COMMISSIONER: Good morning, ladies and gentlemen. Welcome to the second day of the public sessions. I particularly welcome Mr David Swift and Ms Nicola Falcon from AEMO. Can I acknowledge that we meet on the traditional lands of Kaurna people and the area that we have our sessions today is on the Adelaide Plains, their traditional lands. Mr Jacobi.

MR JACOBI: Today's session continues the discussion from last Wednesday concerned with the topic of climate change and energy policy. It does so again from the perspective of considering the future of energy supply and demand in Australia in the face of considerable change. There will be a continuation of the previous discussion on a different basis of forecasts of future demand and the characteristics of that demand, and there will also be a discussion of changing trends and the growth of renewable generating technologies.

The Commission's sessions today will also introduce concepts to be discussed in greater detail this Friday concerning the National Electricity Market and there will also be discussion that touches on the fourth of the Commission's topics, low emissions energy-generating technologies. Today it will address that in part with a discussion of hybrid electricity technologies with Dr Graham Nathan.

At our first session the witnesses are Mr David Swift of AEMO. David is the executive general manager of corporate development of the Australian Electricity Market Operator, AEMO. Prior to joining AEMO, David was the chief executive of the Electricity Supply Industry Planning Council of South Australia which provided expert independent source of advice to the South Australian Minister for Energy and the industry regulator ESCOSA. He joined the planning council in June 2004, after four years in the National Electricity Code Administrator as the associate director, and prior to moving to them worked for 24 years in the electricity industry.

The second witness is Ms Nicola Falcon from AEMO. Nicola is currently the group manager of planning at AEMO and she is responsible for the AEMO planning publications, including the Gas Statement of Opportunities, the Electricity Statement of Opportunities, the National Transmission Network Development Plan and the Victoria Annual Planning Report.

She has nearly 15 years' experience in the energy and environment sectors and prior to joining AEMO last year she worked for Sinclair Knight Merz, providing consulting services to government agencies and private investors. Her relevant project experience includes market modelling of the carbon pollution reduction scheme and possible variance for the Federal Treasury, and assisting the Climate Change Authority in its review of the renewable energy target. We welcome them both to the Commission.

COMMISSIONER: Thank you, David and Nicola, you've both been sworn in. Can I start, David or Nicola - however you want to play this - broadly give us a quick precis of the role of AEMO.

MR SWIFT: Obviously I'll be giving evidence on Friday in more detail about the market and the way in which AEMO operates in that market but just a quick summary: we operate the electricity market often called the NEM, or the National Electricity Market that runs through South Australia, Victoria, New South Wales, Queensland and Tasmania. We manage the power system across that interconnected system, as well as run a market. We have a five-minute market that actually dispatches energy across that grid. We also supply a range of planning and information services to participants in the market to ensure that market is as efficient as possible.

Our forecasting services that we're talking particularly about this morning go from the short run - we actually forecast what's going to happen in the next five minutes to help run the market - through to in the longer run, where we're looking at 10 to 20 years, because a lot of investments of course being made in our market are long-term: transmission investments, generation investments and so on. So we provide back to industry, and to policy-makers of course, a range of information to try to ensure that the market operates as effectively as possible.

COMMISSIONER: I'm sure we'll go into more detail but that's a good opening summary. Just for my own clarification, you don't have a preference in terms of the technologies that power the - -

MR SWIFT: No, AEMO has been very specifically set up from day 1 to have 60 per cent government, 40 per cent industry ownership. We are specifically set up to be independent of all parties and we are strictly technology neutral.

COMMISSIONER: Thanks. Mr Jacobi.

MR JACOBI: I think today we're going to address the aspects of two reports. I think this is the first slide, and the first report being the National Electricity Forecasting Report Overview and the Emerging Technologies Information Paper. Perhaps we can start at the level of are there any key underlined assumptions, particularly with respect to the first report, in terms of the forecasting or modelling that's undertaken by AEMO?

MR SWIFT: I guess we'll go through some of the techniques we use but I think the key part of it is that in all our forecasting we're not trying to forecast to achieve a particular outcome, as some people might, as you will hear from some other witnesses who are interested in achieving a particular level of carbon emissions or a particular level of economic development. What we do try to do is to understand

trends in the market and to thereby forecast what we expect to happen with the current policy settings, economic factors, the technology settings, and the business and customer behaviours that we're seeing.

We'd certainly say what we'll focus on on a lot of the slides here is our most likely forecast or an average forecast but in all our work we publish ranges and in our forecasting we have a low and a high range. In our planning we use some scenarios to try to capture the fact that there are uncertainties around all the work that we do.

MR JACOBI: If I can come to the particular uncertainty that might be the implementation of the climate policy and certainly the changing technologies that might be expected as a result of that, I'm just interested in understanding at a very high level how climate policy is built into the forecasting and modelling work that's undertaken by AEMO.

MS FALCON: So from demand forecasting perspective we take into account the existing policies on direct action and the impacts that that might have on electricity prices and therefore the flow-on effect that that could potentially have in terms of consumers' responses and demand consumption. So we look at the existing policies' impact on electricity prices. We also look at the implications from things such as the small renewable energy schemes in terms of solar PV uptake and some of those other emerging technologies because they will drive consumers' behaviour.

So we look at the existing policies in terms of both the consumers and also in terms of the reaction to higher prices.

MR JACOBI: And are those concepts built into the forecasting report that we're talking about now?

MS FALCON: Yes, they are.

MR JACOBI: In terms of current government policy - that is, Australian federal government policy with respect to the announced 26 to 28 per cent reduction on Australian emissions by a fixed time - is that built into the electricity modelling that we're talking about today?

MS FALCON: Only to the extent that there are defined mechanisms to achieve that outcome.

MR SWIFT: We would note that when the government announced that, that that's just a negotiating position to take to Paris at the end of the year and they undertook within I think it's 2017 they would consult and work with the community to come

up with policies that would deliver something like that. Certainly the plans that we'll be putting forward in the NTNDP, for example, would not achieve a domestic reduction of that scale. But there's a lot of issues for government to work through and in policies that will deliver that.

So our plans are trying to reflect our understanding of what's in place and what's likely to happen at the moment.

MR JACOBI: Are there particular barriers to building that in in terms of there not being a sufficient granularity or specificity of what that policy will mean for the electricity sector to enable you to do that at this stage?

MS FALCON: Yes, it's the lack of specificity. We make, for example, some assumptions around the safeguard mechanism and what that might mean going forward in terms of a penalty or a price, so we do allow in our different scenarios some variation on the type of penalty that might be opposed, if you like, from generators going forward, but that's still very uncertain in terms of how the policy will play out.

MR JACOBI: Does that include issues such as the ability to purchase carbon credits overseas as opposed to making domestic reductions? Are these the sorts of difficulties that you face?

MR SWIFT: Yes. Yes, certainly if you are going to have an ability to purchase credits from overseas how would that fit in Australia? Do you have some sort of emissions trading scheme or whatever against which you can offset your accountability by purchasing, so how that might work and what linkages might be made or might not be made to international schemes is one of the things obviously you'd expect the government to work through in trying to implement a carbon reduction policy to meet whatever targets are agreed out of the top 21 discussions.

MR JACOBI: Perhaps if we can move to - and again just think about the first of the reports, the forecasting report, and just at a very high level I'm just interested to understand the methodology or the methodological approach that's used for the purposes of arriving at the sorts of forecasts that are contained in that report.

MS FALCON: Sure. Just before I even talk about that I think it's pretty important to just make it clear some definitions that we use in the report.

MR JACOBI: Yes.

MS FALCON: We talk a lot in our reports about what we call operational consumption, that's electricity that's used and supplied by the transmission grid, it's usually measured in gigawatt hours. In contrast there's also underlying

demand, which includes all onsite consumption and it would include things like solar PV, so I just want to make that clear because most of the time we'll be talking about operational consumption and that is what's drawn from the transmission grid.

MR JACOBI: Yes. I think there's another concept that's often used and this appears on a number of occasions that things are expressed as a percentage in terms of probability of exceedance. Could you explain that in simple terms?

MS FALCON: Yes. It's just the likelihood that a maximum or a minimum demand forecast will be met or exceeded, so if we talk about a 10 per cent POE we would expect that that level of demand would be exceeded one year in 10, a 50 per cent POE would be exceeding one year in two.

MR SWIFT: We would need to draw out there that particularly in South Australia we have a peak load which is driven a lot by weather conditions and obviously in some years you have a milder summer, some years if you have a massive heat wave in early February with a sequence of 40 degree plus days then you would expect to get up in to that sort of 10 per cent probability of exceedance and a year which has had milder summer or you don't have that sort of a heat wave it would be lower, so this is trying to give a view about the peak demand only and peak demand and energy consumption are two different components and both have to be met in a power system.

MR JACOBI: You've just referred to "peak demand", we're going to look at a number of graphs today I think that show that, they're expressed in terms of operational maximum demand. Are they the same things?

MS FALCON: Yes, and to the extent that we're talking about the electricity drawn from the grid, so once again there's still that distinction between what's operational maximum demand and then what's the underlying maximum demand.

MR JACOBI: If we can come back to thinking about the underlying methodology. I understand that there are a range of methodological approaches that are used in order to construct an overall forecast where a different methodology is used depending on the different component that you're looking at forecasting. I'm just wondering whether you can give a brief overview of that.

MS FALCON: Yes, sure. The key components that we model are large industrials, residential/commercial and then we also make separate assumptions on the roof top PV, the photovoltaics, and energy efficiency and then there's a very small component of other which covers small non-scheduled generation of transmission losses, so most of what I'm going to discuss at the moment will be focused on the large area of large industrial, residential and commercial and then

the PV and energy efficiency.

With large industrials we take our forecasting methodology by looking at surveys as well as economic growth, so we have assumptions on economic growth, particularly GSP going forward over time and then we actually one on one talk to a lot of these large energy intensive users to understand what their plans and their expectation of the outcomes are going forward and when I talk about large industrial loads I'm talking typically about loads of greater than 10 megawatts in size.

In the residential and commercial we use what's called an econometric model to try and project what the demand would be going forward and that basically means that we look at relationships between the electricity prices and between income as measured by GSP and consumption from residential and commercial, so we have a look really at those relationships and try and project how that would look going forward given assumptions on what future income and future electricity prices might be and we actually split that up to separate out what's going on from a population growth perspective to what's actually happening at an individual consumer's perspective, so we focus on what we call consumption per capita, so that's per person what they're actually going to use from the grid. We look at, as I said, the relationship with income and electricity price and historically we've seen that declining and we can expect that that will continue to be the case although at perhaps a slower rate than we've seen before and we then, once we've got that consumption per capita, overlay assumptions on population growth to get the total outcome for the residential and commercial.

With PV we really take an economic assessment. We look at paybacks for the PV, we look at the types of schemes and support that have been provided from government and we also look at the cost of the systems and how they might decline over time to try and estimate the uptake. We also look right down at the household level in terms of how many separate dwellings there are in an estate and what's the likelihood that it'll reach a sort of penetration rate, so we take that all of that into consideration and then we build up a model of solar PV uptake based on that.

The last component of the forecast I just wanted to point to was the energy efficiency and we really focus on trends and new technologies, but simply based on the existing and planned federal programs and state programs for energy efficiency, so without other policy drivers we're not anticipating what else might come from the energy efficiency, it's really based on those existing schemes going forward.

MR SWIFT: Obviously if you project on history your projection already contains trends that are evident in the last few years and energy efficiency has been a

feature. We have improving standards for a lot of appliances, so there is some built in to the trend and what we've tried to look at is what is above the trend and there is some additional reductions expected from a range of schemes across Australia promoting improving efficiencies in some key appliances.

MR JACOBI: I think perhaps we can move to what's I think shown on the next slide, which is a statement of key predictions in terms of near market outcomes and just perhaps if you can offer in terms of what is AEMO's short term future demand estimates and perhaps we can move from there.

MS FALCON: Yes, sure. The chart, as you can see, we've really split into a couple of different periods; one we talk about is the short term which is from 2014-15 to 2017-18 and then we talk also about a medium term projection which goes out to about 24-25. In the report we also then go another 10 years out from that, but if we just focus on the short term and medium term at the moment. The first thing I want to say is that actually in the historical year 2014-15 operational consumption was flat compared to the year before. This is significant to note because before that time we had been seeing a decline in operation of consumption and there are a number of factors that we believe attributed to the flatness if you like. One was that we had warmer and longer summers in many regions; we also had some response to lower electricity prices, so the carbon pricing scheme had dropped of electricity prices and some areas did fall and the combination of the warmer weather and also the decline in electricity prices led to some of the flatness in the consumption. Going forward for 2014-15 we're anticipating that there will still be those lower electricity prices and that will give some rebound, if you like, to the consumption from the residential and commercial sector, but the main point to note in that shorter term is that we're seeing about a 2.1 per cent annual increase in the consumption forecast and that's largely driven by anticipated uptake of LNG or in fact the demand required by the LNG during its ramp up period. So we are mindful, we don't want to be saying that this is the recovery of consumption overall, it really is driven largely by the LNG uptake in the next few years.

MR JACOBI: Is the LNG the reason why you have got a division in future forecasts from out to 17/18 and then a projection beyond that time?

MS FALCON: Partly, I mean we often will separate out and talk about the short term and the medium term anyway but there is a distinct trend difference in the next few years as LNG ramps up, so yes that is certainly one of the reasons why it is useful to communicate these trends for the different time periods. Once we have got beyond the sort of 17/18 year, we are seeing that there is a bit of a split in terms of what is happening in the different regions, so we have some growth in New South Wales and Victoria, driven by population growth largely in the residential sector. This offsets some decline in South Australia and Tasmania where we are still seeing operational consumption per capita declining and also

quite a large growth still in the solar PV. We are expecting both commercial and residential roof top PV to continue to grow but probably at a lesser rate as some of the government schemes drop off and reduce some of the incentives. In general, the commercial roof top growth is going to dominate that period.

MR SWIFT: Just draw your attention on that graph to the dark line which is the operational consumption we talk about often and then we have also shown on that graph the growth in PV and in energy efficiency above trend energy efficiency. So you can see although the line that we are talking about remains relatively flat over that 10 year period from the beginning to the end, that the actual consumption used by commercial and residential households has increased but it has increased in behind the meter changes have met some of that increase. I would also point out that I am involved in a number of – couple of international groups and I would say that this kind of trend of improving energy efficiency and reducing consumption is quite widespread across most of the developed nations of the world. Most of the OECD countries are seeing this kind of trend.

MR JACOBI: So am I right in understanding that notwithstanding that growth is overall expected, over the long term at about .5 of a per cent that that still builds in declines in individual household consumption.

MS FALCON: Correct, yes.

MR JACOBI: It might be helpful from the next slide, we haves spoken about solar PV, to talk about what the projections are for the uptake of solar PV, that is the – what might be non-operational consumptions.

MS FALCON: Yes. Sure. So this slide actually, I think, tells quite a fascinating story. I said before that the growth and the uptake perhaps would be at a slower rate than it has been in the past but we are starting from a bigger base now, so you look at the chart where we are today and we are roughly at about 5,000 gigawatt hours of solar PV. We are anticipating that within the next decade we will get up to about 18,000 gigawatt hours that are supplied by solar PV. So that is still a fair amount of increase in terms of the consumption that is done down at the household level and also at the commercial level as I mentioned before. Just looking a bit more at the chart, you can see that the largest contribution is up in Queensland, followed by Victoria and New South Wales but probably get to it in another slide, South Australia in proportion to its actual total residential and commercial load is actually leading the way in terms of the amount of solar PV uptake.

MR SWIFT: The other thing to note here is the initial run up where we got the quite high growth rates back from 2009 were driven a lot by some quite generous government assistance schemes in different states. They have pretty much all gone now and the assistance is much more modest. But the cost of the systems has

fallen so much that it now is growing more on the basis of the cost and competitiveness of the solution.

MR JACOBI: I don't suppose this is over the time scale that we are looking at on that chart but is there anticipated to be a point in which growth will slow as points of saturation are reached with respect to consumption?

MS FALCON: Yes. You do tend to see the sort of "S" curve that people talk about as it starts to slow down. Within the period we are looking at, we do see that in the residential area in some states but the commercial area, I think has still got a long way to go before it starts reaching that plateau.

MR SWIFT: We will also start to see – we already have our first utility scale solar gain now, so that is not on roof tops, that is where it will make an entire farm of solar and generate from that. So there are other opportunities but within households obviously you get to the point where standalone households, the majority have solar, so it becomes difficult to find a roof to put solar on.

COMMISSIONER: How sensitive is your forward projection to government subsidy?

MS FALCON: As Dave mentioned, now that it is becoming more economic standalone it is a lot less sensitive than it used to be.

COMMISSIONER: Okay.

MS FALCON: We expect even without it that it would still get continued uptake.

MR JACOBI: The graph shows differences between the relevant states in terms of penetration in those states and I think perhaps – I think the next slide is also drawn from the report shows those distinctions. I wonder whether you might be able to explain the reasons for – or the underlying reasons for differences that emerge between jurisdictions?

MS FALCON: Yes. There is a number of drivers to that. Obviously the cost of the system is reasonably similar across the different states but you have got quality of the solar resources in the different states contributes a lot to that and also the electricity price, or the tariff that a consumer faces will impact on the economics and the payback period. South Australia in particular has got relatively short payback periods which is encouraging the uptake.

MR JACOBI: Am I right in understanding that there is a high level of sensitivity to the tariff price charged in a particular jurisdiction to – in the model that is set up, that we see in front of us?

MS FALCON: Yes. That is correct. I mean we are not making any sort of assumptions on how the tariffs might change in the future, so we base our analysis on the existing tariffs. But Sydney there has been work done which shows that if you move more to a capacity tariff, or more to time of use tariffs then you will actually get different responses from consumers.

MR SWIFT: So that is to say that both the level and the structure of the tariffs charged will have an impact on the attractiveness to people, to customers to purchase solar or to go an alternative way.

MR JACOBI: We spoke about total demand; I just want to move to the characteristic of peaking and demand, or maximum demand. AEMO has undertaken projections of that and perhaps by reference to the South Australian chart, you might be able to explain what the projections are with respect to maximum demand in South Australia?

MS FALCON: Yes, sure. I think in a few slides time we will look even in more detail at South Australia but one of the interesting things to note in this chart, you have got a number of coloured bars that show our projection from the historical maximum right through to what the current actual is. The one year from now, which is the orange chart and then 10 years from now. It is interesting to note, if you are looking say at South Australia, that 10 years from now we are still anticipating that maximum demand will only be roughly on par with the historical maximum. Sydney won't have recovered to the historical levels we have seen before and that is in part due to the solar PV uptake but one of the important things to note is that the solar PV, the highest contributions in solar PV does not occur at the points of highest demands in the system as well, so we are seeing shifts in the timing of the maximum demand and it does bring it down a little bit but not to the extent that it would do if it occurred simultaneously with PV.

MR SWIFT: Certainly safe to say that this forecast, as put out here, is a paradigm shift for the National Electricity Market and you never would have in the past seen a graph like this where over a 10-year period there is so little growth.

MR JACOBI: And perhaps by contrast to South Australia, if we look at a case like New South Wales what is the reason that explains the – as I understand it, the increased maximum demand expectations in to the future, as shown by the grey bar?

MS FALCON: For New South Wales, it really comes down to two things, one is population growth and the other is the uptake of solar PV relative to some of the other states. So it has not got – given the current tariff structure, it is not going to have as high an uptake of PV that we are projecting as in other states.

MR JACOBI: We can come to South Australia's demand and also maximum demand projections. I think it is shown by the next slide. I'm just wondering whether you can offer some insights in explaining both the short-term and the long-term projections that are shown beyond the dotted line.

MS FALCON: This is to be interpreted in a similar way to the overall NEM we're talking in the short-term period to 17-18 and then the medium term period to 24-25. With this slide I might actually start with focusing on the strong black line that David pointed us all to on the NEM slide before. Unlike the NEM total, you'll see that that dark line, which is the operational consumption, is anticipated to continue to decline over the period to 24-25. So we're not anticipating operational consumption to recover to historic levels at all within the time line that we're looking at. A large part of that is due to continued decline in the residential and commercial sectors. The per capita consumption is still anticipated to decline in South Australia. The population growth, as I mentioned, is not as strong as in some of the other states. The increase in the rooftop PV, as you can see by the orange and yellow lines is pretty strong. So that's actually a large driver for the reduction in the operational consumption that you can see on that chart.

In the shorter term there is a little bit of a recovery and that's largely driven by a completion of the Port Pirie refurbishment which is increasing their consumption to historical levels. Again, there was a decline in the previous year. So it's an increase in the industrial load in the first few years but then the underlying trend of the decline in per capita consumption and the increase in the rooftop PV is meaning that overall the consumption is going to be going down.

MR JACOBI: In terms of where we expect maximum demand - actually, no, we've spoken about rooftop PV and I think you've got a further chart that shows where rooftop PV is expected to go in South Australia.

MS FALCON: So there's some uncertainty around where rooftop PV will go so we have actually created several scenarios on where we see that might go in the future, largely depending on how much further the costs of PV will come down but also obviously on income and expectations from consumers. For the first time this year we split the rooftop PV into different components. So we actually modelled the residential and small and large commercial separately. The interesting thing with these slides I think is highlighting that we are starting to get to the sort of S-curve that we talked about earlier for residential PV and even potentially for the small commercial, but the large commercial has still got a lot of scope for increase going forward. You can see that with the sort of flat lines in the middle chart on your right there.

In terms of installed capacity, you can see that we're still anticipating a significant

increase in the residential from about 575 megawatts now into about 1700, so a more than a threefold increase within the next 20 years. But if you look at small commercial, for example, we've only got about nine to 10 megawatts and now we're expecting that to be about 839, so a tenfold increase in the commercial.

MR JACOBI: And difference between small commercial, is that less than 10 megawatts?

MS FALCON: It's less than and greater than a hundred kilowatts.

MR JACOBI: I think we have - - -

MR SWIFT: I was sort of saying before how some of this could be seen as a paradigm shift. If you look at those numbers, I'd point out that those megawatts in solar would exceed previous conventional large generators in South Australia when you're talking about a nominal 500 megawatts out of Northern or a nominal output of about 1200 megawatts out of the whole Torrens Island, and you're seeing here thousands of megawatts of solar. So it is a large amount in total compared to the South Australian system.

MR JACOBI: You've also undertaken projections of maximum demand and also load factors. I think they're shown by the next chart. Perhaps if I can get you to explain your projections with respect to maximum demand and where that's expected to go.

MS FALCON: The underlying drivers in terms of behaviour for residential consumers, commercial and the like are obviously still there for both maximum demand and also operational consumption, but it comes down to the timing of the occurrence of the maximum demand relative to some of these other factors such as solar PV. What we're finding is that because maximising the solar PV does not coincide with the maximum demand, we're finding that there's a split between the growth in maximum demand and the growth in the operational consumption. What that means is, in a term called load factor, we've seen the load factor is decreasing over time which essentially means that your average demand and your maximum demand are separating a lot more than you've seen in the past. So we're getting a peakier-type system, if you like. That's really what some of this chart with the load factor is trying to show you. We're still anticipating there will be some growth in maximum demand which is obviously slightly counter to the operational consumption.

MR JACOBI: Are there any particular implications to the electricity system caused by a decrease in load factor of the magnitude that you're looking at there?

MS FALCON: Yes, there certainly are. I think David will cover some of them in

a bit more detail. One of the things in a later slide we'll show you is that it changes the shape and the profile that needs to be met by grid-connected generation and it creates a lot more volatility. It changes the mode of operation required for the generation but it also has implications for how we manage the security and reliability of the system.

MR JACOBI: Also, I would say in terms of the utilisation of a lot of fixed plant to achieve the peak demand to give the reliable supply that customers are expecting obviously you need to meet the peak demand and then that's using network equipment, generation equipment, storage equipment perhaps in the future which is not being used for much of a percentage of the year. So that obviously has implications for the efficiency of use of infrastructure and therefore the cost per unit.

MS FALCON: One other thing, sorry, I didn't mention before was in South Australia we're seeing that the impact of the solar PV uptake is actually shifting the maximum demand peak to occur later in the day. There's already been a shift to about 6.30 at night and we're anticipating that by the end of the forecast it will be a shift to about 7.30 at night. So that has implications in terms of even costs and tariffs and everything else as well.

MR JACOBI: To what extent do those projections take into account potential measures for maximum demand control that can be built into electricity systems?

MR SWIFT: I think as we've tried to highlight through our work, we are basing these forecasts on current measures. If one had a wider role out of advanced measuring more options for people to shift, you could imagine a different outcome. So that's a part of the scenarios and thinking that we're doing in our planning, but at the moment these are based on current trends and current policies in place.

MR JACOBI: I think the next slide shows AEMO's projections of maximum demand into the future. Perhaps if you could explain both the dots and then also the ranges that are shown by the lines on the right of the slide.

MS FALCON: This really shows and highlights how different the maximum demand could be depending on the temperature and weather conditions that occur in a particular year. So even in the history, which are the dots, you can draw a little bit of a trend but there's a lot of ups and downs along the way and it really just depends on whether we had a hot summer. When that hot summer occurred, was it going to be before school comes back or afterwards? Was it after four or five days of a heatwave or not? So there's a lot of factors that actually will go into driving the maximum demand.

What we try to do with that as we describe the 10, 50 and 90 POE type projections is try and understand the band or range of maximum demand forecasts that could occur in the future just dependent on weather. So the three lines going forward show if it's a relatively cool summer then maximum demand is going to be sort of following the blue line. If it's a lot hotter, it's going to be up towards the grey line. Really, there's quite a sizeable difference between each of those lines; between roughly about six and seven hundred megawatts difference.

MR JACOBI: Am I correct to understand that what will ultimately be realised will ultimately in turn depend upon the weather conditions in any given year?

MS FALCON: Correct. So it could move within that band.

MR SWIFT: The two major factors are what we call the calendar variable and the temperature variable. So you could have a massive heatwave but if it occurred in the holiday period, which happens to coincide with our summer of course, you may not get much of a peak demand anyway because industry is off and stuff like that, but if you get a combination of a heatwave on a week day when business is back at work then you'll be up towards the top end.

MR JACOBI: If I can just deal with, and it doesn't arise from the graph, specifically with the issue of how AEMO models energy efficiency and builds energy efficiency into its models. The reports and the underlying technical reports refer to a gradation or an increased stepping up of energy efficiency measures of about 18 gigawatt hours in 2014-15, 93 gigawatt hours by 17-18 and then ultimately a greater amount by 24-25. I'm just interested to understand how AEMO's arrived at those particular figures with respect to energy efficiency. We've heard other evidence with respect to more ambitious targets for efficiency to meet climate change targets and goals.

MS FALCON: Yes, it really comes back to something we mentioned at the start which is that we're really only modelling the current schemes in our system, so if one were to take a different approach and say we're trying to meet a certain climate change target energy efficiency is often called the low hanging fruit and that's a fairly cost effective way of trying to meet an abatement target, so if our approach had been that we were trying to target a certain 26 to 28 per cent then it would have been something that we would actually be considering more fully than we are at the moment. What we've done with our energy efficiency is really just taken data and information that's available from the state and federal schemes for energy efficiency that are currently planned and outlined and so that the 93 gigawatt hours and so forth is based on that assumption and evidence to date and the facts to date about how that's been achieved.

MR SWIFT: Some of that of course is not driven by – policy is obviously not the

only factor. You've got business models and approaches to customer service that drive some of that. Technology is a big driver. It's not that many years ago you would have had trouble finding an LED light, now if you go to your local hardware store you'll find almost nothing but, so some of them are driven by things other than policy as well and certainly worldwide trends in energy efficiency are making better airconditioners, better fridges, better lighting popularly available and that's had as a driver regardless of government subsidies or interventions per se.

MS FALCON: Yes, that's actually a good point and it reminds me that it's very difficult in our forecasts to say what part is only attributable to energy efficiency because we said how we've got per capita consumption declining, one of the reasons for that decline is the uptake of energy efficiency-type appliances and more awareness of the use of energy and so forth, so part of it is actually in our underlying forecast, and I'm using the wrong definition right at the moment, but part of it is already in the trends that we're assuming going forward and in the numbers that you quoted already just incremental that we don't think would be captured in those trends of behaviours.

MR JACOBI: If we can I guess shift reports in a sense and move to the emerging technologies report that's been published by AEMO this year. It addresses three fundamental technological shifts and perhaps if we go through them in order and deal first with projections with respect to, I think it's what's referred to as, IPSS or battery storage with solar PV and perhaps if we can start at the level of the assumption or the methodology for the preparation of the projections there. Could you explain what was the methodology used to make projections with respect to the integration of the systems?

MR SWIFT: Before we start with that could we just make clear that this was written as a paper to expand some of these emerging technologies and their likely effect. None of these have been quantified and included in our current forecast, so these go beyond what's shown in the NEFR that we've been through so far this morning.

MR JACOBI: Yes.

MS FALCON: Yes, and because they are emerging technologies they are a lot more difficult to forecast and project than even say the solar PV when we now have some time series of histories, so this paper is a little bit more of a thought piece to try and actually start understanding some of the implications going forward and therefore there are certain assumptions that we've made and with battery storage or the IPSS for example we've only focused on new installations, we're not looking at any of the retrofit market, and we're only focused on residential, so obviously it's not the full potential for uptake of battery, but we're

starting somewhere and it seems that on the new installations that's a good place to start. The reason I stress that is that that does have implications for South Australia where you've already got quite a large uptake of solar PV in households, so what we've had to do is have a look at the data that we do have available in terms of the tariffs and daily profiles for consumers and the contribution from solar PV and had a look at how storage might play a part in a consumers daily management of their power. When would be the right time to use the battery? When would be the right time to use the solar PV? Would you export to the grid or would you let the roof top PV charge the battery? A lot of different behavioural-type combinations and we found depending on the type of tariff and the solar resource and the timing of all of that within a day we see different behaviours emerging from different states in terms of how the battery and PV might get used.

Our first phase is trying to collect all that information on the demand, profiles, tariffs and try to understand how battery might get used in a day. Then what we do is have a look at what the cost of those systems might be and combine that into an economic model to say, "Well, what would be the likely uptake? What are the payback periods for these different technologies in the different states given all of those different variables," and that's helped us come up with an uptake per annum that we've made a projection on and then ultimately what that might do in terms of the impact on the maximum demand that we've been discussing up till now.

MR JACOBI: I think we've got the table which I think is the upshot of that analysis as our next slide.

MS FALCON: Yes, so, interestingly perhaps, by the end of the 20 years we're seeing that roughly 2 per cent of the maximum demand might be impacted from the uptake of battery storage on new homes and 2 per cent is in Queensland, New South Wales and South Australia. Quite a lot more in Victoria and a little bit in Tasmania, about .3 per cent in Tasmania. In both Queensland and South Australia the fact that there's quite a large portion of roof top PV on homes already means that there's less impact as I mentioned before on the battery storage. In Victoria and in South Australia they actually have relatively favourable tariffs compared to some of the other states for managing your power between different times of the day and particularly in some instances where there might be a capacity tariff that actually encourages you to reduce your demand at maximum demand time and that's really what's causing those differences that we see between the impact on maximum demand in the different states. Tasmania's very low because even though we actually do anticipate that there would be growth in uptake in the storage systems in Tasmania of course they're winter peaking, so the impact on the maximum demand in Tasmania is not as great as perhaps in the other states.

MR SWIFT: We should point out again though this is the battery storage that

we've analysed in here which is for new residential solar PV.

MS FALCON: Yes.

MR SWIFT: There could be uses by utilities, there could be uses by networks, there could be uses by commercial businesses and there could be the retrofit market to the existing PV on top of this, so this gives you a glimpse of some of the aspects here. It also focuses on maximum demand because of course storage doesn't affect the energy consumption you're going to use over a year. If anything it would slightly increase the energy consumption because of losses in the storage profile, but what it does do is it shifts around where that peak demand is and it potentially can make quite a difference to that graph we saw earlier where we get this deteriorating capacity factor and storage has always been I guess the holy grail of power systems. If you could store electricity it would be great, but it's always been expensive and difficult to store electricity, that looks like changing over the outlook period. People would argue about how long that outlook period is, but certainly in the next 10 to 20 years we're sort of now looking at having an uptake and it's not that many years ago we would have shown you a chart like that, it would have just said zero, zero, zero, so it is a change.

MR JACOBI: Before I come to the issue of costs on our next slide, I am just interested to understand whether – you have mentioned a limiting factor or the limiting assumption that we wouldn't retrofit batteries to existing solar PV panels in South Australia and that is that would South Australia expect to see figures similar to Victoria if that is the very, very significant reduction in maximum demand if one was to relax that assumption?

MS FALCON: Yes. Look just to clarify that it was only an assumption, it is not that they wouldn't - - -

MR JACOBI: Yes.

MS FALCON: - - - direct that but it was just the assumption we made at the moment. It is difficult to say. You would certainly expect to see greater uptake. The problem is that – or part of the problem is that the current tariff structure and the small payback period for a solar PV at the moment means that the incremental value from battery storage for a consumer in South Australia is not as big as it is in perhaps some of the other states. So under the current tariffs it would be difficult to see that it would have as great an impact as in some of the other states but then things can change quickly.

MR SWIFT: Victoria has a total rollout of interval metering, so that allows tariffs that are more finely tuned to time of use and peak demand. So that is a potential changer for these kinds of technologies. I think the other thing is that the business

models, which we have yet to see, but expect that retail markets for electricity, competitive retail markets will take the opportunity to market and sell this kind of technology and how successfully they can bundle that up to make that look attractive to consumers will have a significant impact on the actual outcomes.

MR JACOBI: If I can turn to the issue of the costs that have been used to underpin the projections, I am just interested to understand what the basis was of the cost projections that are used to drive the increased uptake in the previous table?

MS FALCON: Yes. Look there is a lot of speculation out there at the moment about how quickly the battery storage costs will come down. Is it going to be the same phenomena as what we have seen with solar PV, where it has been so rapid and caught everyone by surprise? The chart here shows what Bloomberg New Energy Finance has put out as a potential cost curve, or a learning curve for battery storage and when you look at the sort of numbers that Tesla has been quoting, all being released in US dollars quoted around at the moment, it is seems that we are already on the point in the cost curve from Bloomberg that is sort of seven years down the track, so without speculating as to what their business model is to be able to get those sorts of costs, it seems that some of the efficiencies that Bloomberg was expecting over time are already going to be captured by Tesla. There is no doubt that as some of these new technologies get increased in their market share then they are going to be able to bring their costs down on that curve quite dramatically but exactly what that rate will be is uncertain. We have assumed that if we start with a base of the sort of prices that Tesla is putting out now, probably reasonable to anticipate that the immediate reductions that Bloomberg anticipate have already been realised and are unlikely quite as dramatic but we are still anticipating, as you can see that the costs will come down quite considerably over the next 20 to 30 years.

MR JACOBI: I think our next slide shows the total number of systems projected to be installed and I assume this is a product of the cost projections from the previous model. I am just wondering whether you can explain the import of those calculations?

MS FALCON: It just really gives you a bit of a sense for – allows you to bring it back to your own home and neighbourhood you live in and think about and just how many people would potentially have batteries with their solar PV installations over time. Obviously this is across the NEM, these numbers of 29 and 30 per cent by 2035. That, you know, 1.5 million installed battery storage and that is only just when we are looking at the new market. That is still sizeable and I think there is no question that is a potential game changer for this market.

MR SWIFT: It also highlights that point I was making before about the business

models. That shows that there is a potentially attractive market for companies there to try to meet and to serve that sort of demand.

MR JACOBI: Am I right in understanding that that doesn't take in to account any notion that there is a government policy that promotes these technologies and nor that any retailer that is promoting the installation of these technologies either?

MS FALCON: Correct. You could imagine a world where quite a different tariff or a different policy subsidy would actually increase this far beyond what we are anticipating.

MR SWIFT: Alternatively, a restructuring of tariffs could reduce those numbers as well.

MR JACOBI: Can we move on to the second part of the report which deals with electric vehicles? Perhaps if we can start with, again, the underlying methodology and assumptions that underpin calculations that were made with respect to the take up of vehicles?

MS FALCON: Yes.

MR JACOBI: Just one seemed a starting point.

MS FALCON: Yes, sure. Electric vehicles was even more fledgling that battery storage at the moment in terms of trying to get the data and it has obviously had a bit of attention over in Europe and so it is not in its infancy so to speak. There are markets building over there but in Australia it is pretty small at the moment. I think to date, period, up to about April 2015 only 2,000 electric vehicles have been sold in Australia. So unlike the battery storage, we weren't able to build an economic model to try and assess the impact of this and on this occasion we created an electric vehicle tool that would just allow us to see the impact on demand under certain assumptions on future uptake. So we weren't forecasting the uptake, we just said, if two per cent of vehicles were sold, or five per cent of the fleet was electric vehicles in a certain period of time what impact would that have on the NEM? And that was based on a tool that we used that made assumptions around when vehicles would be charging, how many kilometres a day would you be travelling, all of those sorts of things.

MR JACOBI: As I understand it there was a linear – it was in fact a linear projection of uptake, is that right for the electric PVs?

MS FALCON: Yes. That is right. But really that was just a hypothetical. We just said, you know what would happen if we got to, in a linear fashion got to about five per cent uptake but I know there is other publications out there from

other agencies that are postulating of things 20 per cent, 80 per cent. The numbers – and the idea really is that the tool that we develop would allow you to put in your own assumptions and have a look at how that might change, rather than it being a projection as such.

MR JACOBI: What was the key conclusion with respect to increased annual demand on the NEM?

MS FALCON: Yes. Look if you assumed five per cent of new vehicle sales were electric vehicles by the end of the period, it was pretty minimal. We are still talking – I think the numbers were in the points of percentages rather than anything that would be noticeable. Obviously does depend on when we assume the charging would occur. That tends to actually – based on our current assumptions, boost up the demand over sort of midnight periods and so forth but yes, it was pretty minimal at those sorts of uptake numbers that we assumed.

MR JACOBI: Did you reach - - -

MR SWIFT: (indistinct) considered - I guess numbers would be considered "bareish" by a number of parties who are promoters of electric vehicles.

COMMISSIONER: Did you get to a figure where you saw a significant impact on the NEM? In terms of uptake?

MS FALCON: I wasn't actually involved in testing some of those parameters but if you think of the total energy consumption for motor vehicles in Australia and you would assume 90 per cent of them were electric, you know your imagination could go quite quickly to the fact that it could be significant at that point.

COMMISSIONER: Yes.

MR JACOBI: I don't know if we can get the next chart – there was a chart that showed the increase – it does. I think there is a small green section which you can see on the globe profile - - -

MS FALCON: Bit of snow at the top of the peak - - -

MR JACOBI: Yes.

MS FALCON: - - - that is about it.

MR JACOBI: Yes. And that doesn't make any assumptions with respect to when one charges one's vehicle? That, I assume – that assumes end of day charging, is that right?

MS FALCON: Yes. It pretty much assumes end of day charging. There is a bit of charging during the day but we have made assumptions on what proportion would be during the day and what proportion would be a night. But you are absolutely right, there is a lot of different models – business models – for charging - - -

MR JACOBI: Yes.

MS FALCON: - - - that could be considered in the future and depends on if you want a slow, medium or fast rate of charge as well. You might be quite happy to just sit and have it going overnight, or you might want to stop in the middle of your freeway and get charging as quickly as possible or somewhere while you go and coffee. So it depends on what the consumer wants at the end of the day as to when the charging will occur and how much. But yes, our assumptions are based on some other studies that have already been made, just making assumption on that.

MR JACOBI: The third part of the study that was undertaken looked at fuel switching. I just wondered whether you might explain briefly what that is and then explain the methodology behind your analysis.

MS FALCON: So in the context of the NEM fuel switching refers to the replacement of gas with electric appliances in existing households and also the development of new households which are solely powered by electricity. So we're really talking about the switching from gas to electricity. The study that we looked at is suggesting that the impact on the NEM would be relatively low, and you can see you've got that table there that suggests operational consumption might increase by .4 per cent by 24-25 and 1.2 per cent by 34-35. That's largely due to the fact that there's quite a limited number of consumers that will actually benefit from the fuel switching. It would be fair to say Victoria is probably a good target area but a lot of the other areas don't even have gas or rely on gas for heating at this stage, so it starts to limit the number of potential options for fuel switching at the residential level.

It's also fair to say that there are a number of non-economic barriers that stop people switching immediately. So there will be things - I mean you just have to think about your own home and the form of heating that it's not a trivial thing to suddenly change and get rid of all your gas ducted and switch to reverse-cycle airconditioning or something like that. There's an up-front cost. You can imagine it will evolve slowly over time as people shift or renovate their houses but not something that you would do as soon as it seems economic to do so.

Our expectation is that on the electricity market the impact of fuel switching would

be relatively modest. It could have a bigger effect obviously on the gas market.

MR JACOBI: Again, in terms of underlying government policies or programs that might be thought to drive or be desired to drive particular outcomes, to what extent does the model take account of those sorts of concepts?

MS FALCON: It doesn't consider any future policies that may or may not emerge.

MR JACOBI: There are two final topics to address before we conclude, and they are on both AEMO addresses uncertainty within its forecasting and modelling and I'm just interested to understand how it takes account of different sorts of consumers as part of that underlying modelling?

MS FALCON: Scenario modelling is interesting or at least our choice of the scenarios. You could sit in a room and speculate on a number of different futures and I guess where we draw the line is we're not speculating on different policies. We've already sort of speculated - I highlighted before - and we're not speculating on winners and losers in terms of technologies or anything like that. So our scenarios that we've imagined for demand forecasting are really around the engagement of consumers and how much of the demand will be from centralised sources or be putting demand on the grid versus how much would actually be driven by on-site generation, whether it's in the form of solar PV or some other sort of generation.

So everything that we've talked about today has been based on the medium energy consumption which really imagines a reasonable high engagement from a consumer. We've got strong uptake in solar PV, energy efficiency and the like, and medium economic conditions. But we can also imagine a world where there might be low economic activity or more engagement with consumers taking power into their own hands and so forth and having more of an uptake in that respect, and similarly on the high side is the reverse of that. Our scenarios have been based around really the impact that that would have on the operational consumption, which is what we, as a market operator, are really focused on.

As I said, there could be a number of different types of scenarios that you could speculate but really the purpose of the scenarios for us was to understand the impact that would have for us on the grid.

MR SWIFT: We also try to ensure that a scenario is internally consistent, and if you look at a scenario where you have low energy consumption it may be driven by a range of factors, including low economic activity, you'd expect higher prices out of that because of poorer utilisation of assets and so on. So if you have that sort of low consumption then you'd expect higher prices, you then expect that

there's more of a driver for consumers to take charge of their consumption and their pattern of consumption, more ability for them to make choices. So those sort of fit together. Whereas if you have a higher energy consumption, a more buoyant economy, perhaps then it's more affordable and people kind of take an easier route.

We're trying to capture in those scenarios an internal consistency that sort of envisages a future at different ends of the spectrum and therefore would have a different outcome. Particularly for us as the energy market operator, it would have a different outcome for the dispatched plant, the centrally-managed plant, and a different the transmission grid as our plan of course is actually called the National Transmission Network Development Plan. So it is actually driving at trying to understand how the national network ought to grow and develop to meet customer needs.

MS FALCON: I should also just add to that, when David mentioned the National Transmission Network Development Plan, the uncertainty at the moment is pretty large in that we're talking about various centralised sources but also we've just mentioned about emerging technologies, battery storage and so forth. So if you start overlaying different assumptions on the uptake of those technologies on top of the three scenarios we've just identified here, you can see that the range of potential futures could actually be quite large. With the NTNDP this year, one of the things we are looking at is sort of a low scenario with quite a large uptake of energy storage.

MR JACOBI: I was going to ask how you expect the medium scenario to change into the future because I wouldn't have thought 10 years ago that the medium scenario would include rooftop PV uptake. Did you have views about where you think that medium scenario might be at some point in the future?

MS FALCON: I'd have to say at the moment this is our best expectation of a medium scenario. We are constantly talking to the market and internally to try and think about what might be the next changes but at this stage that would be our best expectation.

MR SWIFT: I mean industry is moving to create new products and services for customers. There's a process in place now to enable the competitive roll-out of more advanced meter infrastructure. Home automation is already available but we expect it to be a growing market. So there's a range of things in that space that you might expect to change. There's a range of things in the space of emissions that you might expect to face if governments decide on a particular targets and then implement policy mechanisms to try to deliver certain outcomes that could mean quite a big change in that. We certainly expect our forecasting department will be quite busy for the next few years.

MS FALCON: I think the most immediate one is after Paris when we get a better idea of what's going to happen with the policy from 2020 onwards. Immediately we'll be putting that into our meeting projections.

MR JACOBI: I'm just hoping that we might stroll down into what in practical terms a high energy consumption scenario might mean; that is, not the scenario but just the element of energy consumption. What in practical terms in terms of industrial production or resource production would we be looking at if we were to reach a high energy consumption scenario?

MS FALCON: I mean that could be more things like more LNG trains, expansion of Olympic Dam in South Australia, development of the Rex Minerals Hillside mine in South Australia. Some of those expansions are currently assumed in our high scenario - even desalination plants operating being at full capacity. All of those things would actually have an impact from an industrial perspective.

MR SWIFT: We're in a highly speculative area here though too because that would also depend on the Australian dollar and international competitiveness and a whole range of matters like that.

MR JACOBI: If we can just finish off dealing with a unique aspect for the first report and we'll move away from emerging trends report and deal with a particular chapter concerned with South Australia on minimum demand, and perhaps if you can pull that slide up. I'm just interested to understand if perhaps you can explain first why you're interested in minimum demand in South Australia.

MS FALCON: The point of this slide is really to inform the market on what may be a shift from what we used to do in the past. I mean last year we saw I think it was about 790 megawatts as the minimum demand in South Australia because there was a large proportion that was provided from solar PV at the time. We really want to understand the implications going forward if that continues to decline and the chart is actually showing that, all else remaining equal, we're anticipating by about 23-24 we could get to what we call a negative operational demand, which really just means that solar PV exceeds the amount of your local demand and is actually exporting back into the grid route, so it's actually contributing and there's no further demand needed on the grid.

It's really important for us to understand the implication from that in terms of managing our grid securely and reliably and so the purpose of doing this forecast was really to just give us the information, to be able to do further studies and we're currently trying to understand what all of those implications will actually be.

MR SWIFT: I point out that Boxing Day last Christmas was the lowest operational demand we've had in South Australia since the market started in 1998,

so it was very low and the peak demand for the day was just after midnight when the so-called off peak electricity kicked in and the minimum demand was around about 2.00 or 2.30 in the afternoon when the solar PV was at maximum, so that just shows under situations of low demand and high sunshine that we are getting quite a change there and that then effects – we manage the power system by controlling the large generators and so this is showing that you're moving to a paradigm where under some circumstances the large generators will become a lesser and lesser portion of the supply, so that asks us questions about how do we manage that, how do we integrate all this renewable into the market and that's an area that AEMO has got some major projects on at the moment and where we're talking to the COAG Energy Council about the impacts of that and how that might be managed into the future.

MS FALCON: I think the other point just to note on that slide the table we've got to the right it just shows you that in 2011 and 2012 we used to see the minimum demand occurring early in the morning. Since then it's now occurring middle of the day and that's where we expect it to occur going forwards, so it has changed quite significantly.

MR SWIFT: Yes.

MR JACOBI: Is this a characteristic that's appearing in other jurisdictions?

MR SWIFT: I think it's fair to say that South Australia's in the vanguard.

MS FALCON: Yes.

MR SWIFT: The amount of renewable generation in South Australia was a portion of the total, depending on what measure you adopt is right up there in terms of some of the largest in the world, but of course it is of great interest around the world and, you know, we deal with a number of large grid operators around the world who are projecting these sort of things and seeing some of these things, but I think South Australia is certainly up there in terms of the amount of solar and wind generation here as a proportion of the total demand.

MS FALCON: We are focusing on minimum demand in other regions now, we're looking into that. Queensland's probably one to start looking at, but this is certainly more immediate.

MR JACOBI: You referred to there being a number of large projects being undertaken in AEMO to look at this issue and also issues in terms of complexity of management. I just wonder whether you can give us some insight into the sorts of things that would need to be considered in address this particular issue.

MR SWIFT: One of the things that we're looking at in this case if you imagine very large amounts of solar and wind generation in a system that reduces what we call the inertia of the system, so that creates – because these sorts of generators – a PV generator is actually not like an old fashioned rotating machine. It actually connects to the grid through an inverter, a solid state device, and in a traditional grid to change the frequency of the system you have to actually shift the rotating machines that are actually locked to that frequency. When it's an electronic device that's connected to it it doesn't actually stop the frequency moving, so that sort of inertia effect that has a significant impact then on how is the system going to be resilient to changes in demand to trips in networks, those sorts of things, so we're looking at a lot of the security related impacts of that and understanding how a system like that will perform and, as we say, I mean, this is pretty much in the vanguard, but it's an area that a lot of the world's advanced economies are now thinking about and so we're not on our own in thinking about it, but it is quite an issue that needs to be understood and which we currently don't have the full amount of information on, we've got time to get it. We certainly can guarantee that we're maintaining security for the foreseeable future, but trying to understand a lot more about exactly how that system's going to perform in the medium to long term is important.

MR JACOBI: I think picking up the issue with respect to the time and the shifts in the time of minimum demand the next slide shows a change in demand profile and I was just hoping that you might be able to take us through, perhaps by reference to the date in January, the implications of the shifts in the change in demand pattern as reflected in first chart.

MS FALCON: Yes, so this is an average daily profile in January for a relatively large residential consumer in South Australia and I think it's actually really useful to understand how the profile is changing and then also imagining how that would mean your generation mode of operation would also need to change to meet the change in profile. The easiest way to go through it is probably to start at the top with the pink solid line, which is the highest peak on the January day, that represents what the underlying daily consumption would be for this particular household if there was no solar PV, no battery storage or anything like that. You then have, it's a bit harder to see, a gold dashed line that drops down quite significantly from about 7 o'clock when you compare it to the underlying and then peaks up at around 6.00, 7 o'clock at night, that's the contribution or the change and shape that would occur if solar PV was installed, so you can see that it immediately makes quite a trough in the middle of the day and that's what's starting to drive some of that minimum demand that we're seeing. The blue dotted line below on the chart is also then showing that not only will you be getting on average solar PV contributing to that consumers demand, but they will have excess that they will be able to export to the grid on those summer days in January. We then have one final series which is the red solid line, sort of sitting in the middle of

that chart, which shows our estimate of the profile if there was battery storage installed as well, so what's happening in this situation is that the consumer is choosing to charge their battery with the excess solar PV, so you get the blue solid line as showing that there's less solar PV now being exported to the grid, is getting used to charge the battery and then the energy from that battery is able to manage the peak and reduce the peak so that their actual consumption from the grid is considerably lower and is putting this pressure on the grid during peak times.

COMMISSIONER: I think that concludes the evidence that we seek. Thank you very much, David and Nicola, for a very expansive view on AEMO and its work. We'll adjourn until 1100.

MR SWIFT: Thank you.

MS FALCON: Thank you.

ADJOURNED **[10.18 am]**