Prof Enzo Lombi (00:00):

Good afternoon, ladies and gentlemen, and welcome to the session which is the Barbara, how duration our future and a supply. My name is Enzo Lombi, and that will be the MC for today. As I mentioned today, we speak about the future of energy in in this operation, which is dedicated really to Barbara Hardy. Probably I don't have to introduce Barbara Hardy too much, but Barbara started really working and as a leader in a science education, environmental advocacy, and in charity activities since the 1970s. And she had she covered a lot of position, including she was commissioner of the Australian heritage commission. And of course she's a co-founder of a nature foundation essay. Bubba was also instrumental in established the investigator science technology center and for her activities, she has been recognized widely for instance she was appointed the officer of the general division of the order of Australia in 1997.

Prof Enzo Lombi (01:12):

She received the award for a advanced and award in 1991 as a great award in 1992, the ABC Eureka award for advancement of science in 1994. And then she was named south Australian citizen of the year in 1996 and more recently senior south Australian of the year in 2014 Barbara also as had a very strong connection with soul three university. She's a graduate of both other university and Flinders university. And more recently she has been associated with a university of south Australia, and she has been the patron of the Bubba Hardy Institute, which was of course named after her. And I'm especially happy to to be the emcee today because my chair position as chair of environmental science and engineering at the university is actually named after, after Ababa Hardy. Today, we are going to hear from three very good speakers about about energy and the future of energy.

Prof Enzo Lombi (02:19):

And yesterday I was listening to some interviews. The Barbara Hardy gave her just last year in occasion of their 90th, whereas they on the ABC. And she mentioned that, you know, our economy depends very much on the health of our environment and the nexus between environment and energy is of course being at the center of the public debate in the last decade in relation to you know, the emissions due to energy production and other sources of greenhouse gases and the impact that they have on the environment. So today we will about about the energy industry and contest of what is been doing what has been doing in terms of solving the problem and ensuring environmental sustainability as much as a as a society development.

Prof Enzo Lombi (03:18):

And I guess that the you know, the nexus for me is very strong because we are now in a phase where the environmental sustainability is not just important per se, but it's also been the catalyst if you want to innovation in in the economy. So the first speaker today that I'm very pleased to introduce is my colleague Peter Murphy, he's the Stein leader for energy and advanced manufacturing in the uni university of south Australia, future industry Institute. He has been the first person to be nominated as a industry professor from the university in 2014 for in recognition of his activity at the interface between the academia and, and industry. And he is a worker in fact, in industry for over a decade before joining the university he's specialties is really, our expertise is related to advanced materials, but he has a very keen interest in regards to energy. So without further ado, Peter,

Prof Peter Murphy (04:29):

Thank you. Good afternoon. So kind of the next 10 minutes, I'm going to share some interesting facts with you about energy. And I think when you look at those three pictures on that first slide, I've lived here, my whole life, both of those pictures, I think we can relate to over the last two and a half, three years, we are a state in a phase of energy transition, and we're leading the world in that and the rest of the world is watching us keenly. So what I'm going to do to start with here is talk to you about the current state of our electricity grid in the country. How many of you actually know where our power comes from? When you look at this graph, I'll give you the quick caterer. If it's brown, it's brown, coal. If it's black, it's black call. If it's red, it's gas, if it's grain that you can see there, that is wind.

Prof Peter Murphy (05:16):

So looking at that, what you can say is that as a country, our power generation is absolutely dominated by brown and black hall. The two things that stand out there, perhaps the most essay where you can see that we've got no coal, electricity distribution, we haven't, since they shut down the port Augusta power stations, little over two years ago. And the other thing that probably stands out there that I'd like to point out is that mustardy, that must be yellow color that you can say, that's your rooftop, solar. So people's rooftop. Solar is starting to show up in terms of how much energy it is putting into the grid in this country. Now there's a great app that you can get on your phone. It's called pocket name. That's where this little map comes from on my left. And if I open my phone up and show it to you, it's a lovely little interactive map that gives you real time data about where power is flowing around the electricity network in Australia.

Prof Peter Murphy (06:17):

And it actually shows you the market price at 10 minute intervals. And you can see here if you're on the spot market. And that's where a lot of our small companies reside on the spot market for electricity, your power price fluctuates enormously. You can see across Australia, the states that except for Victoria there, that really are generated brown and black coal electricity generation tended to be cheaper at that particular time. That was at 1205 today, but great new lab place down light, it's called pocket name. It's available for Android and for apple it's free and it gives you great information. I will just pop back, look at the price of power there. If you want to start a controversial conversation in Adelaide, talk about the price of power. We all talk about it July last year, as you can see from that table, we went to number one in the world in terms of the cost of electricity.

Prof Peter Murphy (07:11):

Now we've probably eased off slightly since then because the wholesale prices have been dropping, but it wasn't really a ranking or a place that I think we aspire to get to, but we weren't number one. And when you compare it to the United States, you can see the great advantage that these other countries that have lower power costs have manufacturing, because we have to absorb those high power costs into the goods that we produce, the cheaper your power. Usually the Biddy applies in terms of your manufacturing sector. Now how much you know about the electricity network in our country, geographically, we have the longest interconnected power grid anywhere in the world. So we have a power grid that runs from canes up past canes and find north Queensland all around that onto the west coast of south Australia. There are certainly bigger power grids elsewhere in the world, but in terms of length hours is the longest.

Prof Peter Murphy (08:06):

That makes it a complicated thing. And as you can see, there are lots of small offshoots from it. You can see, unfortunately, south Australia is at the end of that network too. It's also quite obvious that Western Australia has remained completely separate. So here's the Northern territory. Tasmania is connected to the grid through the Basslink it that flows under bast right now, when we go into south Australia, we can see why we've had problems in recent times. The network here in south Australia is often described as stringy. So there's bits that go off. And if something happens to one bit, there, isn't another way to bypass it, to put power down it. And so you can see particularly places like air peninsula. You can see there, they've got a single supply line down the peninsula, also out into the river land and also up north.

Prof Peter Murphy (08:56):

If anything happens to there, to that link, to that part of the grid, those folks are in deep trouble because it's not easy to bypass it. It does mean repairing that part of the grid. And this is a diet that I think changed the way we look at energy power in this state forever. It's the great blackout. The 28th of September, 2016, those of you that were here or shore a member as an employee of the university of south Australia. I left this campus at five o'clock that day and pulled out on the highly straight. And I might at home two and a quarter hours later. It's not great driving home in the dark without street lights and traffic lights as unite. I think we saw how much chaos there is without an electrical supply. That was really to a large extent beyond our control. It was coolest by our severe weather system and embedded in that weather system.

Prof Peter Murphy (09:45):

Those black spots that you can see there were actually small tornadoes. So we do get small tornadoes in Australia. They hadn't hit pylons. They took down the main feed lines. Suddenly there was a great drawer on the interconnector from Victoria. So down to Victoria where the Intercon to interconnect is our, there was a massive drawer on it to try and replace the power it trip, get like a fuse. It tripped. And we went into a state being black. Yeah, that's not somewhere we ever want to go again, but I think it's forever more changed where we will go in the future. And you look at some of the great things we've done as a state. I'd say there's a lot of things to be proud of in terms of what we've done in recent time. We've got a battery, the world's biggest battery currently.

Prof Peter Murphy (10:27):

We've got another one about to come online at the top of your peninsula. That's received very little publicity. We're leading the world, we're showing the world, how do you tight, renewable energy, particularly what we call intermittent, renewable energy. So energy that isn't always there. So if the wind stops blowing, it stops. You've got a solar panel system at home. You know, when the clouds go over, suddenly your production of electricity drops and that's difficult in the electricity grid to cope with. So our cloud electricity grid is really doing things that it was never designed to do. And one of them is it was never actually designed to type power going back into it from us, from our rooftop solar. So we're asking our grid to do things that it was never designed to do. And in some ways, in some places it's struggling with that.

Prof Peter Murphy (11:10):

And this is one of the exciting projects that we've got coming up in the state. This is up at port Augusta, and this is the big solar reserve project for concentrated solar power and why this project is so significant is because it's what we call baseline, capable power generation. So baseline mains, it can be there day and night. And so what this particular system does is it uses great big mirrors to reflect sunlight to the top of that tower. It hates assault up to create a molten salt that is then stored. And at night time, it can be used to heat water to create stain, to generate electricity. So that's coming and that's certainly going to change the way that we look at renewables in this country systems like this are already up and running in Europe and the United States. And China is also going there at the moment that tower to give you an idea is more than twice as tall as the tallest building we have here in the CBD of Adelaide, that tower is huge.

Prof Peter Murphy (12:07):

Over 220 meters tall. It's a massive tower. It's going to be, I think, a great bit of tourist attraction out there. I think people you won't miss it. You'll certainly notice it. So what does our future look like in terms of energy as a state? What we are showing the world, how to do is to take wind power and to take solar powered electricity generation, and to combine that with an electricity grid, using a battery and to make the whole thing work, and we're doing it on a big scale, bigger than it's being done anywhere else in the world today. So the solution is a hybrid mix of energy generation, coupled with storage. Now, storage is really important and I'm sure you've all heard about the Tesla battery sitting up near Jamestown in the mid north of south Australia. The initial view of much of Australia, unfortunately, not south Australians, perhaps, but particularly the rest of the country was that we did that in case there was a blackout so that we could have electricity to our homes, as you would know that battery can't power, a lot of homes for very long.

Prof Peter Murphy (13:13):

But what it does do is it gives us time to address the electricity problem that we have the supply problem to find a solution, to provide backup power for that period, and to stabilize the grid to stop it tripping out. And since it came online, just before Christmas last year, it has been incredibly effective at doing that. So when we've lost some big coal-fired generators into state, our battery here in south Australia, the Tesla battery has actually stepped in and stabilized the power grid right throughout the country. And it can do it faster than any gas fired power system. It responds in what we call milliseconds. So fractions of one second, it starts to see the frequency dip because a big power generators dropped out into state and it instantly starts discharging. Now the quickest response before that was gas fired power generation. And that took a number of seconds, usually between five and 10 seconds to avert the sort of blackouts that we saw across the state. You need to have that incredibly rapid response. So that's what our battery is doing really well here in south Australia, it's actually helping the whole of the country and we're going to do it as flash three. The next two, I'd like to show you a video. I think this is really interesting. This shows you how they build one of these concentrated solar power plants. This is my last slide runs for about two minutes, 20 seconds. We'll run that place, have a look. This is what will happen up at port Augusta starting later this year

Speaker 3 (14:51):

[Inaudible]. So this facility is actually in Nevada was just under three years for this plan. The facility for the gospel had more than 11,000 each mirror driver, a hundred square maintenance. And what it does is attract the sun from morning till night. So it's a huge piece of glass that is tracking the sun over a hundred square meters of glass. It's a very heavy with a big tanks at the bottom. They're being built to store the hot salt it's circulated through that talent. One of the big challenges of building these systems is that they're often built and usually built in very oud environments. And the ring hears me remind my cations. So construction is not straightforward or simple. Then you see the mirror, the big mirrors going on some 100 square meters, 10 by 10 meters. [inaudible], as you can imagine, there's a big job there for someone that people don't make it, you lose about 10% of your efficiency that speaks to them from the end.

Prof Enzo Lombi (16:32):

Thank you. I'll hand over to next week. So then our second speaker is professor Frank Bruno franca is actually the of Stagen chair in energy. And again, it's from the future industry Institute at the university of south Australia and has been involved for over 25 years in research consultancy and teaching an era of Selma storage, which we just heard the Peter speaking about low energy buildings, air conditioning, refrigeration, and psilocybin. Right. Okay. Thank you.

Prof Frank Bruno (17:10):

Good afternoon, everyone. Yeah, I'll to that, we'll be talking about energy storage and particularly in relation to a grid with a renewable electricity grid. So I'll probably start off with the slide here. This, why is energy storage important? Well, the reason why energy storage is important with our renewable electricity grid is because renewable energy sources have a variable energy supply, like for example, solar and wind, and now won't match the electricity demand. So we require some sort of storage to try to get, get it to match, but also another, another good advantage of energy storage. If, if we look at this graph, it's, it's a a demand duration curve. So it tells you how much electricity demand is used for the percentage of the year. What it shows is that the grid is designed for a maximum capacity.

Prof Frank Bruno (18:03):

And what this shows is that the 24% of that maximum capacity is only used 1% of the year. So in fact, the maximum capacity of the grid is only used a few hours of the year. What it means is that we have to build more infrastructure, what we're building more infrastructure, which we're not using very much, and that's very costly. And that adds to the way our energy prices. So by using energy storage, we can actually try to avoid keep increasing that demand the peak demand. And so that, and overall lower the energy prices. Now, when we talk about energy storage technologies, I think the first thing that will come to people's minds is batteries. And Peter has explained how batteries donate actually only provide energy storage, but they actually stabilize the grid. They can quickly put electrical power on the grid in less than a second should another power supply dropout.

Prof Frank Bruno (18:54):

So that provides a new shear, which basically stabilizes the grid. One disadvantage of Bret batteries, I suppose, is they're still very costly. They're, they're expensive and also their life lithium-ion batteries typically have a life of 10 years as some other batteries have a life of 20 years and their depth of discharge reduces over time. So there's a number of disadvantages with batteries. However, if you look at this slide here, this shows the, the global installed energy storage that's connected to the grid around the world. What it shows is that 99% of energy storage is actually Palm anti-drug. So it's when water is pumped up the hill and when there's excess electricity, and then when it's required it goes down the hill and it turns to these turbines which generate power. So around 99% of energy storage connected to the grid is pumped.

Prof Frank Bruno (19:48):

Hydro. If we look at the other, which is 0.7%, and this is a study done by the international energy agency around half of that is actually compressed air energy storage. So it's where they compress air, mainly in Kevin's underground at high pressure. And then when the electricity is required, the pressure reduces and the air is used to drive turbines. So it's only half of that really, that that's batteries. So it's only a very, very small component and either they also find flywheels, which are starting to make their way through. Anyway, one thing that's missing there and it's, it's usually missed in a whole lot of studies is thermal energy storage that is storing energy as heat or cooling. So that's missing. And, and that actually happens to be a twice of the amount of the other. So it's around a one and a half percent. So that's been missing in this study. It's also missed, and CSRO is a renewable electricity grid study for 2050.

Prof Frank Bruno (20:53):

So it's quite significant. And growing now thermal energy storage, it's actually been around for a long time. So you'll be familiar with your hot water electric tanks they've been around at least since the 1970s, the whole idea of that was to make use of the cheap off-peak electricity during the night generated by the coal-fire power stations, which can't be turned off and you generate your hot water during the night. And then during the day you can basically use your hot water. And so that's a device that he'll S helped reduce peak demand. Then there's also a large hot water tanks in Europe. That's used to provide district heating and buildings, and in the United States, they actually use ice. They freeze ice overnight and then they use that to call buildings. So, so it's very popular there at the university of south Australia.

Prof Frank Bruno (21:42):

We actually have working on using what we call phase change materials as the material that stores the heating or cooling. The big advantage of phase change materials is that they can store a lot of heat or cooling in a smaller volume. So if you look at for example yeah, this tank here, if it was a liquid, if you had water, because water is a phase change material, would it, it can priests to ice. It's what we call a zero degree phase change material. So if, if, you know, if you have this big tank of water and instead you try to store the cooling as ice, you only need a small, a small tank about one third to one 10th of the size. Now ice is great. If you want to store the cooling at zero degrees, that's okay probably for air conditioning. But there are limitations. Well, we actually develop phase change materials that actually melt and freeze at any temperature from minus 50 up to 900 degrees. So if we have a specific application, like a 500 degrees, we try to tailor make a phase change material for that temperature. So it stores heating at 500 grace.

Prof Frank Bruno (22:51):

About five years ago, we actually we have a number of demonstration systems. This one here is one at Perilla premium potatoes. So this one here the, these are PCM tanks, phase change material tanks. They have materials that freeze at minus 11 degrees that happens during the night where on the, on this farm, they have a limited power capacity. So the phase change materials frozen during the night, and then during the day it melts and it provides cooling in these large store core rooms. There are about 2000 meters squared floor plan area and there's about 40,000 kilograms of phase change material for that. So it takes about 1% of the floor area. So this system is actually proven to work quite well.

Prof Frank Bruno (23:37):

Now, painters are already spoken about the concentrating solar power plant that's proposed to be installed in port Augusta. One, one thing I want to mention about concentrating solar power systems is that they provide a special energy. That what it means is that it can quickly put electric electrical power onto the grid, not as fast as batteries, but still pretty quick. One of the advantages of concentrating solar power plants, the only reason why it has a future really is because you can stall the molten salt as heat.

So, so here are these tanks and you can store it as heat. And what the advantage of storing energy is heat is that it's around five times cheaper than battery storage and thermal energy storage will always be cheaper than battery storage. So that is the big advantage of concentrating solar power plants.

Prof Frank Bruno (24:30):

Now, one of the things I've mentioned is that about trying to reduce that peak load, the peak load coincides with hot days in, in Adelaide. And so it's primarily due to air conditioning and refrigeration. So one of the things we really got to try to do is try to make air conditioning and refrigeration systems more efficient during this hot hot with them. Now at the university of south Australia, worked with Sealy international in about 10 years ago to develop what's known as the climate wizard. This is an air conditioning system. It's an evaporative air conditioning system, but the difference between this one and the ones you've probably used to that you've seen this one here, actually calls air for lower temperatures. And it also actually doesn't put moisture in the air that goes into the, into the building.

Prof Frank Bruno (25:20):

So for example, in Roxby downs, when we tested it there, we were able to call hot air from 43 degrees down to 13 degrees without adding any moisture in the air that went into the building. So that, that was one of the key advantages. And this unit has been sold around the world now, but only in commercial applications up to this point at the university, we're also working on building efficient refrigeration systems. So we're working on using CO2 as a refrigerant. One of the reasons is that the, the current conventional refrigerants we're using an air conditioning and refrigeration they're being phased out that's because they have a higher what's known global warming potential. We using carbon dioxide as the refrigerant, the Glo, the global warming potential of carbon dioxide is one. And the refrigerants we're using at the moment is somewhere around 400 up to a thousand.

Prof Frank Bruno (26:13):

So you can see it's a a much more environmentally friendly refrigerant. The problem, the CO2 refrigeration systems is that they are inefficient in warm climates. That's why these are very popular in the UK. They work very efficiently there, but not in the warm and hot climates of Australia. So what we've done is we actually have incorporated the, this climate wizard product into the CO2 refrigeration system. And as a result last year, we proved that we've actually developed the world's most efficient refrigeration system, because CO2 is also very efficient re refrigerant for refrigeration systems.

Prof Frank Bruno (26:51):

And one of the other things we've been working on over the last couple of years is about integration of renewable energy technologies. So over the slide, you can see we've got our CO2 refrigeration system, which operates very efficiently throughout through all conditions. And we have we, we can source electricity from either the solar PV or the electricity grid. And we actually have, what's known as a cloud-based control and that they will determine whether we should without electricity, if we should store it in the battery or whether we should store in our phase change material, thermal energy storage system, where energy storage is much cheaper. So you'd expect this energy storage system to be much larger. And the, and then the, the cold room here can either get the cooling from the free melting the phase change material or directly from the CO2 refrigeration system.

Prof Frank Bruno (27:38):

So anyway, a system based on these technologies integrated this way has actually been installed and was commissioned last month at the the Benz motor sports park. So over here, you can see, you can see the refrigeration system, you can see the phase change material thing with storage tank, and you can see the climate wizard. So by integrating all these technologies we have what's known as a very energy efficient refrigeration system that can source renewable energy and can basically optimize the storage through the, into the battery or the thermal storage system. And that concludes my section. So thank you.

Speaker 5 (28:23):

[Inaudible]

Prof Enzo Lombi (28:23):

Thanks, Frank. And the last speaker for today is Dr. Steven Berry Steven has had a long career in the stack and public service managing government policy and programs to improve their energy and greenhouse gas emissions performance up of the stadium building sector. And I've recently moved to the university of south Australia where he pursued his patient for investigating how we can improve the quality of people's lives or better building and pursing design and the application of renewable Steven.

Prof Peter Murphy (29:03):

So I'm going to change the pace of this. I want to start talking about people rather than technologies, because technologies only exist to serve us. So we faced some massive challenges, some incredible challenges. And as a festival of of ideas, we should be talking about big ideas, big ideas that can change the quality of people's lives. So we need to be thinking about how to address a whole bunch of huge, enormous, incredible challenges. And so what I'm going to do is take you through some of these issues and then talk about the solution. Well, that was quick energy costs are ridiculous. As we saw earlier, south Australian energy costs are the highest in the world. They may have dropped a little bit since then, but they're still ridiculously high. And that has impacts huge impacts. We've gotta be very conscious about what that means to people.

Prof Peter Murphy (30:13):

And so there are lots of people out there who have to choose between paying an energy bill and food piling in energy, bill and medicines, pairing an energy bill or providing shoes and clothing to their kids. So they can go to school. Yeah, these are huge issues. And we have to think about how the hell do we address this? Yeah, there is massive social inequity because of the decisions that we make. And I spent a lot of time researching with families who are struggling with these, these tensions. And I can see the mental health and physical health consequences of higher energy costs. At the same time, the climate is changing and it's changing fast. You'll be surprised how fast the climate is heating up. And this is a massive issue that we're probably not taking it up or paying enough attention to what we're seeing is not only are we measuring the climate, increasing the temperatures increasing, but we're also, we're also able to see what impact that has on the natural environment, what impact that has on the animals, the trees, the vegetation, what impact that has on people.

Prof Peter Murphy (31:43):

We got to move from a situation where we have too many ridiculously hot days already to doubling that number, to move towards more than a month of days where it's over 35 to graze. Yeah. And this is not very far away for us. Whew. We're increasing the number of days above 35 degrees all the time. And that has consequences. People die when it's too hot. People die. When it's too cold, the body doesn't cope very well with extremes, our network costs. And we talked about those a little bit. My colleagues talked about those earlier. Yeah. You'll be surprised that yeah, 45% of our total energy bills are actually related to, you know, a small number of, of hours of infrastructure need. We have to build it to cope with the extremes, but maybe we can solve that. And of course, energy security we've talked about that nowhere else in the world has lived through energy security issues to the degree that we have recently. And so we know what to do. It's like to lose power right across the state. The economic consequences are massive health consequences, massive for that. So yeah, these are big issues and we need a solution for that.

Prof Peter Murphy (33:05):

We also, at the same time need to grow out our economic wealth as a state. We need to build up the number of jobs we need to build up the economic wealth of the people. And that's an important part of, of what government does as a role. So how do you balance all that? Well, one of the big ideas, why are the big solutions is actually a really, really simple one. We call them net zero energy homes. That is homes that are so super efficient, that they don't need much energy, if any energy to be thermally comfortable all year round. So they don't get hot in summer, too hot. They don't get too cold in winter. And then they fall of energy, efficient appliances and equipment. So they don't use much energy for others. That's stuff that there are a lot more than that, but that's an easy way of trying to understand them.

Prof Peter Murphy (34:12):

I have a wonderful demonstration site here in south Australia. We have probably the most environmentally sustainable residential village in the country Lochiel park. And we do our research out there. We're privileged to do that. The people of Lochiel park are just wonderful people. We collect data from every home every minute of every day. And we have for some eight years or so now we have a ridiculous amount of data. We know everything that happens out there. Yeah. We, we, we collect watered Archer and gas doctrine, electricity Dodger, and a whole bunch of other stuff. We know how many times they flushed the toilet. Yeah. Panther. We sit around going, oh, block number 32. Just flush the toilet. No, but no, we we see when people do stuff, when we understand why and how people do stuff, and that estate is a sensation or a state, the houses are a minimum, excuse me, 11 and a half star thermal comfort.

Prof Peter Murphy (35:15):

When they were built, the building code was moving from four to five stars. Now it's six, but these homes are seven and a half. They're way more comfortable. Mind you. They're not 10 out of 10. They're only seven and a half, but some of them are a bit, a bit better than that. They have solar hot water systems. They have solar, solar, PV systems to generate most of their own electricity. And it's fascinating to see what happens when you build super homes with lots of great technology and put normal people in them. They're just ordinary people in the, these homes. And we find out lots of stuff. And so can you actually create these net zero energy homes? Or we actually have some homes out at Lockhill park, a net, zero energy homes that is, they generate more, they produce more electricity than they ever used.

Prof Peter Murphy (36:10):

Many of the households that local park have never paid an energy bill, never paid an energy bill after eight years. That's a pretty good deal. Yeah, I'd like to be in that situation that I never have ever have to pay an energy bill. And so that changes the way people think and the way people act and it changes their quality of life. So what we can see here is what we build now is new homes are horribly energy inefficient that disastrous. And it means that we've got a legacy of crack homes with people suffering with high energy bills for a long time, the existing homes are a little bit better related to the fact that they are average size of existing homes are smaller than what we build. Now. They're not so energy efficient themselves, the existing homes, but they're just smaller. Okay. We'll park homes are as big as, as a new homes that we build here, but super efficient and provide a much better energy profile for that. Are they affordable? Is it realistic?

Prof Peter Murphy (37:27):

Everybody who buys our home, that isn't where it isn't a net zero energy home is losing money. So this is data from real homes. They actual cost of doing them. We find that on average, you will make $25,000. If you have a net zero energy home compared to an ordinary home, yes, I cost a bit more, but you can pay off your loan faster because you never pay an energy bill and you're healthier. You're more comfortable. You love living in those homes. There's a lot of other benefits. The kids can learn easier. Your productivity is better at work. There's a whole bunch of, of positive externalities from this, but you're financially better off. And of course the state, and we've done the research into this as well. The state is incredibly better off if we change and we regulate. So every single new home must be net zero energy. So big ideas providing big solutions to the big challenges we face. So thank you very much.

Speaker 5 (38:47):

[Inaudible].