RESUMED **[11.01 am]**

COMMISSIONER: We'll reconvene. I remind you of topic number 2, National Electricity Market, structure and operation of the NEM. I welcome the ElectraNet witnesses. Thank you very much for joining us. Mr Jacobi.

MR JACOBI: The Commission calls Rainer Korte, Hugo Klingenberg and Brad Harrison. Rainer Korte is the executive manager of asset management of ElectraNet. ElectraNet owns and operates the high voltage 275-kilovolt transmission system in South Australia which transports power between metropolitan and regional South Australia and the National Electricity Market. Mr Korte's, among other things, responsibilities include network development, investment decision-making, technical solutions for connecting generators and loads to the transmission network, and he has over 25 years' experience in the electricity industry.

Mr Hugo Klingenberg is responsible for network development business at ElectraNet which performs the functions of network planning and development, managing network dynamics, network connection assessment, project estimates and project sponsorship, and he has over 20 years' experience in network planning and development and, before joining ElectraNet four years ago, was responsible for sub-transmission planning and generation connections with the then ETSA Utilities.

Mr Brad Harrison is the principal energy market analyst at ElectraNet and Brad has over 10 years' experience in Australia's National Electricity Market working for both the AER and the Australian Electricity Market Operator. He has been with ElectraNet for four years, responsible for demand and supply forecasting. We welcome the witnesses to the Commission.

COMMISSIONER: Thank you. If we could start with figure 1, and let me address the questions for the group and you can decide who answers. Can you just walk us through the transmission network for South Australia, just the critical points?

MR KORTE: Sure. The South Australian transmission network, as you can see

on the map, is a fairly thin, stringy network. The main network was developed a long time ago now, largely in the 1970s and 80s.

COMMISSIONER: So it's a legacy network.

MR KORTE: It is a legacy network that has been with us for quite a while. The main strength of the network is between the north, Port Augusta, where we've had coal-fired power generation in the Northern and Playford power stations. Of course, we have recently heard the announcement that that's closing. The main strength of the transmission network, which is a 275-kilovolt network, extends from just around the north there down to the Adelaide metropolitan region. The main electrical load in South Australia is concentrated in the Adelaide metropolitan region. I don't have the exact figures in my head but it's of the order of 70 or 80 per cent of the load that's actually within the broader Adelaide metropolitan area. So we then have quite stringy network to supply all the outlying areas.

In, I guess, the eighties, heading towards 1990, we then interconnected with the eastern states. So the 275 network from Adelaide down south into the south-east was built at that time to support any interconnection with Victoria and the eastern states. That was commissioned in about 1990. So it's a fairly radial network from the north of the state through to Adelaide down to the south and its main purpose is, of course, to provide a transport vehicle over which generation can get to the demand, where it is in South Australia. We have then sort of lighter transmission elements at 132 kilovolts that extend out into the regional areas, so down into the Eyre Peninsula, down to Port Lincoln, across to the Riverland. That 132 network was there before the higher capacity 275. So we also have legacy networks extending down to the south-east and also between the north and Adelaide.

COMMISSIONER: Could I just ask a question about that Eyre Peninsula network. Noting that's where most of the wind resources are, could you just talk about the capacity and the opportunity for growth on that network with the current transmission lines?

MR KORTE: There are some excellent wind resources over there. I'm not sure I would call it the foremost wind resource. The mid-north of South Australia, the area you see in blue there, I think, on the map, is where most of the wind resources have connected to date. I think one of the main reasons is because it's close to where there is capacity on the transmission network. I guess it's fair to say that the wind resources on the Eyre Peninsula are pretty much equally as good but we have limited transmission capacity over there to actually get that power away. We do have two major wind farms on the Eyre Peninsula. In fact, they were two of the first to be built in South Australia, amongst the first, one right down the bottom there near Port Lincoln and one about halfway up, the Mount Millar Wind Farm.

A few years ago you may recall the South Australian government did do a green grid study which actually had a look at what the quality of the wind resource on Eyre Peninsula would be and how we could maybe evacuate that, but to date there has not been any economic driver to really strengthen that transmission network. One of the things that could trigger that network to be built or to be strengthened is if we had mining loads. ElectraNet actually put some work out in the public domain a couple of years ago that looked at the investment case for strengthening that network from the north near Port Augusta, Cultana, Whyalla right down to the middle of the Eyre Peninsula and then further down to pick up a large load increment but, of course, commodity prices have gone through the floor and we're not at the moment seeing the driver coming, although Iron Road is still quite optimistic about their load.

If a mining load was to come along and be prepared to commit to a connection to the network of sufficient size, something of 50 megawatts or more, then that would actually trigger an economic case to strengthen the transmission network down, at least halfway down the Eyre Peninsula, and that would provide the opportunity to evacuate more wind. That would improve the economics of additional wind on the Eyre Peninsula.

COMMISSIONER: Mr Jacobi.

MR JACOBI: Perhaps I can pick that up. In terms of strengthening the transmission at that point, do you mean an adjustment up from the 132-kilovolt line?

MR KORTE: Yes. The work we put out a couple of years ago I was referring to proposed building a 275-kilovolt, double-circuit line or possibly a single circuit down from Cultana which is near Whyalla, down halfway there to a point called Yadnarie.

MR JACOBI: Perhaps if I can just round out the complete story of the transmission system in the State. The Yorke Peninsula itself is served by – is that a 132-kilovolt line?

MR KORTE: That's correct.

MR JACOBI: Has there been any justification for expanding that particular network in view of the wind resources that are available there?

MR KORTE: No, not at this point. I mean, there is a fairly significant wind farm at the bottom of that Yorke Peninsula leg but that gets its power away through that 132-kv line that's a radial line down to the bottom of the peninsula. There is

potential or there was in recent years potential for a mining load on the Yorke Peninsula as well, Rex Minerals. I think we might come to it but as we look at forecasts for demand in South Australia, one of the cases that we look at in our transmission annual planning report that we published in 2015 the higher demand case actually assumes that load, but again I guess it's not looking as promising now as it was a few years ago.

MR JACOBI: I think that we've already mentioned the interconnection into the NEM through the south-east. I understand there's currently an augmentation of that transmission system.

MR KORTE: That is correct. So currently ElectraNet and – well, just take a step backwards, ElectraNet and AEMO did some joint work to develop an economic case for upgrading the existing interconnector link. Currently, as you can see on the slide, that link has a capacity, a nominal capacity of 460 megawatts flowing in either direction and the upgrade that we are building to be commissioned middle of 2016 would lift that capacity by about 40 per cent up to a nominal 650 megawatts in either direction.

MR JACOBI: Is there a conceptual limitation on the further augmentation of that particular interconnection, transmission wire?

MR KORTE: There is some potential for further augmentation. There are no specific plans or demonstrated cases at this point but you know, ElectraNet, as the transmission body in South Australia and Hugo and Brad are involved in our planning function. It's part of our ongoing work to look at what the future needs of the network are and part of the work we're actually looking at, at the moment, is the economics of future interconnector upgrades, or even new interconnectors but very early work at this stage. You know, the most recent work we have done suggested that further upgrades would not be economic but there are some factors at play that are changing. For example, higher gas prices in South Australia can improve the economics of further interconnector work. You know, and of course the very high level of renewable energy that we have in South Australia, particularly wind, you know also improves the economics for being able to export that. So currently we are upgrading to 650. There are some options technically for going beyond that. But ultimately whether that turns out to be economic depends on a number of variables that we have to see how they play out.

COMMISSIONER: Sorry. Could I just interrupt there? You said 650, technically feasible?

MR KORTE: No, 650 we are building to, so that is the upgrade.

COMMISSIONER: What is the high limit that is technically feasible?

MR KORTE: The high limit, without building a major new transmission line - - -

COMMISSIONER: Yes.

MR KORTE: - - - could be something around 900, okay. But whether that is technically feasible has yet to be determined.

COMMISSIONER: But in that region.

MR KORTE: But just in broad terms - - -

COMMISSIONER: Yes.

MR KORTE: - - - that is right. If you just think about the thermal capacity or what the underlying assets can actually transfer, with some investment, you may be able to get it up to that level.

MR JACOBI: This might be a question for Mr Klingenberg. I am just interested in understanding that perhaps at a higher level what are the key factors that drive the need for transmission network development?

MR KLINGENBERG: In terms of transmission network development in the past was mainly driven by demand growth within the state. In recent years, due to increasing penetration of rooftop PV but also energy efficiency measures, demand growth has flattened. So going to the future we consider that investment (indistinct) more be driven by the changing generation of feed that services the load, more so than demand.

MR JACOBI: And by demand, are we talking about peak operational demand, or are we talking about some other measure that is used to - - -

MR KLINGENBERG: Yes, it is mainly sort of planning the transmission network is mainly driven by the peak operational demand, more so than the energy that flows through the network.

MR JACOBI: And to what extent does reliability form a factor in terms of planning transmission augmentation or additions?

MR KLINGENBERG: It is a critical factor for us. We have got obligations that are set by the Essential Supply Commission - - -

MR KORTE: Essential Services.

MR KLINGENBERG: Essential Services Commission and we have to adhere to those standards. Those are published in the Electricity Transmission Code and we plan to those.

MR JACOBI: Have issues of reliability justified improvements or increases or augmentation of transmission in South Australia?

MR KORTE: Definitely. All of the recent investment though, if we look back even over the last 10 years, has largely been about upgrading supply points rather than building new transmission lines. So most of our transmission lines have been in place for 20 years or more. I think the last time there was major, very major, transmission line development in South Australia was at the time of building the interconnector to the eastern states. There has been some work since but it's been of a relatively minor nature. So most of the investment in the network in recent times has been around upgrading connection points to the network as we call them, to accommodate growth. So that for example, could mean where you have a single transformer supplying a load or even a two with some redundancy. When the demand grows and you can no longer meet the reliability standard that Hugo talked about, that is set out in the Electricity Transmission Code that we might have to replace them with larger capacity transformers. That is an example of the sort of upgrade that we have made in recent times. But of course the outlook looks a little different now.

MR JACOBI: In terms of utilisation of the existing transmission system, can you give a bit of an overview about the areas where there is either recent changes in the level of utilisation or areas of low utilisation of the existing system.

MR KORTE: Sure. I am not sure that there has been major changes in utilisation. I think the – if I could just say this, speaking fairly broadly, the level of utilisation of the network is very much a function of the legacy investments that have been made in the network. As we have described before, there hasn't really been any recent transmission line investment of magnitude. I mean what we are seeing generally of course, is that demand growth is not there as it was because of the increase of distributed energy resources, largely solar PV, rooftop solar PV and also just the change in the economy and the strong drive to energy efficiency. We have seen very large reductions in per capita energy use in Australia, including in South Australia and all of those factors now mean that the outlook for demand, for grid supplied energy, is pretty flat. Unless we see major economic developments like the mining developments we talked about earlier, that will drive investment.

So of course I think there is things that can impact on the utilisation of the network, things like the Alinta Energy closure, the northern power station, Playford power stations. That will change the way the network is utilised but there is nothing really that says we don't need that, or there is elements of the network

we don't need immediately. Alinta Energy's closure, ElectraNet is now looking at for example, some of the assets that were specifically serving that generator and we have to look at that and we then change our plans. So there were investments for example that ElectraNet was looking to make to renew old infrastructure up towards Leigh Creek and that obviously has to be rethought now. You wouldn't go ahead and make those with the change of use arising from the closure of the power station. So there are bits at the end of the grid where there may be some change in utilisation but the bulk of the grid, the trunk, we are not expecting to see any immediate shift in a bulk utilisation.

COMMISSIONER: You will appreciate that one of the things that the Commission needs to investigate is nuclear power plant.

MR KORTE: Mm'hm.

COMMISSIONER: Is there a place within the grid that you could connect a 1,000 megawatts or something of that size without significant investment in the existing infrastructure?

MR KORTE: Yes. Well, I can comment on that. By the way ElectraNet publishes a transmission annual planning report each year by nature of the name. And as part of that, we do actually set out quite a lot of information about the capacity of the network and also the capacity at various points for connecting new demand.

MR JACOBI: Mm'hm.

MR KORTE: And also for connecting new generation. To get to your question, there is probably three points on our network that could accommodate; at one of those points you could accommodate up to about 1,000 megawatts. One of them is at Davenport which is near Port Augusta, which is where essentially the current northern power station is connected. So that is a very strong connection point on our network. The other two are in Adelaide, in the Adelaide metropolitan area where you are not likely to see any major development of a power station for environmental reasons and others. And then Tungkillo, which is in the Adelaide Hills, is also a very strong connection point on our network where, you know, we estimate you could inject up to about 1,000 megawatts, technically feasible.

COMMISSIONER: If we were to go to a small generator, say something around four to 500, does that open up the opportunities any further?

MR KORTE: Possibly it does. I think in our 2015 annual planning report we've reported that there are quite a number of points where you could inject up to, or more than even, 200 megawatts, and I think I had that number here written

somewhere, but, you know, I think it's of the order of about - - -

MR KLINGENBERG: Around ten points.

MR KORTE: Ten points - - -

MR KLINGENBERG: 200 or more.

MR KORTE: Thank you, Hugo. About ten points, which would include those first three that we spoke of. So there are another seven points or so where you could connect something of the order of 200 megawatts.

COMMISSIONER: If we were to introduce major windfarms, presumably that would give you the same opportunity if they were around those sorts of levels without any significant upgrade to the transmission system?

MR KORTE: That's correct, and as I said before, the reason I would say that we have seen so much windfarm development already in South Australia in the mid-north region is because not only it's an excellent wind resource in the mid-north, but also it's close to the transmission network and there is capacity on that north-south link. So they've been able to connect in there with minimal transmission costs, essentially just the cost of connecting windfarms into the transmission network in relatively cross proximity to where those windfarms are located and, you know, they have good confidence that they are not constrained in getting their power to the market.

One thing that may be of interest is that, you know, the way the national electricity market arrangements work is that generators, when they connect to the network, they pay for just their immediate connection costs. We call that a shallow connection arrangement, and any deeper network costs they would also have to pay for. So typically, they are going to be looking for sites where there is a good wind resource and where they're close to existing infrastructure that minimises the costs of their connection.

MR JACOBI: If I could just pick up the case that I think we came to previously where there was discussion about windfarms on the Eyre Peninsula. You talked about there being a case that could be justified, that is, if there were proposals to install generating capacity, that there would be need for an expansion of the existing transmission line. How would the process work there in contrast with the sort of arrangement where one is simply connecting into an existing transmission system?

MR KORTE: Sure. Just to clarify what I said earlier, what I said earlier was that the economic case we looked at for reinforcing the transmission supply on the

Eyre Peninsula was more driven by mining demand, okay. And I guess the point I was making was that if there is a mining load that then drives the economic development of additional transmission on the Eyre Peninsula that then improves the business case for connecting wind to that, because essentially they can then just connect onto that infrastructure and not have to pay a share of the cost of it.

MR JACOBI: Now, if we can, I think, pick up from a discussion that we've had about the projections in terms of future demand in the State, and this might be for you, Mr Harrison, as well. As I understand it, ElectraNet have undertaken their own projections of possible pathways in terms of demand. Could you explain those?

MR HARRISON: Yes. So we receive demand forecasts from SA Power Networks as a starting point and beyond that, we explored the potential for these larger mines to occur over the next ten and 20 years with slightly stronger growth as a result of that. Again, that sort of drives demand forecasts that look like what they were a few years ago with steady growth but nothing terribly strong. So under those scenarios, we could see demands in the order of 3700 megawatts, 2023, 24, whereas right now we're looking at in the order of 32, 33 sort of numbers.

MR JACOBI: Just so I clearly understand the drivers for the wedge that appears in the right-most graph, what sort of mining production is that particular model developed upon?

MR HARRISON: Yes. So that's assuming two mines are going to go ahead, one is in the order of 300 megawatts on the Eyre Peninsula and one is in the order of 70 megawatts on the York Peninsula.

MR KORTE: Yes. So specifically, those two assumptions were based on the central Eyre Iron or Iron Road mine on the Eyre Peninsula and Rex Minerals mine on the York Peninsula that we referred to earlier.

COMMISSIONER: Have you also modelled the potential for Olympic Dam?

MR HARRISON: We did, but we made assumptions that that would happen in the second ten-year period. In many cases what we were looking at there was more - we don't know which ones are going to go ahead. So let's put down some numbers that are indicative, and a lot of what we found with the scenario in 2023, 24, it wasn't that strongly related to what actually happened. The general development things were similar.

COMMISSIONER: I'm presuming if it did go ahead that graph would be a lot steeper.

MR HARRISON: Yes.

MR JACOBI: If we could deal with the graph on the left, I'm just wondering whether you might identify the sorts of factors that underpin ElectraNet's thinking in terms of the flatness of that demand growth that's described there.

MR HARRISON: Yes. So there are a couple of things that have occurred and recent trends that have occurred. One of them is the rise of PV systems. Distributed nature has helped push maximum demand towards later into the day. So that's certainly dropping off some of the demand growth in the near term until five years out when we start seeing peak demands happening later in the night when PV is not an issue. But we're also seeing significant changes in energy efficiency over the last few years and the link between economic growth and energy growth is somewhat different to what it has been in the past as well with economic growth not driving the same sort of increases in electricity consumption.

MR KORTE: Yes. I think that's right, and just on that latter point, I mean, we're seeing a change in the economy in Australia, aren't we, a shift from manufacturing to a more service-based economy and of course a service-based economy uses less electricity than manufacturing. So I think that's one of the economic drivers certainly there that Brad is referring to as well. I think that, you know, we've identified there the key drivers certainly.

MR JACOBI: The Commission has also heard about changes in the minimum demand forecasts, and I'm interested to understand how these minimum demand events reduce minimum demand events, how they impact your thinking about the transmission system.

MR HARRISON: Yes. Well, I can talk to the minimum demand. So historically, and by that I mean the last few years, minimum demand used to occur at 3, 4 o'clock in the morning, 5am-type periods. Now we're starting to see that on a nice, mild, sunny day, particularly on public holidays when demand is already quite low, the PV trough is starting to pick up and that's actually now reaching or exceeding what used to be the middle of the day. Where expecting PV growth continues, that trough will keep getting deeper and deeper.

By 2023 again we're expecting that on those low demand days where there's nice sun - you know, Christmas Day is a sort of great example where the sun should be out and there won't be people using much electricity - we expect demands as low as zero on the network, which means any generation in South Australia beyond PV would obviously need to exported to the east coast.

MR JACOBI: Yes. The event that you've described, and the deepening of those

troughs that you've described, does that have an impact on the way that you think about transmission planning?

MR KLINGENBERG: Yes. Maybe I can answer that. It definitely does. Voltage control on the transmission network is something that has to be managed 24/7. So a loss of or deepening of that trough leads to rising volts. So that's definitely something we need to plan for and make sure that we're prepared to manage those volts going forward.

MR KORTE: So just speaking more generally, you know, what we're saying, that as we have more and more high levels of renewable generation in South Australia, solar PV, wind, et cetera, and particularly as we have less and less traditional conventional generators, you know, that are coal-fired or gas-fired, which have certain characteristics that support, you know, the overall operation of the power system and provide additional services that we call ancillary services in the National Electricity Market. They provide things like voltage control, frequency control. So to maintain the technical characteristics of the electricity supply within limits that ensures we have a secure power system and a reliable power system. As we see that trend continue, it doesn't mean that there's a problem we cannot solve but it just makes it more challenging. It introduces some new challenges to manage power system security and those issues are quite actively being looked at, at the moment by AEMO in particular but also ElectraNet has done some work with AEMO in that area. So voltage control Hugo just spoke of is one of those things that we have to pay some more attention to.

MR JACOBI: Just to round out where we were going with respect to demand, I think we've got a further chart that you supplied that describes forecasts. I'm just wondering whether you can offer an interpretation of that chart.

MR KORTE: Do you want to do that, Brad?

MR HARRISON: So this is a chart supplied by AEMO. This is actually the energy forecast. So it's not peak demand. This has got more of a correlation to our average demand, if you like. So what this is showing is, the top line on the left, the highest line on the left, that's what actual consumption has been over the last few years. In sort of 2008-9 you can see that that peaked and has slowly declined since then, not a huge decline but certainly that's a very unusual feature, that the demand would plateau or decline like that for such a considerable period of time. So the three lines coming out of that that are dashed are the forecasts of energy consumption from AEMO looking forward under three scenarios. The solid lines of the same colour are the most recent forecasts for those same scenarios, if you like. So it's a way of comparing last year's forecasts to this year's forecasts as well as comparing the forecast to what we've seen historically.

So I guess the most important feature of that graph is the current solid line, the medium forecast in the middle. We're not really expecting that decline to continue. We're not looking to see energy rush away but it's not growing either. It's staying pretty flat over the foreseeable horizon. The other line which has quite a strong trend down, that's the consumption per capita, if you like. So what that's reflecting is that people are expected and have been, as has been demonstrated, using less energy per person. So that comes back to that point that economic growth, if you like, is not the same driver for energy consumption growth that it once was.

MR KORTE: And energy efficiency, I guess, is reflected in that chart as well.

MR KLINGENBERG: And of course the localised PV generation. So they're generating their own electricity and not consuming from the grid.

MR JACOBI: If I can move off trends in demand and shift to questions of trends in supply that ElectraNet are observing, we've already spoken of the growth of solar PV domestically and also wind connections. I'm just wondering whether you can offer any insight into where we're likely to go in terms of the next five years in terms of new generation being stored in South Australia.

MR KORTE: Do you want to pick that one up?

MR HARRISON: So probably the strongest driver of new supply right now would be the RET, the renewable energy target from the federal government. That has got the potential to drive quite a fair bit more wind in the National Electricity Market and likewise, given the wind resources in South Australia, we've got the potential to pick up a fair bit more of that as well.

The other strong driver is not so much for new entrants but that the gas price is expected to rise quite substantially over the next couple of years on the east coast with the LNG facilities in Queensland. The gas network, like the electricity network, is connected on the east coast as well. So any gas available in South Australia is also available to be exported. So that's expecting to triple demand for east coast gas in the next – well, once the three facilities are completed. So that's expected to happen in the next 18 to 24 months, that all three facilities will be operational. That's going to put pressure on the gas plant particularly in South Australia.

MR KORTE: Just to maybe add to what Brad has shared there and particularly with reference to the chart that's in front of us now, this chart simply makes the point that South Australia actually has the highest per capita wind penetration in the world. I think everybody understands that we do have a very strong renewables sector here in South Australia with a lot of wind, a lot of solar, but

sometimes maybe just the extent of that isn't understood. So we're really out there in terms of the level of penetration of renewables. So that's what that chart is showing, that if you compare us with other nations – and you can see Australia in there as well in the red across, all of the nation – we've got a very high penetration level.

Currently we have nearly 1500 megawatts of wind resources in terms of capacity connected to the network and our average demand in South Australia is about that same level. So it means that the average energy usage of everybody in South Australia, as far as supply from the grid, pretty much equates to the wind capacity that we have. Certainly on individual days across the whole year now about 30 per cent plus of South Australia's energy needs come from wind. I think it's about 6 per cent solar. So we're quite out there in terms of solar PV penetration as well. There's still capacity - - -

MR JACOBI: I think we have a slide that deals with that.

MR KORTE: Yes, that's right. The next slide actually picks that up. So this is solar and wind together, taken together. Again, South Australia, I think if you can pick that up there, is second from the left.

COMMISSIONER: What time frame is that?

MR KORTE: This was as of December 2014, so as of about six months ago.

COMMISSIONER: I can see that.

MR KORTE: I guess we expect to see the current trends continue. We have over 600 megawatts of rooftop solar installed now in South Australia and that continues to grow. I think we have a chart that follows that has a forecast – well, this one here shows a forecast of rooftop solar. So that's showing – I can look at the version I've got closer to me. If we just look out to 2025, so within the next 10 years – this is an AEMO forecast – they are forecasting anywhere between 1800, 1700 to 2200 megawatts of solar capacity. So that actually goes above the current level of not only average demand but even extending beyond that. So it means, as Brad described before, at times of the day we expect, by the time we get to 2025 or that's what the forecasts would tell us, there will be times of the day, times of the year when the call for power from the grid is a net zero, but of course when the sun is not shining and the wind is not blowing you still need that capacity there, you still need the grid at this point.

I think the slide we skipped over might be just worth a quick comment because your question was about what do we see happening in terms of future generation. This chart here is again an AEMO chart that was published just in August of this

year and it just shows you the publicly announced and committed generation projects South Australia. There's quite an abundance of potential projects there that have actually been announced. There's no guarantee they will go ahead, of course, but there's lots of opportunity there. I think again if you have a look at that you can see that the majority of those projects – there's 19 of them there or so. The majority of them are wind projects.

COMMISSIONER: Do you map those individual potential projects to see what the impact on the network might be?

MR KORTE: Do you want to answer that one, Hugo?

MR KLINGENBERG: We have a process where as those wind farms become known we include that as part of our planning process and provide the proponents with options report of what are the best locations on the network where they could connect to. That usually then impacts on what the cost of that connection might be. That then influences their business case of whether that's a viable project or not.

COMMISSIONER: You do that individually. Do you do it collectively?

MR KLINGENBERG: It's usually on an individual basis. As the proponent comes in, we look at that proposal. It's usually a process of first in, best dressed.

MR KORTE: If I could just add to that, from a planning perspective which I think is where your question was coming from, we would do that. So for example, if we were going to have a look, as I indicated earlier, further opportunities to increase interconnector capacity then we have to actually model what we expect to happen on the system over quite an extended period, maybe 20 years out in to the future. We would therefore have to make planning assumptions about where future generation is going to come from. What we normally do and Brad is our expert in this area but we would actually use publicly announced projects to actually provide input in to setting up the scenarios for modelling the future. So we do take those in to account in that way in our forward planning.

COMMISSIONER: I was just assuming, with that number of wind projects, it would have a significant impact on your current transmission network and therefore you would obviously have a view about the long-term viability of introducing that additional amount of wind in to the network and what might need to be done.

MR KORTE: Yes. Look I think I can make a comment, the guys can add to it. What I would say to that is if you look at the amount of wind there, we are looking at just under 3,000 megawatts capacity that has been publicly announced. And we

talked earlier about the capacity of the network to connect new generation, so I think there is substantial capacity in South Australia to connect new generation, including new wind. So then we have to think about the technical feasibility and the commercial feasibility and I think ElectraNet did some work a couple of years ago, that was made public, where we estimated at that time we could easily get around sort of 2,000 to 2,500 megawatts of wind generation a way in South Australia that would be both technically and commercially feasible. Now that work is in the process of being updated and there has been some changed drivers. But I think the key point here is once you start to get up to those levels of capacity it is really – you really need stronger interconnector capacity to make that commercially viable for the wind farm, so that their power can get to somewhere and you are not just driving the price in South Australia down to zero.

MR JACOBI: I think I might pick up that question of interconnectors in terms of - - -

MR KORTE: Okay.

MR JACOBI: - - - strengthening those interconnectors and I think we have got a slide that shows its output from the study. You referred before to ElectraNet having done a study in conjunction with AEMO to analyse interconnector options. I was just wondering whether you could briefly outline was those options were?

MR KORTE: Sure. Look this goes back a few years, not so many though. I think it was in 2011, 2012 AEMO and ElectraNet undertook a joint feasibility study to have a look at what options were there to increase interconnector capacity out of South Australia and one of the drivers for that; there were a number of drivers but one of the drivers was that was around the time that the green grid concept that the South Australian government had done some work on, was being spoken of, and the chart that you have in front of you shows some of the major interconnector options we looked at in that feasibility study. So starting at the top – and you will see how there is a correlation here between what you see on the chart and the major injection points, or the strong points on our network that we spoke about earlier. We have up top at Davenport, we looked at two options for links right across to Sydney where of course we have a very major load centre. So those links are about 1,000 kilometres in length of course and we looked at very high capacity new interconnectors and alternating current or direct current option of 2,000 megawatts or so transfer capacity. So cost estimates at the time gave an order of magnitude of costs there of about three billion dollars, so we are not talking about an insignificant amount of money.

Then we had a major option through the centre there, we called the central option and that connects in at Tungkillo, again one of our strong network connection points, also going through close to the Sydney load centre. Then we also looked at

just strengthening where the current Haywood interconnector is in the south-east and what would it look like if we built a new – I think that was also at 500 kV actually, at a higher voltage. So a much higher capacity but a shorter link and less expensive because it hooks in to the existing infrastructure. So that was the range of options that we looked at. At that time, none of these options were shown to be economic and what we did then do as a result of this, we did get some indications coming out – we did also look at upgrades to the existing links at that time and that looked a little bit more promising and we did further investigation on those incremental upgrades then. Ultimately that is what has led to the project that we are building now that will be commissioned in the middle of next year because as we firm that all up in the subsequent years there was a solid economic case for that.

MR JACOBI: Were there particular conditions that were thought to drive – sorry, perhaps I'll start again. Were any of the particular options, the northern, the central or the southern option thought to be more economic than the other in terms of what their likely net benefit to the market would be?

MR KORTE: I think you are testing my memory now, I have to say but I think certainly the southern option was more economic just because the cost was significantly less. I think the others were in first order of approximation roughly equivalent. I am not sure if you guys have any more to add to that? But I guess that is why we have ended up with an incremental upgrade. So the incremental upgrade, post this feasibility study, as I said, ElectraNet and AEMO had a look at let's just do a little bit more work here to see whether an incremental upgrade of the interconnector could be economic. That work showed that it was promising and then we went in to it full blown, what we call a regulatory investment test process, which is the national electricity market regulatory investment test that needs to be undertaken for any of these kinds of investments. A very public process that applies a lot of scrutiny to those investments and the economic case behind them.

In that work we also looked at – we discarded all those northern and central options but we did retain an option like the southern option which was a higher capacity new link, as well as comparing that with various options for upgrading the existing capacity. One interesting thing of note that came out of that is in fact that new higher capacity southern link was shown to have a positive market benefit. But the way that the regulatory investment test works, the AER promulgates, the Australian Energy Regulator is that when you are comparing investment options, you have to choose the option that delivers the greatest net market benefit, positive net market benefit and the much lower cost option, even though it – to upgrade, even though it delivered less market benefit, delivered a greater net positive benefit and that is why that option was chosen. But I think it is positive that larger new link was shown to have a positive net market benefit and

that is what actually gives us some reason to have a look at the drivers, I guess, that have changed since we did this work and perhaps investigate a little further in the future.

COMMISSIONER: Could I just ask, is that southern link still viable now once the Haywood connector is increased in capacity?

MR KORTE: Well, that's a good question and that is the question we would like to answer but we don't have an answer for at this point. So as we said earlier, as part of our ElectraNet planning process, we will continue to look at options like that and in fact, as recently as this week, we have been talking about some work that perhaps we need to do to just retest some of those assumptions that were input for the previous feasibility study and economic assessments and to just think about with the way things are changing, the trends in the market, whether there is actually a case there or not. So that is something we look to do over the next 12 months or so.

MR JACOBI: Are there thought to be factors that – this is a very general level, that might now exist, that didn't exist perhaps back in 2010, that might lead to a different result in terms of – in fact to a positive result?

MR KORTE: That is an excellent question and I am going to ask Brad to answer that because he has got that.

MR HARRISON: Yes. Probably the most significant one, I would have thought, would be the gas prices. Having said that, in the last six months that seems to have moved again with the global oil price changing quite a lot but 12 months ago we were looking at gas price forecasts that might have been in the order of $9, $10 a gigajoule, even higher potentially and historically we have been in the $3 to $4 range so that is really quite a substantial increase. So that thinking has changed quite a lot since the study was done. Add to that renewables in general seem to be coming down in cost would be my general take, faster than we had anticipated. Certainly PV, I would be quite certain is much cheaper now than we were anticipating back then and wind may be as well.

MR JACOBI: The one factor that I am interested to be specific to understand is that it would be expected that a carbon price would affect the viability of those interconnector options.

MR HARRISON: Yes. Sure. Absolutely. The lower carbon price would actually, I think in the short term tend to support them because what the interconnector right now would do, something like one of those northern options when it is windy we would be exporting, when it is not we would be importing and we would be importing probably coal from the east coast. So with coal remaining

cheap without a carbon price, that dual nature would probably suit itself quite nicely to an inspector.

COMMISSIONER: I am assuming, as wind power becomes cheaper, all things being equal, more profit is generated and therefore a better case for the positive side in terms of connectors such as the northern one?

MR HARRISON: Yes. I guess the caveat; we assumed quite high carbon prices as well in those studies which would have helped support them as well.

MR JACOBI: And I am right in understanding that the viability depends not only on the export from South Australia, also depends upon a view of being able to import - - -

MR HARRISON: Yes, absolutely.

MR JACOBI: - - - electricity?

MR KORTE: Yes. The import is usually at times – in fact we are importing quite a lot today we noticed as we walked out of the office but the times when we really need import is at times of high demand in South Australia and we do rely on that support from interstate, typically on those peak demand days.

MR JACOBI: Moving away from interconnectors, I am just interested and the Commission understands that there are likely to be significant developments in terms of distributed battery storage within homes. I just wonder whether ElectraNet, a) has a view about what that change – how rapid that change is likely to be?

MR KORTE: Yes. Well, look ElectraNet; I guess is keeping an eye on that as everyone else is. We don't have an iron forecast or clear view there but I think one thing we can observe is that the pick up, or the take up of - the current forecast, if you like, of take up of battery storage, distributed battery storage, is perhaps much more aggressive than the forecasts that were given a couple of years ago. So I think we are seeing signs that change is happening more quickly than we would have thought even a year or two ago. There are a lot of forecasters out there who are giving predictions. AEMO of course in its published publications, including the South Australian Electricity Accord et cetera has made forecasts. I do have a couple of points in front of me here. AEMO is forecasting that within 10 years, by 2025 that we would actually have – because battery storage will help those who already have solar PV systems on their rooves but in the short term people won't take that up because if they are on feed-in tariffs they actually need to see that time period out, just because of the arrangements that are in place there.

So I think AEMO's forecasts currently that they are publishing assume that battery storage will just be for those who are starting afresh not for existing solar installations. But taking that in to account, the numbers I have got here suggest that by 2024/25 we would see 18.5 per cent of new rooftop solar PV installations in South Australia with battery storage. So that is about one in five new solar installations would have a battery as well and about 8.8 or close to 10 per cent, one in 10 South Australian households with rooftop solar PV installed would also have battery storage at that point. So that just gives a bit of an idea over the next 10 years of one particular forecast. I mean we don't actually see those having a dramatic impact on grid supply demand. In fact AEMO suggests within that same timeframe 2024/25 they are forecasting just a very minor decrease in maximum demand of the order of one per cent in both summer and winter. We talked earlier about minimum demand and how solar PV is increasing in penetration; it is driving down the minimum demand.

So we are seeing that initially at least, that minimum demand would actually be picked up because those that have a battery storage device as well as solar, would tend to be actually charging the battery instead of squirting power back in to the grid at those particular times. So that will slow down, if you like, the reduction in the minimum demand. So those are some of the trends we are seeing and a particular forecast from AEMO. So I am not sure if that answers your question. I mean we are seeing, looking forward, that battery storage costs will continue to reduce in price and a number of commentators, including some work we have had done for ourselves, suggests that by 2020 battery costs could reduce by about 40 per cent. And I think by 2025 about 60 per cent. Those are sort of a broad forecast that is being floated around by a number of commentators and forecasters.

COMMISSIONER: Does that also apply to commercial battery storage?

MR KORTE: Yes, we are seeing – in terms of the cost reduction.

COMMISSIONER: Yes. And also the pick up of commercial battery storage?

MR KORTE: Yes. Well, I think when we talk about distributed battery storage we are very much talking residential and commercial.

COMMISSIONER: Yes. So you don't differentiate?

MR KORTE: There are – I think that broadly what we have talked about so far applies to both.

COMMISSIONER: Right.

MR KORTE: The forecasts of AEMO, that I mentioned earlier, include residential

and commercial.

COMMISSIONER: Right.

MR KORTE: I guess what we might come to talk about later is larger scale storage - - -

COMMISSIONER: Yes.

MR KORTE: - - - on the transmission grid. We certainly would see that differently. But there are individual forecasts for residential and commercial. I mean we haven't seen a large take up, as much as residential at this point, of solar PV. So that is expected to kick up sort of quite a lot and I think same with battery storage. I mean it is very early days for battery storage at this point.

MR JACOBI: I think part of your answer has just anticipated where I was about to go and that is do you see that battery storage on the transmission network as a likely step in the future of transmission?

MR KORTE: Do you want to have a turn Hugo?

MR KLINGENBERG: Yes. ElectraNet is part of a consortium with AGL and Worley Parsons doing a project which is partly funded by ARENA, looking at what is the commercial business case to install a grid scale storage on the transmission network. Looking at what is the potential benefits to help something like a wind farm up with energy trading but then also is there potential benefit in deferring any capital expenditure on the transmission network. And then thirdly, where we see the biggest prospect going forward is in what is called the ancillary services market. Rainer mentioned before that traditional generation provides them services like frequency control, voltage control as part of the package where the newer type inverter connected generation which is the wind farms and solar PV does not have that added benefit. And that is the one potential of grid storage to be able to provide those services in to the future but it is very early on in the stage to determine whether that is a viable or the least cost solution to address those increasing constraints coming our way.

MR KORTE: So just a couple of comments to what Hugo said, I think there is certainly a role there for grid-connected storage. It is early days. The study Hugo has referred to; we are just at the stage of actually writing up the conclusions of that study for ARENA, so all of that information will be public. What we've found – it has been quite an exhaustive study looking at what's the opportunity, what's the role, as Hugo has explained, for grid connected storage in South Australia in particular. With, I guess, the value streams that we could extract in our study and looking at different locations on the network, we don't find that there is an

economic case at the moment. The proposal was to make an investment or to explore the possibility of investment of a 10-megawatt battery, storage facility, on the Yorke Peninsula at Dalrymple with 20-megawatt hours of storage. Hugo mentioned some of the value streams we were looking to extract there.

So currently the costs of that outweighs the benefits. So there isn't a positive business case but we do see over the next five to 10 years, as costs come down – we actually went in the study out for request for information. So we went out worldwide to suppliers to get some information about costs and technology, performance of these facilities, so that we could feed that information into this business case. From that we also got the view, or their view collectively, that by 2020 the costs would come down by about 40, 45 per cent. So if you take that into account, the forward costs curve, and also, as Hugo mentioned, some additional value that we might be able to extract from an application like we've discussed, we do see that such applications could be commercially viable at a grid scale within five or 10 years. That's the current view that we have on that.

MR JACOBI: Are the costs principally driven by the costs of the batteries themselves in terms of that system?

MR KORTE: The costs of the battery – and again, guys, you might be able to help me – probably make up about half, 60 per cent of the total cost. What would you say, Hugo?

MR KLINGENBERG: Yes, I would say 60 per cent, two-thirds maybe.

MR KORTE: Yes. So that's a relevant factor because the battery costs themselves will keep coming down but the other costs, balance of plant costs as, I think, we often refer to them, won't have that same reduction cost necessarily going forward.

MR JACOBI: When is that study due to be released?

MR KORTE: In fact today, I think, we're reporting to ARENA. The report goes to ARENA today and we will be presenting that report to them in early October.

MR KLINGENBERG: I think it's worth pointing out that that report that's delivered today, there's a further report which will be a completely public report. There's the knowledge sharing part of the ARENA engagement where the information will be shared of what the experience was that was gained from the project.

MR JACOBI: Well, the Commission would be interested in a copy when it's publicly available.

MR KORTE: We're happy to provide that.

MR JACOBI: To change topics away from batteries and to come to deal with network stability – there has been some discussion of that today with AEMO – we're just interested to understand your perspective on the largest generator that could sit on the system as it currently sits, given what has been explained in terms of the need to be able to prevent the next worst possible event, that is the failure of that particular system.

MR KORTE: Who would like to answer that one?

MR KLINGENBERG: I can start. There's a bit of legacy involved here as well. In the past the biggest generation contingency was based on the biggest unit we had online in the state. This was one of the northern power station units, close to 300 megawatts. So most of the development, looking at system security and stability, that is one of the critical contingencies that are being evaluated quite often to say can the system survive that level of contingency. We have also done some studies in the past to say can we push that limit a bit further. We reported on that in our annual planning report in 2012 where we believe the biggest contingency of generation loss can be pushed to about 450 megawatts, but that would be amended with potentially a bit of investment to actually make that work properly and in a secure way.

MR JACOBI: Are there ways that the transmission system, I guess, could be augmented to manage that risk, if one was minded to install a larger generator in the system?

MR KLINGENBERG: There are two perspectives. One is importing power into South Australia. The 450, there may be ways we can push that beyond that. It's not quite apparent to me right at the moment. On the export side, if you're generating, say, 1000 megawatts within the state and you export that across the interconnector, should you have an event that the interconnector gets severed you could then potentially or you would then trip that generation and could potential stay secure for the state. Importing that amount of generation across the interconnector would be a lot harder to manage.

MR KORTE: So what you're saying is we could put – there is work that could be done, I think we're saying, that may require some investment and also emergency control schemes and things like that can be put in place to manage that situation. Is that right?

MR KLINGENBERG: Yes.

MR JACOBI: Is it another possible approach to divide, in essence, the generator up into parts so that you wouldn't lose any one part of that global amount at any one point in time?

MR KLINGENBERG: Yes. That would be, I would say, potentially a less costly option. So if you're thinking of a 1000-megawatt installation, if you divide it into three or four parts of 250 or 300 megawatts, that one contingency is limited to less than 300 megawatts, then you could follow the similar approach to what we do today. That wouldn't be that big an impost on the network.

MR JACOBI: I think just to finish, I'm interested to understand – we've spoken about batteries and new wind installations and an increase in solar PV. I'm just interested in what your perspective for the future role of transmission entities, that is transmission entities generally, is likely to be.

MR KORTE: Just a couple of comments on that. I mean, clearly a message that has come through the information shared here today is that we're seeing significant change in the electricity industry. We're seeing a lot more customer choice in terms of how they source and use their energy and we're seeing that manifested at the moment through the high penetration of solar panels on people's roofs. So people are choosing to source some of their own energy from those panels. So I guess that's causing, as we discussed before, a drop-off in demand growth.

There's a lot of very smart people in the industry seeking to answer the question that you've asked and lot of study is being done and maybe if I could just refer to one and then will give my own view as well. The CSIRO undertook a fairly major study that was reported on – I think it was in 2013 – called the Future Grid Forum study. That was a collaborative study that they led with industry and involved a lot of the foremost thinkers from across the industry. What they set out to do was to look out well into the future to 2050 and to try and develop some scenarios of what the future could look like so that we could then collectively think about, well, what does that mean for the electricity industry and how people receive their energy.

So there are a number of scenarios. I won't describe them but the intent was, as always is the case with scenario analysis, to look at a range of possible futures which ranged from people being much – I guess some of the extremes that were looked at were a very aggressive take-up of distributed energy resources, including people disconnecting completely from the grid. So that was one of the scenarios considered. Then there was another scenario, I guess, that supported more the centralised grid which involved a lot more large-scale renewable energy, like wind farms, driven by climate change policy. So those represent, I guess, two of the extremes considered in those scenarios.

I guess the point I make coming out of that study was that for the next 10 years or so, no matter which of those scenarios you looked at, the utilisation of the transmission networks really didn't change very much. As you went beyond 10 years there was a reduction in utilisation in the more aggressive scenarios which included people going off the grid but there was still a very substantial role. So when I'm talking about a reduction in utilisation we're talking about maybe from – transmission networks, typically how you measure utilisation, because they are built with redundancy, typically you'd expect them to be utilised around half, depending on how you measure it. We're talking a reduction of maybe 10 per cent or something of that order.

So I guess the key point I'm making there is that even under very aggressive future assumptions what that study found, at least, was there was still a very substantial role for the grid moving forward. That's how we would see it as well. So I think the nature of the grids is changing. So their role in the future will be different to what it is today but there's still a role for the grid to play.

I think even more recently there's some great information that's being put out by the Energy Networks Association that ElectraNet is a member of to try and educate people and help them to understand that even if you do have solar PV on your roof, even if you do acquire battery storage to help you get the most out of that, there is value in actually remaining connected to the grid because there are a lot of services that you get from the grid that are probably not foremost in people's minds, just simple things like back-up, supply, being able to actually supply your surplus energy into the market and have a means of getting some value from it. There are also other services like some of the ancillary services type services that we spoke about earlier. A grid scale would also apply to a residential customer.

The ENA work actually showed that to get the equivalent amount of reliability that a residential customer gets today connected to the grid would actually require them to put in a much larger PV system, much larger battery storage than they otherwise would if they remained connected to the grid and it would actually be much more expensive for them. It's not actually an economic choice or a commercial choice for them at this point.

COMMISSIONER: Can I dive back into a bit of detail, final question. One of the proponents of full renewable energy a couple of days ago talked about the upgrade of the Heywood interconnector giving us the surety that we could rely on the connector whenever renewables weren't available. I was just wanting to understand – you have a comment here about the unlikely loss of the Heywood interconnector. Can you just give me an idea of what might cause the loss of the interconnector and perhaps how remote that might be?

MR KORTE: Well, certainly it is a very remote event. Maybe just to explain a

couple of things that are relevant to your question, we actually plan – and AEMO is the market operator. We plan to cover what we call a credible contingency in a market. A credible contingency, which is defined in the National Electricity Rules, is the loss of a single element. So if you tripped inadvertently a major generator or you lost a major transmission line, the system is designed to be able to withstand that kind of event. There are some more extreme conditions that are planned for that we put emergency control schemes in place to protect against.

The loss of the Heywood interconnector, because it's on two circuits – on the map it's just drawn as one line on what we've shown you earlier but it's actually a double-circuit transmission line. So the loss of one of those is considered credible. The loss of both together at the same time is not considered a credible contingency at the moment, although the National Electricity Rules do make some provision for AEMO to be able to reclassify a non-credible contingency event as a credible one in unique circumstances. So, for example, on our interconnector with Victoria - - -

COMMISSIONER: It's a catch-22.

MR KORTE: - - - on the Heywood interconnector when we have lightening storms. So that's one scenario where you could potentially lose both circuits at the same time, to answer your question. Historically, in those circumstances when those sorts of events are seen coming AEMO can reclassify that as a credible contingency. What they then do as a result of that, they'd say. "Okay, if we're now treating that as credible, what do we do to manage the risk of that or manage the consequence of that risk occurring?" What they would do is they would reduce the transfer capability allowed on the interconnector. So currently it's a nominal 460-megawatts or close enough to 500. So they would halve that, typically, and take it down to 250, historically, to then say, "Well, okay, if we lost both we can survive that at that transfer level but we couldn't at the 500."

Now, I guess as we look to the future what we're seeing is that – we've talked about the Alinta closure. We've talked about the take-up of much more renewable energy. Sometimes on the South Australian system we have only a few conventional generators operating at any point in time. As I also explained earlier, they have traditionally contributed to ancillary services like frequency control. So if we were importing to the maximum capability of the interconnector and then the interconnector was severed, all of a sudden you'd have a supply-demand imbalance and frequency would reduce. If that's not arrested then it can lead to widespread disruption in the power system.

So there are controls in place to manage that but some of the traditional controls, which has been the existence of having more conventional generators online, with the inertia that they carry it means we have to look at perhaps different ways of managing that. So that's the challenge for the future and that's getting quite a bit of

airplay at the moment. AEMO and ElectraNet are looking very carefully at some options that we can use there to manage that. Does that answer your question?

COMMISSIONER: It does. I look forward to the additional work. Gentlemen, thank you very much and thank you for your time and your evidence today. We'll now adjourn until 1300.

ADJOURNED [12.17 pm]

RESUMED [1.32 pm]

COMMISSIONER: Good afternoon. We'll reconvene, 1.30, with Mr Craig Oakeshott. Craig, welcome. Thank you for joining us.

MR OAKESHOTT: Thank you.

COMMISSIONER: Mr Jacobi.

MR JACOBI: Craig Oakeshott is a mechanical engineer with 30 years' work experience in the electricity industry. He's currently the director of wholesale markets for the Australian Electricity Regulator. He's worked in power stations, in business development, and in preparing the South Australian Generation Corporation at the start of the National Electricity Market. Over the last 20 years he's been involved in South Australian and national electricity planning, renewable energy development policy, and electricity regulation at the Electricity Supply Industry Planning Council, the Australian Electricity Market Operator, and the AER, and we call Craig Oakeshott.

MR OAKESHOTT: Thank you.

COMMISSIONER: Right. Perhaps you could start with the key functions of electricity regulation here in Australia.

MR OAKESHOTT: Certainly. Probably the overarching parameters that cover the electricity regulation and National Electricity Market are the principles that underpin it in the first place, and that is that we were looking for a structure which promoted competition, provided technology neutrality, and structural separation. So to look at the way the market exists currently, the existing electricity supply network was broken into down parts. So there was generation, which was designed only to supply electricity into the transmission and then down to the distribution network.

The transmission and distribution network has monopolies within to be regulated, whereas competition would act on the generators, and at the final end before the