Australian Government

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National Electricity Market Reform – A blueprint for the future

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If you ask a friend what's the most complex machine in the world, their answer will depend on their background.

A physicist will tell you it's the enormous hydrogen-fusion reactor under construction in France.

A biologist will tell you it's the human brain.

As an engineer, I'll tell you that the Australian electricity grid is a contender. I am in awe of the five thousand kilometre long network that stretches from the far north of Queensland to the west of South Australia.

The National Electricity Market, fondly known as 'the NEM', is a stupendous feat of engineering blended with sophisticated market economics and governance. Its formation was a powerful example of co-operative national economic reform.

But in its essence, it is one giant physical machine.

And as you know, every machine of any type needs preventative maintenance to minimise the risk of breakdown.

In September last year, the electricity supply in South Australia blacked out. This was the first time an entire state had gone dark since the NEM was formed in 1998.

In response, COAG Energy Council commissioned our Review.

But our Review was not tasked to analyse that one event.

The primary purpose of our Review was to develop a national reform blueprint to maintain security and reliability in the NEM.

To do so, my fellow panel members – Chloe Munro, Karen Moses, Mary O'Kane and Terry Effeney – and I, drew on our collective experience in electricity generation, distribution, retail, governance and commerce.

We conducted an exhaustive consultation process, with large industrial users; energy companies; industry groups; consumer groups; academics; public servants and ministers.

More than 390 submissions were received.

The panel attended more than 120 meetings with stakeholders.

Around 450 people attended consultation sessions.

Internationally, we visited regulators and operators across Europe and the United States.

On our request, the International Energy Agency, headquartered in Paris, prepared a review for us of international best practices.

We commissioned independent economic modelling of various scenarios.

Finally, we asked the power systems engineers in the Faculty of Engineering at the University of Melbourne to look at how the physical electricity system would perform under our policy scenarios.

Throughout, we identified ways to ensure the optimal operation of our electricity system in Australia.

And the deeper we dived, the clearer it became to us that to capture these opportunities the NEM needs to embrace new technologies and practices.

As we engaged with individuals, companies and organizations across the five states and one territory of the NEM, the cries for change were loud.

The common chorus we heard was that the NEM needs to evolve much more quickly than it has to date. "Business as usual is not an option", they said.

Historically, our electricity system has served us well, but as we described in the Preliminary Report last December, the NEM was designed for a different world.

The economics were different.

Demand grew every year.

And prices were low because most of the coal and hydro generators were established by state governments.

The technologies were different.

Until about a decade ago we had enjoyed a hundred years of technological sameness.

Electricity generation technologies got better decade by decade, but they were fundamentally the same as their predecessors. Whether their primary energy source was coal, gas, diesel or hydro, they all operated as so-called "synchronous" generators.

Electricity flowed in one direction, from large generators towards end users.

The electrical load curve during the 24 hours of the day rose and fell smoothly and predictably. Thus the coal fleet could slowly ramp its output up and down to match the load during the daily cycle.

Those days are irrevocably gone, here and around the world.

Consumer demand patterns have changed.

Disruptive technology has lived up to its name.

One technological disruption is that ever cheaper wind and large scale solar, even without subsidies, are dominating investor interest.

Investors prefer wind and solar because they are now cheaper to build than traditional generation such as hydro and coal.

Investors also like wind and solar because they can be rolled out in small steps, say 100 megawatts at a time, then scaled up to meet demand. This minimises the risk that by the time a much larger project is finished the increased demand might not have materialised.

A second technological disruption is the nearly two million rooftop solar generators that householders have installed.

The electrical load curve and the generation mix now ramp rapidly up and down during the day to the extent that it becomes difficult for slow-responding baseload generation to cope.

The market into which coal generation operates has been forever changed.

A third technological disruption is just beginning, delivered courtesy of stunning improvements in battery capacity and cost.

This is a grassroots revolution. It's driven by billions of people wanting their smart phones and laptop computers to last longer between charges.

To meet that market pull, global manufacturers have invested massively to improve the performance and lower the price of rechargeable batteries.

Re-purposing these batteries has enabled manufacturers to configure grid scale batteries. These are now being installed internationally at a level and cost that were unimaginable five years ago.

And sitting right alongside, we have the prospect of pumped hydro storage, for which many sites have been identified in Australia, including the Snowy Mountains.

A fourth technological disruption results from the fast evolving digital technologies that dominate our lives. Uber, TripAdvisor and Netflix have disrupted the way we commute, travel and seek entertainment.

So, too, digital technologies are poised to enhance our electricity system, allowing it to flexibly accommodate millions of distributed rooftop solar generators, two-way current flows and the connection of microgrids.

The final disruption is that homeowners are becoming market participants. Empowered by friendly software, they are keeping tabs on their own power generation, storage, demand management and electric heat-pump heating.

Further, there is the imminent possibility of a shift to electric vehicles.

For the past eight months, I have observed our electricity supply struggling to cope with these disruptive changes.

But I don't want to exaggerate. The system is not broken.

It is, however, at a critical turning point. We must improve on what we have, to prepare for the growing wave of disruptive changes sweeping electricity markets here and around the world.

Globally, policy makers and market bodies understand that the key driver of that change – technology – cannot be reversed.

When we met our counterparts overseas, the thing that made the biggest impact on me was the long-term policy certainty in other countries, which enables them to efficiently plan for the energy transition.

It is clear they are ahead of us.

For example:

- Ireland has a multi-year program, *Delivering a Secure, Sustainable Electricity System*, to actively integrate renewables into the power system.

- The United States has the *Quadrennial Energy Review,* to enable the modernisation and transformation of the electricity system.

- And New York has the *Reforming the Energy Vision* strategy, which establishes targets for emissions reductions, renewable generation and energy efficiency in buildings.

These examples illustrate the need for us to adopt a more proactive approach in Australia.

The design and governance of our electricity market will need to be resilient to match the constantly evolving market.

Resilience is achieved by *actively* integrating new technologies to ensure needs are met.

For example, when it comes to new generation technologies we can't afford to have them connect to the grid without giving due consideration to their impact on the whole of the system.

If we don't actively manage these issues, we'll end up swimming outside the flags.

Since its creation in 1998, the NEM has a strong history of security and reliability.

Between 2001 and 2015, the reliability target of 99.998 per cent was met at all times bar one occasion in Victoria and one in South Australia.

But since then, there have been warning signs emerging in the technical data.

- For example, in 2016, the NEM spent more time outside the expected operating frequency band than normal.

- And in 2015 and again in 2016 the level of system inertia in South Australia was lower than in the previous five years.

Everywhere we went in Australia, we heard first-hand the pain being caused by rising power prices.

We heard from the irrigators in rural communities who need electricity to pump water, from copper miners, from meatworks, from welfare groups representing vulnerable consumers – we heard the message loud and clear.

In the short term, the biggest cause of high electricity prices is the cost of gas, which is increasingly setting the prices in the wholesale electricity market.

In this regard, I note that the Australian Government made an important announcement yesterday about measures to increase domestic gas supply that will ultimately lead to lower gas and electricity prices.

Our Review shares the concern about gas supply, and we make recommendations related to landholder compensation, data transparency for exploration and fuel

contracts, case by case assessments, and last-resort intervention rights for the electricity market operator.

Other factors that contribute to high prices include substantial transmission and distribution charges. The Government announced yesterday it will address these through strengthening the hand of the Australian Energy Regulator and limiting the ease of appeal. These measures are consistent with our Review recommendations.

In respect to retail charges, performance and transparency are being considered by the Commonwealth Government, COAG Energy Council and the ACCC. Our Review endorses that work.

But for the longer term, it became clear to us that a more fundamental, underlying reason for rising prices in the wholesale market, especially in the price of forward contracts, is investor uncertainty. That uncertainty revolves around current and future emissions reduction policies.

In the long term, resolving this uncertainty will put downward pressure on prices by bringing new generation online.

This was the overwhelming position put forward by stakeholders during the Review.

We have thus recommended an orderly transition package that consists first, of an agreed emissions reduction trajectory, second, the Clean Energy Target to incentivise investment in generation, and third, a minimum of three years notice of closure to be provided by existing large generators.

This last provision, that is, the three-year notice of closure, will provide time for local, state and federal governments to assist communities affected by job losses and reduced economic activity.

Importantly, it will also send signals to investors that there is an upcoming electricity generation gap to be filled.

This orderly transition cannot be rushed.

I'd like to reflect for a moment on the difference between outcomes, as opposed to the details of where we obtain our electrical energy.

The Review takes the position that reliability, security, lowest cost, and reduced atmospheric emissions are the critically important outcomes.

The generation mix is an input. The exact mix of coal, gas, solar, wind and hydro is not important as long as the outcomes are met.

To minimise future price increases we will need a diverse energy mix, including fossil fuels.

Our modelled emissions reduction pathway is not a dash for 2030. Instead, it is a continuous trajectory in the electricity sector that reduces steadily towards zero in the second half of the century, consistent with the Paris commitments for the whole of the economy.

Along the way it delivers a 28% reduction in emissions by 2030, also consistent with the Paris Agreement.

Our modelling shows that under the Clean Energy Target there will be 42% renewable energy generation in 2030. The greatest proportion of that will be large scale solar and wind at 24%, up from 17% in a business as usual scenario. In addition, 8% comes from hydro, 9% from rooftop solar and 1% from biomass.

This renewable energy will operate alongside existing coal generators. These coal generators will supply 53% of our electrical energy in 2030. This is 4% less than under business as usual.

In 2050, our modelling shows coal will persist at a higher level than under business as usual. The reason is that with policy certainty, the owners invest in major refurbishments, thereby preserving the existing coal generation to achieve emissions reductions at lowest cost.

Because the Clean Energy Target is technology neutral, if the price of gas comes down in future to lower than what is currently estimated, then gas will contribute to a greater extent than we have modelled.

Consistent with the technology neutral approach to achieving the outcomes, we did not recommend any prohibitions on technology. As an example, if a coal plant were to be built with carbon capture and storage it would benefit under the Clean Energy Target at nearly the same rate as a wind or solar farm.

The key purpose of the modelling is to provide a basis for comparison between different policy scenarios.

As is the case with all modelling exercises, the modelling undertaken for this Review depends on the assumptions.

We have been very clear about our assumptions.

For example, we consulted extensively to determine the financing costs associated with project risk for large projects, and the financing costs associated with uncertainty risk in the absence of an emissions reduction policy.

We were conservative in our estimates of wind and large-scale solar generator prices. Indeed, in recent months the prices for wind generation have already come in lower than what we modelled.

Most important, our modelling shows that the price to residential consumers in the long term will be lower by about 10% compared with business as usual and for industrial consumers will be lower by more than 15% compared with business as usual.

I took into this review what I learned during my working career not only as a scientist and as a businessman, but as an engineer.

That is, engineering is the art of optimisation.

You can't build a bridge based on pursuit of perfection. That would be too expensive.

You can't build a bridge based on compromise. That would result in failure.

Instead, what you can and must do is build a bridge by optimising all of the variables.

Our blueprint seeks to co-optimise four outcomes in the NEM: future reliability, increased security, lowest possible prices for consumers, and lower emissions.

Not easy, but my colleagues on the Panel and I have no doubt that the combination of new technology with a strategic approach can do it.

To optimise these four outcomes there will be three enabling pillars.

First, the orderly transition that I described earlier, to bring into the market new generation and reliability.

Supporting this will be an obligation for new generators to be able to dispatch electricity to meet the extreme demand that occurs during Australia's hot summer afternoons.

The specifics of the requirement will be calculated for each state, looking at present and future needs, while avoiding heavy capital expenditures that would drive up end-user prices.

As an example, in a state like Queensland, the initial obligation on a 100 MW wind farm might be a requirement to provide power, even when the wind is not blowing, at the 10 MW level for 4 hours. The additional capital expenditure would be 10% or less, meaning that the new wind farm would still be cheaper than a wind farm of the same capacity built just a year ago.

There are many means by which this capability to produce power when needed could be provided. It could come from on-site batteries or liquid fuel generators, or it could come from a contract with new sources such as a pumped hydro facility or an off-site gas generator.

The second enabling pillar will be more system planning to ensure the ongoing security in each region of our electricity system.

And the third will be stronger governance through a new Energy Security Board. The Energy Security Board will be key to efficiently delivering the recommendations of the blueprint.

Further, it will help to coordinate market development, and it will provide an annual report to COAG Energy Council describing the performance, opportunities and risks in the electricity market.

Above all, our blueprint is a plan to preserve the security and reliability of our electricity system in the face of certain change. It is a plan to do both at minimum cost.

Minimum cost, but not the cheap electricity of the past. I wish it were possible. More realistically, our blueprint is about achieving the lowest prices for commercial and residential consumers into the future.

To do this, consumers will also need to be part of the solution.

They are at the heart of the energy transition and need to be the centre of governments' plans for the NEM.

For example, an important part of the Panel's blueprint is to reward consumers for contributing to reliability and security. Incentivising consumers to modify their demand will help to create a more secure, reliable and affordable NEM.

If we don't act now, Australia risks being left behind.

Our future will be less secure, more unreliable and potentially very costly.

Although we use the term in our modelling in a very specific way, there is actually no such thing as *business as usual* because the system is dynamically evolving.

The past is gone. That's why we subtitled our report a *Blueprint for the future*.

To preserve a stable system at lowest cost we need to embrace that future.

Embrace. Not race.

Move too slowly and we will miss out on what the future offers.

Move too quickly and we put at risk the stability and affordability of our electricity system.

Industry and consumers recognise this need for balance and have expressed their support for the Review's recommendations.

In that spirit, I warmly welcome the announcement yesterday by the Australian Government that 49 of the 50 recommendations made in our Review will be supported by the Commonwealth at the next COAG Energy Council meeting.

I am also pleased to note that the Government will continue to consider its response to the Clean Energy Target and will undertake further analysis.

To conclude, let me pay homage to the insights in the historical novel *The Leopard,* by Giuseppe di Lampedusa*.* I read this book when it was the prescribed text in my younger son's Year 12 English class, and its central message stuck with me ever since. Thank you Alex.

The novel opens in 1860 Sicily.

Lampedusa's protagonist is the Prince of Salina. He is the head of a regal family that enjoys feudal authority, until Giuseppe Garibaldi lands on the island to violently kickstart the unification movement.

The Prince's singular goal in life is to preserve his family's power. It's not working. His shrewd nephew sees the need to change with the times, and points out to his uncle that "everything must change so that everything can stay the same."

So, too, if we want to preserve the NEM as a stable and affordable electricity system, we have to proactively respond to inevitable change.

A more pragmatic statement of the same principle comes from Jack Welch, the former CEO of GE – the only company to have survived in the Dow Jones Index since the index was formed 110 years ago.

Jack Welch crystalized this principle when he said:

> *"If the rate of change on the outside exceeds the rate of change on the inside, the end is near."*

The lesson is that the National Electricity Market must change on the inside in order to remain effective.

As I said in the preface to the Review, we will know that we have been successful if, in three years from now, electricity is no longer a topic of discussion in the general community.

Thank you