ABC

HD **Solar, the next generation**

WC 10,246 words

PD 9 May 2014

SN Australian Broadcasting Corporation Transcripts

SC ABCTRS

LA English

CY (c) 2014 Australian Broadcasting Corporation

LP

Hopes for Australian budget 2014

Australia playing catch-up with Europe, US and **China** in deploying renewable **energy**

TD

Death spiral begins for Australian electricity companies

Elizabeth Kolbert - The Sixth Extinction

Steve Jones - The Serpent's Promise - The Bible retold as science

Robyn Williams: This week the 52nd Australia **Solar** Council industry conference has been on in Melbourne, so does this herald the deployment of spectacular new **solar** technology across the nation? Don't believe it. After all, this is Australia.

The Science Show on RN. Yes, the **solar** brilliance is there but Australia seems to have a strange reluctance to join the 21st century. Hello, I'**m** Robyn Williams. And lots of other Welshmen in today, which can't be bad.

Meanwhile, the budget. Ah yes, the budget, you've noticed. Has the discussion about the budget been driven by imperatives about the future, our health, innovation, education? Who better to ask than Professor Attila Brungs, Deputy Vice Chancellor Research at the University of Technology in Sydney.

First of all Professor Brungs, congratulations on becoming, eventually in July, Vice Chancellor.

Attila Brungs: Thank you very, very much, I am really looking forward to it.

Robyn Williams: And looking forward to the budget, what would you most like to see, if all goes well, on Tuesday?

Attila Brungs: One of the things I most want to see is a recognition by the government of the absolute criticality to the nation of science and research, and I think that can be best exhibited if they take seriously all the listening that they actually have been doing around infrastructure, the funding of infrastructure research, quantum of research funding, and also looking after the future. So we've got whole schemes like Future Fellowship programs.

Robyn Williams: Of course the Prime Minister has said he is the Prime Minister for infrastructure, hasn't he.

Attila Brungs: He has indeed, and that's perhaps why…and even there was a speech by Minister Pyne this morning at Monash University opening one of their excellent pieces of infrastructure they have down there…that again, I've got cautious optimism. He indicated quite strongly that they had been listening to and understanding just how important base infrastructure is for all research endeavours across Australia.

Robyn Williams: Well, that's the optimistic view, but of course there aren't terribly many votes in science, are there?

Attila Brungs: No, science is never a vote-winning issue. People vote for other things; health, roads and all sorts of very important things. I think part of the issue is they don't realise that the health that they get today, the well-being they enjoy today is entirely due to the research that happened 10 or 15 years ago. The jobs that they get so much satisfaction from today, the jobs we can create today are often based on

service innovations, research innovations, manufacturing innovations that happened 10 or 15 years before in research.

Robyn Williams: And how could you get that message across effectively?

Attila Brungs: I think there are many people across the nation trying to do that. I think Professor Chubb is doing an excellent job. I think the universities of Australia for the first time are actually contributing to the debate in talking about, you know, how do we keep Australia clever, not only through the wonderful education we want to give to our students and the youth of Australia but also how important research is in playing that. I think there are a whole host of players now really taking that responsibility seriously.

CSIRO has for many years had a very strong communication arm. I know my group of universities in the ATN, we are producing case study after case study, story after story in relating how research actually impacts everyday lives. You've heard of The Conversation, a wonderful piece, again getting academics to connect directly with the public to just explain in the simplest way here's the latest bit of research and how it affects your lives, how it makes a difference for you.

Robyn Williams: Okay, so infrastructure, communication, a sense of the future, an underpinning of wealth. What would you not like to see happen in the budget?

Attila Brungs: Well, you have the Commission of Audit come out and they've made some very, very interesting suggestions across a whole host of fronts. Some of them I find frankly contradictory. They want to get rid of sector-specific funding programs, yet at the same time say the government needs to be more directive in where the money needs to be spent. That seems somewhat counterintuitive to me. And they've made a number of recommendations for other cuts, the CRC program, for example.

Robyn Williams: That's the Cooperative Research Centre, that was surprising, wasn't it.

Attila Brungs: Absolutely, particularly given…again, I've had a lot of engagement with the industry minister, and I know their absolute deep commitment to getting universities, researchers in general and industry to work more closely together. The good news I suppose, even in the Commission of Audit, was that while they were proposing cuts to the CRC program they said the quantum of dollars invested in university and industry research should not change, and that money should be redirected. That of course is a matter for government policy of how they want to do that. So I would like to make sure that that quantum of dollars would grow, certainly not shrink. And the Commission of Audit said it should not shrink.

Robyn Williams: What about CSIRO?

Attila Brungs: CSIRO is an absolute asset to the nation, we are very fortunate to have a research organisation whose whole charter and essence of being is actually to do research that makes Australia a better place and improve the lives of Australians.

Robyn Williams: And finally, what about the young people involved in research who really need some sort of continuity. Instead of, what, two years on, two years off, you know, two years driving a taxi, two years doing research and wondering where you are going to be next year, that surely is terribly unfair after having studied for so long?

Attila Brungs: Absolutely, and there are a number of ways of solving that problem. We have excellent programs the government currently has around the Future Fellowship schemes, they fund early and mid-career researchers. That again is another one of the funding cliffs coming up, but the government seems to be indicating that they've been listening quite strongly to all of the universities. And it's odd that universities get all together around issues but we've all gotten together and said it is those types of things for our young researchers that we need to give more continuous funding to. Similarly getting longer grants in the MHMRC and ARCs, again to allow early and mid-career researchers to have more certainty of their future.

Robyn Williams: And it's quite cheap really, isn't it, science?

Attila Brungs: Science is…particularly when you are funding the people part of it is actually quite cheap. Again, I'm biased, I have a completely biased perspective, but the value for money you get out of it is quite incredible.

Robyn Williams: Thank you very much, and I'll talk to you after the budget has been delivered.

Attila Brungs: I look forward to talking to you then, thank you.

Robyn Williams: Professor Attila Brungs is Deputy Vice-Chancellor Research, soon to be Vice-Chancellor at the University of Technology in Sydney. A budget summary on The Science Show next week on RN.

The sun shone in Melbourne this week, the National **Solar** Conference, and one of the leading innovators in the field is, appropriately, the University of Queensland where the sun rarely sets. Paul Meredith, our first Welshman, has been leading a big team who want to know how best to put those panels on your roof or how best to convert Dickensian power stations into modern ones. This is how it's happening experimentally:

Paul Meredith: If we take the two flavours, if you like, of **solar energy**, that is to say photovoltaics where we directly convert sunlight into electricity using a **solar** panel, and then the other flavour which is **solar** thermal where we take the sun's heat and we concentrate that heat to heat a working fluid and then produce steam to drive a turbine. The basic technology is, well, decades-old to be perfectly frank. I mean, we've been using **solar** thermal for as long as man's been walking. But certainly **solar** photovoltaics has been around for probably 30 or 40 years, and it's very similar to its current form right now. So you wouldn't say there is a technological revolution. What you would say is that our need and our appreciation of what you can do with these technologies is emerging very, very rapidly, partly by need of course because of the need to produce clean, renewable **energy**. But also partly because the systems that we put around the basic elements which generate the electricity are getting better and better and cheaper and cheaper. So we are now seeing more tractable applications of both photovoltaics and **solar** thermal.

Robyn Williams: I'**m** very keen to know about the things that you've been doing actually in the real world, not just in the lab but out there, taking old-fashioned power stations and making them different. Give me some examples.

Paul Meredith: Okay, well, a lot of the challenges and issues that we face in deploying this stuff in what we now have as a conventional electricity network and creating power for people, is about how these **solar** PV panels or the **solar** thermal systems interface with our conventional grid systems. And that's very much an engineering endeavour of course, and it requires people to start testing systems at a scale which is meaningful. It's all very well and good putting a couple of **solar** panels on your roof and plugging it into your house and using it to drive your television or washing machine. It's a completely different issue to put megawatts of **solar** PV or **solar** thermal either into an industrial setting or indeed deploy the stuff at a utility scale.

So we've taken a pretty systems-based approach in our work and we've got a number of projects where what we are actually trying to do is test how these systems work at a scale which generates meaningful data for people to deploy at the megawatt scale and hundreds of megawatt scales. So we have projects in both photovoltaics and we have projects in **solar** thermal.

Before I describe a couple of those, it's probably worth noting that **solar** thermal is seen very much as a technology that can be deployed at the utility scale, that is to say to replace, for example, a **coal**-fired power station. Whereas **solar** photovoltaics, and this is predominantly the way that it has been rolled out across the globe, is more of a local affair, if you like. It's quite suited to putting five or six kilowatts on to somebody's house and using a fully distributed idea of how to generate power. So there are some quite subtle differences. That's not to say you can't deploy PV at the utility scale.

And so our photovoltaics projects, for example…one of the first photovoltaics projects we did was to deploy around about a megawatt of PV, that's 1,000 kilowatts, which is 200 times bigger than you'd probably put on your house, at our university campus in Brisbane, at the St Lucia campus. And that was really an exercise for us in learning how to do this from an engineering sense, how to put all these **solar** panels on the roofs of the university, how to optimise that system, how to select the right spaces to put it on and then how to connect it into our local grid that's inside the university and then use that power in a very effective way to both reduce our carbon footprint, to understand how to do it from a technical perspective, and also really to build the business model, to allow people to look at the data that we are generating to see how much electricity our **solar** panels were producing in Brisbane during the summer and the winter, 27.7 degrees south, and then really fully value that electricity in a consistent business model. And when we built it at the time, which was something like three years ago now, there was scant data available on developing that sort of business model, so people were generally reticent to do that because of course business is there to make money, and if you can't build a business case then you generally don't make an investment. So that was one project.

Robyn Williams: And what did you learn doing that?

Paul Meredith: Well, we learnt first of all that there is more than one way to optimise the system design. For example, in a simplistic sense you could say, okay, a **solar** panel will likely produce the most power if you just point it at the Sun at specifically the angle of your latitude, which for us is 27.7, and in the southern hemisphere you want to put your panel facing north at 27.7 and that should give you the most electricity.

It turns out however that is not a simple case. For example, if you want to generate as much electricity as you possibly can over the year then it's probably best not to have all your panels facing north but maybe

some of them facing west, for example, to flatten out that yearly profile. So we now have a really very good understanding of how you optimise the output of those systems.

I think the second thing we learnt was how to build this sort of system within our existing infrastructure, how to put them properly on roofs so that you didn't damage the building infrastructure you're putting them onto, in fact how you entranced the capacity of that building. That was a very interesting exercise as well because the roofs that we selected were all very different and we had to use some slightly different engineering approaches to get them on the roof in the optimised manner.

I think the third thing we learnt was how valuable this was. And we've been able to verify all the predictions we made as to how much electricity we would produce. We've been able to value that electricity now for the last 2.5 years, so we know exactly how much…I'**m** not going to tell you how much, but how much that electricity is worth to the university in terms of the avoided cost that it delivers.

Robyn Williams: Is it substantial though?

Paul Meredith: It is substantial. It's nothing to be sneezed at. And on the basis of that we were then able to build a business case and calculate the payback of the system based upon the investment that the university has made. So those were three first-order things that we learnt. I guess second-order things, we learnt that people were really interested in this stuff. We've had more than 1,500 visitors come and see our systems. We built a nice little web interface where people can log on, look at the data, see what our system is doing. It's quite compulsive viewing if you actually log on and have a little look, you can see what's happening at the UQ **solar** site pretty much every minute of every day. So that engagement tool really taught us something about what presses people's buttons.

Robyn Williams: It really amazes me because, as you say, you've had been putting **solar** on roofs for decades, and in places like Israel it has been compulsory on new buildings, and one would have thought that it's kind of done and set, finished.

Paul Meredith: Yes, one would have thought that it's kind of done and set and finished, but there is some learnings from us. I think every time you design and put a PV plant on somewhere it's very location-specific. There are certain constraints that you work with, for example if you are in North Queensland you might be afraid of the cyclones, so you would take that into consideration in your design constraints. Israel pays a different price for their electricity to what we may pay in south-east Queensland, for example, and so the value proposition is very different. Different **solar** panels behave differently under different temperature conditions. For example, thin film **solar** panels have got so-called different temperature, lower temperature ratings than silicon **solar** panels, so they work better at hotter temperatures. And these are very site-specific and condition-specific things.

You may as well decide that you want to match the electricity you produce to the demand that you have for using it, and that's a very site-specific thing. So although you are quite right in the fact that the first **solar** panels were actually deployed I think in Japan back in the '70s and are still operating quite nicely, thank you very much, and the Israelis have been doing it for several decades, as have the Germans, as have some elements of the American market, I think for us in Australia we've got our own lessons to learn and I don't think necessarily you are able to take somebody else's learnings and directly translate them to your own environment.

There is also a 'learning through doing' kind of philosophy as well of course, that if you do something yourself you tend to trust the outcome more than asking somebody else who's done it in a far-off, remote country.

Robyn Williams: And you're going to tell me now next about the **solar** thermal, maybe as applied to an old decrepit power station.

Paul Meredith: Yes, that's a really very interesting project. We are at the other end of things there, and I guess about 18 months ago a **company** called RAC, RATCH-Australia Corporation, they are the large Thailand-based utilities **company**, they owned a power plant up in North Queensland near Townsville called Collinsville, very near to the Collinsville **coal** mine that has been recently in the news. It wasn't a particularly big power plant, I think it was 60 megawatts total with three turbines, a conventional **coal**-fired power plant which was to be decommissioned and taken off the electricity market.

And RATCH, because they owned the facility and didn't necessarily want to see all of those assets being closed down, decided that they would look at the feasibility of transforming that old **coal**-fired circa 1960 power station into a modern hybrid **solar** thermal gas power plant using a gas-fired boiler to augment the steam that was produced from a **solar** thermal collector field. It sounds like a very nice plan. Why would you do it? Well, you may want to reuse the turbine sets that were sitting there that have been well paid for over many decades. You may also want to use the transmission infrastructure that was built to that power plant. So there were some good sensible reasons for doing it.

And so they approached us and asked us if we would partner with them as a research partner in this feasibility study and look at some of the more detailed aspects of how to build and integrate a gas-fired boiler, for example, with a **solar** thermal field. So they brought the technology to us, they were working with a German technology **company** for the **solar** field, and some standard technology with the gas-fired boiler, and over the last 12 to 18 months we've been working with them to really look at the feasibility of doing this. How do you technically do it? What of the assets up there can we reuse in a cost-effective manner? How should we optimise the combination of the gas-fired boiler and the **solar** field to get the maximum value out of the plant in terms of selling electricity back on to the national interest to market?

And these are really interesting questions, both from a fundamental perspective, the thermodynamics of running a gas boiler, for example, with a **solar** thermal field is very interesting indeed, and then of course the techno-economics of making this a valuable proposition. And so they are coming to the end of that feasibility study. I can't tell you what the outcome of that feasibility study is…

Robyn Williams: Give me a hint!

Paul Meredith: I think it's a very viable proposition. Look, ultimately Australia is playing catch-up, I'**m** not going to hide that fact, we are playing catch-up with our European cousins. We are playing catch-up with the United States. We are now even playing catch-up with **China** in many ways in rolling out and deploying renewable **energy**, not just **solar** but renewable **energy** in general. And so we are on a fast learning curve and I think we need to sprint up that learning curve, for many reasons. Do we want to be technology developers and sellers or do we just want to be customers is one question you should ask yourself, even given the fact that we have plentiful conventional resources at our disposal, gas and **coal** et cetera.

So this sort of project is very much a case in question of where for a relatively small investment you can do a heck of a lot of learning on the ground and start to do the type of business-related things that one needs to do, for example examine how you put these systems together, examine how to put together the purchasing and value chains to manufacture these things. Maybe this is an exercise in pre-manufacturing feasibility. Maybe the idea of us being a manufacturing hub for **solar** thermal systems is not ridiculous considering the denudation of our current manufacturing base and the need for replacement. So these are all I think very good, relevant and viable questions to be asking.

Robyn Williams: Going to Collinsville, I've got a picture of here is an old-fashioned power station where essentially you burn **coal**, you've got a fire, it heats water, turbines go around. Now, what you do instead is you take the water which is heated by the sun directly, so you've got your hot water, back into the turbines, they are going around, electricity. It doesn't sound too complicated a proposition. Is it?

Paul Meredith: At the very base level, no, it's not a complicated proposition. What it fundamentally boils down to is what have you got to do? Well, to run a steam turbine you need to generate steam at the right temperature and pressure…

Robyn Williams: As you said, boils down, yes…

Paul Meredith: That's what it boils down to, thank you! So really it is that proposition, and since the invention of the steam engine we've understood the power that we can produce, and really the technical question, the engineering question boils down to how do you do that at the highest thermodynamic efficiency? And we do know that a higher temperature steam produces a more efficient thermodynamic cycle.

And so one of my all-time favourite projects currently being built in the world is the Ivanpah project in California which is a very, very large **solar** thermal power station. And ultimately I think that plant will be 390 megawatts electrical output in three very large **solar** thermal concentrating towers. A different technology to that which we are proposing at Collinsville. At Ivanpah you've got three massive towers and on the ground thousands and thousands of mirrors which focus the sunlight up into the centre of one of these towers or three towers when they are all operating, and at the top of that tower you can generate steam temperatures of 900 or 1,000 degrees centigrade. Whereas the sort of steam that we are generating in a gas boiler, for example, or the type of system that may be involved at Collinsville would maybe only be 400 or 500 degrees centigrade. So the thermodynamic cycle efficiency is considerably better, as so there's a big move actually globally now in the utility end of **solar** thermal to move towards high temperature steam systems.

And so your question about what is tough about it is really getting the last ounce of thermodynamic efficiency out of the system for the number of dollars that you invest in that system, both in its capital expenditure and then of course the costs to run that plant over its lifetime. So that's really the balance dynamic that one is dealing with here.

Robyn Williams: Maximum efficiency for your money. But is it happening across the land? Will all this **solar** brilliance be realised? Paul Meredith is professor of physics at the University of Queensland.

Can you see us sprinting towards 2020 and having the kinds of technology that you talked about as replacing the old-fashioned 19th-century kind?

Paul Meredith: We have a particular environment in Australia, I mean electricity environment, which is going to make it actually rather difficult for us to at this moment in time deploy a considerable amount…let's focus on the **solar** power argument, I think the argument goes equally well for geothermal, for example, as well. It's going to make it actually quite difficult for us to deploy very quickly large amounts of utility-scale **solar** power, whether it be **solar** thermal or whether it be **solar** PV, and that is the structure of our grid and our electricity transmission systems, so the poles and wires that take the electrons from the power station and deliver it to an ABC studio.

We have one of the longest, thinnest, stringiest electricity networks of any country in the world. Our western side of the country and eastern side of the country are not connected by a wire, so we have separate grids on opposite ends of the country. We don't have electricity transmission infrastructure in areas where you might plausibly and viably build very large **solar** plants, for example in the desert regions of the inland over the Darling Downs and towards the northern territories in Western Queensland.

These are quite significant technical problems. So to deploy large amounts of utility-scale **solar** power would require a rethink of our transmission systems and our distribution systems, a quite dramatic rethink. And if you also think about it from the economic perspective, some quite dramatic policy changes in the way that we run our electricity markets. Can we overcome these barriers? Of course we can, need will drive. Can we have massive rollout by 2020? I would personally and pragmatically think not. We are now beginning to build the first utility-scale **solar** PV plants.

Another project that we're involved in that we haven't talked about is the AGL **solar** PV plant down in New South Wales. Two sites, Nyngan and Broken Hill in inland New South Wales, both with good electricity transmission infrastructure, 159 megawatts total on the two plants. That will be deployed and rolled out by I think probably pragmatically the end of 2016. That will be a large **solar** power plant, one of the biggest in the southern hemisphere. Could we replicate that on a multiple basis fast? I think that would be very difficult for us to do, both within the current regulatory framework and planning framework that we have, and simply because of the current status of our electricity markets and the structure of our grid. To do that would require something of a scale of a kind of NBN for electrons, if you will excuse the phrase. It requires quite a systematic rethink of our national infrastructure, and of course that national infrastructure cuts across state boundaries, it cuts across jurisdictions, et cetera, et cetera.

Robyn Williams: 'Et cetera, et cetera' sums it up. Paul Meredith, professor of physics at the University of Queensland, and director of UQ **Solar**. And the national **solar** conference was on in Melbourne this week.

This is The Science Show on RN, where a couple of weeks ago Jess Hill presented at Background Briefing on the price of power. In it she gave an indication of what's behind the inertia Paul Meredith talked about. Here's Jess Hill with a summary for The Science Show of her report.

Jess Hill: If you've noticed your power bills going up, it may not be because you're using more electricity. Australian electricity prices have doubled over the past few years. We now pay some of the highest power bills in the developed world. The Prime Minister has blamed the price rise on the carbon tax and the renewable **energy** target. He says the target is significantly pushing up the price of electricity.

So what makes up the bulk of that 100% increase? Well, 20% goes to your **energy** retailer. That pays for things like customer service and marketing. Another 20% goes towards the actual electricity that you use, and around 50% of your bill is paid to network companies who own and manage the poles and wires. The portion of your bill that's going to network companies is slowly paying off the $45 **billion** investment they made into the poles and wires over the past five years. That money was spent because, according to the network companies own data, **energy** demand in Australia was rising fast and the poles and wires weren't big or strong enough to cope with it.

So in 2009 the Federal **Energy** Regulator approved **billions** of dollars worth of investment into the grid. That very same year however, for the first time in Australia's history, demand went down, and it has gone down every year since. But even as the data showed that **energy** demand was falling, network companies insisted it was rising and continued to spend **billions** of dollars on the poles and wires. We are now paying off every dollar of that through our electricity bills.

Nationally, **energy** demand is now lower than it was in 2006. That's partly due to the loss of manufacturing and the rollout of **energy** efficient appliances. But it's also because in the last six years 1.3 **million** households have installed **solar** panels on their rooftops. Thanks to the sharp rise in our electricity bills, **solar** panels are now not just an ethical choice, they are an economic one, and they are saving people up to 60% on their **energy** bills. That might be a good deal for consumers but it's a disaster for the traditional power industry.

Coal-fired power plants make their biggest profits in periods of peak demand. There are two peak demand periods every day; one in the afternoon when kids come home from school, and another in the evening. During that afternoon peak over a **million** households are now getting their **energy** directly from the Sun, and many of them are feeding excess **energy** back into the grid. That is making life very difficult for the owners of **coal**-fired power plants. In fact the federal industry minister Ian Macfarlane says the cost of **coal**-fired power is lower than it was in 2001 and the **energy** market is now in oversupply. That's a problem, he says, and the traditional **energy** companies generally agree. By and large they want to see the renewable **energy** target reduced.

Solar panels have one fundamental drawback though; they can't make **energy** at night. Until people can afford batteries to store the **energy** they produce, they'll have to remain connected to the grid. But some **solar** analysts believe that we will see commercially available battery storage systems within the next year or two. And in Queensland, Ergon **Energy** says that within a decade it will be cheaper for their customers to use **solar** with battery storage than it will be for them to buy power from the grid. This is what the power industry calls the death spiral. It goes like this: as electricity gets more expensive, it makes more sense for people to install **solar** and perhaps leave the grid entirely. That means the power industry has to recover their costs from a smaller group of customers, which means they are forced to raise their prices. This makes more people leave, prices get higher, more people leave, prices get higher…you get the idea. Power companies say it's not fair that consumers who don't have **solar** should have to pay more than people with **solar**. But the real reason people are paying so much for electricity is because of the $45 **billion** that was spent on the grid, some of which was based on demand predictions that were wrong.

Bruce Robertson, a beef farmer from Burrell Creek in New South Wales, played a key role in exposing the network companies' faulty demand projections. He says the incentive to overinvest is clear. He says, 'These electricity distribution companies that build the poles and the wires are paid purely based on their assets. They are not paid on the amount of electricity delivered, they are not paid on the efficiency of doing that, they are only paid on their assets. So if they build more, they get paid more.' What Bruce Robertson is referring to here is the 10% guaranteed rate of return the network has got over the past five years for every dollar they spent on the poles and wires. That rate of return was granted to them by the Federal **Energy** Regulator, who says it was necessary at the time because after the GFC it cost a lot for companies to borrow money.

But it's clear where that rate of return went. Data from the Australian Bureau of Statistics shows that two years after the investment began in the grid in 2009, the electricity industry's profits had risen by 67% to $9 **billion**. During this same period, our electricity prices rose by over 40%. The Senate held an inquiry into the price of electricity in 2012 and found that the overinvestment in the network had been driven by this perverse incentive to invest.

The Labor MP who chaired the committee, Matt Thistlethwaite, says he visited a $30 **million** substation in Newcastle that wasn't even connected to the grid because the **energy** demand that had been projected for that substation never eventuated.

Robyn Williams: Jess Hill, who asks; with infrastructure projects as large as any in Australia's history, why wasn't the public consulted? And if you're going to build a huge electricity grid for the future, why didn't the blueprint take sufficient heed of **solar** and other renewable **energy** options? Jess Hill's Background Briefing was broadcast on April 27, it's very much worth listening to. There's a link on the Science Show website on RN.

Also on RN on Breakfast this week, Elizabeth Kolbert talked about her now famous book, The Sixth Extinction: An Unnatural History. Yes, there have been five other massive extinctions, and few understood until recently what was behind them. Elizabeth Kolbert is talking from her home in the US with my colleague Greg Borschman.

Greg Borschman: Crafting a credible script for the end of the world as we know it is fraught for any science-fiction writer. It's even more fraught when you're talking about the real thing, and blaming it on humans. So for credibility reasons alone, you'd expect the task would fall to a well-credentialed peer-reviewed scientist. It didn't. Journalist Elizabeth Kolbert, staff writer for The New Yorker magazine since 1999, took on the job. She admits she needed lots of help. So why did she do it?

Elizabeth Kolbert: The reason such a book could be written by a journalist and on some level maybe even had to be written by a journalist is that scientists are increasingly specialised, everyone is looking at a narrow slice of the problem. And although many of the people that I certainly went out with have a very big-picture view, they don't really talk to each other that much.

Greg Borschman: Is that a bit of a worry? If they're not talking to each other they are probably not talking to anyone else, certainly the wider public.

Elizabeth Kolbert: Well, I think that one of the reasons really that people were so generous with their time to me, and I got to go on some quite extraordinary expeditions, is that that they really would like this message and the contents of their work to reach a wider public. But that is not the job of scientists, for all sorts of structural reasons that have to do with what scientists have to do to get grants, and it's generally to publish in scientific journals, it's not to be a populariser, which is actually a very fraught occupation for a scientist.

Greg Borschman: Can we come to what is being called the sixth great extinction or the Anthropocene later. Let's look first at those earlier mass extinction events. The world has seen five of them in the last 450 **million** years. What triggered them? Because they were all different, weren't they.

Elizabeth Kolbert: Yes, and there was a moment in time, if we'd had this conversation maybe 20 years ago people might have told you, well, maybe we will find some commonality to all of these events, we are going to find the key that unlocks them all. But I think people have rather given up on that, there does not seem to be just one single cause that can explain all of these mass extinctions in the record. And in fact the thinking has come 180 degrees and now what I've heard scientists say is, well, perhaps it's just the fact that they are so freakish, they haven't happened before in the history of life, that makes them so devastating, because obviously if you've never encountered something in evolutionary history, it's that much more dangerous.

Greg Borschman: Yes, but climate change and catastrophe certainly figure highly.

Elizabeth Kolbert: Yes, climate change of one kind or another. I mean, if we look all the way back to the very first of these extinctions about 440 **million** years ago when life was still predominantly confined to the water, there was very little life on land at that point, it seems to have been caused by a sudden cold snap, a glaciation event. And then when we look at the very worst of all mass extinctions, which occurred about 250 **million** years ago, that was a very warm spell, that was a time of very significant climate change in the opposite direction.

Greg Borschman: In some ways the most recent extinction that happened at the end of the Cretaceous, 65 **million** years ago, is the most interesting, not just because it wiped out any land-based animal bigger than a cat, including the great dinosaurs, but because even until the last decade or two there has been enormous dispute about what actually caused it.

Elizabeth Kolbert: Yes, one of the interesting things that happened is that Darwin, to name one very, very important figure in this story, didn't believe there was such a thing as mass extinction. He felt that all extinctions happened individually, species died out because they were out-competed by another species. And that was the dominant view from Darwin to very recently, and even when people saw in the fossil record these moments when there seemed to have been very sharp breaks and very calamitous drops in the diversity of life on Earth, they were sort of embarrassed by that, they didn't know what to make of that, they just said, well, we must be missing something here.

And then in the '80s a pair of American scientists out at UC Berkeley came up with the theory of what had caused dinosaurs to go extinct, and many, many other creatures, and they posited that it was an asteroid impact. And that really flew in the face of this idea that there is only gradual change on Earth, and this was a sudden and disastrous event, and it caused a real ruckus in science, and it took quite a while for people to get their minds around that. But now it is quite widely accepted that the dinosaurs and 75% of species on Earth were killed off in quite short order by an asteroid impact 65 **million** years ago.

Greg Borschman: It's incredible, isn't it, because when that theory first came out, as you say, in the late '80s, early '90s, it was described as codswallop.

Elizabeth Kolbert: It's actually a very interesting story about how science does respond to the evidence, and that's a case where scientists had to look at the evidence…at first they resisted it but eventually the evidence became overwhelming.

Greg Borschman: Elizabeth Kolbert says the evolutionary history of the world is a story featuring 'long periods of boredom, interrupted occasionally by panic'. So are we in one of those periods of panic? And how did a so-called weedy species, Homo sapiens, come to be the culprit?

Elizabeth Kolbert: Well, the Anthropocene, the definition of it, if you will, is it a new geological epoch in which human influences on the planet are the dominant influences, even on a geological level. And there's a great deal of formal debate about this in geological circles, even as we speak; should we formally rename the period that we live in, which is officially known as the Holocene? And its defining characteristics would be…have human impacts really overwhelmed the great forces of geology that have shaped our planet for hundreds of **millions** of years? And increasingly many, many scientists would say yes, we have become the dominant force on the planet. We are clearly not the only force on the planet but we have become the dominant force.

Greg Borschman: You detail recent extinctions or near extinctions, the Panamanian golden frog, the great auk, the Sumatran rhino, but you then say there is a bigger point, it's the pattern that they are participating in. What do you mean by that?

Elizabeth Kolbert: Well, I think that we can see what links this current extinction event to the past extinction events is very dramatic changes going on at a rate that many species can't adapt quickly enough to, and that is really unfortunately what's going on and why we are in danger of precipitating another very, very serious extinction event because we are changing the world, and ocean acidification is a very good example of that. Reefs have gone out in the past, there have been moments in time when there have been no reef-building organisms, and those were associated with some of the worst crises in the history of life. So that is not something to take lightly at all, that's something to take very, very seriously.

Greg Borschman: And you also highlight a contradiction, that people care about extinction, enormous efforts go into conserving the last of a species—for example you point to the Hawaiian crow, extinct in the wild but 100 left in captivity—and yet we are pushing our nearest relatives, other great apes, almost certainly over the abyss.

Elizabeth Kolbert: Yes, it is really interesting, and definitely one of the themes of the book is that people are many different things. What it means to be human is unfortunately full of contradiction, and one of these, as you say, is that we are absolutely heartbroken by the loss of a species. And I visited several animals who were among the very last of their kind, and the people who were taking care of them and desperately trying to keep these species alive, the Hawaiian Crow, another one was the Sumatran rhino where you have basically 100, 200 individuals left and people are going to tremendous efforts to try to keep these species alive.

On the other hand, all of these forces of change that we've set in motion—climate change, ocean acidification, moving species around the world, which is a tremendous problem in Australia, you have tremendous problems with invasive species, as I don't need to tell you, mowing down habitat—all of these big, big drivers of extinction continue to have this interesting way in which we go to great lengths for individual animals. We go to great lengths for the trees, meanwhile the forest continues to be felled.

Greg Borschman: So with the forest falling all around us, what's driving the inability to see that, or at least acting to prevent it? Instead of blaming the failings of science, is this a problem of perception, or simply belief? For example, a poll taken by the Pew Research Centre in the US late last year found that a third—yes, one-third—of all Americans reject the idea of evolution, including 64% of white evangelical Protestants, and 48% of all Republican voters.

Elizabeth Kolbert: Yes, I think that we have a real unfortunate mismatch between our capacity as a species to alter the planet using very, very sophisticated science and our willingness to get our heads around what is some pretty basic scientific facts. I guess I'm going to call evolution a scientific fact, and that is particularly true in the US unfortunately.

Robyn Williams: I wonder why? Elizabeth Kolbert from The New Yorker magazine with Greg Borschman from RN Breakfast, on her book The Sixth Extinction.

Which brings us quite naturally to God, and another Welshman. Steve Jones is a rapscallion. He tells tall stories. He's having fun, as he should, given his eminence at the University College in London where he is professor of genetics. His latest book is called The Serpent's Promise: The Bible Retold as Science, and he gives a clue about what Liz Kolbert was referring to at the end just now.

Your book is called The Serpent's Promise. Now, what was the serpent's promise?

Steve Jones: Well, it's the serpent's promise to Eve. I've just been in New Zealand, which is, as also New Zealanders believe, as close as you can get to the Garden of Eden in this modern world.

Robyn Williams: I agree with them.

Steve Jones: And of course what happened was in the original Garden of Eden a serpent appeared (it was clearly an Australian import), and offered this alien fruit to Adam and Eve. And the promise the serpent made to Eve, and I'll translate the Latin, was, 'If you eat of this fruit, ye shall be as gods, knowing of good and evil.' And so she ate of the fruit and they became knowing of good and evil. What was the first thing they noticed? Well, the first thing they noticed meant that they had to put aprons on immediately, so that's when sex began, that's when all the troubles began. And they were thrown out into the real world, or into Australia, which approaches closely to the real world. And that word scientia is at the centre of my book, knowledge. Knowledge was scientia, that was the promise, you will get knowledge.

And of course science gives us knowledge. In some senses, if you want to be overdramatic about it, it gives us…at least genetics gives us knowledge of good and evil because the sin of Adam and Eve loaded us all

with original sin, with inborn failures and weaknesses which we either can, according to some religions, or cannot, according to others, do something about. That's what DNA does of course, you can now scan people's genes, and you can ask questions, is it the case, and it does indeed seem to be the case. Are there genes that vary from person to person that make somebody perhaps more likely to be violent under certain circumstances? And I would say that the evidence is quite strong that there are. That's a scientific issue.

But the interesting point then is what do you do with the scientific information. Then it becomes a theological issue, not a philosophical issue. You see that most of all in a really very grizzly field, which I'm passionately opposed to, which is the issue of the death penalty in the United States. There have been cases in the US where murderers, people who are clearly guilty and have often done it under the most vicious circumstances, have appealed against the death penalty on the grounds that they had some inherited defect that made it impossible for them to control their rage and their anger.

Robyn Williams: Sort of biological original sin.

Steve Jones: Yes, it is a biological original sin. I think to you and I and perhaps to no doubt the majority of your audience that would seem a reasonable argument; I wasn't possessed by gods, as you were in the old days, I was possessed by the double helix, please forgive me, shrive me of my sin. And in general I have to say that doesn't work as an argument, it hasn't worked.

The state of Georgia, when that argument began to be used, the President, what was his name, George W Bush, I'm not sure what became of him, immediately changed its laws about the death penalty to say that anybody who poses a continuing threat to society shall be subject to the death penalty. So what that means is if you say, 'I've got this gene that made me do it,' off you go to the death chamber. Now, I hate that idea, but I have to say that the logic of 'kill me' is as strong as the logic of 'forgive me'. And science can't interfere in that argument. And I think that's what an awful lot of the religious people who've complained about my book, and take it from me, there have been lots of them…

Robyn Williams: I've read them, yes.

Steve Jones: What they don't see is that there is a limit to science. Science produces facts. What you do with that fact is a matter for society.

Robyn Williams: Let me just quote you AC Grayling, the philosopher, who you know I think, and he said that science and religion have the same origin; ignorance.

Steve Jones: I would be a little bit more positive and say 'curiosity', because I'm sure that we are the only creature that know that we are ignorant. I think that's central to the human condition, is curiosity, to find why does this happen, why are there men and women, why is there death? And these are the questions which of course the Good Book asks.

There is a spinoff on that statement which is perhaps my favourite quote from Darwin, and I can bore you for hours with favourite quotes from Darwin, as I'm sure you can. Darwin, in a letter to somebody criticising another piece of work, said, 'Ignorance is more often a cause of confidence than is knowledge.' Now, that's a very powerful statement, that should be tattooed on the forehead of every geneticist, if not every scientist. If you don't know what you're talking about, you can be completely certain that you're right. And the history of genetics is exactly that. Francis Galton, who was Darwin's cousin, wrote a book about hereditary genius in which he became convinced, with no evidence whatsoever, that people…that genius, crime and all these things were in the genes, in the DNA as we'd say today, and that led to the horrors of the eugenics movement, which did dreadful things, with complete ignorance.

Now I think in my science, and I hope in other sciences, at least we understand that we are ignorant. And in genetics and we are much more ignorant than we were 10 years ago. It's much, much more complex than we ever thought. And I look forward to the headline I hope in my lifetime, 'DNA is not the genetic material'. We aren't quite there yet, but it turns out that DNA is just one small part of an astonishingly complicated machine that we scarcely understand. So I hope that geneticists will stop blathering about their science. I won't, but I hope the rest of them do.

Robyn Williams: Yes indeed. Let me hit you with another quotation, which is in your book, and it's Napoleon talking about the function of religion. What did he say about the rich and the poor? That religion is what stops the poor from killing the rich.

Steve Jones: Yes, that's right. He said, as you said, that religion is what stops the poor from killing the rich, and that's one of the models of the origin of religion. But he also read a book by Laplace, a great mathematician, about the universe. And I've tried reading and it's heavy going, I can tell you. And he said to Laplace, 'Why is there no mention of God in this book,' and Laplace said something which is very precious to me, 'I have no need of that hypothesis.' Saying that God did this doesn't add anything to the argument.

And I think Napoleon's later statement about how religion is the only thing that stops the poor killing the rich is a matter of observation. There is a science, a stronger science than you might think actually which, again, I knew nothing about, which looks at the science of religion. Why do we have this strange thing…?

Robyn Williams: Indeed, that's what I wanted to ask you, the evolutionary significance. Because even though you say that religion is here and there and somewhere else, it's virtually everywhere.

Steve Jones: Yes, it's virtually everywhere, but you can say with great confidence when the kind of religion which is powerful, with a God that is up there that scrutinises one's every move every day, when did that begin? That began quite certainly with the origin of farming. And you can see early cities in the very first days of farming, much earlier than people had thought actually, which are replete with symbols and with temples, and that reflects without question the development of social class.

Robyn Williams: But what about the hunter gatherers, what about, you know, if you look at primitive societies they had totems, they had witch doctors, they had people doing ceremonies, they buried their dead with ornaments.

Steve Jones: Yes, they did, to a much lesser degree. In fact what you find is that many hunter gatherer societies do have a belief in a god, there's no question of that, but it's a much less specific belief. The god is up there but it's not really interested in them. There is a god that causes thunder, there's a god that causes the Sun to rise, but is not intimately concerned with their sex lives, that they've been to church three times on a Sunday, that they have to pay their tithes, all this kind of stuff. Those kind of socially powerful religions begin with inequality, and that's true across the world.

There is enormous differences from place to place in the proportion of people who claim to be religious, and there's an almost uncanny fit between a particular measure, which is called the genie index, which is a measure of inequality, how flat is the income distribution. You know, the inequality is very high, let's say in the United States, it's much lower in places like, say, Finland. Across the world in every continent, within the United States in every state, there is a linear direct relationship; the more unequal a society, the more religious it is. Now, I can't help thinking that is trying to tell us something.

Robyn Williams: It's to keep the peasants under control.

Steve Jones: That's one view. A more optimistic view is that it's to draw people together in order that they stop fighting among themselves. And there is some evidence that that has happened in some circumstances. Religious communes tend to last much longer than nonreligious communes. So the problem isn't necessarily religion, the problem (and it's an overwhelming one and always has been) is religion.

Robyn Williams: Plural.

Steve Jones: …because once you've got these warring groups then everything falls apart, and that's the history of history, is groups with different mindsets. I say, perhaps rather daringly…I believe it, many people despise the notion, that actually we are on the edge of a new global universal system of thought. It's not a religion. Some people might say it is a religion. But it's called science, and the science I do is the same as the science a **Chinese** person does or a South American does, and you see that in scientists, a completely open exchange of ideas. You will never, ever see that in religion.

Robyn Williams: In religion you have to have things without doubt. You know, this is the catechism, this is what's right, this is the law. Whereas in science you are changing the laws all the time.

Steve Jones: Yes, there are doubts, but the doubts are thrown in…you know, they grease the wheels of religion. You're allowed to have a few doubts. But too many doubts, you're out of the religion or you are being burnt at the **stake**.

Robyn Williams: Instead of being infallible, the Pope is less fallible.

Steve Jones: Yes. If I had the desire, as every scientist of course does, to start learning Norwegian, in other words to win the Nobel Prize, what would I do? The only way I could win the Nobel Prize would be to prove that evolution never happened. Now, I don't think I'll ever do that because the evidence is overwhelming that evolution did happen, but there is a possibility that that could take place. It took place, more or less, in physics in 1904 when the then president of the Royal Society said to the amassed physicists, 'Give up doing physics, it's over, it's done, it's finished.' 1905, relativity, quantum theory, the whole of physics (one level) fell apart, completely surprisingly. And no religious person could countenance that. And that's the difference; science is for pessimists, religion is for optimists. And, being Welsh, I've always been a pessimist.

Robyn Williams: Final question, something that was thrown at Richard Dawkins after he wrote The God Delusion and various other people who have put science and religion together, were you accused violently of not knowing your theology and therefore getting it all wrong?

Steve Jones: Yes, again and again. And I put my hands up, you're right guv, I don't know your theology. I've tried to read it and a dark mist comes before my eyes and I can't understand a word of it. My response to that argument is if you read my book, and if you don't like it, burn it, but at least pay for it first.

Robyn Williams: Exactly. Well, the trouble with that sort of argument—you don't know your theology—it's an unlimited accusation. There's no way you can ever know enough.

Steve Jones: Well, the same is true of science. I mean, Darwin was more or less the last person to know everything about biology, and Milton perhaps was the last person to know everything about everything. I don't think anybody could know everything even about cell biology today, so it has got bigger and bigger. Science I hope is more humble than it used to be.

Robyn Williams: Thank you Steve Jones.

Steve Jones: Thank you.

Robyn Williams: The Serpent's Promise is the book, published by Little Brown, and Steve Jones is at the University College in London, professor of genetics. A longer version of that chat is on RN TV, do watch, there's a link on the Science Show website.

Next week, citizen science, the present revolution.

Production by David Fisher and Russell Stapleton. I'm Robyn Williams.

NS gsci : Sciences/Technologies | ntra : Transcripts | gcat : Political/General News | ncat : Content Types | nfact : Factiva Filters | nfce : FC&E Exclusion Filter | nfcpex : FC&E Executive News Filter | niwe : IWE Filter

RE austr : Australia | brisbn : Brisbane | melb : Melbourne | usa : United States | victor : Victoria (Australia) | apacz : Asia Pacific | ausnz : Australia/Oceania | namz : North America | queensl : Queensland

PUB Australian Broadcasting Corporation

AN Document ABCTRS0020140512ea590000b

