximum price in the half-hour, just as an aside, each five minute period, six of them, we add that up and average it and that's the trading price for the half-hour. So none of them went above, say, $5,000/$6,000MWh. The interesting thing on that was that the week prior to this, looking at AMO's forecast on pre-despatch we saw hours and hours of VOL, of hitting that market price cap, but when we actually got there, the price outcomes were much more benign even with those thermal trips that Lane mentioned with Loy Yang coming off and Basslink.

So Lane's talked to this slide. The interesting thing obviously is the comparison between South Australia and Victoria, both in terms of the mix, the contribution of solar, the contribution of wind. Just for interest a quick show of hands again, who has a solar panel on their roof? About one in three would you say? Victoria is about one in five on average, South Australia about one in four, so we've got a representative audience. You can see what your panels were doing on those days of actually taking demand that the centralised system saw down a touch, but not really changing the hour that peak demand hit because solar has a very strong correlation with the angle of the sun onto the panels and you might remember on those hot days that peak temperatures hit towards the later afternoon when the solar panels are starting to come off, so that's the pattern that you see there.

So, why did we get those benign price outcomes? And it goes a little bit to what Lucy was saying, that when you compare five years ago, 2008/09, to what we saw in 2013/14, we've seen a lot of new build, essentially in wind driven by the renewable energy target, but also some investment in gas and hydro plants in Victoria. Just as an aside, I should mention that most of this talk is focusing on Victoria because it's obviously where we are, but it also provided some of the more interesting case studies. In the same five-year period though you can see that peak demand has actually fallen by a few hundred MW, and that's driven by the combination of all of your and everyone else's solar systems, but also large industrial load coming off the system; the price shock of electricity prices coming up, meaning that people are using less electricity; and a whole range of other factors. So compared to 2008/09, when the market was a little bit tighter on supply/demand, the market had more room to move or more excess supply in the most recent heatwave. And that's not assuming that wind produces everything that it's got or nothing that it's got. It's just if it generates then that's great and it provides extra capacity to the system, but if it doesn't then obviously the system has to be there to supply the load, otherwise we get blackouts or brownouts.

An interesting thing that Victoria's got up its sleeve in peak demand that I'll come back to is also the aluminium smelters. So back in 2008/09 one of the things that might have happened was that the market operator or whoever had control of the aluminium smelters can shut down that load even quicker than starting up a gas-fired peaking facility, and that can take about 1,000MW of load off the system for a given period of time. So that was one of the things that could have been triggered if we'd got to a very tight situation. As it turned out, in the last heatwave we didn't need that but if we actually got closer it might have been something that AMO despatched as part of its reserve trader provisions.

So we're going to focus tonight mainly on the implications for hotter and drier summers, but it's interesting to put that in the context of a market where demand is falling. So, as Lucy said, NEM demand is declining; energy efficiency, manufacturing slowdown, solar photovoltaic. The other thing we should bear in mind is Point Henry, the aluminium smelter in Geelong, has been announced that it will shut in the next few months, in August, so that's going to take 360MW of demand off the system instantly. So it's not like ace up your sleeve, demand response just on the peak days; it's all the time it is off and the only other smelter that can now participate is Portland. So the interesting thing on this slide is as market demand has come off, new generation capacity has been built. Not just the renewable energy target, but also earlier, a few years ago, people still had the idea of growing demand and actually built some thermal capacity to meet the anticipated growing demand, which obviously didn't come. At the same time, I should point out that about 2GW or 2,000MW of this there have been retirements as well as the same time, so we can't just look at new generation capacity without looking at retirements as well.

I wanted to bring in another case study so we're not just focusing on four days in January this year. It's going back to the drought of a few years ago and – David can correct me if I'm wrong – but this isn't just a story about temperature, it's also a story about water. A few years ago, in 2008, what we saw was less rain across the eastern seaboard for an extended period of time, and this chart in the blue line we've taken a proxy for that water shortage which is Snowy Hydro's main storage reservoir, but it wasn't just happening at Snowy. Wivenhoe, the dam in Queensland, was running low. The dams and facilities that feed the Latrobe Valley generators for cooling, they were also starting to run low as well.

So take the blue line as a proxy for basic water availability. Low water doesn't just mean that the hydro generators like Snowy and Hydro Tasmania have less to run; many, many coal-fired power stations, almost all coal-fired power stations need water for cooling and if you don't have water then they get reduced output as well. So we saw curtailments in Queensland during this time and there was concern around the Victorian generators as well. So the price – which is the red line – the aggregated quarterly Victorian average spot price spiked from $30 up to above $80 for a period of time. So this is far more of a price shock than, say, the price shock that we talked about with carbon tax coming on; this is several multiples of that. But obviously it was short-lived. As the water came back the restrictions came off, the price outcomes became more what we're used to. And you can see carbon coming in there, the big rise in 2012 is the carbon price coming on.

So, this is my last slide. I just wanted to round out, so what are the implications for the NEM of hotter, drier summers? So this is EMO's' forecast, the market operator's forecast of peak demand and you can see we're all starting to reforecast peak demand. The dotted lines are what was the forecast and the solid line is what is the new forecast, and the different lines are what EMO call the 10% probability of exceedance (POE), so you can think about that as a one in ten year event; the 50% POE, so the one in two event; and then the 90% POE down on the blue line. The interesting thing about the heatwave that we had in January is that that was above a one in ten, we called it about a P5. So it's an event that was beyond the 10% POE. But these probabilities are calculated on the basis of long term historic averages and I think when you listen to David's talk, what we can probably conclude is that making assumptions of the probability of where future events are going to go on the basis of historic probabilities and historic averages is probably not going to be very robust. So we should expect to see more and more incidences of extreme demand, more towards those red lines or even above those red lines.

So yes, the NEM demonstrated that it was resilient to an extreme day back in the middle of January, but we have to acknowledge that plant and network equipment will be stretched in these environments. So Basslink, the link that connects Tasmania to Victoria, tripped on one of those hot days. It's design limitation – for the electrical engineers amongst you, of which I'm not one, would understand the stress that that kind of equipment gets under at 45 degrees. Similarly, thermal assets as well. We can expect demand to be more volatile as there's more proportion of renewable and variable output generators in the system. We can expect ramp rates and other NEM short term fluctuations to put more of a stress on the system as well. And then you've got those black swan events like water availability – the case study of the drought – and also bushfires. I liked your quote about regardless of what gets said, the climate will determine what happens with the incidence of bushfires going forward. And a bushfire under a transmission line can mean major impact in the electricity market.

So that being said, if everything works then the system holds up, but I'm not sure if we can rely on that, given what the science is saying about what happens with hotter and drier summers in the future. Thank you.

LUCY CARTER: Thanks Julian. If I could just invite all of our speakers to come back up on stage, we've now got a bit of time for a Q&A session. So just before we get started with some questions from the audience, we've heard a couple of different perspectives here tonight and to start with, David, you made some comments around hot days and the number of hot days increasing. But then we've heard from our other two speakers that, in fact, when faced with some peak demand events recently the system dealt with that quite well. So, should we be worried for the future? If we are getting more hot days and we're getting climate change and we're talking about how we mitigate and adapt to these hotter summers, is the power system well-positioned to deal with that? What's the wrap-up?

DAVID KAROLY: I can talk about the hot days, but I can't talk about the power system.

JULIAN TURECEK: I just felt like I did talk about the power system, so maybe Lane, you could have a go.

LANE CROCKETT: Thank you very much. Well, actually, no, I actually thought you finished it quite well. I mean, the reality was there weren't any really unusual things going on and actually I'd forgotten about back in 2008 when the levels of water – which a) you can get hydro generation from and b) it can end up curtailing large thermal generation – had a massive effect at the time. But then if you get some upset conditions like large transmission systems going off then that can just create some chaos. I guess to some extent we were lucky in that the environmental conditions, while very hot and stressed the system, the system was able to cope. But there's certainly things that could happen that could make it go pretty awry. Although the interesting this is you saw Tasmania there, they had a large negative price during that high event, so there were some odd things going on in the market.

DAVID KAROLY: The other interesting thing, even about the 2014 January case study that Lane talked about and Julian talked about as well. January in Victoria was just above average temperature. It wasn't hot in terms of anything particularly unusual. We had a very hot week, but we've been in what are relatively ambient conditions. Most heatwaves in summer and dry conditions are associated with patterns of large-scale circulation and ocean currents associated with what's called an El Nino event: cold waters have disappeared, we've been in that condition; we've got hot ocean temperatures in the central Pacific Ocean, that brings dry conditions to Australia; and most heatwaves are associated with El Nino. We haven't had one for a number of years. The Bureau is forecasting we're heading towards an El Nino, most other climate forecast centres are saying we're heading towards an El Nino. That means drier conditions and more extreme heatwaves.

So the conditions in 2014 were by no means extreme, it's just that it was hot for a few days in a row and we haven't had that. So we should consider that as a normal heatwave. Get an El Nino heatwave, it's just going to stress the system even more because that will also come with the sorts of conditions we had in 2008/09: dry and hot. That's what we didn't have in 2014. It could be a lot worse. Now, I'm not a pariah saying, "Let's head for hotter and drier conditions" but that's exactly what we're looking at.

JULIAN TURECEK: And the other thing that could have made it worse, you never know when a heatwave's going to arrive. It could arrive on a weekend, no problem. It just so happened to arrive two weeks before schools and universities went back. If it arrived two weeks later, it might have been a completely different story. So we never know when the heatwaves are going to arrive, but what we do know is the pattern of demand and when we know we're going to be at peak demand.

LUCY CARTER: Sure, and that's obviously one of the challenges with peak demand, that there are these statistical variations. Happy to take some questions from the audience, raise your hand if you have a question.

AUDIENCE: A question for Julian. Given our history in the NEM, Julian, perhaps you could cast us back ten years or so and just recall the frequency with which we used to hit VOL in the National Electricity Market during January and February, as opposed to what appears to be happening with the volume of renewables in the market now, we tend to not be seeing the same sort of situation as what we would have had. And I can think when Yallourn went out in the first year of operation of the NEM and lost 1,300MW in Victoria. Maybe you'd like to cast your mind back to compare the situation now to what it was when we started the NEM.

JULIAN TURECEK: Yes, that's a good thought. I think you could say that we now have a strong diversity of supply sources with renewables, solar and wind; much stronger interconnection than we had; and we didn't have Basslink at that time. So the market was much more susceptible to a single unit failure leading to VOL, or a whole power station, as the case may be. But, for example, we lost most of Yallourn with the flood or other issues and the NEM just continued; it just doesn't blink an eye because there's diversity of supply. But also, you can't get away from the fact that since 2009 demand's come off and for every smelter that you hear about or Ford or industrial closures, there's a whole range of other closures that you don't hear about that are happening. Our market economy is becoming less energy-intensive, so I think that's also part of the equation. There were a whole range of whacky things happening in that week as well with negative prices and ramp rates and constraints, but I thought that would be out of scope for this discussion.

AUDIENCE: Could the deindustrialisation be a positive factor on our ability to cope with hot days and electrical power system reliability?

LUCY CARTER: I can have a first crack at that. We've done a bit of work around this and have found that definitely there has been some structural changes in the Australian economy and, along with residential declines in consumption, these structural changes are definitely leading to falling electricity consumption at all times, including, by extension, during the peaks.

AUDIENCE: I wanted to ask a question because it came up a few times, the benefits of renewables and how they're lowering the price and shaving the peaks maybe. Do you think that we're getting to a point now where generators will start putting renewables on the grid without incentives or do we will still need regulation to be put in? Do we need the target really anymore?

JULIAN TURECEK: Well, I suppose the thing that was missing from the analysis is what do you need to put a wind farm in place and what you need is the capital to do it and also, typically, a power purchase agreement so you can project finance it. So yes, wind farms have very low marginal cost, well, zero basically, but they still need in the case of solar an upfront investment or in the case of wind an upfront investment. So then the question is what makes that upfront investment possible? And we haven't put up the comparative economics of wind versus gas versus coal versus oil, those kind of things, but the reality is that wind still costs more in a long run marginal cost sense, full capital cost and everything, than our traditional power sources even with carbon. So when you ask the question, you still need some kind of subsidy like a RET. If you want wind you need to the subsidy. If we took the RET away – Lane can correct me if I'm wrong – I don't think you would get a flood of investment of wind.

LANE CROCKETT: Yes, I'll agree with that. Funnily enough, you won't get any investment and I guess the whole idea of the RET is to cause the transition. So whilst Julian's right in saying that wind is more expensive on a long run marginal cost, it's more expensive than existing infrastructure but not necessarily more expensive than new gas or coal-fired electricity. So there's a bit of a nuance there between old and new. And, to be honest, if we talk about subsidies, a lot of the existing generation is already subsidised, the existing thermal generation like, for example, the prices of coal going into the New South Wales power stations is well below market cost. So you have subsides thermal generation and that's what new wind farms or solar plants are trying to compete against.

So yes, you do need a target. I mean, the whole idea when the policy was put together was that there would be a renewable energy target out to 2030 which would create the industry capacity to get the industry going and make it effective and efficient. But that a carbon price, which reflects the external impacts of thermal generation, would become mature enough such that there would be a level playing field for all forms of generation. Now, we're seemingly really stumbling with that policy and so I would suggest that you need the RET even more now.

LUCY CARTER: Yes, just to add that as well, obviously no-one builds new generation capacity unless you need new generation capacity, and at the moment I think there's an argument to say that if there's excess capacity in the system then it's unlikely that any new major systems will be built.

JULIAN TURECEK: EMO's forecast is that over its planning horizon over the next ten years there is no need for any new generation in either Victoria, New South Wales or South Australia. Queensland is the only jurisdiction that has any need for new capacity in the next ten years on their last forecast.

DAVID KAROLY: Unless there's a realistic price on carbon introduced.

JULIAN TURECEK: No, even then, regardless of the carbon price. The carbon price just determines what you build; the first question is do you need to build something or not? And where demand has fallen to is suggesting that we don't need to build anything to meet demand.

DAVID KAROLY: No, I think you're wrong, because if you put a realistic price which actually covers the real cost of coal-fired electricity on society, it's probably about $200 per ton of emissions, then you'll close down all the brown coal power plants instantly. I wasn't talking about the actual price; I was talking about a realistic price.

JULIAN TURECEK: I agree with that, and Tony and I were having this discussion yesterday at another conference about the mismatch between the aspiration of what the science says we need to do and the reality of what's happening because of policy settings.

DAVID KAROLY: Sure.

LUCY CARTER: Politically palatable.

AUDIENCE: Not much has been said about demand management and yet there are substantial opportunities for demand management through the use of technologies like Smart Grid and in particular Smart Meters. Now, some Smart Meters, and I don't know if all of them have the facility, but they can be fitted with an additional module to actually achieve demand management of individual domestic loads and this can be done very cheaply. This of course can be extended or should be capable of being extended to actually control the demand on the network. Now, this offers the opportunity to reduce the need to augment the network and also is a mechanism to actually deal with high spot prices in the NEM.

So there are considerable opportunities there but further, through demand management you can modify demand so that it matches the variable output of renewable generation sources. It does mean a certain amount of inconvenience to consumers, but I think that in view of the serious implications of climate change these are things that we may wish to tolerate, but the regulatory regime needs to be modified so that demand management actually can be incentivised.

LUCY CARTER: Are there any comments? I think the key point there being that at the moment there's other opportunities to give households incentives to modify the way that they use electricity, rather than focusing just on the supply side.

LANE CROCKETT: I think it's absolutely right, but I also think you hit the nail on the head, that the regulation changes at a glacial pace and that's the barrier to getting to some of these opportunities.

LUCY CARTER: I would just add to that, we've been doing some work around this and the question really is how do you actually encourage households to do that, what's their incentive? And the conclusion that we've come to on that is if you actually price the network in a cost-reflective way so that people pay more at times when the network is constrained then you can get a price signal in there so that households then have an opportunity to say, "Okay, there's an opportunity for me to save some money here if I take a proactive stance on this" so there becomes an incentive for people to actually respond.

AUDIENCE: I think if you force it onto the network owners so that they do the demand management and then the price reduction automatically flows on.

JULIAN TURECEK: We've actually done it commercially and Energy Australia have a program called Smart Grid, Smart City where we actually have Smart Meters deployed into households and we've offered network-reflective-style tariffs where customers can see a day ahead, get a notification that prices will be what we call critical peak, and even on the hot days we're seeing 20%, 30% voluntary demand reduction. So I agree, it does work, we just need to figure out how to make that a broader program than just the trials and the pilots.

AUDIENCE: But if you put it back on the network operators, then the network operators can also interface with the customer loads and actually switch those loads on and off so that you control the overall demand on the network.

LUCY CARTER: Yes, and I'll just comment on that. There are some structural barriers in terms of the way that different businesses have different interactions with customers and often networks don't necessarily have direct one-to-one relationships with customers; retailers do. So where that fits within the power system is not necessarily as simple as saying, "Who owns the meter?"

Just on a related question, I've got some questions here that people posed during the registration process and I have one here which says, "If peak demand is public enemy number one for the electricity industry, would electricity storage alleviate peak demand and would the benefits of subsidising the early development of a storage industry outweigh the costs of implementing such a scheme?" Any comments on that one?

JULIAN TURECEK: I don't necessarily see it as public enemy number one. I mean, it's what we're there to do is to supply energy on any day, whether it's today or peak demand day. We had a Grattan session here a few months ago on storage and yes, absolutely, there could be a role if there is sufficient value and the study that Roger and others did on understanding the value of volatility and could storage play a role. The question though is with the heatwave that we've just had, without the price response the actual value of volatility in the market right now is a quarter of what it used to be. So regardless of whether you're advocating storage or advocating demand response or advocating any other form of peak reduction, the value of doing that in the market at the moment is relatively low. So, it doesn't help utilities any more than it doesn't help any other advocate of peak demand reduction.

LANE CROCKETT: I guess I see there are two types of storage. I think you've covered the wholesale level of storage which I think, as you say, the price volatility just honestly doesn't provide enough variation to provide the investment to go forward with it. But I think where storage might occur is behind the meter-style of storage. So you have a lot of people who moved to solar rooftop PV and what has happened is all that investment into the networks means that – and this can get slightly complicated – the standing charge in your bill when you own a solar unit on your roof means that that equation has shifted. So in the future it is possible that people who have solar on their roofs will want to get storage to work with their solar unit so that they can drop off the grid because the price of just being connected has become too high. And I think that's probably the area that you're more likely to see storage come in, and this could work with electric vehicles for example or it could be separate or it could be both. But people already want to take control of their energy management and purchasing and that may be a step that's seen in the future.

LUCY CARTER: Any further questions from the floor?

AUDIENCE: There's an incredible richness of the material here tonight, but I suppose I also have a degree of frustration. David, I was impressed that you showed no graphs and thank you for showing no graphs. However, what I'd like you to do is to look at some other graphs - and this is not even half tongue in cheek - but the graph against, for example, and there's just two or three I've written down: rational economics versus current government policy and these things can be graphed, that's why I say this is not even half tongue in cheek, and rational economics against current political bullshit – you might have to change that word, but not much; climate change certainty, the way that that has increased against the way in which the denial has also increased; international actions, and the United Nations stuff announced today is a good example of that, compared with what Australia is doing; and the last one I suppose, because clearly this is an economic issue as much as an environmental issue of investment vis-à-vis cost, vis-à-vis price, vis-à-vis subsidies, and to somehow illustrate that, not just talk about it, and demonstrate very clearly some of the stupid paths which we're currently following.

LUCY CARTER: Any responses to that one?

JULIAN TURECEK: I was going to take that as a comment, rather than a question.

DAVID KAROLY: I mean, I agree with many of the things you've said. I've been trying to talk about them a lot. But it's important to understand that when we talk about rational argument, it is clear that most politicians have a clear logical perspective about why they're making decisions and to recognise that their framing of their decision making is rational in their perspective is the best way to think about it. It's just that they're using a different set of arguments and decision making processes for how they reach their conclusions which may well be very different from yours, but they're doing it rationally. They're thinking about it, it's just that the reasons that they're doing it are likely very different from the reasons that you would choose. But they're doing it rationally. They're using a logic, it's just it's based in a very, very different framing than you or some other people would use. To say that they're irrational is wrong. They've been elected, they have the majority of Australians in some areas supporting them at present, and what we have to do is present clearer information to show that the majority of Australians no longer support their decision making process, if that's the case.

AUDIENCE: Therefore is it arrogance or ignorance which is the real challenge?

DAVID KAROLY: I cannot assess that.

LUCY CARTER: Perhaps some combination of the two.

LANE CROCKETT: I suppose there's an electricity industry impact is that it's becoming an impossible position to invest to do the things, well, certainly that we believe we have to do in terms of transitioning to meet what we need to do. And it's not so much that they're irrational, it's just that it's so uncertain. And the fact that there are carbon price is, I guess, about to be removed and the fact that they are even now talking about completely removing the renewable energy target, these are very difficult times in which to try and run, frankly, any sort of energy business.

LUCY CARTER: Yes, and I'd certainly second that from a policy perspective. It's a challenging space to try and get any cut-through through. I think there's a lot of fatigue amongst the general community around these issues and it is very hard to get media space or public attention on these sorts of things.

AUDIENCE: Expanding on the demand response question, I remember that there was a rule change proposed last meeting about pricing demand response. It did not go through. Do you guys think it is now time that we start pricing demand response essentially as MW or through any other mechanism?

JULIAN TURECEK: In our view, there already is a signal for demand response, it's the value of capacity, the value of what we call caps over $300, and I did have a back-up slide which was the last slide which, as I said before, the value of volatility has really just dropped off. So there is a signal for demand response. There are companies doing demand response. The smelters are one example, but there are a whole range of other companies that are doing it as well already in the commercial market. So you don't need the rule change to facilitate demand response. The concern or the obvious issue is that if you don't get the price volatility then the value of demand response isn't there. So if you're investing capital in your business to make sure that you can come off at certain times when the prices go high, like when you saw VOL there, if you don't get VOL that often then that is not a good use of capital.

AUDIENCE: I wanted to come back, Lucy, to your point that in your analysis most of the price rises in electricity come from network investment. So in that environment we talked a lot about demand management, yet from the end user perspective they're facing price rises from capital investments that are not responsive to things like peak demand. So how then do we design a mechanism in which that demand can be responded to?

LUCY CARTER: So I was saying that they're very responsive to peak demand. One of the challenges has been that they've been based on peak demand forecasts, not actual peak demand outcomes, and what we've seen is that the forecasts have been well in excess of the actual outcomes. To some extent what that means is that there's a lot of money that's been invested, a lot of capacity that's been developed, and then that can result in a situation where there is a lot of capacity; you don't necessarily have to spend more for coming years, but you don't necessarily see a price reduction because of the way those assets are paid for, often there's a life of around 40 years. However, we come back to the economic principle that having cost-reflective tariffs for users in the network is a good way of getting an appropriate response from users to what the price signals are, to the pressures that they put on the network.

So what we're suggesting is that charging households based on their energy use is not an effective way for recovering those network costs and that if this money has been invested and if it has to be paid for, then there are fairer ways of doing that. Our position is that that should not necessarily be appliance-specific, so we're not trying to punish people with an air conditioner or punish people with a solar system, but things like capacity-based charges so you pay based on how many kW you use rather than how may kWh you use, are possibly a fairer way of reflecting the pressures that users put on the network.

There's also an argument to say that in planning processes, if there is a situation where networks are considering spending a bunch of money to upgrade the capacity of the system then there's an argument that they perhaps should consider whether it's possible to install some equipment, have some critical peak-type pricing in that area to elicit a response, if that's going to be cheaper than funding a major upgrade. They're the types of things we've been looking at.

DAVID KAROLY: Isn't it also true that a number of economists, including Ross Garnaut, have argued that there's been substantial gold plating of the network and that the pricing system allows the network operators to then effectively charge or to get a return on that investment without much control over how much investment they've put in?

LUCY CARTER: Yes, in short. There's been talk about gold plating and overinvestment in networks; we've seen massive run-ups; there's been discussions around the rates of return that networks are earning being too high; but there's also a significant factor around reliability standards, so the amount of excess capacity standards that have to be built into the network to guard against blackouts being very high. I would note that that has varied significantly between states. So most of these cost run-ups have occurred in New South Wales and Queensland and Tasmania, which have seen massive increases relative to its population, which I will also notice the states where there is government ownership of some of those assets and it's the same governments who are earning the dividends that are setting some of those reliability standards. There have been some changes that have been put in place over the last couple of years because that issue has received a lot of attention.

LANE CROCKETT: I suppose the galling part of that has been a Queensland Premier stands up and blames renewable energy for the price hikes in Queensland, when in fact it's the Queensland government taking large dividends out of the transmission and distribution companies there. But I think part of the problem was there was a five-year regulatory cycle and that's very long term and cumbersome but, as you say, the light has been shone on that and I'd expect that to improve.

LUCY CARTER: Thank you very much for being here today. Once again, this is the second *Energy Futures* lecture this year. There will be a number of others which will be following on between Grattan and the Melbourne Energy Institute. For those interested in public policy more generally, I would also note that the Grattan Institute is running a *Policy Pitch* series in conjunction with the State Library, so please check out our website for that information. Thanks very much again for being here and I hope you've enjoyed the night.

END OF RECORDING