Right Climate for Nuclear Power

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Whatever your take on climate change, nuclear power is the safest option for averting Australia's looming energy crisis, argues Bright New World Founder Dr Ben Heard.

Once upon a time, Australia made the National Electricity Market (the NEM), geographically the largest electricity network in the world. The NEM operated efficiently for many years until the conditions on which its design was predicated began to erode.

With coal as the mainstay of our electricity supply, we were somehow caught short as power plants began to reach economic end-of-life. By 2040, 70 per cent of Australia's 23,000 megawatts-electric (MWe) of coal generating capacity will be 50 years or older. Our protracted political fight on climate policy left Australia with a policy vacuum for long-term energy investments. Irrespective of personal beliefs about climate change/anthropogenic global warming, it is locked in as a risk on the radar of banks and utilities, an inescapable reality in a globalised economy. Australia may have run, but we cannot hide much longer. Our longstanding over-reliance on coal and our failure to diversify has left us exposed.

The only durable energy policy has been our Renewable Energy Target. This policy efficiently identified and incentivised investment in the lowest-cost renewable options: on-shore wind and fixed solar photovoltaic systems. But it was blunt, simply rewarding clean electricity production, whenever it happened to be produced. New, climatically variable capacity was brought to market with the benefit of subsidy and without any associated reliability support. This hastened the process of fossil fuel retirement, cutting our greenhouse gas emissions but also diminishing system reliability. Australia became more dependent on responsive gas generation, but at the same time as growing LNG exports tightened our local supply.

Our energy crisis has been at least a decade in the making and likely will be at least a decade in the fixing. Anyone with a platform tells Australians that we must solve an energy 'trilemma'—establishing a new energy system that is at once clean, reliable and affordable. This very framing of the debate is a fallacious artefact of our determination to exclude the energy technologies that are at once clean, reliable and affordable by design.

If Australia lay down on the counsellor's couch to talk about nuclear power, we would find a patient wracked with hypocritical self-loathing. We sell uranium to the world for power generation and forbid ourselves from using it. We run one of the best research reactors in the world and squabble about managing its modest waste stream. Australia's 'environmental' movement fights to maintain and deepen that dysfunction. While shouting the urgency of climate change action, Australian environmentalists sabotage that message by cherrypicking evidence to attempt to dictate a limited and inadequate portfolio of solutions. They regularly demonstrate that cutting greenhouse gas emissions is less important than getting their own way. They demonstrate the very petulance they mock in those still arguing the basic science of climate change.

This author, originally (still?) an environmentalist, identifies with an evolved school of thought called eco-modernism. Eco-modernists take climate change so seriously that we would never presume to artificially constrain options in our energy system. Renewable technologies, energy storage, demand management, nuclear fission and sequestration must all be on the table. Eco-modernists face up to our gravest challenges, but we do so by recalling and focusing on the innovative, successful and progressive side of humanity. We choose informed optimism. Ecomodernists cherish modernity, and the breathtaking progress of humanity achieved through access to energy. We want to boost energy access since human development must flourish, both as a moral and an ecological imperative.

OUR PROTRACTED POLITICAL FIGHT ON CLIMATE POLICY LEFT AUSTRALIA WITH A POLICY VACUUM FOR LONG-TERM ENERGY INVESTMENTS

As humans embark upon futures of greater opportunity, we swiftly choose smaller families, putting the essential boundary on population that can help us achieve sustainability. Clean, dense energy, in conjunction with human ingenuity, then lets us develop substitutes for services currently provided from nature. We can use that energy to shrink the footprint of our food production, our habitats and our resource extraction and consumption such that natural and wild places can

sustain and then grow into a stronger, healthier planet. To protect that which is truly scarce—such as endangered species and intact biomes—we must make clean energy truly plentiful.

Excessively leaning on the diffuse, variable energy of the sun and wind provides no prospect of this future. The inclusion of nuclear technology brings the vision of a high-energy/clean-energy planet into reality. Nuclear technologies can dispatch electricity when needed even re-using existing sites of fossil generators, close to our cities, and without any fossil carbon fuel. Where black coal holds about 30 MJ of energy per kilogram, mined uranium in a standard reactor offers about 500,000 MJ per kilogram. Humanity has little prospect of devising a better battery than a pellet of nuclear fuel. That's what we used to call energy storage after all: fuel. Once used, those pellets are easily and safely stored for future recycling to produce perhaps 25 times more energy without mining any more fuel.

It is inarguable that nuclear meet the 'reliable' and 'clean' aspects of the trilemma. The contemporary question mark sits over the affordability. The 400-plus reactors in operation around the world today have historic data proving their affordability. However, the restart of nuclear construction in the United States, Great Britain and Western Europe has been fraught.

Australia must avoid the error of Anglo-European bias in assessing the available evidence. Australian investors would demand a competitive global tender, inviting bids from providers in China, Korea, Russia, France and Argentina. That's what Australia did for the OPAL reactor at Lucas Heights, with Argentine organisation INVAP delivering arguably the best multipurpose research reactor in the world. That's also how the United Arab Emirates launched a nuclear power sector. That nation, with less underlying expertise than Australia, is now poised to commission 5.6 GWe of nuclear from a turn-key project delivered by Korea, from a standing start in 2009.

Large programs of large reactors can be a great way forward. But they do present genuine deployment challenges. Our ability to connect large nuclear plants without enhancing our transmission network is constrained. This is not an intractable barrier. The Australian Energy Market Operator recently touted the development of Renewable Energy Zones in remote Australia, requiring a major expansion of transmission capacity. That same investment in a reinforced grid would also facilitate large nuclear plants. Systematic exclusion of nuclear power means Australia literally has no idea what the optimal mix of infrastructure spending could be to achieve the necessary energy transition.

> TO PROTECT THAT WHICH IS TRULY SCARCE SUCH AS ENDANGERED SPECIES AND INTACT BIOMES WE MUST MAKE CLEAN ENERGY TRULY PLENTIFUL

The same is true of appending storage infrastructure. Storing surplus electricity production makes sense when the marginal economic and environmental cost of production is low. This is the case for solar PV, wind, and also nuclear fission. The difference is that wind and solar might be in excess supply occasionally, such as high production/low demand periods in spring and autumn. A nuclear fleet could utilise energy storage infrastructure reliably, by maintaining full production

every night for storage, with supply re-dispatched the following afternoon. Storage should be used in conjunction with all these sources, but what is the optimal mix for lowest average cost? We don't know, because we refuse to look. We pretend instead that energy storage is a trademarked product of the wind and solar industry.

Whether nuclear electricity is affordable or not also depends on cost of the capital. With build times of 4-6 years, the levelised cost of nuclear electricity can appear overpriced if compared with other quickly-delivered options using discount rates of, say, 10 per cent and short amortisation periods. Such analyses are overly simplistic. Where wind and solar have expected lives of perhaps 20-25 years with declining performance, nuclear power stations have design lives of 60 years, potential life extension to 80 years or more, and potential power uprates based on technology improvements. Plants commissioned this year, such as the new AP1000 and EPR in China, might have taken five years to build but are likely to be operating at full capacity in the year 2079! Such plants provide power reliably, in all weather conditions, as well as providing vital inertia to stabilise the electricity grid.

Assessing such infrastructure as electricity-only with a 10 per cent discount rate reduces any benefit beyond about 20 years to nearzero. Is this the right decision? If a dominant assumption in analysis (commercial rates of return for energy investments) is not in the service of our goals (reliable, affordable, clean energy to serve coming generations) it behoves us to check the assumption. This is where the commercial use of nuclear technology intersects with modest government intervention in the form of impartial access to low-cost money for long-term clean energy investment.

The other pathway is for nuclear technology to change its product to reduce both the capital cost and the exposure to cost of capital. Enter the Small Modular Reactor (SMR). SMR refers to reactor units of 300 megawatts-electric (MWe) or smaller. SMR power plants will be built with several units at the same location, operated via a single control room. Factory-based manufacturing raises quality, boosts learning and hence lowers capital cost. 'Drop in' delivery of the reactor unit to a completed balance-of-plant lowers overall project risk. Early revenue can flow from the operation of the first units while further units are manufactured, delivered, installed and commissioned. Smaller operating units facilitate connection to existing electricity networks with minimal upgrade requirements. The appeal of this type of nuclear is obvious but we must apply caution and reasonable scepticism. At the time of writing none of the above is operational. SMRs are not rolling off production lines like jet-airliners. Designs must be completed and licenced. Order books must be filled. Factories must be constructed, workforces deployed, all to deliver the evidence that matters most for a smaller nation such as Australia: reality.

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While the SMR road is littered with attrition, there is cause for genuine optimism and even a measure of excitement. US company NuScale is licensing its 60 MWe reactor. This is based on

the pressurised water reactor technology that dominates the world today. Arrays of up to 12 units will create power stations of 720 MWe, greatly enhancing the load-following ability of the nuclear plant. These small, integrated reactor units are placed in their own reservoir of emergency cooling water, rendering the design passively safe. NuScale's first customer is ready to build the licensed design, and recent testing confirmed the design will produce 20 per cent more power than originally touted.

The Integral Molten Salt Reactor (IMSR) from Terrestrial Energy is in the second phase of pre-licensing vendor design review with the Canadian regulator. The IMSR uses liquid fuel in the form of a molten salt with dissolved uranium fuel. The sealed reactor vessels are designed for seven years of continuous operation and then lift-out replacement with new units. The physical behaviour of the liquid fuel renders runaway over-power events impossible. The IMSR has an outlet temperature of 600ºC, suitable for many nonelectrical industrial processes such as hydrogen production and the subsequent production of ammonia, as well as mineral beneficiation and food processing.

So, picture a new Australian energy system. We use developments in software to help us manoeuvre some of our loads. Existing roofs with low-cost solar panels take advantage of our sunshine.

> THE FUTURE OF NUCLEAR TECHNOLOGIES REMAINS INNOVATIVE, EXCITING, AND TOTALLY CLOSED TO AUSTRALIA

We deploy small nuclear reactors at strategic nodes across the grid, utilising existing plant locations and transmission networks. We develop only the optimal sites for pumped hydroelectric storage, letting us drink the available sunshine during the day, catch the surplus wind and nuclear power whenever it is available, and re-deploy this energy to maintain smooth, predictable prices. We keep an efficient amount of fast-response fossil gas and we build a rationalised transmission network, no more than our requirements, sparing our landscapes that unwelcome intrusion.

The future of nuclear technologies remains innovative, exciting, and totally closed to Australia. While there is no guarantee that any utility or investment group would select nuclear technology as a new investment for our market, they must be given the option. Otherwise we can be confident that Australia will finish as an energy loser in the crucial decades to come.

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