MELBOURNE ENERGY INSTITUTE

GRATTAN Institute

The Future of the Electricity Network in Australia

Chair:
Michelle Groves

Speakers:
Craig Oakeshott
Prof Hugh Outhred
Dr Tony Morton
Chris Dunstan

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Transcript

Effective and efficient transmission of electric power from generators to consumers is a vital part of the electricity system. Australia's national transmission network is the longest AC system in the world, extending 5000km from Queensland to Tasmania to Port Augusta, supplying 19 million residents.

As demand continues to grow and the penetration of renewables on the grid increases, the national transmission network will require significant extensions and upgrades. But what is the optimal design to support a very different energy system in the 21st century? Variable and distributed generation and potential large storage systems (such as an electric vehicle fleet) make this a diabolical question that the panel of experts addressed in detail.

Chair: **Ms Michelle Groves**
CEO, Australian Energy Regulator

Speakers: **Mr Craig Oakeshott**
Senior Manager in Strategy and Economics, AEMO

Prof Hugh Outhred
Professorial Visiting Fellow, University of New South Wales

Dr Tony Morton
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Mr Chris Dunstan
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AUDIO: This is a podcast from Grattan Institute, www.grattan.edu.au.

TRISTAN: My name's Tristan Edis, I'm a Research Fellow with the Grattan Institute. I'd like to all welcome you along to this seminar tonight on the future of Australia's electricity network. We really appreciate the level of interest that's here in this topic. I'm surprised actually because it can be a rather dry and arcane topic at times and hopefully the speakers will be able to gloss over some of the technical detail and still keep it relatively interesting but also informative. So this is a joint seminar of the University of Melbourne, Melbourne Energy Institute and the Grattan Institute. We hold a number of these seminars throughout the year, and the next one's The Future of Transport, is that right? So that's coming up in the near future, so please keep an eye out. This issue is not necessarily one just related to the idea of fancy computer electronics and smart meters and turning fridges on and off and solar panels. There's a huge range of other issues that are … they're actually here and now problems that we're trying to deal with. So, for example, over the next five years we have already locked in over 40 billion dollars worth of investment into electricity networks, and that's causing a considerable amount of controversy and political challenges that are out there associated with that topic alone and in fact it well outweighs the … well it's very close to the national broadband network where we've had far more focus and attention. So, there are some real near-term issues that we need to manage with this and we tried to bring together a collection of speakers that can give you really good first hand insights on this topic from quite a practical perspective and also a near-term as well as a far-term, well into the future perspective. And to start things along, I'll hand it over to Michelle Groves who is the Chief Executive of the Australian Energy Regulator. Thank you Michelle.

MICHELLE: Good evening everyone and welcome to tonight's seminar on The Future of Electricity Networks in Australia. I think we're very lucky tonight to have the range of speakers that we have here with us with very, very significant levels of experience that they have in both

the national electricity market, its development, as well as many of the current issues confronting it. As Tristan already spoke about, clearly the effective and efficient transmission of electric power from generators to consumers is both a very important and a very topical issue. At the moment we often talk about Australia's transmission network of having some fairly unique characteristics. It's the longest AC transmission network in the world, coming from Queensland all the way around to Port Lincoln in South Australia, and also connecting the AC system down in Tasmania through a DC link.

Now, I'm not an engineer so I'm not going to explain to you all of those implications, but the understanding is that we have a long stringy transmission network that gives rise to a whole range of challenges for us when confronting the future of our generation needs. Our network has been built around our existing generation fleet, so what we need to think about are what are the issues going forward.

Just a little more context, I suppose, what we're talking about is having a transmission system for electricity that supplies around nine million residential and business customers, and in 2010 provided a peak demand of … delivery for a peak demand of approximately 34 gigawatts which was an increase of basically eight gigawatts in about 10 years. And so it's that growing peak that is actually giving us a whole range of issues that the networks need to deal with. As well as the very long, 5,000Ks of transmission network we have, we also however have 750,000 kilometres of distribution networks. And these networks have a regulated asset base currently of something around $45b. These are their current ones and as Tristan point out, we are basically committed to spending over 30 … almost $35b more in distribution alone over the next five years. So these are very big issues.

To talk to us about them, we have four very, I think, experienced speakers. Our first speaker tonight will be Mr Craig Oakshot. Now Craig works at the Australian Energy Market Operator who is the, as the name suggests, the market operator for the national electricity market. He's held this position since AEMO was created in July 2009, but he has a very long experience of both system planning as well as system operations. He is a mechanical engineer who has worked within network businesses in the past, as well as being involved in government and providing them with significant policy advice.

Professor Hugh Outhred is also on our panel tonight. I was most interested to read that Hugh apparently retired in 2007 and then the rest of his bio goes on to list all the things that he's currently doing since his retirement which includes some very significant positions at the University of New South Wales, Murdoch University and at Jogjakarta in Indonesia. So Hugh has a very experienced perspective from a very … I think over 35 years of experience in electricity systems.

We have Tony Morton also joining us tonight. Tony is with a specialist consulting firm that provides engineering advice to the global energy sector and he specifically focuses on the integration of renewable energy into power grids and the sustainable utilisation of electricity. He is also an engineer by training, but provides very significant advice and assistance to a whole range of businesses and government clients.

Our fourth speaker, well, the fourth person on the panel, not necessarily the fourth speaker, is Chris Dunstan. Now Chris is a Research Director at the University of Technology, Sydney's Institute for Sustainable Futures. He also has a very long career in … and experience in energy policy, strategic management and sustainability. Chris provides advice to governments on a whole variety of issues around regulatory and market barriers to the development of sustainable energy. Clearly his experience will also bring very significant insight to tonight's panel.

Each of the speakers will be speaking for about 10 minutes, then there'll be an opportunity for you to ask questions at the end. So, without further ado, I'd ask Craig to come up and speak to us tonight.

CRAIG: Thank you Michelle, and thank you all for coming. Nice to see so many faces looking down at me. Maybe that's not right, the way of expressing it, but never mind. If I can get my

presentation to work. Future Transmission. I guess being the National Electricity Market Operator, formed two years ago, one of the main reasons that we were formed was actually to integrate a national planning focus onto the way the market operator was to work. Perhaps an interesting combination to put a market operator with a planner, but I guess the way AEMO has approached it is to make sure that we aren't going to assume that transmission is always the right answer. As Michelle kindly point out, it's the longest grid across the world, it's a … it's characterised by some rather curious arrangements. They tell me if you parachuted into America you'd land somewhere within five kilometres of a transmission line. I'm sure that if you parachuted into South Australia or into New South … back end of New South Wales or Queensland, you'd have an awfully long walk to find the transmission line.

We have concentrated loads and distributed energy sources and at the moment they're distributed in particular locations that may not be where they go into the future. So is transmission more the answer into the future or is it only part of a very complex answer? And I think what AEMO would be saying is it's part of a very complex answer. As Michelle again said, the demand is growing very quickly. When I was a boy the old rattling fridge in our kitchen was certainly probably consuming the same amount of power as the one that I've got in my kitchen right now except that that one was only tiny and this one seats four. So things have changed, but our consumption patterns have only increased rather than going down. We have changes in generation technology and control that we never had dreamed of 20 years ago or 50 or even 80 years ago when some of the transmission lines and systems were built.

And the international and domestic playing field has certainly changed a lot. I work better in pictures, so I thought I'd put a few pictures up to keep you amused. What is our … what are the distributor challenges? There's some magnificent speakers that will follow me to actually highlight some of the issues that'll come out of it. But looking at the conventional grid that we've already got, we've got a lot of power stations, they're not going to shut down tomorrow, even if they have incentives to do so because of federal policy, there's still going to be a lot of fossil fuel out there for a long period of time. We've got an increasing penetration of renewables. South Australia now has 20% of its energy coming from wind farms alone. You can see home automation affecting things. Now that's at the grid level, what about at our home levels? How many of you here have got solar panels on your rooves. How would some of those things change if you had a smart car that actually had a storage facility? Like an electric vehicle these days is a bit like the snail with its shell on the back, only what you're doing with an electric vehicle is carrying your energy requirements for the next day around on your back. Well what about if the cost of those batteries changed from $20,000 or $30,000 for a vehicle battery down to $3,000? Wouldn't you want to pick one up and put it in your shed? That'd match nicely with your solar panel. Might match nicely with some of the other things. At that rate you could have three or four days without actually needing energy at all from the grid. What does that do to the way we build infrastructure?

If I look at an even bigger level across the strategic type of development, how are we going to build new infrastructure? How do we make sure that we put in the right size infrastructure so that we don't preclude another solution from coming along. There are incentives for a TNSP, for example, to try and delay the investment as long as he possibly can in new infrastructure, and then put in something that will take him out for an extensive period of time. I'm using a male, I don't know why. But in terms of looking at the development choice that you may be doing by picking up a significantly larger asset or building a significantly larger asset than was needed to meet the necessary change in demand, you might then be precluding some other technology from coming along later on.

I guess the way AEMO is approaching it, it might be a little bit different to the way the traditional TNSPs have looked at some of their growth in demand. We're trying to make sure that we examine the full playing field. It's not a question of saying particular circumstances won't occur, it's making sure that we can tell … we can work out what the signposts are into our future, we create a planning scenario that actually tells us where all of the signposts align, where we should end up if all things go the way we're predicting it. But if you're doing that sort of level of prediction, you then have to counter that by saying well, we might be wrong. So this signpost that says we're going in that direction might actually lead us in a completely different one, or we

may never hit it. So knowing where your signposts are means that you can test your scenario that you've got for planning. It also means that you can test the robustness of your potential developments against changes in all of those factors. CCS doesn't work. Well, all of a sudden you start … you've taken out potentially a large portion of what the future generation fleet might be. If geothermal was to be stopped because it might interfere with aquifers, then that again would be one of the planks that would be removed from our potential future. Conversely we might get a change in the availability of some other new technology. We might get bathroom scale nuclear or something like that, that means that all of a sudden things that you're not demanding the energy from the grid that you were, you're now bringing it in from your home, you're converting beer cans and banana skins into energy for your house, just to go back to the future.

So, there are certainly a lot of factors to consider and AEMO is trying its best to make sure that we not only engage with the industry and the stakeholders that are important in this future, and that includes industry participants, current and potentially future ones, technologists that bring all sorts of different things into our market, energy efficiency, electric vehicles, home automation are some that I put on one of the pictorial slides earlier. But there is a bunch of other minor things that could be changing. How many of us would have thought five years ago that you were going to have fluorescent … as many fluorescent globes in your house as you currently have? Is that … it'll be likely to go to LED lights after that. Is there something else that'll follow us and deliver a new future that we hadn't predicted?

Certainly in terms of energy transport, one of the issues that we are facing, and I've particularly and deliberately used the word energy transport, why are we … well, we are considering the cost of building a transmission line with respect to the cost of building a pipeline. Is it cheaper to deliver the energy to a new location and build your generator closer to or beyond the network constraints so you don't have to build transmission? Is the extension of that, that we supply more gas to people's homes and we generate at home, or we supply another fuel to people's homes so they can generate at home? Is there a storage option? One of the issues that could have come out of the geothermal revolution if it occurs in the … up towards Innamincka in the Moomba area is that you could actually instead of generating electricity, you can generate methane. Use a hydrogenation or electrolysis process, and a methanation process, and heck, you've got pipelines right out in front of your door that you can stick that fuel into and it can go to Melbourne, it can go to Sydney, it can go to Adelaide on the existing infrastructure. So it might be a significant saving. How does it work? We need to find those things out.

High efficiency fossil fuels, well we've all heard of those. But what technologies are going to be available at particular locations? Geothermal in the Moomba Basin is a good example. If CCS doesn't work, and I'm not choosing that because it's a likelihood or I have any particular opinion on it, but if CCS didn't work, then the La Trobe Valley would not naturally be a generation centre anymore. You might need to generate at another location. So how is it going to be? How much can you build in a particular location?

And then the high levels of wind penetration. Well we've got plenty of experience with high levels of wind in South Australia. We're one of the world leaders in that sphere. People often quote Denmark as being the highest penetration, but they also have significant interconnector capacity to their neighbours. So if you talk to a Dane about how they manage their wind system, the first thing he'll probably say is we don't manage it, the rest of Europe manages it 'cause they cope with the variations.

Significant roof top solar PV. I think when they created the policy on subsidising PV into people's homes, they didn't anticipate that we were going to get quite as much as we have. Certainly South Australia's target was 60 megawatts. It looks like we will have more like 160 megawatts. If that is translated across the other states, we could have 1500 to 2000 megawatts worth of wind instead of … sorry, of solar, instead of a target of 800 to 1000. How do we integrate that? How does it change the picture? Solar thermal, with and without storage. Are we going to have significant quantities of mirrors around the place. And again it comes down to distributed versus central. Do you switch fuels? Do you do all sorts of other things? And I've left

the last issue as probably the largest and gnarliest (sic) one which is a carbon tax. What does it … does it end up by being implemented the way it's discussed? Is it some other way?

So, AEMO's focus is to understand exactly where we're likely to go. Try and predict some of those future outcomes, but also take into account that we may be wrong and test our outcomes against those potentially alternate futures. Understanding what the investment drivers are for the different technologies. My group strategy in economics group has got a relatively small but very highly talented staff who are out there trying to understand how quickly some of these technologies will mature, how … what their long term prices will be. We've tried publishing a lot of that work and we're trying to engage with the industry to make sure that we get this stuff across. How am I doing for time?

Understanding what the international competitive position is, and understanding that if we're going to export, if we've got six to 10 trains of LNG, we're going to be exporting more LNG in natural gas form than we're actually going to burn in Australia. So that's a fairly significant figure to carry in the back of your mind. Intelligent optimisation to maximise the benefits. Well to maximise the benefits you need to know where all the benefits are. And again, you need to be thinking ahead about how you might balance that investment decision with other things. We're trying to be involved in policy evolution but we're also trying to monitor, what you can't be involved with to change, it's best to keep an eye on.

And I've got the last point there is understanding the balance between the desired long term position and the short term incremental journey to get there. Who knows what that means. What I was trying to say is, if we look at 2050 where we've got federal and state governments saying that we want to be either carbon neutral or zero emissions electricity network, or electricity market, then what do you actually need if you're in that position as opposed to if you start right now and incrementally develop the network and then evolve something by 2050, do they look the same? If you had your druthers and started from a blank slate or you actually took into account some of these things and made some bold decisions to include or preclude things, you might end up with quite a different answer. That's another one of the things that we're trying to take into account.

Possibly what that sounds like is I don't know what I'm talking about and AEMO can't give you a black and white answer as to what the future is, and if I've got that message across, it's right, we don't know what the future is. What we're trying to do is make sure that we cover the possibilities so that when other technologies come along, we're ready for it and we're making sure that the investments that are made are actually sensible into the longer term. That's me.

MICHELLE: Thank you very much. I'm now going to call on Tony, Dr Tony Morton to come and speak to us. And as I've said, Tony is a principle power systems engineer with Senergy Econnect Australia. And the turn is yours.

TONY: Thank you. So, I guess I'll just make a brief presentation here. I hope it won't be too technical, but I'll try to keep it non-technical. I'm very happy to get technical in the questions, of course. When we talk about the future of electricity networks, what I like to do is … that's just an overview of the presentation. But what I like to do is reach back into the past and just start with a few people from over 100 years ago who really began the kinds of networks that we're talking about now and I've got a photo there of Alexander Graham Bell, of course, considered by some to be the grandfather of telecommunications. Invented the telephone. And there I've got two other people, Thomas Edison and Nicola Tesla who really who really jointly, some of the most important pioneers in electricity networks. Thomas Edison not only invented the … was one of the inventors of the light bulb but also gave us a lot of what you see when you open up an LV switchboard. Nowadays you still see his fuses, circuit breakers, LV wiring. A lot of that in fact was originally devised by Edison. And then Nicola Tesla, he invented the three phase synchronous machine which still generates most of our electricity today, and gave us the idea of three phase electricity transmission. So really fundamental ideas in electricity networks. The interesting thing is that if you look at electricity networks today, and you look at telecommunication networks today, I think you would say that perhaps up until the 1980s, the

telecommunication network or telephone network would have looked more or less the way Alexander Graham Bell might have recognised.

But in those intervening 20 to 30 years, our telecommunications networks have grown beyond recognition. They've been completely transformed. So we now have high speed digital data instead of analogue phone lines, and we have a multitude of services being provided over the same infrastructure. And I guess this came about through technology development and consumer demand for better services. But if you look at the electricity network today, really it's still in a form that is equivalent to what the telecommunication network was in the '80s. It was still in a form that the pioneers of the networks would still have recognised. We're still generating power in large central stations, we're transmitting it over three phase AC transmission lines and it's all flowing mostly in one direction still, towards consumer loads, which are still based on your slightly improved version of the traditional fuse box and the infrastructure is still fairly recognisable to someone from some time in the past. But this possibly isn't going to be true for much longer. What we see is that our electricity networks aren't just providing the one undifferentiated server. It's not just about providing raw kilowatt hours anymore. We are looking at, well first of all we had deregulated markets where you don't have just one supplier of electricity, you don't get it all from the state electricity commission anymore, you get it from a multitude of suppliers and they operate in a free market. There's retail contestability, so there's a lot of innovation happening in the business of providing electricity to consumers. And on the consumption side, we have users wanting to be empowered to manage their usage and make it more efficient. And it goes beyond just flicking switches. It's now different kinds of services we want from our electricity network in order to use our electricity better and to use it in different ways. And there's a few examples of this that have been gone into by us at Senergy and also by our colleagues at the University of Melbourne, obviously better generators, household PV panels is a very good example of user empowerment. We're generating our own electricity, we're not just taking it from the meter. Air conditioner set point variation, there's some interesting work that's been done by the university there which I don't have time to talk about, but feel free to ask me.

Generator connection in weak grids. This is very non-traditional kind of location, as Craig was talking about. This raises particular challenges. And of course plug-in electric vehicles will raise challenges in the future. But this is all about new innovations in electricity that's not just about supply from A to B, it's also about going from B to A, going from B to a lot of other Bs.

So the … really when we develop large systems, we were talking about telecommunication systems or power systems. There are really two aspects to their development. There's the development in the way we apply the service that's been provided. So for example, we now use the telecommunication network to browse the internet on our computers, and not just to make phone calls. And then on the other side, on the supply side, we have the roll out of new generation network infrastructure and protocols. So we now have voice over IP, we have DSL over phone lines. So the infrastructure and the user level applications have come together in telecommunications to actually revolutionise the way the whole system has evolved. Those aspects, the application aspects and the infrastructure aspects developed together and they reinforced each other. And that's given us a complete transformation in the way we do telecommunications. And I think we're seeing the beginning of that in the electricity industry.

Previously in the electricity industry, we've had the application area on the consumption side develop in a completely separate silo to the network side. Now, I'm exaggerating slightly, but really, there have been two disciplines within electric power engineering. We've had power systems engineering and electricity industrial applications engineering. And they focused on quite different issues. One's focused on the development of applications, and it's taken the network pretty much as something that we're given. There's an AC power point or there's a three phase connection at a certain voltage and we just take what we're given and we do something with it. And we don't worry too much about what's happening on the network side. Whereas network engineers on the other hand have been looking at managing these three phase AC networks, and when things have changed in the application side, they say well there's a problem here, we're getting a problem with power quality due to what these customers are plugging into their networks and how do we get around that and how do we manage things

better to do that. And I think there's been a requirement for the two to start doing what's happened in the case of telecommunications and actually have solutions that can reinforce each other. So, I tend to think of this as networking application convergence and this comes about through a field called power electronics where we actually look at applying sophisticated electronic technology to power systems. And this initially started in the applications area. But from the applications area it's gradually moved into the electricity networks area. So now what we're seeing is there are now innovative network technologies that are based on the same kind of power electronic innovations that we're seeing on the consumer side. So we have HVDC transmission, we have what's called FACTS devices, flexible AC transmission systems. And there are innovative ways of managing electricity networks that have emerged in the last … just the last 10 or 20 years that are actually using technology that's come from the power consumption side and is now converging on the network side. And I think as we see … as we see this continue, and we see the evolution of these smart grid technologies, we're going to see application thinking penetrate into the network area and also network thinking is going to penetrate into the application area. This is happening a little bit more slowly, but perhaps we're starting to see some ideas around active load management and some other areas that are just starting to grow. But this has a long way to go obviously. And of course the term smart grid is one that's often used here.

This term has obviously a lot of very broad and very narrow interpretation. Some people interpret smart grid to be a very narrow sense and to just mean smart meters or time of use pricing, something like that. But we like to define smart grids as being an idea that's based on this whole convergence between network technology and application technology and power systems, and using that, getting some converging technology there to promote market efficiencies and to empower network users, such as we're seeing with embedded generation with … or see it with electric cars and it's really a broader context for all sorts of developments along those lines. Craig's talked about some of those.

So just touching briefly on some of the work we've done. We did a report to the WA Office of Energy about five years ago, looking at the penetration of intermittent generation in the South-West system. And we looked at the technical, economic and environmental challenges that are raised there. And what we saw there was there are both system wide issues and there are local network issues. And I think a lot of those Craig has talked about. The system wide issues, output variability, intermittency, this … these are issues that people AEMO deal with every day. Capability of the system to survive major disturbances. And then you've got local network issues which are concerned with specific pieces of equipment in specific locations. So this is ratings, preventing overloads, getting around operational limitations, constraints in the network, power quality and ensuring the protection of the system is coordinated, so the system operates always in a failsafe mode. So there's more work we've done there which has informed that.

This is a study we did again for the … in WA for the Independent Market Operator. This is looking at storage in the context of solar. Solar intermittency is obviously a very big issue because the sun doesn't shine at night. That's something you can forecast with 100% accuracy. So it's not about accuracy of forecasting, it's really about knowing that you're going to have an intermittent power supply. And then you can … you can start asking the question, well exactly how much storage do you really need in order to get a 24 hour supply from solar plants? And we've done some work there which I can go into more detail if someone wants to ask. But what we find is if we have thermal storage, so we're looking in the context of thermal storage technology, if we have about 10 hours at full load, we can actually get a good approximation to base load under realistic conditions in Australia. And then there's the whole issue of using available technologies better. We have a lot of … we now have a lot of embedded PV systems out there and they all have power electronic inverters providing supply to the grid. And this is a very sophisticated technology which we can actually use better to manage the actual distribution feeders. And obviously I haven't got time to go into that. But there's a lot of commercial barriers to that. People need incentives to actually provide the support that's needed, and that's going to be needed increasingly as we see more penetration of these new generation sources inside the feeders, because the feeders aren't designed for it.

Building network capacity. That's … I think Craig covered a lot of those points. We see a lot of cases where people are connecting embedded generation in very weak systems that aren't designed to take that generation capacity, and this is an issue for the network companies and also for the people who want to connect generation. There has to be a meeting point with these, and I think Craig's touched on that. I'll skip over DC micro grids. If anyone wants to ask me about that, that's a topic I can go into great length about. But really, just to conclude. What we are really seeing, we're seeing an evolution in our power systems similar to what we've seen in telecommunication networks, just in terms of the broad ideas where we have user applications and network technology that's converging to deliver a better system. We're moving away from the traditional simple station approach. We've got more decentralised generation and we've got this convergence of network and application objectives. How rapid this evolution is, is really going to depend on us engineers. It's going to depend on the ability to harmonise the network oriented thinking that we've always had in power systems, with the application oriented thinking that we've had in the industrial applications area. And people in those areas really need to work together much more than they have in the past. And of course, when we're talking about renewable grids with high penetrations of renewable generation in non-traditional locations, and in the places where we're not used to seeing power generated like in distribution networks, there are a lot of challenges where, both for engineers and for policy makers, where everyone needs to work together for effective solutions. So I'll finish there and hand over to the next person.

MICHELLE: Thank you very much, Tony. I'd now like to call on Professor Hugh Outhred to come and speak to us around how we integrate variable supply to the network, which I think will follow on very nicely from a range of the issues that both Craig and Tony have raised with us.

HUGH: Thanks Michelle. So the title here is The Role of the Network in the Evolving Stationary Energy Sector. And the reason I've called it the stationary energy sector there is I want to discuss the interaction between electricity and gas, as we go through. So just an outline, what do we mean by the stationary energy sector? What are its key characteristics? What's the network role in that and how do we organise the decision making about the whole industry in a coordinated way to get the kind of outcomes that we're all hoping that we can achieve.

So first of all the historical evolution of the sector. It obviously started off with people with some desire for what I've called here end use energy services. But notice it's not electricity or gas that they're interested in, is some service delivered by those, and I'll just call them energy commodities for the moment, for shorthand. The distinction's important because, to the extent that we can deliver the service with less of the commodity, then we change the balance between the supply and the demand side of the industry. Of course to actually deliver the service, we need what we call end use equipment, the equipment that goes in the buildings to deliver the services, and the design of that equipment is critical of course not only to delivery of the service, but to the amount of energy that's needed to provide the service. At the other end of the chain, the starting point, we have primary energy resources, a whole range of different resources. One of the important factors that we have in the electricity industry is that we can create electricity from virtually any primary energy form with the qualification that electrical energy is thermodynamically high quality energy and so it's not always easy to manufacture it.

In the beginning we had a very simple electricity and gas industries that were just … all of the equipment was located in the end user premises. Over time, we started to build the networks. And the networks became larger and larger. And finally we've got to the stage where the electricity networks are continental in scale and very complex networks to boot. And with gas, it's actually got to a global scale now by the time we take into account liquefied natural gas as a way of transmitting gas around the world. And that global interaction is starting to become important, for example, in terms of pricing and the availability of resources in different parts of the world. And there's increasing interaction between these industries, as Craig pointed out, and that interaction has to be thought about as well as the individual industries themselves.

Coming back to the energy conversion chain, the primary energy resources, conversion into secondary energy flows, either electricity or gas, flowing in networks, the network in either case is providing connectivity. That's a useful way to think about it rather than transport. Transport

really doesn't capture some of the characteristics we have to worry about in electricity, in particular the fact that electricity travels with the speed of light. And finally, at the end user premises, the conversion into end use energy flows which are a secondary issue at that point. It's the services that people want, so that energy flow we often treat as waste. But the end use energy flow is in itself an important resource, and I think Chris will probably pick up on that point later. The equipment providers are very important because they limit what we can do here, particularly in a country like Australia where nearly all of our equipment is imported, we're very much reliant on global development of technology. And the other problem we have with this industry, as with most others, is that there are unintended consequences. And our politicians in Canberra of course are debating the problem of climate change, it seems endlessly, and the energy industry is a major contributor of course to climate change emissions, particularly in a country like Australia.

So how do we think about all of that? We can think about technology in three important ways. One is the hardware, and that's the obvious part of technology that most people think of when you mention the word technology. But another important dimension is software, and that's the knowledge as to how to, at the detail level, design the technology and at a user level, enough software to know how to use it. But finally, and as we develop more and more complex technological systems, orgware becomes more and more important. And the orgware is the institutional context in which the technology operates. Now, tonight in the session that we have tonight, both Michelle and Craig come from the orgware side of the stationary energy sector, dealing with both electricity and gas matters. These are becoming more and more important, that's … they can look important at this point, because they are really the people that hold everything together, and of course if something goes wrong, you now know who to blame. And of course it's not me, I'm retired, we've heard that.

Another important point about technology is that it doesn't stand still. And unfortunately as you get older, this becomes more and more of a problem. I'm trying to keep up as the technology keeps racing ahead. And we can think about innovation in two useful ways. One is incremental innovation. And that's like my hair disappearing over time. And the other is disruptive innovation, and that's where we're making a sudden, dramatic change in technology. And Tony was just talking about disruptive innovation and introducing a whole lot of new ideas that perhaps will become important in our industries over the next few years. But how we manage disruptive innovation is a very important question, particularly in complex systems.

So coming back to make this a little more concrete with our electricity industry, traditionally we've had the large scale generation up here. These days we're hearing more and more discussion about so-called embedded generation, or even generation at the point of end use. This might be the PV panels on the roof of your house, or a micro generator in the garage. And these new types of generation are representing aspects of disruptive innovation in this industry, as is the growing link with the telecommunications industry, which was another point that Tony raised. So the networks are sitting in the middle of all of this and so they really are an essential part of these industries now, but as we change the way in which we structure the industry, the network role can change dramatically. And understanding how that change might occur and then managing the change process is really at the heart of the problems that we're now facing, or at least the opportunities to make it more positive that we're now considering.

So then the emergence of these distributed resources on the electricity industry introduces new, what I'll call temporal and spatial risks, but also new risk management capabilities. And again Tony mentioned some of those new risk management capabilities. So we have a combination of new risks and new ways of managing those risks. This slide is just looking at the temporal risks, and in electricity industry, we have to worry about very short timeframe, microseconds, through to very long timeframe, 10 years and beyond, and everything in between. Traditional sources of risk, and I'm sorry the typeface here hasn't come out quite the way I'd like it, it's not quite as tidy as I'd hoped. But traditional sources of risk came from the network, from the generation technologies, and the behaviour of the demand side of the industry. And we have developed over many years traditional risk management tools for managing those risks. What we're now seeing is emerging additional sources of risk and emerging additional risk management tools.

But creating the new overall system that combines all of these new techniques is still a work in progress.

If we turn to the spatial dimension, both Michelle and Craig mentioned that the Australian so-called national electricity market is one of the largest networks in the world. It has a scope that ranges from in fact metre by metre within buildings, through to four to even five thousand kilometres in scale, depending on how you measure it across the grid as a whole. And we have to worry about all of those spatial dimensions as well. And once again, there are traditional spatial sources of risk and traditional risk management tools for those spatial risks, new emerging sources of risk and new management tools. But again, the challenge of working out how we bring all of this together is a very significant one.

So how then can we manage all of this decision making? Ideally we would start from the end user because the end users are the ones that know about the value of the energy services that they're wanting to enjoy, and have their … are able in theory to consider all of the different ways in which they might meet those energy service needs. And some of those ways are within their own building or in a local area, and others go right into the heart of these very large systems that we've built. So we can distinguish here between what I call local infrastructure and remote infrastructure, but they're all interconnected. And the final problem is, the end users typically don't even know they're part of the electricity industry. I guess most of you out there think you're humans, right? Sorry, you're not. You're all parts of the electricity industry.

So, what we have to do is fit all of you, all the users more fully into the existing decision management schema that we've worked out for the industry as it now stands. And the focus of the existing schema is all on the supply side of the industry. So now you can start thinking about what role you want to play. Do you want to be a governance decision maker, a regulator like Michelle, a system market operator like Craig, a regulated industry participant, and I don't think we've actually got any here at the front today, maybe in the audience, a network service provider, or a competitive industry participant. Well, I've got news for you. Most of you, whether you realise it or not, you're in the competitive part of the electricity industry, at least when you go home at night. So start competing, guys. There's an Olympic games coming up.

So we can think more about how this … these regimes work and the different type of decision making they're engaged in. And one of them that we're all engaged in is the governance regime. We might like watching Julia and Tony on television, but we're also actually involved in a social context in politics, whether we like it or not, and that is over time influencing the decision that all of us takes. But we have much more specialised, much more specific skills that are deployed by the various decision makers that know that they're in the industry.

Let me just take, finally, a couple of innovation examples, and then try and wrap all of this up. Disruptive innovation, an example that we've been working through in Australia for the last decade, is wind integration into the national electricity market. And Craig over there, modest fellow that he is, didn't tell you that he played a very significant part in managing that integration process. And I can tell you that the work that he and his colleagues have done, and there's quite a very wide range of people, not only in AEMO but across the industry as a whole, have created a world best integration process for wind energy in any electricity industry anywhere. And the group at the University of New South Wales that I'm involved in, have played a small part in that process. So out of that, there are some very clear successes, arguably world best practice, in terms of how the integration has been managed, and I'll pick up a specific example later of wind forecasting. It's too early at this stage to know how well this is going to work in the long run, but in the near term, it's working very well indeed.

So in conclusion then, the Australian energy sector, stationary energy sector continues to involve, whether … evolve, I'm sorry, whether we would like it or not, and we're all part of it, we're all on a journey here. The network role in it is and will remain crucial, but it may change significantly as people have already pointed out. The present decision making framework that we've got has served us well to date, but it will have to continue to evolve. And there are emerging challenges and some of these have been already mentioned. But one that's overhanging the whole thing at the moment is what I've just called their contested social

priorities. Unless we can settle down as a society and decide whether we do or don't want to do something about climate change, we're going to leave a very uncertain future for this industry, and in the end, that will come back to haunt us. We really need to come to a landing, all of that, and get on with whatever it is we decide to do.

I just have two, three slides here that I'm just going to flick through to get to the end so that it's ready for our next speaker, Chris. This is the wind energy forecasting system implemented by AEMO. This is a tool that we developed at the University of New South Wales, in particular Dr Nick Cutler developed this as part of his recent PhD project and a post doc. If you want to play with this, you can find it at this website. There's an online demonstration so you too can be a wind forecaster in your own homes. This just summarises some of the work that we've been engaged in at the University of New South Wales as part of this managed innovation process, as have many other educational institutions. There's a little bit of stuff about me, we'll move on from there though. And that's the end of my contribution. Thank you.

MICHELLE: Thank you very much, Hugh. I'd now like to call on Chris Dunstan to come and speak to us around some of the potentials for energy efficiency and demand management and the opportunities that can provide consumers.

CHRIS: Thank you very much, Michelle, and thanks to the Grattan Institute and the Melbourne Energy Institute for inviting me along to what I think is a very timely event. Given that we're gathered here in the Sydney Myer Asia Centre at the University of Melbourne, I thought that I should make some small acknowledgement of our wider geographic location. And so I've included a small piece of Chinese there. Now you might think that given I don't speak a word of Chinese, this is perhaps a little unwise. But I thought perhaps someone in the audience might be able to help me out here. Do we have any Mandarin speakers who can tell me what these characters here represent? Is anyone? Mandarin speakers? Yes, up the back there, in a loud voice, can you … what does that say?

AUDIENCE: Danger.

CHRIS: Danger? Yes. That's the first character, I understand. Can you tell me what the second character is?

AUDIENCE: Opportunity.

CHRIS: Opportunity. Interesting. Any other Mandarin speakers here who would like to disagree about that second character? Could get in trouble here. And what happens when we put those two characters together? What does it create, something else, by putting them together?

AUDIENCE: Risk.

CHRIS: Risk, yeah. Well, what I'm told, and this, as I said, may prove to be imprudent, is that these two characters together represent the term crisis. And this idea that crisis combines the two Chinese characters of danger and opportunity was an idea that was popularised first by John F Kennedy in a speech in 1959 and it's sort of rolled on from there. However, there are people who, and again, correct me if I'm wrong, who suggest that opportunity isn't the right word for that second character, that it's actually more about a moment of change rather than opportunity. And it's in that theme of crisis and moment of change combined with danger that I'd like to focus on where we are with the electricity network industry right now. In terms of the overview, I want to talk about some of those challenges and then focus on the role of energy efficiency and demand management, what's actually the status of energy efficiency demand management in Australia, what are the barriers, and what would happen, how could we change the way we're addressing these issues if we really took energy efficiency and demand management seriously in the context of the electricity sector and the network sector in particular?

Okay, so crisis. Which crisis? Well, there are a number of challenges for the grid. One that we're very familiar with and which remains a very significant one is rising peak demand. But

there's a whole range of other emerging issues that we've started to talk about tonight. The issue of peak oil. There's a crisis if ever we saw one. And what does that mean for the electricity industry, particularly as we start to move from petrol vehicles to electric vehicles. Peak gas. Well, when we run out of oil, gas is expected to be the next cab off the rank. But in the shorter term, we might see some impacts of this of changes in gas prices as we move towards that global gas market that Hugh alluded to. What happens if we pay the same for our gas in this country as what international customers are prepared to pay for liquefied natural gas?

Peak coal. Well, we're not going to run out of coal any time soon. But the amount of coal that we use needs to peak and it needs to come down relatively soon because of the issue of climate change. This might seem like pie in the sky when we look at how we're going in trying to get a carbon price up in this country, but it's interesting to note that between 2009 and 2010 the total amount of electricity generated from coal fired electricity fell across the national electricity market. It fell in Victoria, in Queensland and in New South Wales. And at the same time gas fired and renewable energy increased quite significantly over that same period. This transition has begun. And the driver ultimately behind that is the issue of climate change.

What about the next step? What about peak energy? Is it possible that we could not just be tapering off and reducing our consumption of coal in the electricity industry, but also levelling off and starting to reduce a total amount of energy use. Again that might seem far-fetched but that's exactly what happened between 2009 and 2010. And for the last four years in New South Wales, average electricity consumption in households fell by about two per cent per annum. And that's where energy efficiency starts to come in. Rising prices is a real challenge for a lot of consumers, and it's perhaps one of the key reasons why I think now these issues of energy efficiency and demand management may get the attention that we haven't given to them for the last couple of decades. And that's where the demand management picture comes in.

So, what if the climate scientists who our political culture seems to part … having difficulty in responding to in terms of an effective carbon policy, what if they're actually right? What if when they say it is critically important that we bring about a reduction in emissions effectively by 2020? And to ensure stabilisation of CO_2 in the atmosphere, global emissions must peak by 2015. What if that actually got taken seriously? What would that mean for our electricity sector and our networks, particularly if you're a country like Australia that has the highest per capita emissions of all significant countries in the world.

Well, the International Energy Agency has looked at this question and they have told us that if we want to achieve that outcome of limiting to a two degree increase in temperature globally, then we need to reduce the amount of emissions quite rapidly. Peak soon and turn it down. How do we do that? Well, they suggested there's a role for CCS, carbon capture and storage, nuclear, biofuels, renewable energy. But the key area, the biggest area is that one at the top there, energy efficiency in generation, but also in end use. In fact over half of the abatement or reduction in our emissions, they expect should come from energy efficiency. And yet if you look at our electricity sector in Australia, there's very little evidence that we are taking energy efficiency anywhere near this seriously. So just to clarify the picture of when I'm talking about demand management, I'm talking about the broad areas of energy efficiency, peak load management, that is addressing those times of peak demand and distributed generation. And there's a range of technologies that fit into each of those categories. And I'm probably going to need to speed up or Michelle's going to throw me off the stage.

The opportunities in terms of energy efficiency are highlighted here. In those sort of, I don't know what colour you'd call that, sort of this aqua area here, this energy efficiency in building, the grey area, energy efficiency in industry. What's interesting about this is not that they are very significant amount of the potential emission reduction that we can achieve, but they're below zero, they're negative cost. They save money. And that's why these issues or these particular technologies around energy efficiency should get a lot more of our attention.

So what about prices? In a sense it's a pain in the hip pocket, if we look at what's been happening to electricity prices lately, but it may actually lead us to focus on the real solutions around energy efficiency. That shows the trends in electricity prices over the last 20 years or so.

And you'll see they tended to be pretty flat or even downward, until the last five years or so when suddenly things have turned around pretty dramatically, particularly with the orange line there Australia wide, you can see what's happening. That's up to the year 2009. And this is just looking at New South Wales. There's about a 50% increase to 2010. In the most recent determination by the regulator in New South Wales, that represents a 76% increase in electricity prices over a five year period. That's enough to get your attention.

So what's going on? Why is electricity prices going up so much? Is it the carbon tax, which doesn't exist yet. Or is it something else? Well, let's have a look in the electricity market. What this graph shows you here is the average price in the wholesale market, effectively competition amongst the power stations to generate. And as you can see, between essentially 1999 and 2010, prices have been pretty flat, with a possible exception of South Australia. But this shows what's happening in the Australian … amongst retail prices. So while the generation prices have been pretty flat, retail price is going up quite dramatically and thanks Michelle for these graphs, Very helpful. From the State of the Market report. Excellent report, you should have a look at it. Do you think I've bought an extra minute that way? Okay. Components of … so what's behind this increase? If it's not generation, where's it coming from? And the answer of course is networks. This is a figure from the Independent Pricing and Regulatory Tribunal in New South Wales again, showing the increase in prices and the causes between 2009 and looking forward this time to 2013. And the single biggest component in that increase is network price increases. The next biggest component is the carbon price which again, we don't have yet.

Behind that, largely investment in infrastructure. Capital expenditure by the networks are over 45 billion across Australia over the current five-year period. So you're seeing it's an enormous amount and it's a dramatic kick up compared to the previous five year, which itself was a significant step up from the five years prior to that. So something's going on. Why are we seeing so much investment in the networks? There's a few reasons. Don't have time to go into all of them. Partly it's about replacement, partly it's about changing reliability standards, but a very significant part of the driver for this increase in network investment is rising peak demand. What can we do about it? And that's where energy efficiency and peak load management comes in. If we can invest in energy efficiency and demand management, not as a lifestyle choice but as a resource, there's enormous potential for us to reduce that growth in peak demand and reduce some of the pressure on this investment in the networks and the consequent price increases. So how are we going? This is actually not from Australia, this is from the United States where they have reported and tracked investment by the electricity utilities, at least back as far as 1989 and even before that. So over 20, 30 years this is an issue that's been significantly … significant enough for the US government to track it. How's it going? Well, reduction in peak demand equivalent to 4.4.%. Most of that's actually coming from energy efficiency. Now these are just measures undertaken by the utilities themselves, the networks and the retailers.

So what about in Australia? Well to date, we haven't had this information. This is not information that we have collected But fortunately we're starting to fix that and through our work at the Institute for Sustainable Future, we were commissioned by the Australian Alliance To Save Energy, to undertake the first national survey of demand management by electricity networks. And what did we learn? This is the amount of expenditure across the states of Australia, and in 2010/11 the expected expenditure on demand management was $50m. Fifty million dollars, that's not bad. It's equivalent to about half a per cent of the annual expenditure on infrastructure. So, mm, that doesn't sound quite so much in that context. What's it delivering though? It's not what you spend, it's what you get. So this provides a picture in terms of the overall energy delivered, the energy savings. We've got it by technology, around distributed generation, energy efficiency and load management. Michelle, are you flicking that forward so to trying to … oh no, sorry.

MICHELLE: I have a lot of power, but not that much.

CHRIS: Someone's trying to give me … by sector … by sector residential, commercial, industrial. And then by jurisdiction, the states and territories. And so if we look at what's emerged from that, it's equivalent to about .02% of the energy consumed across those states. So in that context, doesn't sound like an awful lot. Bearing in mind though that we're talking

about network investment here, and networks are focused on peak demand rather than how many kilowatt hours are consumed. So let's look at peak demand. The results are shown here. Again, looking a bit better up around about seven per cent, sorry, 0.7% of peak demand, nationwide, but that's dominated by one state in particular, Queensland, and if someone wants to ask me why, I'm happy to take a question on that later.

The projects are spread across the country. They tend to be cost effective for those which we have data. The savings far outweigh the expenditure. But the question is, why so little? So we also undertook a survey to investigate what are the barriers to demand management. We asked a range of stakeholders across the country, 800 in a range of stakeholder groups. We got 200 responses from utilities, government end users, a service … demand management service providers and others. We asked them 25 possible barriers in the areas of information, cultural barriers, payback gap, pricing problems, regulatory problems, overall lack of coordination. And this is the responses that we got. We then grouped those 25 into the seven categories, those 25 barriers. And the overall highest level of agreement was in relation to a lack of coordination, confusion at a state and federal level. And you can see how the other groups line up after that. Specifically, the number … that was the number one barrier. Secondly, this is a bit of a surprise to me, the lack of a demand management or environmental objective in the national electricity law, and … which I thought was a bit boffiny but nonetheless there was a strong level of agreement about that. And then way down the list, a carbon price. The absence of a carbon price is a barrier, it's just there's about 17 other barriers that people seem to think are more important.

So what do we do about it? If we want to address these problems, these barriers, how can we do it? Well if we look at the barriers or the potential responses in terms of the stick. Okay, someone give me the wind up here. This is … I'll try and just keep up with the slides. Then we can … there's a lot of things you can do. And if I was going to focus on three, they'd probably be those three. I know that's harsh. Targets, coordination and funding. So to wrap up then, how would we put together an effective strategy to develop demand management energy efficiency. Targets, reporting and funding. Three key elements. There are some precedents for that. And … oh, I give up.

So let's … let's say that things progress and time may not always be on my side. And with that, I surrender.

MICHELLE: Thank you very much, Chris. Very challenging circumstances there with the gremlin in your system. I'm now going to move on to questions. There are a couple of roving microphones. I just ask people to identify themselves and where they're from, if that's appropriate when they go, and I'll turn to this gentleman here in the front. If you want to go ahead?

AUDIENCE: Yeah. Oh sorry, I don't have a microphone.

MICHELLE: Oh well. Allegedly there are a couple of roving microphones. Thank you.

AUDIENCE: My name … is it on?

MICHELLE: Yeah.

AUDIENCE: Yes.

AUDIENCE: Hello? My name is Siegfried Angerer, from the Australian Wind Energy Institute. I also work with Xanthe International Smart Grid Interoperability Standards. We're on the executive of NIST and on the executive of City and Guilds which means we define the international training standards for renewable energy. We're also on OASIS dot org. My question is this: given the various challenges that we're … the Australian electricity network is facing, and given the fact that we're working with local councils and communities who basically want to own their own energy, when will we get policy that allows unrestricted third party access to the grid?

PANEL: It's yours.

MICHELLE: Absolutely. I'm the Regulator.

PANEL: You're the Regulator.

MICHELLE: Does anyone want to have a shot at the question about policy and third party access to the grid? I don't seem to have any takers on this one. No. Tony's looking … thinking about it.

TONY: I'd just say that perhaps the national market objectives we have in our national electricity market, national electricity law, might be pertinent there, given that there is nothing about the kind of mix of generation that we have and whether it's renewable or not, whether it's low carbon or not, and so on. Really the objective is always, and for understandable reasons, been written around the reduction of prices to consumers, and that may not in fact be compatible with complete open access to the grid unless we recognise some other objectives.

HUGH: Michelle, it …

MICHELLE: Hugh?

HUGH: Perhaps if I can just add a couple of words that give a little historical perspective. The electricity industry restructuring process in Australia essentially has commenced at the primary energy end of the electricity industry with large generation and transmission. And that's partly because under our federal system, the states could agree, as it were, to hand over to a central process things that they thought were somewhat remote from the end user. There's always been difficulty in migrating that restructuring process through towards the end user and local network issues which was the kind of question that you were raising. And in Australia that's because those things are perceived as being individual state matters and of course each state government has its own view about how it should be done. Whereas what we really need is some form of uniform Australian approach. So I think in Australia the politics have really prevented that process going very far. If you look in other situations, like in the United States where the states are geographically much smaller and there are many more of them, then within the individual state, they were more inclined to focus on the end use matters, and similar sort of situation arises in Western Europe on the whole. So it's partly our social situation I think that has been really frustrating the sort of developments that Chris has been talking about, the sort of developments that Tony was suggesting, and also the issues that you raise.

AUDIENCE: My name's Beth Barlow, I'm from Better Place Australia. Now, my question is really in relation to demand management. So with electric vehicles coming, there's clearly an opportunity to really significant value in transmission and distribution infrastructure through time shifting, discretionary loads at the household level, like electric vehicle charging. And we know that for this to work, we need to be able to measure it through a separate metering operation so that companies like Better Place can actually optimally coordinate the charging of electric vehicles so as not to exacerbate peak load issues. Unfortunately at the moment at the household level, the market for metering is not open to competition in all states. And what we found in our early roll out of EV charging infrastructure is that meter installation is very expensive and very slow to implement. So this question is really for Michelle in this context. What is AER's view with respect to improving service levels and competition in household metering?

MICHELLE: I guess … thank you for the question. And as the chair I'm always very pleased to take them. The … clearly the role of the regulator in this space is to implement the regulatory policy that's set in place by the framework. To date, the framework around metering has been set either at a jurisdictional level through state policies, and the … with overall examination too at the federal level about what we should do with metering going forward. I think it's probably really a space for the policy makers around where those issues might go. Certainly, through the examination processes that we do around network determinations, at times we have had cause

to examine whether or not metering services could be provided more contestably in some of the markets, or what components of them can be, and that has varied on a jurisdictional, well even almost by business by business basis, depending on the level of contestability that currently exists within those markets. But that has really been in a fairly limited way I think in the context of the overall policy frameworks and regulatory frameworks that we face at the moment. So I don't think that is really going to answer your question, but unfortunately at this stage it really is a bit outside the remit of the AER to be looking at those broader issues and we really are within the frameworks that currently exist. I think there was a question up around here first. Gentleman had his hand up for quite some time. So.

AUDIENCE: Hi. Look, my name's Nick Farr [?] from a company called [Cray Gibbon Anderson ?.75:39]. Look, I'm interested in the panel's views on the end user because I think at the moment the end user is in absolute revolt about what's happening here and this is a major, major challenge I think for the power industry. How do … what is the panel's view on how we take the community with us on what are obviously essential reforms, 'cause at the moment, this is a big change, people have been very used to sort of a, you know, a fairly staid, mundane industry that is now going through quite significant change. So how do we bring them along? How do we bring the community along with us on this?

MICHELLE: Okay. Do you want to start with that one, Chris?

CHRIS: Sure, Michelle. Thanks. I think one of the most important things we need to do is we need to get much better alignment between the interests and the incentives of the industry, and in particular the networks and the consumers. Let me give you an example. The way in which the AER, Michelle, you may want to respond to this, the way in which the regulations are set, the economic regulation, the price regulation is set can have a big impact on how the networks engage with the customer. For example, in the states of South Australia, Victoria and New South Wales, the networks earn more money if people consume more electricity. More kilowatt hours flow through the network, they earn more money, they tend to be more profitable. In other states such as Queensland, that doesn't exist. They operate under what they call a revenue cap, so if people consume more electricity, then the price needs to be reduced. And that is I think part of the reason why we're seeing more of an engagement with issues of demand management in Queensland. But trying to get alignment between what's in the interest of the consumer and the interest of the networks I think is a crucial step. Also having much better information out there and reporting back on some of the issues that matter to consumers is another key element.

MICHELLE: Hugh, did you want to comment on that?

HUGH: Yes, I wish I could give a good answer, but unfortunately it's … I think where we are at this stage is more at the process of defining the problem rather than having the solution. If you remember my slides about the decision making framework, first of all just in Michelle's defence perhaps, I talked about a governance level and the regulator level, the task of the regulator like the AER is to implement policy rather than make policy. So what we're dealing with here really is policy failure or, in the language I was using, orgware failure. So perhaps what we need is some policy Viagra, but we would have to give it to all of the energy Ministers in all of the jurisdictions simultaneously, when they're all together in one room, and then we might see some action.

MICHELLE: Maybe we'll just put that image at least out of our minds. And I'll just … to Tony, and is there anything that you wanted to add to that, Tony?

TONY: Well I can't but agree with the first two and certainly the … I like the idea of the policy Viagra, but even on a serious note, I think the alignment of objectives between the various market participants is a very important thing. I'd really emphasise what's already been said, that the electricity user and the gas user are clearly energy market participants. They're not necessarily well informed energy market participants at the moment, we need to improve the processes and the governance that actually provides that information to people. But also, the consumer of electricity or gas who is increasingly sometimes a producer as well, wants to have

more power over what's actually happening, and not just be the passive recipient of a bill that keeps increasing for reasons they don't understand. And obviously the market needs to … and the processes we have need to understand that.

MICHELLE: Craig, did you have anything …

CRAIG: I was hoping you weren't going to do that. The … I mean it's always a scale question, to a large degree. You quite rightly said that indirectly, individual customers are part of the national electricity market. But the scope of the code and the way the market operates is not designed to be mums and dads participating in what's actually happening at that level. We don't collect infor … we do collect information from them but obliquely. We don't do it indirectly. So part of it is definitely information, part of it is making sure that people understand that what they do on an individual basis affects the whole. But to give them a voice, you actually need to give them a vehicle over which to do that and there are aggregators that can do part of that. There … but do you actually want to get, and I think every … in every Minister with Viagra in his system or not, is always going to protect those people who can't represent themselves. And despite what sounds like a fairly simple market, it's actually not simple at all, and do you actually want to be constantly and intimately involved? I wish I hadn't put intimately and Viagra in the same sentence, but … and Ministers. But you don't want to be involved potentially at that level. But I completely agree with your position, it is … it's going to be a balance that we haven't tried to address completely and that's a personal observation, not an AEMO one.

MICHELLE: Oh, And then we'll come back to you next. Okay.

AUDIENCE: Oh just … oh, Peter Fitzroy. A short question for the panel. Do you see any opportunities for DC transmission?

PANEL: Of course. Yes.

MICHELLE: AEMO sees all possibilities.

CRAIG: If you were to … I mean if … I always liken these red wine thoughts that I have with my feet up in front of the fire, but you don't need to think too hard about if you're going to integrate or even more strongly connect Far North Queensland with the other end of the network, you're not going to do it with simple AC networks. You've got to start thinking innovatively about the best way of doing it, whether it's a long stringy DC, whether it's ultra-high voltage with a back to back DC at the other end, there is going to be opportunity to do that. AEMO's focus is always which is the right spot from what end, what drives you to do that when it can be, depending on the scale, an expensive option.

MICHELLE: Okay. Hugh, did you want to add anything to that?

HUGH: I think Craig said it all.

MICHELLE: Okay. There was one question here and then we'll go up into the back.

AUDIENCE: Thank you. Simon Holmes à Court from Hepburn Wind. I've got a question for Craig.

CRAIG: Oh bother.

AUDIENCE: Craig, there's … as you know, there's a persistent meme in the community and even amongst some elected officials that renewables need to be backed up at all times and this negates any emissions reduction benefit it might have. You've written an excellent paper debunking this myth and very grateful for that, the Peter Lang paper.

CRAIG: Yeah.

AUDIENCE: I'm wondering when you think this myth will die and what AEMO's role is in educating the public. Thank you.

CRAIG: Can I have a question on sport?

MICHELLE: Or phone a friend?

CRAIG: Yeah, I think I might phone a friend. Was a very good question. Certainly the … one of the most commonly misunderstood factors about the Australian energy market, it is fully privatised. People make the investment decision, it's not centrally planned. We're not dictating that if you build a megawatt of wind, and we want a safe and secure network, we have to build a megawatt of something else. Disconnect. We say that the reliability standard and the system security standards are set. We will monitor what is happening and we will put a signal out to the market that says if you build more of these things, we might need something else. But we can't dictate and we will not dictate what is going on. That is not AEMO's role. How do you educate the public in that? All I can do is keep saying that statement. The problem is that there are other markets across the rest of the world, and particularly in Europe and England and Ireland and particularly other places where wind is a significant contributor, where that isn't the situation. So frequently there are commentary that comes in from other places that said well every time you build one of these you've got to build one of those. Not in our case. We don't regulate, we don't … we do regulate, but we don't control exactly what is going to go on and yes, it is a disappointment to … that is a myth that is very hard to break and dissociate in the longer term. Does that …

AUDIENCE: Whose role is it to debunk it?

CRAIG: This is going to sound like a copout, but I don't believe it's the market operator's or the planner's role. It's … the investors in the industry understand how that's working, and I mean you're an investor, so you would understand that that's it. My guess is, and I'm sorry to throw it back at you, but it's partly your role. When you're selling your wind farm projects, you should be perhaps drawing on some of that other comparison. This is not Europe, this is not America, this is the way our electricity market works. Nobody is going to dictate the next piece of plant that gets built. It gets built on a market opportunity. And there are signals there which say it's an opportunity for somebody else to invest in something if that works. Equally it could be a battery that fills the void or a spinning fly wheel, as they've done in New York and a few other places. So it's completely wrong for AEMO to back or to promote any particular technology. That's not our role.

AUDIENCE: I would have thought that it's a commercial decision, if you want to build storage …

CRAIG: Exactly.

AUDIENCE: … take advantage of the spot price and quite clearly that [unclear 86:20] hardly discount [unclear].

CRAIG: Yeah, absolutely.

MICHELLE: Up the back?

AUDIENCE: Thanks. Cameron Taylor from the City of Whittlesea. We're a growth council on Melbourne's northern urban fringe and we've been going through a process for the last six months of trying to connect up urban planning and energy planning. And there's a remarkable lack of situational awareness. So we've been approaching that, looking at a framework plan and how that relates to transmission planning and a pricing structure plan and how that might relate to distribution system network planning. We've got a precinct structure plan coming online quite soon, the Wooller Precinct Structure Plan. It's about 15,000 houses and a couple of town centres. And it's been going quite well, talking to the participants, our local DNSP, AEMO, UDIA, others. But I'm just thinking ahead. Is there a simple way that the energy sector can start

talking to the urban development sector through things like practice notes? So in the urban planning sector you have things like practice notes. They tell the developer, the applicant, how to go about doing things to satisfy the responsible authority to council. So whether there's a role for some simple communication techniques, through a practice note, through a regulator, explaining how to take part in the national electricity market as a potential customer, if you're building 5,000 homes on the urban growth fringe, how does that developer go about thinking about what that means for them and the network? It's an open question.

CRAIG: Don't look at me, Michelle.

MICHELLE: I'm going to throw it back to … I'm going to throw it back to Craig, mostly because he's got to run off in a couple of minutes so this'll give him an opportunity.

CRAIG: Yeah, to go out on a bang. Look, I agree with you, I think there is certainly some informational asymmetries that should be addressed by better information or provision from places like AEMO, from the DNSPs and from the T&NSPs. I'm very pleased to hear that you are putting in that effort to communicate with those bodies that actually coordinate some of that. So partly AEMO's, I'm not going to say defence, but partly … one of the complexities that we have to deal with all along, and if you've read any of our long term planning documents, ESU or NTP or others, we use a criteria to try and assess what the seriousness of a generation proponent is as he approaches us and work out whether he's going to connect, what time he's going to do it, has he got board approvals, has he got all sorts of other things that will give him the … give us the confidence that this is not … this is a serious project that's likely to go ahead. We currently don't have an equivalent mechanism for doing that with demand aspects, nor do we have it for demand management. We actually look … we put up a survey that says who out there has got demand management initiatives. We don't actually put any rigour back on the other side of that to say, and you say you've got 100 megawatts of this thing, how the hell does it work, how do we get confidence that it's there if we need it. So we are looking at trying to do that and we would be very open to communication from bodies that would like to participate in us developing that. I'm not sure that it's going to make it into the electricity SOU that's about to be published. In fact I'm fairly sure it won't. But we have looked at it in the past to try and publish that sort of criteria which might actually aid you then to bring your case to T&NSP and SP to make it seem more appropriate and be taken perhaps in a brighter light.

AUDIENCE: With the urban planning process you get the DNS [unclear 90:01] customers three years before they ever hear from them to connect. It's not [unclear 90:08] to go much further back into when the customers [unclear] their application in the urban development process, before it's a connection, when they're building the application.

CRAIG: Oh, that sounds good.

MICHELLE: Hugh?

HUGH: Yes, I really just want to point to the … in my conclusion slide, the last point there, a growing need to formalise end user participation. And this is a very general issue that keeps coming up in these questions. The problem that we have is that our present policy making doesn't recognise this problem. It thinks of the industry as being the supply side of the industry, not the demand side. Now how we can change that, to be honest, I'm not sure, but we have to re-educate our politicians and I guess our public servants to understand that the demand side of any industry is as equally important as its supply side. And in a situation like we're now facing, a context that we're now moving into where a lot of the innovation that has to take place or that is likely to take place is on the demand side and significant disruptive innovation. We desperately need a good policy framework and governance process in which that can take place. What we're seeing here at the moment is people like Craig and Michelle who are one level below the governance, they're implementers of policy who are being caught into the policy development process. And where is the COAG representative here, I ask.

MICHELLE: I won't point them out. Yes, over here. Thanks Gemma.

AUDIENCE: My name's Jim Lambert and I've been working with Beyond Zero Emissions. And I've been struck tonight by the … I'm interested in the 100% renewable scenarios. I've been struck tonight with how many of the issues have been addressed in the zero carbon Australia plan. I was hoping to ask Craig about whether … I understand that AEMO's been asked to prepare 100% renewables proposal, and I was wondering how that's going. And I was particularly struck by the people have been talking about the … Australia's ability to handle the variability of wind and the non-variability of solar thermal storage is an appropriate sort of companion with the wind. And I was hoping to have some discussion with Craig about how those scenarios mapped out for the future.

MICHELLE: I'm sorry about that because he did have to race to catch his plane to get back to Sydney tonight before the airport closes. I don't know, Tony, was there anything you want to comment on, those other broader issues?

TONY: Perhaps just bringing up the telecommunications analogy again. I guess 100% renewables is like having a telecommunications network based on 100% optical fibre. I think we can see a way to it in the future, but it's obviously a very disruptive change from what we had in the past. And it means that we don't have a telephone network the way people have thought about having telephone networks. And so it's … certainly it's a disruptive change, as people say, and it raises a lot of engineering challenges, a lot of policy challenges and of course commercial challenges. I guess I can hear Craig in the back of my head in a way saying that ultimately what you want is perhaps, yeah, 100% renewables makes … it's a worthy goal, but he'd probably also say that the aim would be 100% zero emission network and that would be done by market signals based on emissions ultimately, that would drive whatever appropriate changes out there to make that happen, whether that is going to 100% renewables or whether there's something else out there, heaven forbid CCS if it ever happens, but … but from a purely technical point of view, it's a challenge that engineers can ultimately solve.

MICHELLE: Hugh?

AUDIENCE: [Unclear 94:51]?

MICHELLE: No, I'm just sorry, I just pass over here to the panel.

HUGH: Just very briefly. The experience with integrating wind is a very good starting point for dealing with other renewables because they tend not to be any more difficult than wind. The … one of the issues though with wind is that it's a relatively conventional technology in a hardware sense and wind farms are relatively large. So in our national electricity rule context, even though it's a … what I'd call disruptive innovation, it's fairly close to incremental innovation. Some of the other technologies are more disruptive and small scale solar, because we don't have that orgware out there that extends sufficiently far down into the distribution system. Even though technically we could do it, we're pretty well handicapped by the lack of the good governance and policy framework in the end user part of the industry. So that's the main blocker there. It could be overcome, but it needs policy makers to get on and do it. And at the moment there's a vacuum in the policy making in that area, I think.

MICHELLE: Chris, did you want to add anything?

CHRIS: Yeah, just briefly. To move to 100% renewable would be very expensive. We're also discovering that business as usual is turning out to be very expensive as well. Even if moving to 100% renewables were to lead to say a doubling in unit costs of electricity, well that's kind of the path we're on at the moment anyway, but even if it did, if we combine that with energy efficiency and achieve a 50% reduction in our consumption compared to what it would otherwise be. We end up with no overall increase in costs. And then once we add in load management and demand management as a mechanism of managing variable generation from renewables, we've got quite a robust and cost effective package.

MICHELLE: Thank you. I think we have time for one more question. Did you have a question? Yes, gentleman right here in the front, Gemma, I don't know where the other second mic is. Just here. Thank you.

AUDIENCE: Thank you. Thank you, Marcus Wigan. I've done a bit of work on energy strategies for UNDP and I work with Melbourne University on transport related issues. My concern is that with most engineering-driven areas, and I am an engineer, supply side dominates. Regulations follow, standards follow. The consumers and the demand side are obviously the things you deal with last. And of course they'll do … they'll respond when you hit them on the head with the right amount of pricing. Have I got it right? No, I thought I'd got one culture right, but the other culture is the one that matters. Not only do we have to make sure that people understand that negawatts with an N is a lot cheaper than megawatts with an M. But we have to get the main community to do it, that in fact households are a very large chunk of this and much harder to deal with than the small generators. We're currently throwing away almost all of the goodwill we had from the community by the appallingly poor rollout of smart meters, which are not smart, a lack of information flow in a bi-directional form, no policy for doing so, and at the same time, turning off communities in a very big way. This is an extremely expensive strategy. I'm sure the supply side can give me a reason for why this is being done. I wait patiently, but not with great enthusiasm for the answer.

MICHELLE: Chris, did you want to say anything, and I'm sure Hugh might want to make his comments about policy makers again.

CHRIS: Look, I tend to agree with what Hugh was saying earlier. The … if you looked at that graph earlier about, for example, the generation sector and how we've managed to keep very low prices in the generation sector, we have tasked an industry with doing that, and they've done a very good job of it. We've tasked our network businesses with the job of building and maintaining a reliable electricity supply network and they've done a good job of that. We haven't tasked them or anyone else with the task of creating a low cost energy sector that makes the most of our energy efficiency and demand management opportunities. And that's actually not a failure of the engineers who are doing what they've been asked to do, and I'm not saying they will be the best people to do it necessarily, but it's a failing of our political system and that's partly our politicians, but at the end of the day it also comes back to the broader community about what we're demanding. So it is a collective responsibility if we're going to solve this. I think we can solve it. It's nice … you know, the solution is actually a pretty attractive one, but it requires engagement by policy makers, by market institutions, but by the broader community as well.

MICHELLE: Okay, well thank you very much. I think that's all we have time for in questions. I'll now ask … call on Susannah to close up the evening.

SUSANNAH: Thank you. On behalf of the Grattan Institute and Melbourne Energy Institute, I'd like to thank our excellent speakers, Michelle, Craig, Tony, Hugh and Chris. Chris, I think I can speak for everyone, we were very sorry that the computer rushed you at the end there. The efficiency opportunity crisis is certainly a fascinating one. Thank you to the audience for your excellent questions and thank you to Gemma Stefano, Angela Henderson and Andrew McDonald for your wonderful work pulling tonight's event together. As Tristan mentioned, the next seminar will look at the future of transport in Australia. It's on the 25th October, and following that we've got the future of solar power in November, the 16th of November. Hope to see you all then. Thank you.

AUDIO: This has been a podcast from Grattan Institute. Want to hear more? Check out our website, www.grattan.edu.au.

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