

*Powering Up – Australia's opportunity to become a green energy global leader*

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WA Energy Conference  
Perth  
25 August 2023

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Did you hear the story about the two atoms walking down the street? One said to the other "I think I lost an electron." The other atom asked, "Are you sure?" And the first atom replied, "Yeah, I'm positive!"

I wish I could be equally positive about the next steps in the clean energy transition. We know what to do, but every day another impediment raises its head in a real-world game of whack-a-mole. It's worth reviewing a few of these impediments before we turn to the solutions and opportunities.

In my home state of Victoria, the developers of the 400-megawatt Willatook wind farm were stunned when the environmental assessment released a few weeks ago by the Minister for Planning made the project financially unviable. To proceed, the developers must reduce the number of wind turbines from 52 to 19 and limit construction to seven months of the year.<sup>1</sup>

The reason given was to avoid interfering with a small number of brolga cranes and bent-wing bats, despite mitigation plans offered by the developer.

It would appear that tougher conditions are being placed on wind farms that will contribute to the fight against global warming than are applied to the construction of country roads and high-rise buildings.

The irony is that by contributing to the fight against global warming, wind farms are helping to protect biodiversity.

In New South Wales, the major HumeLink transmission line has seen its initial informal estimate of \$1.35 billion in 2019 increase to a formal costing of \$3.3 billion in 2021, with a revision last month to nearly \$5 billion. This is a massive series of cost increases.

VNI West and Project Energy Connect have also been subject to major cost increases.

These soaring prices will inevitably increase the price of electricity in the east coast electricity market.

Nationally, although it was uplifting to learn that battery storage investment in the first half of this year was the largest ever, it was unfortunate to see that solar and wind generation investment in the same period was the slowest since the Clean Energy Council began reporting data in 2017.<sup>2</sup>

Last Sunday, a national poll reported that just 12% of voters nominated environment and climate as their top priority, compared with 48% who nominated cost of living as their primary concern.<sup>3</sup> The message I took from this is that if the national target of 82% renewables by 2030 leads to price increases for consumers, the clean energy transition will lose the support of much of the public.

Our society is extremely negative. I was on a panel recently at a writer's festival. The other panel members and the audience hated the coal and gas industry. They were angry that the government isn't cutting emissions fast enough. And they were also hostile against wind farms and transmission lines. What's left? I suggested to the audience that they need to give up vacation flights to Queensland, or overseas flights to see their children. Silence.

It feels like a burning-platform moment. Earlier this month, I authored an opinion piece in the Australian Financial Review, addressing some of the ways forward in the clean energy transition. My final sentence read, "We need to be a society that says yes more often than it says no, so we can focus on success rather than explain our failure."<sup>4</sup>

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Fortunately, Western Australia is well poised to manage its clean energy transition, in the SWIS and across the Pilbara.

Indeed, Western Australian confidence and capability were overflowing from every table and speaker at the wonderful conference dinner and prize giving ceremony last night. I felt that I was in the wild west, but a sophisticated version of what you see in the movies.

Western Australian authorities are well aware of the five s's of the energy transition: skills, social license, supply chain, speed and scale. Of them all, social license is the toughest and needs to be addressed early and earnestly.

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It is important not to lock in a singular line of thinking. Instead, be flexible and take advantage of emerging technologies.

To that end, in this talk I will discuss the deployment of transmission lines, the importance of batteries, the decarbonisation of mine sites and the opportunities for Australia in shipping zero emissions commodities.

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The slow build of transmission lines is becoming a problem, at least on the east coast of Australia.

And in the United Kingdom. In a report released two months ago, the UK Electricity Networks Commissioner recommended that transmission line projects should aim to be completed seven years after identification of the need, rather than nearly double that today.<sup>5</sup>

If a transmission line project takes too long, there is a genuine risk that the original business case will be undermined by rampant technological change, unanticipated changes in distributed generation, adoption of microgrids, and shifting demand patterns.

Time to completion for transmission lines is one of two major problems. The other is cost.

For reasons I don't understand, construction costs in Australia are much higher than other countries. For example, the 500 kilovolt HumeLink transmission line in New South Wales is 13.5 million Australian dollars per kilometre. A comparable transmission line under construction in the United States is the Ten West Link crossing from California to Arizona. Its price is 2.2 million Australian dollars per kilometre – a mere one sixth of the price of the comparable HumeLink project.<sup>6</sup> How can that be? I wish I knew the answer.

Solving these problems will require the steady hand of state governments. In Victoria, the state government agency known as VicGrid has taken control of the planning process and is escalating community consultation. In NSW, the state government pioneered the payment by government of a hosting fee of \$200,000 per kilometre of land traversed.

In Western Australia, you understand the importance of transmission.

You have the north-west interconnected system plan for the Pilbara and the SWIS Demand Assessment plan for the southwest.

In May, Energy Minister Bill Johnston announced the commencement of planning to expand the SWIS, anticipating 4,000 kilometres of new transmission lines to be built in the next 20 years.<sup>7</sup>

To minimise the risks I have already mentioned, it is essential that the regulators have a laser sharp focus on speed of completion and low cost of construction.

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One of the most exciting technological advances to support the clean energy transition is battery energy storage.

In a report four years ago, McKinsey Corporation predicted that annual demand for batteries would grow rapidly from 184 gigawatt-hours in 2018 to 2,600 gigawatt-hours in 2030.<sup>8</sup> This year, just four years later, McKinsey revised its prediction to 4,700 gigawatt-hours.<sup>9</sup> That is growth by a factor of 26 from 2018 to 2030, or a compound annual interest rate of 31%. This is a truly spectacular uptake rate.

Can it keep up? The prospects are good! Last year, the global increase in factory manufacturing capacity for batteries went up by 72%! This is a *leading* indicator, and it may be that McKinsey's revised, upbeat forecast will prove to be conservative.

Following the price blip caused by the Covid pandemic and Ukraine war, battery energy storage system prices have started to decline again and are forecast to resume their relentless march towards lower prices, possibly halving by 2030.<sup>10</sup>

Of course, price reductions will be driven by increased manufacturing output. This is the standard learning curve.

Equally important, price reductions will be driven by the adoption of new cell chemistries that will reduce the dependence on three expensive metals: lithium, nickel and cobalt.

A battery type known as lithium ferrous phosphate, or LFP, eliminates the nickel and the cobalt. The adoption of LFP in the last few years has been rapid, and last year the global market share of LFP batteries reached nearly 30%, while the market share for lithium nickel cobalt batteries fell to 60%.<sup>11</sup>

For the lithium producers in the audience, this is not a cause for alarm because it is a smaller share of a vastly increased market.

The second new chemistry is the sodium-ion battery, which eliminates the expensive lithium, too. That is, all the materials in a sodium-ion battery are earth-abundant and cheap. This year, the two biggest battery companies in the world, C.A.T.L. and B.Y.D., which between them produce half the world's batteries, started commercial deliveries of sodium ion batteries.

The ever-decreasing price of battery energy storage systems, their plentiful availability and their lack of dependence on transmission lines means that they are becoming increasingly competitive with pumped hydro energy storage systems, even for durations as long as 24 hours.

There are many opportunities to use battery storage systems to great advantage.

Batteries are already playing an important role in microgrids in small towns and remote Indigenous communities across Western Australia.

And across the nation's electricity networks, short-duration batteries have been used to provide system services.

Going forward, as the percentage penetration of combined solar and wind increases towards 40% and above, it becomes ever more important to use medium and long duration batteries to provide energy storage. Again, Western Australia sees the need and is investing in a number of big batteries.

To support solar and wind generation, it makes a difference where those batteries are located. Positioning battery storage systems within the fence line of solar and wind farms provides major benefits.

The first benefit is that the connection line from the solar and wind farm to the rest of the grid will be used more efficiently. The second benefit is that the existing grid transmission lines will be used more efficiently. The third benefit is that curtailment of the solar or wind farm output will be diminished or eliminated.

In China, the National Energy Administration two years ago mandated that new solar and wind generation projects must include storage, and many of the provincial governments are now requiring that the on-site storage must be as much as 30% of the generator capacity.<sup>12,13</sup>

This important storage provision was recommended, with less specificity, six years ago, as the Generator Reliability Obligation in the Finkel Review of the National Electricity Market. However, the regulators have not yet acted. Perhaps it is time to do so.

To capture these benefits, governments could run location-specific processes to support wind and solar generation co-located with batteries. This falls into the category of dispatchable clean generation, but the key point in this case is the co-location.

Specific processes such as reverse auctions are likely to be more effective than market signals.

The south-west market here in WA is unique in Australia in that it already has a capacity market, and under existing rules it could signal the need for location-specific, dispatchable capacity.

Perhaps location-specific investment in batteries to support wind and solar generation could be a role for the upcoming capacity investment scheme in the national electricity market.

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As the world increasingly shifts to decarbonised products, the opportunities afforded by the clean energy transition in Western Australia are immense.

Decarbonising mine sites is the start. All the major mining companies know this and are testing battery powered haul trucks and trains. They are keen to replace diesel generators with solar and wind backed up by batteries and peaking gas generators.

Western Australia has no choice but to think boldly given that it is not connected electrically to the rest of the nation.

You have learned to be independent with microgrids supporting your towns and remote Indigenous communities.

You have committed to closing down coal-fired electricity generation by 2030 and you acknowledge that the essential prerequisite is to deploy sufficient solar and wind to replace it.

By the time you get to 90% solar and wind, the integration costs per additional megawatt-hour will be exceedingly high. For that last 10%, my advice is to use peaking gas generation without remorse, as already envisioned in the SWIS Demand Assessment. At that point, with 90% solar and wind generation backed up by peaking gas generation, your average emissions intensity will be better than nuclear-powered France.

You could use offsets for the remaining emissions, having followed the proper practice of doing as much as you can to reduce the emissions at source before turning to offsets for the remainder.

The role of gas as the ultimate firming source is so important that if the market economics in future become impractical, it would be well worth considering economist Ross Garnaut's proposal for the government to own reserve electricity-generation capacity and demand, sufficient to deal with extremes.

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Shifting to future exports, you might have noticed that commentators have complained for decades that in Australia we do not add value to our exports. But until recently there has been no financial driver to change our dig-to-ship approach.

Now, though, the massive subsidies in the United States, coupled with their efforts to broaden their supply chain away from China, represents a huge opportunity for Australia, and in particular Western Australia, to add value to our resources before shipping.

The shift is already visible in recent investments in rare-earth element refining, lithium hydroxide production and nickel sulphate production.

Another opportunity will be to meet the demand for green iron to produce green steel, in the early days for specialist purposes such as luxury cars and home appliances.

While electrochemical smelting and coke substitution processes might contribute, the interest is particularly strong in hydrogen direct-reduced iron production.

The old model of shipping metallurgical coal and iron ore to the steelmaking countries will not work because the price to ship hydrogen instead of metallurgical coal will be too high.

Further, the importing country would need to have vast quantities of low-cost renewable electricity.

This translates into an opportunity for Australia to use its solar and wind electricity to produce the required green hydrogen and process heat, and use them locally to produce value-added green iron.

Hydrogen will be used as a chemical feedstock in other industries, providing new export opportunities, but only if we can scale up our renewables generation and ensure that it is low cost.

With abundant renewable electricity and green hydrogen, we will be able to make emission-free ammonia, fertiliser and alumina, as well as liquid fuels such as green methanol for the international maritime fleet and green jet fuel for long distance aviation.

We will do the processing on shore, because when using hydrogen, the cost-effective strategy is to use it where you make it.

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Before I finish, a few words about keeping up with the Joneses. The global investment in clean technologies is racing forward and we don't want to fall behind. Big as it is, Western Australia is just one player in a huge global market, so being agile and staying ahead is essential.

Globally, largely driven by China but in many other countries too, the investment in clean energy technologies reached 1.1 trillion US dollars last year, breaking the trillion-dollar barrier for the first time and exceeding the approximately 1 trillion-dollar investment in fossil energy. Even more remarkable, the investment in clean energy technologies is on track to reach 1.7 trillion US dollars this year.<sup>14</sup>

Another remarkable fact: in the first two decades of this century, solar and wind annual generated output increased fourfold in each decade. To achieve a quadrupling in this, the third decade, the annual growth rate has to be 15%. Last year, the global output of solar and wind electricity increased by 20%, well above the necessary run rate.

There is clearly more to come, because last year the global factory manufacturing capacity for solar panels increased by 39%.<sup>15</sup>

Equally impressive, for the first time, in 2021 the solar and wind annual generated output overtook nuclear power generation.<sup>16</sup>

The future arguably belongs to solar and wind power.

Most people think that the use of solar and wind power to replace fossil fuels is a simple substitution. That is not the case, as I have indicated. In addition, there is already an accompanying large and growing expansion of mining to supply the energy transition materials for solar panels, wind turbines, batteries and hydrogen production.

Mining will continue to expand and will be required into the indefinite future for product replacement.

Recycling might help, but so far, the economics do not look good.

To reduce resource requirements, nuclear power might experience a resurgence globally and eventually have a role in Australia. But in our case, no matter how much intent there might be to activate a nuclear power industry, it will not be feasible before 2040. Thus, nuclear power cannot be seen as an alternative to solar and wind, but rather as an adjunct. This decade and the next we have no choice but to invest consistently and strongly in solar and wind generation and the batteries and transmission lines that make them practical.

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A common refrain of late is that battery cell manufacturers and car companies are struggling because of the lack of raw materials. GM in the United States is reporting that electric vehicle production and sales are outpacing battery manufacturing that has been held up due to lack of raw materials.<sup>17</sup>

I am confident that these shortages will be filled. As is said by economists, “the cure to high prices is high prices.”

That is, the market will find the best solutions. However, the clean energy transition is not natural, it is driven by externalities. Thus, the market does not work as smoothly as might be hoped. In recognition of this, governments around the world are subsidising the investment in clean technologies and coupling the subsidies to domestic manufacturing agendas, in a phenomenon being described as deglobalisation.

It is often stated that Australia cannot compete with the generous subsidies offered in the United States. But if we focus on a small portfolio of our-world class export sectors then we should be able to compete at world-class levels.

The Australian government understands that, and at the recent national Labor Party conference in Brisbane, Minister Chris Bowen said that the Australian government is developing its own counterpart to the US Inflation Reduction Act.<sup>18</sup>

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If we get it right, Australia will be an electrostate of the future. That is, we will be a global leader in shipping sunshine, and exporting energy transition materials and decarbonised products to help the rest of the world on the journey to net zero.

We live in exciting times.

My considered advice is that well-worn phrase, “seize the moment.”

May the Force be with you,

Thank you

## Author Bio

Dr Alan Finkel AC is a neuroscientist, engineer, entrepreneur and philanthropist. Career highlights include 23 years running US company Axon Instruments and 8 years as Chancellor of Monash University. Alan was Australia's Chief Scientist from 2016 to 2020, during which time he led the National Electricity Market Review, the development of the National Hydrogen Strategy and the panel that advised the Australian Government on the Low Emissions Technology Roadmap. As Special Adviser to the Australian Government on Low Emissions Technologies in 2021 and 2022, he brokered bilateral low emissions technology partnerships between Australia and each of seven key countries and chaired the Australian Government-hosted Sydney Energy Forum. He is currently Chair of Stile Education and a corporate adviser on climate change technologies. His book, *Powering Up: unleashing the clean energy supply chain*, was published in June. He is a minority investor in Australian companies Hysata and Southern Green Gas.

<sup>1</sup> Willatook Wind Farm with uncertain future, ABC, <https://www.abc.net.au/news/rural/2023-08-04/willatook-wind-farm-proposal-doubt-government-recommendations/102691028>

<sup>2</sup> Renewable Projects Quarterly Report Q2 2023, Clean Energy Council, August 2023, <https://assets.cleanenergycouncil.org.au/documents/Renewable-Projects-Quarterly-Report-Q2-2023.pdf>

<sup>3</sup> Slump in support for action on climate, Sunday Age, <https://www.theage.com.au/politics/federal/cost-of-living-crisis-drives-slump-in-support-for-urgent-climate-action-20230816-p5dwx7.html>

<sup>4</sup> Op ed on nuclear, gas, growth rates, Alan Finkel, AFR, <https://www.afr.com/policy/energy-and-climate/say-no-to-nuclear-and-yes-to-gas-fired-power-20230717-p5dor0>

<sup>5</sup> Electricity Networks Commissioner Nick Winsor, UK, <https://es.catapult.org.uk/news/new-power-lines-can-be-built-in-half-the-time-finds-electricity-networks-commissioner-report/>

The HumeLink transmission line at \$5 billion for 360 kilometres is 13.9 million Australian dollars per kilometre. A comparable transmission line in the United States is the Ten West Link, a 500 kilovolt, 3.2 gigawatt, 201-kilometre-long transmission line crossing from California to Arizona. It started construction at the beginning of this year for an estimated cost of 435 million Australian dollars.<sup>6</sup> See <https://www.permits.performance.gov/fpisc-content/ten-west-link-transmission-line-project-breaks-ground>. That comes out to just 2.2 million Australian dollars per kilometre.

<sup>7</sup> WA flags massive energy grid expansion, AFR, 9 May, <https://www.afr.com/companies/energy/wa-flags-massive-energy-grid-expansion-to-support-industry-20230509-p5d6xk>

<sup>8</sup> McKinsey 2019 battery report, prediction in Figure 3, [https://www3.weforum.org/docs/WEF\\_A\\_Vision\\_for\\_a\\_Sustainable\\_Battery\\_Value\\_Chain\\_in\\_2030\\_Report.pdf](https://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf)

<sup>9</sup> Summary article of 2023 McKinsey battery report, <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/battery-2030-resilient-sustainable-and-circular>

<sup>10</sup> Battery prices have started to decline, per BNEF, June 2023, <https://www.energy-storage.news/global-bess-deployments-to-exceed-400gw-annually-by-2030-says-rystad-energy/>. Battery projections for BESS show decline to 2030 in all scenarios, NREL, June 2023, <https://www.nrel.gov/docs/fy23osti/85332.pdf>

<sup>11</sup> Battery share by chemistry, <https://www.iea.org/reports/global-ev-outlook-2023/trends-in-batteries>

- <sup>12</sup> National Energy Administration in China mandating storage, April 2021, <https://www.pv-magazine.com/2021/04/29/china-mandates-energy-storage-as-it-sets-16-5-solar-and-wind-target-for-2025/>
- <sup>13</sup> Chinese provinces mandating up to 30% storage for new solar and wind projects, June 2022, <https://www.scmp.com/business/article/3182489/chinas-climate-policies-are-forcing-renewable-energy-developers>. Note that storage duration is unspecified.
- <sup>14</sup> Clean energy investment and innovation trends, <https://finance.yahoo.com/news/clean-energy-investment-innovation-trends-141500421.html>
- <sup>15</sup> Manufacturing, <https://www.mercomindia.com/solar-manufacturing-2022-meet-2030-iea>
- <sup>16</sup> Global electricity review 2023, April 2023, <https://ember-climate.org/insights/research/global-electricity-review-2023/>
- <sup>17</sup> Lack of raw materials for GM Ultium batteries, <https://www.greencarcongress.com/2023/08/20230818-wilson.html>
- <sup>18</sup> Counterpart to IRA under development, <https://www.theaustralian.com.au/nation/politics/labor-conference-bidenstyle-fund-the-key-to-our-energy-transition/news-story/41dcd9eea380d589d37f8083a4327c63>