Introduction

Karyn: Welcome to the second in our Positive Energy Future series presented by the Brisbane Institute. My name is Karyn Brinkley. I'm the CEO of the Brisbane Institute. It's my great pleasure to welcome you tonight. As I said, this is the second in our Positive Energy series. Last month we had our first event in the series which was called "What's the Fracking Fuss all About."

Tonight we'll look at the question of renewable energy resources and what contribution they might make to Australia's future. As a country concerned to reduce its own carbon emissions and increase its energy security, but also as a major exporter of energy resources, technology, and expertise.

Australia's vast, accessible, and affordable reserves of coal have meant that this country hasn't had to look very far or very hard for its energy resources. Royalties from coal mining have funded Queensland's infrastructure needs and contributed to a very healthy balance of payments for us for generations, reducing the political incentive to seek more sustainable alternatives, but our reliance on burning coal comes at a very heavy environmental price. Globally and socially, it seems, that we are less and less inclined to pay that price.

Last month we also looked at the impact of peak oil and its ripple effect on our economy and lifestyles. From purely selfish perspective, as Australia's demand for energy continues to escalate, we need to be looking for viable alternatives. At our first forum we explored emerging industries proving alternatives to petroleum, including LNG, CSG, and shale oil, which are becoming increasingly important to Queensland, and which carry with them not a little controversy because of their as yet uncertain impact on the environment.

During that forum we heard a CSG advocate declare that renewable energy could never, never replace fossil fuels. We also talked about the position of the Australian greens who are pushing for 100% renewable energy in Australia. Somewhere between the two extremes we might find the truth.

Various models have been put forward, including the often quoted "Beyond Zero Emissions" report which proposes that Australia could be entirely self sufficient through renewable energy within a decade, but at an investment of thirty-seven billion dollars a year, every year, for ten years.

Our historic reliance on coal has meant that compared to many countries, Australis is well behind the eight ball in investing in renewable energy. But ironically, along with coal, we're also one of the best-endowed countries on the planet for alternatives including solar, geothermal, and nuclear. Seriously, when will renewable energy become a viable alternative in this country? And what will it take to get us there?

We have a brilliant panel tonight to help us answer some of these questions. Let me introduce you to, briefly, Professor Paul Meredith. Paul was a professor of physics at the University of Queensland and leads several major solar

infrastructure projects. You can find his bio and those of the other panellists on tonight's program.

Paul today, and in fact the rest of this week, might not be the best example. We've not had the best weather this week, but Queensland particularly and Australia generally has to be one of the best places in the world to take advantage of energy from the sun.

Growing up in Brisbane in the seventies, solar hot-water systems were quite the thing but they never fulfilled their early promise. Why don't we have solar panels on every roof in the sunshine state?

Panel

Professor Paul Meredith,
Director of Queensland Geothermal Energy Centre

Paul: I think you probably answered your own question there in the first remarks. Whenever you consider why a technology has or hasn't been taken up, first of all you've got to look at the base technology. Then you've got to look at the cost and economics of the situation. Then you've got to look at the politics and the sociological drivers that are making it happen or not happen.

Let's be really clear about where the technology is. I see a Beyond Zero t-shirt in the audience. Many people feel that the two types of solar technology, that's concentrating solar thermal technology which has got utility scale potential, and direct generation of electricity from the photovoltaic process, PV. Many people feel we're there. PV has been around for about forty years in its current form anyway.

Panels from Kyocera, one of the first Japanese manufacturers have been in the field for thirty years and showing greater than 80% performance. You know, you have to say that generation one technology is performing pretty damn well.

However, looking at the PV side of things, there are obviously a couple of challenges from a technological perspective. I think we've nailed the "it can last twenty-five years" one. I don't think anybody's worried about that, with the exception if you buy some cheap Chinese panel, which I suggest you don't. We've nailed the lifetime issue but the efficiencies are still what I would call moderate. A good silicon panel of the type you'd put on your roof, even the best ones from someone like SunPower who claim the highest efficiencies, on the module is about 17% or 18%. That means that of the energy that falls, the sun energy that falls on it, about 18% of it is converted directly to electricity.

For me, that's not good enough. We know what the so-called thermodynamic limit is, called the Shockley-Queisser limit, after the Nobel Prize winner. We know that we should be able to get round about 30% out of these things but we haven't quite got the technology yet to be able to do that. That is not a prohibitive factor.

If you double the efficiency clearly at the same cost point you have the same cost price and you have the cost of the electricity. I'm not a sceptic on that one. Panels at 15%, 16%, 17% efficiency is perfectly fine for me. I've got them on my roof. I'll put that one aside.

But I think the major challenge with PV is what one does with the electricity or how one generates the electricity from these systems when the sun isn't shining. Of course, one of the key solutions is storing it. Storing electrical energy is actually tough, by the way. Battery technology is probably, a conservative estimate, at least a decade behind the generation technology in flat panels. If I were to focus on the key technological hurdle for using PV in utility scale or even in commercial/industry scale, or even the residential level, it's this idea about using the electricity when the sun doesn't shine, storing it up, and spitting it out again.

Allied to that, anybody from EXERGEX -- Ergon? No? Good. (laughter) There are legitimate concerns about the stability of power that comes from a distributed photovoltaic system, both in terms of the voltage stability and the frequency stability and the effect to the local network. I think that can be cured with decent invertor technology, which is a thing that takes the DC power and makes it AC and squirts it into the grid. Certainly we can do that.

A better way of doing it, in my mind, is to package the whole thing with a nice electrical circuit and a good battery that is capable of storing, smoothing, and removing all of those problems that EXERGEX and Ergon have with instability in local grids.

I would say, and I think this is going to be slightly controversial, probably people from the Queensland state government and I work with them, so they know my opinion; I don't feel that our plan of rolling out residential scale multiply distributed small PV systems across the network, which is quite frankly creaking with old age a bit like me, our network is not designed for doing what we're doing to it. For that reason, there are added additional costs that nobody is telling you about embedded in the process of putting distributive PV on roof. You have to restabilise the network after you've done it.

We've rolled out large scale PV across residential sectors. I think my friends at state government told me we're about 280 - 290 megawatts of current and a solar bonus scheme, which has been extremely successful in Queensland, 44-cent net kilowatt hour. That is going to probably get us somewhere near the penetration limits that we can handle on this current network system. The ability to store and to smooth and to do all those things that ENERGEX wants us to do is embedded in an ability to store the energy.

I'm a big proponent of controlling where you put PV, frankly, and turning the equation around completely and utterly; I'm turning it back into the networks and saying to them, "Where would you like us to put this PV so at this moment in time it can help?"

Karyn: Is that conversation happening?

Paul: That's where the conversation is definitely happening.

Karyn: Ergon and ENERGEX are both very publically supportive of renewables, in particular solar energy, and so you would think there would be some incentive with them to be upgrading the network in order to make that happen.

Paul: Yes, there's also incentive to keep the lights on, though.

Karyn: Are the two mutually exclusive?

Paul: They see them at the moment a being mutually exclusive because we're not involved in an iterative planning process, a cooperative planning process. We're going to get there. Minister Robertson understands this, for example. We're going to move towards that. I think what's not helpful is covert plans by people like Ausgrid and the rest of the networks in Australia to "stop residential PV at all costs," which is what they are doing. There are covert plans out there to do that.

I've caged some of the technological problems associated with implementation in the grid and stability and the storage element. I do feel that the base technology for PV is a proven case and we can go further. Let's deal with solar thermal on that front and big utility scale opportunities.

It's not as far along the technological pathway, to be perfectly honest with you. Although it's a simpler technology in many ways, the sun comes down, it heats a working fluid, that working fluid goes off and either creates steam or does some chemical reaction. It's a rather simple thermodynamic problem, to be honest with you, but because of its efficiencies it needs to be done at really large scales to make it effective. I think that's its issue. People are afraid of spending 1.2 billion on 250 megawatts. Anything you do at smaller scale, there are doubts as to whether it's viable to do it. It suffers, again, from the issue of when the sun goes down what happens to the power that's coming out.

It must be said that storing thermal energy is much easier than storing electrical energy and far cheaper. There are solutions out there: the molten salt systems, the solid state graphite storage options, the thermal chemical reaction, they're all out there; no doubt about it. At the moment they haven't lurched forward in terms of implementation to make them a decent price.

We know, for example, that a large solar thermal power plant, pretty close to our heart like Solar Dawn which is being built out at Chinchilla will probably come in at capital about four bucks a watt. That gives you a levelised cost of energy in the twenty cents range, twenty-five cent range.

That brings me to my next point, which is the prohibitive cost of that. If Kogan Creek coal-fired power station is producing electricity at three or four cents a kilowatt hour, and squirting it into the grids, the solar power station next door is doing it at twenty cents a kilowatt hour, that obviously represents a significant challenge for everybody.

Karyn: Is the issue there actually that we are, as consumers, not paying the full cost of coal?

Paul: Of course we're not.

Karyn: It's not that the coal-fired power stations can do it for three cents.

Paul: No, absolutely, that's their cost of capital and all of their cost of fuel. Coal is still very cheap in this part of the world. That will change and the dynamics will change, and it's changing very rapidly across Europe which has got constrained mineral resources supply. It's changing across the United States.

There's a nice example, I was looking at a PV project in California, a new one that's just been announced last week, 250 megawatts PV project. It's in the central valley, California, wonderful place for doing utility scale solar. That's 250 megawatt being built by SunPower and my estimate is that's probably a seventeen cent LCOE over its plant lifetime. That, in California, is going to probably see it somewhere near grid parity in about four or five years. After that of course it's profit.

The interesting thing about this one is it's subsidised. The business case is got up, underpinned by a loan guarantee by the Department of Energy in the U.S. They're guaranteeing one billion on the plant build. They're not giving them the money but it's allowed the financing to say we can get a low interest, low risk loan because the DoE is underpinning it. I think their cost of capital is something like 1.5% interest on their capital build. That's a project now that's getting up at utility scale in California right now.

We've got a different dynamic as our cost structure is very different, and our capital structures are very different. But that's an example of where the world is changing towards that type of cost structure. So that will be a utility scale sun park. There's a few issues.

Of course, the last case is the political. You said it in your introduction. The fact is; Australia is not a country with an energy security problem. Europe is a place with an energy security problem. When Russia decides to turn off its gas supply to Germany, Germany gets very worried and very cold. That's a point we don't have to be forced to face. I think that's a very important thing that everybody needs to understand in this country.

I'm a European. You hear the accent. This is normal for me. When North Coal run out in the United Kingdom, and I come from a Welsh coalmining family, my dad's a miner, my granddad's a miner, closed out pit in 1968. The energy supply in the United Kingdom and Europe has been constrained probably for 30 or 40 years. We're so far behind that historically that we've only just started worrying about this phenomenon so it's going to take us a while to catch up with that.

Karyn: How long is a while? How long will it take us to catch up?

Paul: Until there's a meaningful price on carbon.

Karyn: What's a meaningful price, as opposed to 23 dollars?

Paul: Twenty-three dollars rising to 27 dollars in 2015.

Karyn: Is that a meaningful price?

Paul: It's not as meaningful as some of us would like. (laughter) But the political reality of the situation, I firmly believe this, I'm a pragmatic greenie. I'm sorry, years in this business has told me that you've got to get stuff done. To get stuff done you've got to compromise and if 23 bucks is a decent, meaningful compromise, let's get it done and get on with it, and stop moaning about it.

Karyn: Paul, what's the total potential for solar? Could we actually be running, with proper investment and development, could we actually be running Australia purely on solar power?

Paul: That's a very good question. Not with our current grid system. We would have to completely and utterly redesign our grid system. It's a grid system designed for unidirectional flow which means you have a big power station and you squirt the electrons down this big pipe and then somebody in Brisbane turns the light on.

There's no capacity for a dynamic management of the energy throughout the network and that's what we need. I don't believe we'll ever run the country entirely from solar because there's no need to. Other forms of renewable energy will do the job; we have wind resources, geothermal resources, tidal resources. There's no need for that.

However, it is a ridiculous situation that a first-world nation has got two parts of its grid on the west and the east which is not connected. That ability to connect the resource -- we're perfectly happy to build a railway to ship coal it seems, or to send 47 billion on a broadband network. But we shutter to consider the possibility that we're going to have to re-network our country, rewire our country. I suppose it's like having an old Queenslander, where eventually you've got to bite the bullet and rewire it. I see Australia's network system as an old Queenslander. I've got one myself. I rewired it a couple of years ago and it's still a mess. (laughter)

Unless we take that bold leap forward, unless we do an NBN for the electron, then the capacity for us to pipe electrons from northern territory down to Brisbane, or feed Sydney's insatiable appetite from the centre means that we need to redesign the network.

It's a holistic view of the world. It's not about just the source. It's about use. It's about dynamic use of the electricity and certainly about demand-side management and the ability for ENERGEX to turn your air conditioner off if there's going to be a brown out. I perfectly well agree with that. We have to start viewing our electricity not as a right but as a resource. As soon as you get into that frame of mind then things start to happen.

Karyn: Thank you. From the power above the earth to the power buried beneath it, let's turn to geothermals and welcome Professor Hal Gurgenci from UQ's Geothermal Energy Centre of Excellence. Hal, geothermal energy could be more simply described as hot rocks, is that right, some three to five kilometres below the surface?

Professor Hal Gurgenci, Cleantech Market Innovator

Hal: Four or five kilometres, yes.

Karyn: We have this resource of granite.

Hal: It's a type of geothermal energy we have. New Zealand has a different kind of geothermal energy, of course.

Karyn: And formed from volcanic --

Hal: New Zealand has from volcanic sources, magma coming close to the surface. Then if you have a pocket of water, which is heated from below, if it cannot escape anywhere then it gets hotter and hotter and if it finds and escape it comes to the surface. If it cannot find an escape, if you drill a hole, then there either is hot water or hot steam. Then what you do is run it through a turbine to generate electricity. It is as cheap as coal, as long as you have that sort of geothermal energy, which New Zealand has it so they have a lot of geothermal electricity. Iceland has it so they have 100% coming from that. Australia unfortunately doesn't have that form of geothermal. We have to work a bit harder.

Our form of geothermal energy is stored in hot rocks and it is four or five kilometres below the surface. Just the opposite of the problem we have with solar, with solar we see it, it's all around us. Storage is a problem. With geothermal storage is not a problem because it has been sitting there for millions of years. It's not going to go anywhere. It is bringing it to the surface that's the problem, and that's the main obstruction preventing faster uptake of geothermal in Australia.

Karyn: The Cooper Basin which sits across the border of Queensland and South Australia is a pretty rich resource for geothermal?

Hal: That area, Cooper Basin, it certainly is mainly because we know that area very well because of other mining. Remember we are talking about rocks four or five kilometres below the surface. When you look at it from the surface, it is difficult to see how hot it is five kilometres down. You have to interpolate from existing well data. That area is the largest concentration of wells that have been drilled in the past because of gas fields and people looking for oil and gas.

With that, now people have started looking to other areas. I'm sure there are other areas around Queensland and in other parts of Australia but they're not as well documented as it is in Cooper Basin at the moment. It is difficult to say but probably people are waiting for one success story, and hopefully that's going to be coming form Cooper Basin to give confidence to other people, other companies to explore in other places. It's an expensive business in terms of your first investment.

Karyn: What's the potential resource that's down there? If you could express it in terms that lay people like us could understand?

Hal: The resource is huge. The resource is not an issue. If you can bring that to the surface at a cost which is acceptable -- at the moment it is not cheap, within 30 cents per kilowatt hour. That's expensive. But if you can bring it to the surface at a cost acceptable, that will last Australia for six thousand years. That's not a problem. The resource is not the problem, cost is the problem.

I should take one step back. Up until now the investment in geothermal exploration in Australia has been almost entirely by private capital. Although there have been grants given to the companies, the companies have to give it back because they couldn't come up with the matching grants. I thought at the beginning it was easier, but it is not easier. Nothing is easy in this world and now people realise the technology difficulties.

At the moment you get 25-30 kilograms per second from one well and this is like five kilometres deep well. There are two of them and the idea is very simple. You put a hole in water from here, it goes through, comes up as hot water from the other side, except that you have an 18 inch well and then you have another 18 inch well down at the other end, maybe at the far end. That's the distance between them, so you push water here. The water comes up from there. At the moment people can get 25-30 kilograms, litres per second. That's a fair amount but not enough to bring the cost down.

To take the cost, if you double that flow rate, that will take it down to 15 cents per kilowatt hour. If you triple it, that will take it to 10 cents per kilowatt hour. There are ways and plans to do that. I suspect that there are four or five projects in the States, each one of them two or three million dollars developing enabling technologies to do this. I suspect in the next 10 years we'll see that either in Australia or in the States or in Europe, someone will solve that problem.

Karyn: You think that's a decade away before we get the technology that might allow us to extract?

Hal: To take it down to 10 cents per kilowatt hour, in a commercial sense, yes. I think laboratory success is probably two or three years away, but after that, taking it down to the field will take that long.

Karyn: Okay. The carbon tax announcements, all the government also announced a renewables package, have you seen an increase in interest? Geothermal, I thought, was one of the things that the federal government was quoting was going to be contributing to our ability to meet the emissions targets.

Hal: The pricing model was probably -- he (Ian Rose) is better qualified to talk about pricing models, about different scenarios. But that's both for 2030 and 2050 scenarios, they have about 10% geothermal. There is a bit of irony there because if you get 10% penetration by 2030, by 2050 it will be more like 60%-70%. If you get that sort of penetration that means you would have solved the problem I am talking about. After that, we just roll them one after the other, there is not going to be any obstacle to it.

Karyn: If it's going to take us a decade to get the technology that will allow us to produce it cost effectively, could you see that roll out to a 10% take up by 2030?

Hal: If we get 10 cents per kilowatt hours in 2020, that's what we indicate, if you get 10 cents per kilowatt hour from geothermal electricity in 2020 it only takes two or three years to build a power station. The only bottleneck there is going to be the drill rigs to drill your wells. There are many of them but they are busy drilling oil and gas wells. Other than that, there is no bottleneck.

Put it this way, where nuclear energy was proven when they built the first efficient plant in the early fifties, and when the USA started this big rollout of nuclear plants, they achieved something like close to 10% in a decade, 10% of their total electricity they produced, they just rolled out these nuclear plants one after the other.

Karyn: Once you've cracked it, the momentum --

Hal: It can be done, and a geothermal plant is much simpler than a nuclear plant.

Karyn: What about the risks attached to this kind of technology, if any? Again, it's hard to talk about fracking at the moment without inciting a whole heap of hysteria. Are there environmental risks from geothermal extraction?

Hal: This form of geothermal electricity -- there are two types of risks ... I'm not saying they're major risks but they are the things you have to be concerned about. One of them is you're fracking basically, five kilometres below the surface. You're creating small earthquakes like in South Australia, when they did their simulation a couple of months ago they produced a Richter scale of about 2.5, close to 3. That's a very mild earthquake, but if you are doing it in South Australia no one cares. (laughter) If you are doing it in the middle of northern and south Australia, no one cares (laughter). But you probably wouldn't want to do it, even though you're sure it's going to be limited to 3, you wouldn't want to start doing it underneath Brisbane, Melbourne, or Adelaide.

That's a risk and a real risk like Basel in Switzerland. They tried that and there was an earthquake that coincided with this fracking (laughter) at the time. It was a small earthquake but that was enough to scare them and they stopped the project. I think Basel has had a big, natural earthquake 100 years earlier, and obviously they are sensitive to such concerns. I don't think it's a real issue, but it is an issue that we have to be cognisant of. That's why I think it's a good idea to start from areas where Richter scale shakes of 3 wouldn't be noticed, let alone frighten people. That's one.

The second one is not a risk at all. But since I've been asked about it many times, I'm raising that. The second one is if the coal seam gas people hydrofrack and damage aquifers, it's the same thing. You hydrofrack, doesn't the same thing apply? Except in this case you're fracking five kilometres down. There are no aquifers in Queensland or anywhere else where we draw water from five thousand metres down. Fracking five thousand metres you're not going to do anything to your aquifers near the surface. Aquifers near the surface are like

meteorolic, they are recharged by rain. Five thousand metres they are not recharged because if they were they wouldn't be hot. They are really insulated, isolated, so there is no danger of that. That's something that people have raised.

Karyn; Is sourcing the water for the fracking going to be a challenge?

Hal: This is a new technology so we don't have a lot of experience. Geodynamics in Habanero in Cooper Basin, I think Habanero fracking they use about 20 million litres. Fracking is something you do and then you don't do for 20 years. That's the plan. Twenty million litres is not a large amount of water. In a coal-fired power plant, if you're using wet cooling towers, 1,000 megawatt coal-fired power plant would be evaporating about three million tons of water every year. So 20 million litres which is 20 thousand tons of water, for something that you do at the beginning of a 20-year operation is nothing. Petrotherm in Paralana used three million litres per, that's what they reported. That's even less.

After that, during operation, there may or may not be losses of water. That's again we don't know. In Habanero it wouldn't be because that's insulated, isolated, so water hasn't been lost. It is pressurised water. And in other parts of the world, in tests like in the U.K., and other places, people have experienced water losses at the reservoir in short-term tests. Those didn't last more than several weeks. It's questionable if that would continue or what those losses are. I think the jury's out on the water requirements of geothermal.

Karyn: Lots of potential but still quite significant challenges. If we can crack it within ten years then there's a chance of making it --

Hal: If we solve it I don't think we have to worry about the electricity needs for the entire world because this is a pretty ubiquitous form. Almost every country has it and when you drill down, every kilometre you get heat for 25 degrees Celsius on average. For thousands of years we won't have to worry about it, but there are significant challenges. That's why I want to emphasise that it's not a done deal.

Karyn: Thank you. Let's move the conversation to Fiona Waterhouse, of specialist bioenergy company Utilitas, and the topic of biofuels. The term biofuels covers a very wide range of technologies and potential energy sources. In Australia we're reasonably familiar with ethanol from sugarcane as a potential replacement for petroleum. In the U.S. corn is being used for the same thing. In Malaysia palm oil is being increasingly grown to produce biodiesel.

But while biofuels have been touted as an environmentally friendly alternative to conventional oil, there is increasing controversy about the impact of these industries replacing food crops, contributing to global famine, as well as creating loss of biodiversity and in some nations community conflicts.

So Fiona there's one biofuel that's largely free of these problems. That's biogas. In Queensland we tend to view organic waste as a problem. Are we looking at it the wrong way?

Fiona Waterhouse, Utilitas Pty Ltd

Fiona: Yes we are, definitely. I guess the processes we work on are basically anaerobic digestion and for those of you who have eaten something today, everyone eaten something today? You're currently anaerobically digesting what you've eaten. So in fact you actually have your own biogas plant inside. You put organic material in, you get energy from it. You get a gaseous phase, a liquid phase, and a solid phase resulting. That's how anaerobic digestion works as well, when it's worked in the case of putting together an asset that would generate power and can be connected to the grid.

Karyn: What is biogas, in laymen's terms? Can you explain that a bit and the area you're working with?

Fiona: Biogas is basically produced from the breakdown of organic material in the absence of oxygen. That happens naturally anyway so it will happen in your compost bin. It will happen if you have a septic tank. It will happen in the sewage treatment plant where our ethanol goes.

Basically it's a mix of methane, depending on what kind of organic material has broken down or is digested. It's around about 60% methane. The large part of the balance is then carbon dioxide. When it's produced it's typically a wet gas. It can have, depending on what has digested, it can have small or in some cases a bit more amounts of hydrogen sulfide and a few other chemicals as well. It's a natural gas but where what we typically consider to be natural gas has a methane content of 95%, 98%, 99% -- other people would know that better than me, biogas typically is about 60% methane.

Karyn: How do you capture it? How do you store it? What do you do with it?

Fiona: If you think of a septic tank, everyone know what a septic tank is? If one goes into it, it's a contained vessel. With the septic tank you don't want to stir it up and get lots of methane being produced from the process. But in our process we actually want to stir it up and put it in at the right mix to promote methanation from the digestion of the waste. That naturally creates biogas, and then that's put into a generator in the same way that natural gas is, or diesel fuel is, or the same kinds of engines although slightly modified and tuned slightly differently to deal with a different gas. Electricity is produced.

Karyn: Where are we at in Queensland with this process? What's the current status and what's the potential of it, do you think?

Fiona: Anaerobic digestion is a mainstream part of wastewater treatment, but what's different for about 30 years in the U.K. and Europe it's been a requirement that the processes of anaerobic digestion that exists within sewage treatment processes capture and utilise the methane instead of just letting the methane go into the atmosphere, which is what currently happens now. Basically we waste the methane, largely; it goes to atmosphere. We have that from a manner of different wet organic sources, whether that's effluent from agriculture or human waste or food-processing waste.

At the moment it's wasted, whereas in the U.K. and other places it's been a requirement that you capture and use it for a long time. I think the first plant to do that in Australia was a little tiny sewage treatment plant in South Australia, about 40 years ago did it. Some bloke tinkered with a diesel engine and fed the gas straight into a diesel engine and used it to power the sewage treatment plant.

There's 24 of the sewage treatment plants in Australia, the fairly large sewage treatment plants capture and utilise the gas and have good, connected electricity production. I think we have two of those in Queensland. In terms of using the process in agriculture, we have about three projects in Australia that are good connected, whereas in Germany they have 6,000. I don't know if anyone thinks Germany and goes, "Gee, what an agricultural powerhouse Germany is."

Karyn: You wouldn't necessarily think they're a solar powerhouse either, but they're whipping us on solar projects as well.

Fiona: They have 6,000 anaerobic digestion or biogas plants that are good connected. They average about 300 kilowatts of generation. That's a total of about 2,200 megawatts of installed capacity to their grid. Interestingly, they also put it directly into their gas grid, so it's actually more efficient to directly utilise the gas in process heat, or heating hot water. In Australia it's quite interesting going out and exploring in originating projects here because I take out German colleagues with us. I speak a bit of German and they chat around in the background. I can hear them going, "They're heating water with electricity?" (laughter) "Are they heating water with electricity?"

The whole mentality here is just completely different. The whole structure of our use of heat in processes is completely different. We've been so used to having a coal-fired burner or switching the switch and turning on the electricity. The whole way our industry is structured to use process heat tends to be around coal or coal-fired power producing electricity.

It's quite interesting trying to originate projects in this space because the technology is old. It's well-proven technology, that's not an issue. It's working out how to deploy it in a cost-effective manner in Australia that actually deals with some of our limitations.

Karyn: You see an interesting juxtaposition of a couple of different trends, though, because on the one hand we've got the concern around sustainable energy production. We're also becoming increasingly concerned about what we do with waste and waste management. Presumably you could see these two things coming together and fixing two problems at once.

Fiona: Absolutely, and currently in society we still view waste as waste, as an issue and as a problem, but actually in fact it's a resource. For every 100 ton a day of food and organic waste that we produce, and we produce about a kilo each, per day on average, in a developed country like Australia. For every 100 ton a day we could produce a megawatt of power.

That's a complete missed opportunity. We can deal with the waste and the energy problem with proven technology. That's a really great thing with biogas technology. I'll use that term, even though it's not established in Australia yet. But in creating a biogas industry here in Australia, we have a phenomenal opportunity. Germany, when you look at the cycle that they've been going at for 30 years, and with their 6,000 plants, they're over here on the industry lifecycle curve.

We're at this nascent industry stage but the beautiful thing is we can just pull across all the IP, all the experience, all the supply chains, all the capability and then do what we do well as Australians and sort of tweak it for our conditions. I watch the engineers communicate with each other around the world and looking at the wind loads that our tanks have to deal with, for example, and the fact that we have to design plants that we're putting in Central Queensland to deal with higher wind loads than Germany would ever imagine; just those kinds of simple things, the kind of heat that is likely to get generated inside the containers that our generators sit in, for example, is probably 10 degrees higher, at the higher end. Our ground temperatures, all those things need to be tweaked and optimised the way technology is used.

Karyn: We are fairy innovative people, so it doesn't sound to me there is much there to stop us from doing this.

Fiona: No, there's not. It's just coming up with viable business models to be able to deploy it. The thing we've spent the most time on, aside from tweaking the designs to be appropriate to Australian conditions, and to integrate well -- the one thing that farmers particularly, but sewage plant operators and municipal waste haulers, they don't have much patience for changing the way they currently do things. You can sit back and go, "That's a problem," or you can go "How do we make sure we design the system so that it actually fits with the way they currently do business?

Karyn: And give them an incentive, a bottom-line incentive to change, presumably.

Fiona: Absolutely, well we finance the plants as well, so that helps. (laughter)

Karyn: We keep hearing about peak oil. The other peak thing that I'm starting to hear about, that I think we're less aware of, and which I understand is going to be an issue within the next 20-30 years is peak phosphate, and the requirement for us to be finding new sources of phosphate in order to fertilise the food for the gazillions of people that we're going to have to be supporting on the planet. What's the big opportunity here for us?

Fiona: For nitrogen, phosphorus, and potassium, N, P, and K, the three mineral nutrients that are predominantly used in chemical fertilisers, but are a requirement for plant nutrition, obviously they can come from natural sources as well. Interestingly, we have issues where we have sewage treatment plants that are sending effluent to ocean outfalls or all these other sorts of things, where we view nutrient as a problem as well. The component of the waste, we've got the handling issue with the waste. We've got the storage issue with the waste. We've

got the amenity issue, smells and other things with the waste. But we also have a nutrient burden that we end up putting back onto the environment, whether we store it in ponds or send it to sea, or whatever else we might do with it.

In fact, we have our own supply of nitrogen and phosphorus and potassium. We could actually not only take what we currently call a waste and produce energy from it, but we can also take the nutrients from it. But not only that, it contains water so we can also recover the usable water from it as well. We have a complete utilisation of our waste stream. The great thing is that the technology exists to be able to deploy it at a distributed, local level. You can scale this solution to the actual waste size, volume, type, very easily. And therefore you have an energy plant, a fertiliser plant, and a water recycling capability. It's kind of mind boggling that we only have 27 projects currently in Australia and 6,000 in Germany. By the way, in Germany, they've actually set a goal to double their capacity by 2020. They're currently building about 130 plants a month, on average.

Karyn: Thank you Fiona. Some of the biggest developments on Australia's renewable energy scene are coming from wind. While Victoria's recently introduced tough new laws which look like pampering development of new wind farms, South Australia has announced a new wind project due for completion in 2015 that it predicts will produce a quarter of that state's electricity. It is also combining it with a biomass pilot project.

In Queensland, wind farms are also being proposed for Hewindon (ph.), the Afton tableland and the Darling Downs. Dr. Ian Rose is one of the country's foremost energy advisors. Is wind energy an answer for Queensland, do you think?

Dr. Ian Rose, Roam Consulting on Nuclear and Wind Options

Dr. Rose: Certainly it doesn't have to come from Queensland because these days you could have a butterfly flapping its wings in front of that wind turbine in South Australia and you could measure the change in voltage at Cannes, for example. You don't have to have the wind locally, or the resource locally for that matter. So it's just one big system and I guess it will be the market that will determine whether that wind is produced in Queensland or whether it comes from Victoria, Tasmania, South Australia, or any other part of the grid.

Karyn: The grid's got the capacity and connectedness to make that work?

Dr. Rose: Yes, it's a bit of a surprise that the studies that we've shown, the grid can quite happily deal with something like 20 thousand megawatts of wind, which is about half of the amount of generation capacity that there is in Australia now. The reason is because wind is a fairly dispersed feature of the climate and because population is spread out fairly widely as well, it doesn't need enormous amounts of energy to go from one end of the country to the other. You can have a great deal of wind. You can't have a great deal of the best wind resource but it's a trade off.

You can either say I'll have my wind a bit less windy, but because it's in a good location, say wind for example in the Darling Downs would be great because the grid, as Paul and Hal knows, we have a very strong grid on the Darling Downs, which is there to support coal-fired and gas-fired power stations. Wind can muscle in on that territory, and get a very free ride or very low-cost ride into Brisbane. That's what the big companies, AGL, Origin and many others are looking at. They're looking at the trade off between going to the windiest places and going to the places where the grid is going to give them access to the cities.

Karyn: How does wind stack up commercially, economically, with some of the other technologies we've been talking about tonight?

Dr. Rose: As most of you undoubtedly know, we have a market here in Australia and that market is one of the most intensely competitive in the world. That's why you can get three-cent power out of Kogan Creek, or other coal-fired stations. Those power stations and companies that own them are killing each other to get you power at the lowest price. If you look at it that way, wind and renewable generally can't compete. The only renewable that can really compete on the level playing field with coal and gas is hydro. A lot of that hydro has already been built years ago in the snowy Tasmania and up in North Queensland, and places where it's wet.

Wind can't compete so what the government has done is create a market for renewable by mandating 20% of our electricity must come from renewable sources by 2020. They've made that a market so now all the renewable companies have to compete with each other for that market. It so happens that below a decade ago wind wasn't competitive at all. We had small wind farms, 60 kilowatts, 100 kilowatts. The size of wind farms has gone up by a factor of about 100 in the last 10 years, and that has made them economical on scale basis, and also the wind farms themselves have got much bigger. Now you have 100 megawatt, 200 megawatt, 500 megawatt wind farms.

The prices come down so wind looks like swamping that 20% renewable target, which obviously worries the people who aren't building wind. The governments have then created these other markets like the small-scale renewable energy market which is the one that supports your rooftop solar. They've said we want this much to come from that source, and they've set that in concrete. Of course, that will get built out as well because as Paul said, the small-scale renewable sector has only got so much growth that it can provide before it starts to build out the system that it's connected to, that is the distribution system.

Everything is happening through market processes and it so happens that wind is looking really good in its sector. But it's up to our governments then to create space for the emerging sectors that they know are going to be good in the long run, but aren't quite there yet because they're not as far advanced along the technology curve.

Karyn: Are you confident that our governments are seeing that as an issue and dealing with it at the moment?

Dr. Rose: I am. I was heavily involved for about 10 months in the modeling for the Treasury's 23 dollar price and I do have a great deal of confidence, actually, that they're right in the zone there, and that 23 dollar is a pretty good starting price for change. A lot is really going to come out of that. Yes, I think in a way both sides of government supported the 20% renewables. Both sides support the idea of getting our emissions down by 5% by 2020, which doesn't sound much if you're not in the industry but if you consider that growth is 2% a year, that's 20% in another 10 years. To get the absolute number down by 25% from where it was going to be is a very big ask in deed. That's one of the really big challenges. Yes, I think there's a lot of effort going in now. Maybe we were late starters, but we're strong finishers, as well.

Karyn: I want to move on now to an energy source which is not strictly renewable and which since the Japanese tsunami and the Fukoshima disaster earlier this year is practically unmentionable. I want to talk about nuclear energy for a little while. When I was growing up in the eighties, our big generational fear was a nuclear accident or nuclear war, following those disasters at Three Mile Island in 1979, and Chernobyl in 1986.

We then had a long period of relative comfort. Nuclear energy was even pegged for the ALP national conference, up until Fukoshima happened in March. Since then, we've seen Germany close down half of its nuclear power stations, a move that other nations have criticised because it forces Germany back into dependence on fossil fuels and imports. In looking at developments in nuclear technology over the course of the last few decades, was Germany's response to Fukoshima an overreaction?

Paul: That's a very leading question. (laughter) In my experience, I've lived in both Canada and the U.S. for lengthy periods of time, and I've seen nuclear power stations that have been built and with the reactor fuel loaded, which was then closed down before they'd ever produced a kilowatt hour of exported electricity, and cost five billion dollars to build, and got sold to the local government for a dollar.

If you have enough passion behind things, and people have got passion about obviously, they can stop anything from happening. It's not really a matter of technology and whether technology will advance far enough for nuclear to be safe. I think it's always going to come down to where that nuclear is located and what the risks are and whether the populous will wear those risks.

Karyn: Ian, in fact you prepared a report for the Queensland government a few years ago on the state's nuclear options. Do you think nuclear should remain on the table as a discussion point for Australia?

Dr. Rose: I think it should. I don't think it's going to go away in other parts of the world that aren't as fortunate as we are. There aren't very many places on earth where we have a desert that stretches three thousand kilometres, that starts 100 or 200 kilometres west of all our major cities. We amongst very few countries aside from the U.S., California area, could really say we could really throw everything into solar and we'd be able to get by. You try that in Russia or the U.K. and they

obviously don't have solar as a resource. We've got the luxury on our side of having really good renewable options. Therefore I think it will be a struggle, because the levelised cost of nuclear is likely to remain hardly competitive or even going out into the distant future, unless there's some remarkable nuclear technology that is cheap and doesn't have any radioactive waste, which could happen. Barring that, I think we can have it sitting there but it's hardly likely that it will fit in with the market. I think that geothermal and solar, our modeling has shown that and we're lucky enough to be able to expect that these other alternative technologies are going to come along and maybe help us avoid nuclear.

Karyn: I guess the other issue for nuclear, probably to put it to bed once and for all tonight, I understand the issue for Fukoshima and in fact most of Japan is their nuclear stations have to be located on the coast in order to get enough water for the cooling issues. We would have the same problems in Australia.

Dr. Rose: We definitely have a major issue in Australia. You'd really have to give up your favourite beach or someone else's beach and have a seaboard power station, as we do -- for example Gladstone power station is a seaboard power station. But if you look back at Tarong power station was built to rely on Boondooma Dam which is on the Downs, and had a 1-in-100 year failure probability. Boondooma Dam went dry in the early nineties so we said we'll build a pipeline from Wivenhoe to support Tarong, and then Wivenhoe ran out of water. That's two 1-in-100 year events that have happened in the past 20 years. Nobody is going to build a nuclear power station that isn't guaranteed to have a 1-in-100 year or better source, and there are very few locations in Australia that could support that. It means the coast or nothing, really.

Karyn: Or nothing, probably.

Dr. Rose: The other option that has been suggested by the "nuclear lobby" is that you could conceive of dry-cooled nuclear power stations. We have dry-cooled power stations on the Downs that uses technology that's been used in South Africa for years where it's very dry. You use a fan to cool the turbines rather than water. I can't imagine anybody trusting a bunch of fans to keep a nuclear power plant under control in an emergency. Although dry-cooled nuclear is theoretically possible, it's practically a very tall order.

Karyn: Thank you. One local renewable initiative that I wish we could have heard tonight is from our own Brisbane City Council. Council went out to tender for a renewable energy plant to be built in Brisbane. In the first round of offers solar, hydroelectric, wind, and biomass technologies were all suggested. Council spends around 34 million dollars on electricity each year and it wants to be able to power all of Brisbane's street lights and all of it council buildings, essentially all the energy that the Brisbane City Council uses, from 100% green energy sources.

Of course, Brisbane City Council is unique among Australian councils, to have the spending power and critical mass to look at commissioning its own renewable plant. Understandably because they're in the middle of this tender process,

they've been coy about providing somebody to join our panel tonight, but I wanted to ask our panellists what they think of this initiative. Can I start with Paul?

Paul: An initiative was put in place by Lord Mayor Campbell Newman which at the time he was mayor of Brisbane was an extremely green mayor. I hope he continues to be green in the future. I think Brisbane's got a unique opportunity because, as you say, its spending power.

We as a university put 1.2 megawatts on our St Lucia campus three or four months ago. That's going to give us about 6% of our peak power load, probably at about 2% - 3% of our average energy usage. To be perfectly frank, learning through doing is probably one of the most powerful and persuasive things that any institution can do.

UQ is a 21 megawatt peak user of electricity. It's huge. We spend literally tens of millions of dollars on electricity, just like Brisbane City Council does. There's been a sea change in attitude in our senior executive team. It really is remarkable. They can see the business plan. Everybody log onto UQ solar energy portal. You can see what our solar panels are doing on a minute-by-minute basis. Have a look, it's wonderful. You can see the peak energy days, you can see all the things happening there.

We've built out the business plan now. When we planned the thing it took us two years to raise the capital to do it and persuade some of the senior senate members this was a really good thing to do. Now everybody is an evangelist for the cause. We've learnt how to do it. They can see the business plan. We are predicted to pay back around 10 - 12 years. It's probably going to be about 8 or 9 years now for the system. The CFO has all of a sudden become a complete greenie because he can see 10 years of free electricity for the university worth literally millions of dollars. The business plan is there for all to see and we're sharing all this information with everybody, including Brisbane City Council. Brisbane City Council tried to come in and buy our electricity off us. (laughter) We said no, for obvious reasons.

As organisations like Brisbane City Council and UQ become more and more committed to the cause, this gives supply chain opportunities. We created a whole new set of supply chain opportunities in what we did. It's the largest PV system in Australia at the moment. It will probably remain that way for about another 12 months. So all that critical mass is gathering. I don't care whether the Brisbane City Council does a biogas plant, builds some wind farms on the Darling Downs and pipes it across, or goes out to the Western Downs and builds a nice little 10 megawatt solar plant. I really don't care.

What will happen is there's going to be a change of attitude and a change of philosophy within the organisation that will create a critical mass. We have how many projects on the table, probably 10, including a biogas system, I can't tell you where, but the whole of the organisation now can see what to do and the embedded skill of knowing how to do it. That's critical as well.

Karyn: It's important, isn't it, how we were talking earlier about the fact that we need just one geothermal success project to prove the point. Perhaps all we need, where we've been talking about the missed opportunities around renewables, perhaps all we need is leadership from one organisation of a decent size, like a local government council, to make some of this happen. What do you think?

Hal: Apart from agreeing with everything that Paul said, there are other things that can be done as well, in terms of not only city council doing its own thing. Let's take the cooling of our buildings. That's not too difficult technologies. There are perfectly working, proven technologies like ground-source heat pumps or piles that you can drill, or solar thermal cooling. All of them especially in the ground-source heat pumps, that would generate cooling of our big buildings, at a cost competitive with the cost of electricity and what we use at the moment.

There is no market for it, so there are not people doing it. It takes a bit of push. What is going to push it? A bit of incentive or statutory requirement or regulations. We aren't adding a big cost to it. We're putting a bit of incentive to people to use it. We can do that and then the ground-source heat pump business just almost exploded. It didn't really cost any more to air condition, to build a building. There are things that can be done beyond doing it yourself, but also motivating other people to do it.

Karyn: Fiona?

Fiona: I guess if you looked at the opportunity for something like biogas from the wet, organic waste that's collected every day in Brisbane, it's about 800 tons of wet, organic waste collected. The difficulty though is source segregation. If you remember when we didn't recycle cardboard and plastics and things, and it was all thrown in the one bin, and then we went through a whole phase where people now typically recycle as a matter of course. It's the same basically with wet, organic waste.

Whether you're in a restaurant or at home preparing food and those kinds of things -- in places like Europe, you have an insinkerator in a kitchen, whether it's a commercial kitchen or a home kitchen, that will go down to a basement, where basically the waste truck comes along. It's already macerated. They plug into it with a big vacuum collection system. They take it to a huge biogas plant in the outskirts and bunk it all in. It either gets produced and turned into electricity or upgraded as a fuel, and put into their buses. In Sweden, for example, if you see buses in Sweden they'll say powered by biogas and so will the trains.

There is the potential for it but I think as Paul has suggested, because source segregation, we can't go overnight to just suddenly everyone being really anal about source segregating their waste. There is actually currently market failure in the source segregation of waste, even from larger sources of organic waste, like restaurants and food processing companies and those kinds of things.

We need to start at a practical level and match the kind of plant to what's rationally able to be source segregated in a location. I think in doing that, it lends itself so well to scalability and that is infinitely possible. There's certainly a

possibility to do it but could I pull together, even with the waste haulers, 800 tons a day of material to go to a biogas plant? No. It physically wouldn't be possible at the moment, even though it is produced; getting it source segregated so that it was clean and not contaminated. You could imagine to put it back into the technology context, you wouldn't want to chomp on plastic or a glove or something on your breakfast cereal and that's the same issue for a biogas plant. If you did, it would probably just go in one end and out the other, but if you ate too much of it, it would start to cause you some problems. That's the same. We can't have a situation where oops, we chucked three ton of plastic in the 100 ton of waste. It's got to be source segregated in a way. That's not an easy process.

Karyn: Ian, your thoughts on the council tender and any advice you might give them?

Dr. Rose: I think one of the things I would do if I wanted to provide really large-scale electricity to Brisbane would be to probably make better use of the pump-storage power station at Wivenhoe which is a huge power station, 500 megawatts of generation and 500 megawatts of pumping. If you put in a couple of thousand megawatts of solar somewhere in the Brisbane valley, and you then had a contract with Wivenhoe whereby if the sun were shining a lot you pump the water up the hill and stored it in the split-yard creek dam, which you can drive past on the way to Somerset, and then release that when it was cloudy. Then you would go a long way towards a really major supply for Brisbane.

One of the interesting things about the electricity market that the country has created is that not much is done with that. We have an enormous hydro resource of nearly 4,000 megawatts in the Snowy and a 2,500 megawatts in Tasmania, but those companies are run as independent entities, where they make money by trying to put others out of business. If there was cooperation, you could use a lot of these hydros as storage facilities and Wivenhoe is the one right next door to us that we could in fact use. That's the way I would probably go about it, is using that storage for the times when it's not sunny.

Karyn: With the council initiative, the state government's been pushing investment in renewables for quite some time now as well. It's a bit bewildering we're not seeing the integration of systems that -- fair enough, that have been set up separately, but you would think that we would have the capacity, the opportunity to start to make some of these links and get them working.

Dr. Rose: They weren't set up separately. They're actually set up by planners long ago, but then I would disaggregate it in order to create a market so that people would look after their own interests. It would be reintegrating some of the things that were already conceived of in the first place.

Karyn: Over to the audience, we've done a fair bit of talking so time for you. If you have a question, we have hand-held microphones, could you please raise your hand and wait for the microphone to come to you. We are recording this for a podcast so we need your voice through the microphone. Could you also please make the most of the expertise on the panel tonight as well as respecting others in the audience. We're looking for succinct questions, rather than long statements. Does anybody have anything they want to ask?

Question and Answer

Audience: A comment about nuclear for starters. It's not actually renewable. People might say it's clean. From what I understand there's been about 100 years of reserves left, at current rates of usage. If you actually quadruple it, the math works out about 25 years worth of reserves left. I want to pop this question to Paul. My question is around the massive subsidies governments give to the fossil fuel industry in Australia. I believe it's around about 10 billion dollars a year. We've got the president or head of the International Energy Agency urging especially what I call the overdeveloped countries to eliminate all fossil fuel subsidies by 2020. How can we actually go about doing that in Australia?

Dr. Rose: I think that's in fact what a carbon price does because a carbon price is added to the production from every generator. If you're a high emissions generator like a coal-fired plant or particularly a brown coal plant, if the carbon price is 23 dollars, it's going to add about 35 dollars, 3.5 cents a kilowatt hour which the fuel cost for a brown coal plant is about half a cent a kilowatt hour. You're increasing it from half a cent to four cents a kilowatt hour. That is intended to have an impact, and it will have an impact. It's just that it's going to take time for those companies to realise that it's more economic for them to cut their emissions than it is to absorb the cost. As I said before, everything is done according to a market in Australia. I don't see the market going away, so the government has actually put in place a market mechanism for the recognition of that emissions source. I'm not an economist but I've seen enough of what economists do to believe it's going to work.

Paul: I couldn't agree with you anymore. I was on an inquiry committee over the last couple of years for the state government looking at the energy future for Queensland. One of the themes that came through time, and time again, was that when we do see a common price, the investment decisions about which plant AGL will build, for example going forward, become very clear. They won't build another coal-fired power plant. Paul Simshauser said when the carbon price comes in, it's very unlikely that Australia will get any new coal-fired power plants in the future.

Peaking gas, coal-cycle gas, that may be the case, but de facto what's actually happening is the removal of the subsidy in that process. It's a dissolution of that subsidy by the back door. The energy companies know that. They're not causing that as an argument. They're just saying it's hurting their business. I couldn't agree with Ian more.

The redistribution, it's not a tax, it's a redistribution of the wealth of the energy sector that will naturally cause that process to happen and will naturally clean up our energy systems, even the polluting energy systems. I'm a physicist and I'm not afraid of nuclear power by the way.

Hal: I'll add one thing, the carbon effects. There are going to be subtle effects, even 23 dollars per ton. As we go to more and more gas, because gas is the next one, rather than going to all the renewables, I think that's going to be gas; gas is much different from coal. You can build small gas turbines here and there or other gas

engines. That means you don't have to have a large plant. You can have small, almost neighbourhood gas power plants. What that means is it becomes much easier to absorb the renewables into a grade which is dominated by gas power plants, rather than coal-fired plants. You can start and stop a gas engine or turbine very quickly, as opposed to coal-fired power plants. These are subtle effects that's going to start happening as we have a carbon-priced regime.

Karyn: Interesting, I guess a month or five weeks ago, Senator Christine Milne -- because the greens' position had always been that they saw gas as being a transitional energy between coal-fired and 100% renewable. Milne basically reversed the position and said that they were going to push for 100% renewables straightaway. From what you're saying, we actually need the gas transition or perhaps it's the gas transition that's going to facilitate the investment in the network upgrades and so on, that's going to make the renewables possible? Is that what you're saying?

Hal: We have to be realistic. That's how I see natural growth of things.

Fiona: And more distributed energy, which is more localised energy, which is a point I was making as well. If you use a gas-fired engine, you can capture the heat from the production of the electricity. If you've got an 800 kilowatt electrical output engine then you're getting 800 kilowatts an hour of electricity but you're also getting roughly 800 kilowatts of heat as well. You can use that heat as process heat. You can actually use that to heat hot water, for cooling even.

Karyn: That kind of dual system is something again that we see a lot more of in the States and Europe than we've seen here. Traditionally we've kind of not bothered with that. Is that something you think we'll see more of?

Fiona: Yeah, I think we will see that a lot more, and where I think the issues that Paul was talking about, and obviously I'm not technical electrically, but some of the disturbances to the grid from small generation, those problems are not the same kind of problems if you use a more base load generation, something that's continually generating, like biogas for example. That process, just like our stomach, it continues digesting. Sometimes it works well. Sometimes it doesn't, our stomach, but biogas plants thankfully are a bit more reliable. They can continue to produce gas and electricity 24 hours a day. It doesn't matter whether the wind's blowing, the sun's shining, what's happening; our continual supply of gas, as long as you maintain the health of them, and also then you can produce electricity continually or you can use them as peaking plants and put the power into the grid at peak times. And you can also recover the heat from them.

But we're not very well geared in Australia really well yet to be able to make the most use of waste heat from combined heat and power plants. In an embedded community sense -- that's my view anyway. You might have another view.

Dr. Rose: I might just say that gas is about halfway between coal and renewables in terms of emissions, and that's why as the carbon price increases it'll make gas the cheapest option for a while because coal will be economically unacceptable, won't be able to compete. Gas will be able to compete but that depends on the

gas price remaining relatively low and nobody knows whether the gas price is going to remain low. If we go to a well-parity pricing, then the gas may increase in price fairly quickly. We may go to a renewable world far more quickly than is believed to be the case at the moment.

It's a very dynamic thing. I guess you've got to be in for the ride, and if you believe in your technology then you're halfway there. There's going to be a role for all of these different technologies, and it's not are we going to have a gas world and then we're going to have a renewables world; it's not going to happen like that. It's going to be very dynamic and globally driven.

Karyn: Is there another question?

Audience: We've heard tonight that the carbon price will lead to gas winning if it's just a carbon price. We've heard that with renewable energy target it leads to wind winning. With solar PV and solar thermal on a quite rapid cost-reduction trajectory, what's the best policy option support mechanism to ensure that we travel down that trajectory quickly and allow those to compete and participate in that mix you're talking about? Maybe a question for Paul and Ian.

Paul: I hate to say the word "direct action," but --

Karyn: What do you mean by it?

Paul: I don't know, does anyone know what direct action is? Certainly not Tony. The solar flagships program is direct action. It's taxpayer subsidy of the capital expense of building a solar thermal power plant and a solar PV power plant. The solar dorm plant at Chinchilla is a 1.2 billion dollar, 250 megawatt plant. If I do my sums right I reckon that's subsidised at the level of about 570 million by the taxpayer in Queensland and federal taxpayer, of that order. We're the deed research organisation on that plant.

The Moree PV solar power plant in New South Wales is about a 150 megawatt and a 975 million dollar project. It's not too economically viable, that one. But that's direct action taken by subsidising the capital expense.

There are other mechanisms by which you can take direct action. I mentioned the 250 megawatt California valley project by SunPower and NGR. That's underpinned by financing from the DoE loan guarantee scheme. There are multiple ways of taking direct action, and I hope the Clean Energy Finance Corporation will have that capacity to do that. I certainly would expect it to if it survives a change of government.

I'm afraid that at utility scale, anyway, I still think we're in a place where there's going to have to be some direct action taken in solar energy in order to cross subsidise with loan guarantee probably one of the best ways to do it in order to get these things built, so that we can do the learning and we'll learn a lot from Chinchilla, from solar dorm. I'm a big fan by the way of coupling CSP, concentrating solar power, particularly CST as the primary heating stage for thermal power plants. There's another project at Chinchilla that not a lot of people know about, I think it's called the solar boost. It's 40 megawatts of solar

field being put in at Chinchilla at Kogan Creek in order to assess primary heating. That will save about 30% on the plant emission.

For me, that's a really good way of learning how to do this stuff, establishing supply chains, rattling out the technology, and getting some runs on the board. Again, that is heavily subsidised, probably one dollar in three through the REDP scheme at the federal level. I'm afraid I have to say that at that level it needs subsidy.

Let's wind things back a bit though, to a smaller scale, and there's a lot of discussion around particularly how one stimulates industry development in the renewable and solar sector by placed commercial industrial scale projects. The people in the industry are telling us now that in certain circumstances the kind of megawatt scale solar system, hundreds of kilowatts upwards, is now becoming quite viable because the bottom line is that grid parity doesn't mean the same thing to two different people.

If I'm at University of Queensland, I'm paying 12 cents a kilowatt hour on my forward contract for my commercial industrial scale electricity. If I can now put a system in, as we've done, and prove the LCOE on that is sub-20 cents a kilowatt hour, the cost projection for our electricity means there's a crossover point in round about six years. Our economist is telling us that and we're very fortunate to have economists that can tell us that.

Therefore, the business case is an absolute no brainer. My proposition is quite simple, that commercial industrial scale is a very persuasive opportunity across Australia because it allows one to strategically place installation, and incentivise installation, and so help the network problems we've all been talking about. Plus, it insulates that C&I sector from electricity price rises, plus it stimulates industry development. I think we'll get to a point very soon, the next couple of years, where you simply won't have to cross subsidise the C&I sector in many circumstances.

I've been a big proponent of putting a C&I tariff in place, not just on solar, but on other types of renewable energy. Maybe we'll see that and maybe we won't. But I think it's different sectors have to survive on their own ultimately; the Germans have taken the subsidy from solar to pack it to wind in the last couple of weeks. Big news in Germany, the solar industry moaned for about two or three days and then got on with it.

That's what happens when you develop the supply chains and mature your industry through that process. At the high level, in summary, I think we're going to need direct access subsidy. I'm terribly sorry. I don't think the rate is going to allow us -- it's not enough of a stimulus and certainly the carbon prices are not enough for stimulus at that level. I hope the Clean Energy Finance Corporation will help out but I reckon commercial industrial scale in the next couple of years, little subsidy now, get everybody excited, and it should be off and running in the next couple of years on its own. That's what's happening in the U.S.

Karyn: Other panellists want to add anything?

Dr. Rose: I think that both federal governments have rolled out a very good model in terms of the renewable energy legislation, and they could easily say we want a 1% wedge for geothermal and a 1% wedge for solar. But then let the market decide. I can tell you there will be people flying in on planes tomorrow to take up that wedge, just like there are when we deal with wind companies these days; it's not Australian wind companies. It's Spanish wind companies or Indian wind companies. They're coming from everywhere. It's a question of the government making the space available for that particular technology and it will happen. Then, it will probably grow far beyond the level that they have mandated.

When you think about it, everybody is probably prepared to pay for 1% of solar thermal or 1% of solar PV added onto their bill because it's only going to be a couple of percent extra on their bill. That's the way you stimulate the technology, and you get a very dynamic industry which drives cost down and also leads to us becoming exporters of the knowhow that we've got rather than just -- I don't particularly favour the idea of too many of these direct action options because as they say, you're picking winners. You're saying the government has actually done its analysis and said the best place we think of the next solar thermal plant is at Chinchilla. Great, they've done all the sums, but it might not have actually been Chinchilla. If you opened the market up and said go for it, we'll take the first 1% that comes in, you might have got a different outcome, and that's where you really stimulate the research and development.

Fiona: Just building on what Paul was saying and mentioned before about more distributed localised solutions, I think that commercial industrial space is really critical. One of the problems we've been confronted with in society is we've always wanted to build things that are really big, so when the engineers and planners take over it's kind of like "Oh, 100 megawatts!" You can almost see them beating their chests. (laughter) Of course we have a hefty demand for electricity in Australia and we do need large sources of supply. But to me it's far more exciting to build 100 1 megawatt plants than one 100 megawatt plant.

I think it's not something that's excited people before. People haven't viewed it really as an opportunity. It hasn't been the thing that's been the sexy investment for people. People like to be able to say they've invested in a 200 megawatt wind farm. Isn't that good? I think we have to start looking beyond some of that and to my way of thinking; the real opportunity is in the C&I space. That's where I think the big opportunity is. The other benefit it has, and I'll defer to the guys who know more about network behaviour and distribution behaviour than I do, but the other advantage it has is it actually takes the load -- if you have more embedded generation you put 1 megawatt plants around the place taking up a 1 megawatt load on that site, or maybe taking up 80% of that load. Then effectively you're releasing that power from the grid, so you're actually increasing your capacity and improving in some cases your reliability.

There are technical issues with that but I don't think that's ever factored in because we have had this bigger is better, let's build the big 100 megawatt stuff as the primary ethos, whether it's sewage treatment plants and we do the same thing with sewage treatment plants; we do the same thing with power plants; everything's got to be big and centralised.

I think that we need a whole shift in thinking and maybe we need more women in engineering (laughs) to sort of get away from this notion and start thinking about things more at a local scale.

Karyn: Do you think there is the social appetite to have lots of smaller distributed systems that then are perhaps closer to residential areas? Is that going to be an issue?

Fiona: Those are issues but at first when people were putting PV on houses there were people saying that the world was going to end as a result of that. We do go through those phases. Obviously there's a need to comply with various amenity and planning controls and all those kinds of things, which I think in Australia are well in place. I don't.

If you look at factories, the space Paul is talking about, let's face it, is big factories; it's sewage treatment plants; it's large consumers of electricity and it's big sites. It's often sites that are more remote or in industrial estates where there's a cluster of them. I think if we look at that market in that light, no I don't think those issues exist.

We're in the Brisbane Technology Park and I don't see wind towers running down the row of the street. Where's that? You get that in other parts of the world. In other parts of the world every big roof is covered, every big roof is collecting water. I think we've missed that somehow because it's not big enough for people to get excited about.

Karyn: Thanks.

Audience: I'd like to ask how confident the panel is that we will get an effective carbon pricing mechanism in view of the political uncertainty with a lot of opposition to it in the electorate, and the federal opposition pledged to rolling this scheme back if it does get up on the 1st of July next year, and also pledged to do whatever they can to disrupt the operation of the carbon pricing system in the meantime.

Dr. Rose: I think that there is a lot happening worldwide and I think that politicians can change their minds very quickly, and even when Tony Abbott said he was going to sign something in blood, he's just said, "This is as good a promise as a politician can make." (laughter) I think that said it all. Once it's come to pass it'll be a lot harder to unravel. Maybe there won't be the drive to unravel it then.

Yes, there's a risk but I think there's a risk that almost anything can be unravelled so let's get on with it and recognise that we are going to have a carbon price and it's not going to be the end of the world. In fact, if you look at the 23 dollar price, it will actually add about 1 cent per kilowatt hour to your electricity bill and that is a lot less than some of the other changes. For example, how many people in this room know that you are mandated to buy 15% of your electricity from gas? That was brought in by the state government in 2005, but the thing is, they did it without making a big noise about it so nobody knows about it. You are in fact subsidising gas through your electricity bill.

I think the problem is it's been made into too much of a big deal and there are many other schemes like the renewable scheme is mandated; that's going to add to your electricity bill as well. This is just another thing that isn't all that large in the context of things.

Paul: Was it a core promise to sign in blood? I'm not sure. (laughter) What more worries me is the other elements of the program that I see as equally valuable. It's not just the price on carbon, it's the Clean Energy Finance Corporation for example, which is purported to be a 10 billion dollar investment to help these types of things along.

I'm more worried about that, and I'm more worried about ARENA for example, which is the new Australian Renewable Energy Authority, which supersedes all the little bits and pieces that we've managed to put in place over the last three to five years. It's a very bitty landscape down there in Canberra in terms of helping renewable energy and clean energy along.

I applaud that consolidation in ARENA and I'm terribly afraid that there's going to be capacity at relatively low political cost to a new government to roll back those ancillary bits of the program, rather than the core tax itself, particularly as I say, the investment fund. The reason being is that probably won't come into place until the turn of the next election.

Jillian Broadband has just be appointed as the Chair of the CEFC. She's a reserve board bank member, but there will be a year of consultation and another year of putting legislation in place because it's legislation. That's what worries me, because the tax is one thing but all the things you bolt on, which is not getting very much press actually because people don't understand it, but those are the really important things for me, rather than 1 cent a kilowatt hour on top of my electricity price. That's what concerns me most, I must admit. That's what we should be most concerned about.

Karyn: We have time for one last question if anybody has one.

Audience: I was wondering, it's very hard getting this information out. It's okay we're here tonight but I found the *Courier Mail* which is dismal for Queensland. How do you feel that it reports anything about any of the findings that you're making and in trying to get anything out of that newspaper?

Karyn: Let the sunshine in?

Audience: I've sent them emails, "Wake up, is anyone awake?" It's incredible.

Paul: I think that across the board, I'm terribly sorry but the Australian media just doesn't get it. We go out there, I'm a member of the EPVA and the CC and all these organisations, and they've all got communication plans. It's really very difficult at times.

However, I arrived in Australia in 2001, straight off the banana boat as it were, from the United Kingdom to set up my research program. It wasn't until about 2006 that there was any traction whatsoever and there was a change in attitude

in the country. It was the Al Gore factor. I don't know if you remember it. He came down and gave a couple of lectures. There was this massive rollout of publicity. It was wonderful. All of a sudden the phone was ringing. State government was saying can we give you some cash to come in and do some research?

This was a sea change in attitude. I think one thing about the Australian populous is that yes, it is fickle, but it is also a population that is capable of changing and changing quickly. That's from an outside observer coming in. There are a lot of embedded beliefs here but there's not a huge 300 or 400 year historical legacy you have to deal with like there is in Europe where things change more slowly. You may think they change quickly in Europe but they don't. They change very slowly because of all the historical and political factors.

Stop reading the -- I won't talk to the *Courier Mail*. I won't talk to *The Australian* and many other places, but there are some really good, hardcore things coming through now, particularly in the online media, that are putting good information out there. Things like the Beyond Zero, invaluable in that it's opened up -- although the founding conditions not everybody believed, including me by the way, but it opens the discussion up and elevates it to a new level. That's why we've got to keep pushing these types of agendas. That's the sort of discussion that gets through to voters.

Fiona: I was sitting on an industry panel for a University of Queensland class last week. The tone of the questioning at the end was similar. The guys in the class are learning about all these things that are going on around the world, and all the things that go on in Australia in renewable energy and other things, and kind of questioning why in the mainstream media we don't actually hear about it. Some of the questioning around that was quite desperate, these young people sort of going, "Why? We're sitting here spending all these hours at university. We're learning engineering, learning business, and we're studying doing business in a carbon constrained world. Why is that not the case?"

I guess my response to them was the pragmatists are just getting on with it and that's what Australians have always done. Look at our farmers for example, they deal with all manner of shite raining down on them. (laughter) They get on with it. I think a lot of people who are really trying to get on and do things, or are getting on and doing things are a bit afraid. I'm certainly afraid to put my head above the parapet into the mainstream media. They'll just knock your head off.

I think watch the trade media, as Paul says. If you look at waste management and the environment and trade magazines, and a whole bunch of trade media around renewable energy, you'll find that there's a hell of a lot going on. I think take comfort in that.

Karyn: I think it's a topic for a whole other discussion. I think within a year or two if not already, I would challenge the idea that the *Courier Mail* is still mainstream media. I think that you will find the rise of online communication and the way in which people are using what they're calling social media - there was a fantastic article somewhere today, I think in the *Sydney Morning Herald* about Twitter and

how that is changing the face of journalism, and the depth, and the currency of the information, and how that is making what we've traditionally called mainstream media practically irrelevant. I think that's an area that's changing very quickly, and for people who are connected, and it makes it so important that we get an NBN, for people who have both the opportunity and the skills to take advantage of digital communication, I think that's the new home of informed debate. That's enough of my soap box.

I'm going to ask for brief closing remarks from each panellist. Paul, what's the future and what do you need this audience to do?

Paul: I'm intensely optimistic. I'm intensely pragmatic but I'm intensely optimistic. I'm in a country with enormous resources. It feels like a frontier country to me sometimes. I think it is in this energy environment. You've all got to be evangelists for the cause. We all know what the problem is. We may debate the solutions to the problem, but we're all pretty focused on what the problem is and how to solve it. I think I couldn't agree with Ian anymore because I think as we see the carbon price rolling out, people will gradually become -- just like GST, it will become a part of their life. They'll stop worrying about it, and then the political fodder will dry up. We'll get on with it. That's why I'm optimistic about it. Plus, my kids are giving me hell every day for leaving the lights on.

Hal: We have to be optimistic because the underlying thing is if we keep adding CO^2 to the atmosphere and that's growing every year, it's like a train coming on the tracks. We are on the tracks looking that way. The train is coming to us. It will hit us unless we do something. That's going to get worse and worse in the coming years. There is no escape from it. Either we change, we get out of the tracks, or we get hit. We have to be optimistic.

Fiona: I think small, local, community solutions round renewable energy will play a bigger role. I would also say around reclaiming water from waste sources for industrial processes, reclaiming a nutrient that can replace chemical fertilisers. I think we have this era of globalisation and I think pendulums always swing, they never seem to stop in the middle. They always go from one extreme to the other. We've been this rampant globalisation. I think we'll see a swing. I think we're already seeing a swing back to localisation where community really is important to people and whether that's a high-rise block of flats in the city or where I live in the country, I don't think that matters. Or whether it's a network like we saw in the Middle East, around the world of people that motivate each other for a cause. I think we'll see a revival of community as a concept and I think our whole nature of how we create infrastructure or maintain infrastructure or build infrastructure in the environment, whether it's energy infrastructure, water infrastructure, waste infrastructure, transport infrastructure, we'll all change around that.

Dr. Rose: I was starting to enjoy globalisation Fiona. (laughter) I'm not sure I want this localisation bit. I think in the next 20 years we'll see a worldwide ring of renewable power generation. The technologies already exist and in Europe they're talking about taking a lot of power from North Africa into Europe, and they're serious and have the money to spend on it. I think that we will see a skip across to Indonesia and a lot of Malaysia and Thailand and so forth has already

connected. I think we're going to see worldwide energy going in solar, wind, geothermal, whatever, before very much longer. I can't wait. I think that's what it's all about. The earth is on a 24-hour cycle, so why can't we get our power from Europe when it's daylight there and dark here? I think it will happen. It's a matter of time. That really is where the renewable future's going to come from.

Karyn: Thank you. There's another really important aspect of this energy question which is our behaviour as consumers, whether we're individual or business consumers. We'll be having another forum a bit like this one but not just like this one, on that issue, here on the 6th of December, so save the date for that one.

If you want to check under your seats, there are two little copies on USB of the Griffith Review taped to a seat somewhere near you. If you would like to keep this conversation going, log onto our Facebook page tomorrow where we're going to have a discussion thread open. Would you please thank our panellists Paul Meredith, Hal Gurgenci, Fiona Waterhouse, and Dr. Ian Rose.

We're also grateful to our Brisbane Institute partners, particularly the State Library of Queensland and Santos for their support of tonight's discussion. Thanks to you for caring enough about this pretty important issue to come along and give up your time and join in the debate. Thank you very much, and have a safe journey home.