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The Energy Transition

Are we on track to Salvation or Disaster?

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Ending 2022 with a Bang

What a week that was just before Christmas! We heard from California that laser fusion works and practical power from that source 30 years away – still. Coal and gas price cap legislation passed through federal parliament. Clough went bust, posing completion and cost challenges for the already challenged Snowy 2 project, as well as the EnergyConnect transmission line between SA and NSW. At the time of this publication, in late February, the Snowy 2 delays have been confirmed, along with resulting increases in system risks in the years ahead. To cap it off, the Greens waved through a capacity mechanism intended to "keep the lines on", as long as that didn't include coal and gas-fuel options. The federal government promised to develop a package to encourage low-income households to convert from gas to electricity.

Such a lot to digest! There's nothing more to be said on the fusion option, an exciting but distant prospect, nor on the price cap legislation – it's all been said already. Much more ominous are the ongoing costs and delays on Snowy 2 and what such problems might portend for the huge pipeline of infrastructure spending proposed for the south-east electricity system. And the set against gas implicit in the capacity mechanism decision? Against coal is understandable, but why is gas in all its applications so much on the nose?

In this article I explore the thinking and strategy behind these developments and where they appear to come from, or at least be justified . I then discuss what the future might look like under this strategy.

Source of the Strategy

Readers will need no reminder of the tortured evolution of Australian energy policy over the past decade. Through it all we managed to retain a National Electricity Market (NEM) spanning the whole southeast of the country, albeit with much state intervention to achieve goals such as emission reduction, but often simply the promotion of renewables as an asset class.

One spectacular example of state intervention is the Snowy 2 scheme, backed by the federal government through its ownership. By any traditional measure it is a terrible scheme1. First, the cost is around five times the cost of gas turbines of equivalent capability, even allowing for high-cost LNG purchased on the world spot market. Next it requires a raft of costly new transmission to take advantage of its capability. Third, it doesn't seem like a great idea to concentrate so much market power into one business entity. Finally, such a large, complex project is always exposed to delays and cost overruns from a range of causes, with the consequences of delay felt elsewhere in the system.

The Turnbull Government approved Snowy 2 and the scheme continues to be held up as the poster child for what a firmed, renewable energy strategy should look like in the NEM. One can only reach this conclusion if "dirty" gas is explicitly excluded as a technology option to firm variable renewable energy (VRE). Excluding gas is incompatible with

[1] A previous Insider article (Insider 36) queried the basis for the then-proposed Snowy 2 scheme, on a simple cost comparison with other technologies for similar system duties.

low-cost outcomes but, as I will argue, it is also incompatible with a successful emission reduction strategy, if success includes keeping the lights on.

The 2022 Integrated System Plan

The deal to exclude gas from a capacity mechanism was driven by Green party ideology, but one finds an attempted intellectual basis for it in the 2022 Integrated System Plan (ISP)[2] produced by the AEMO with participation from AEMC, TNSPs and the industry generally.

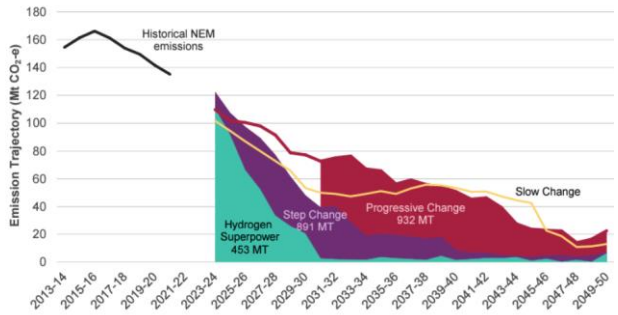
The 2022 ISP is an impressive document. The main report of over 100 pages provides a good overview of the thinking that has produced the 2022 ISP strategy. The main report is supported by seven appendices and a raft of consultant reports and web-based resources filling in many details, as referenced in the main report.

The report devotes much space, indeed a whole chapter, to the "Optimal Development Path" (ODP). As a practitioner of the black art of optimisation, the sight of that word – indeed a whole chapter - devoted to the topic set the heart beating little faster. I waded in, bearing in mind that for a typical real optimisation problem:

- some things are not known and must be input as goals and assumptions;
- given the problem data and those assumed inputs and a suitable goal we can attempt to optimise the means of getting there;
- in that process, sometimes we must break the problem up into smaller parts and make simplifying assumptions to make it solvable; and
- while we can sometimes fudge our way through these approximations, we should also reflect soberly on whether an output makes sense.

Apart from basic technology cost data, the key assumed input in the 2022 ISP is the 2050 emissions target and the speed of getting there. Through a process of garnering a consensus on a set of emission reduction scenarios, a group of energy experts established a "step change" as the preferred case. The figure following from page 32 of the report illustrates the resulting emissions trajectory for this scenario and the less preferred scenarios considered.

Figure 8 NEM carbon budgets and the resulting emission trajectories



Noteworthy is the fact that emissions in 2050 are essentially the same across all scenarios, an unsurprising outcome as all coal plant will be retired by then and no new coal plants are included because of the tight emission constraint and, in the real world, because no coal plant would ever be built without underwriting by government.

It's fair to say that this stage of the process hasn't been optimised. It's driven by an "expert consensus" view that we need to reach net zero in a tearing hurry. Correspondingly tight emission constraints throughout the transition period would discourage coal or gas plant from participating. According to this analysis, a crash program of transmission investment with early coal plant closures is the way to go. I couldn't see a cost-benefit or risk comparison between scenarios for what it's worth, although there is a later note that the cost of the additional transmission investment to support the scenario, while large, is still small compared with the overall cost of energy to customers.

Modelling Issues

Having decided on the central scenario, modelling proceeds in a traditional way, as set out on page 34 of the 2022 ISP report:

- The capacity outlook model projects the generation and transmission build and their dispatch outcomes in each scenario, seeking to optimise capital and operational costs.
- The time-sequential model then optimises electricity dispatch for every hourly or half-hourly interval.

[2] June 2022, AEMO - *2022 Integrated System Plan for the National Electricity Market*

- The engineering assessment tests and validates the capacity outlook and time-sequential outcomes using power system security assessments to ensure that investments are aligned and robust.
- The gas supply model may then validate any assumptions on gas pipeline and field developments.

The critical optimisation is the first step. The remaining steps are essentially feasibility checks at the market, engineering and gas supply levels. They cannot validate the optimality of the decisions made by the modelling in the first step. It follows that the analyst (and report author) should be very aware of the potential modelling pitfalls that lurk in the type of model used by AEMO (and by my own company) . These pitfalls are not removed or diminished by setting up systems to run and report on millions of simulations.

Making a long-term optimisation model of a 5-minute market operating over 30 years tractable requires a great deal of grouping and averaging of time-sequenced data. The optimisation algorithm assumes these averaged data are real and optimises accordingly. While one can adjust parameters to attempt to correct for this approximation, the trap here is that the model will then tend to be biased towards high capital cost options because the volatility that justifies a mor flexible, lower capital cost option such as gas turbines is assumed away. Running a real-time-simulation that confirms the feasibility of using network investment does not uncover this bias against the use of gas turbines to firm renewables.

Storage models used in capacity expansion models tend to be simplified and optimistic versions of reality, especially operationally. When such an investment is simulated, a typical approach will use a deterministic ahead forecast to guide current decisions. Real decision-making is beset with far more variables and uncertainties, especially for large (deep) storages. If my generator with deep storage must run for two weeks to support the system, how quickly should I try to recover my water levels? It may be hard to recover quickly if the system is tight and prices are high. Commercial and system risk assessments may drive in opposite directions. Again, gas turbines with a suitable supply such as LNG do not suffer this modelling and operational challenge.

Finally, capacity expansion models typically do not handle risk explicitly. The tool itself may have an explicit risk capability, but such a facility is difficult to drive because of data and size requirements. It can be useful as pedagogic tool. Understandably, it appears that no such facility was used for the ISP capacity expansion modelling.

If a capacity expansion model does not account for risk, an expansion plan involving large, capital-intensive projects to support firming may be determined as optimal. In practice, the large capital-intensive plant could be much riskier than smaller, lower capital cost and quickly installed plant, that for the relatively brief periods used may be more costly in fuel and higher in emissions but with little impact on total costs or total emissions.

The Need for Social Licence

At various points in the report (e.g. Sections 6.4.1 and 7.3) there is a discussion on the need to gain a social licence for projects on the proposed development path and to recognise that doing so may involve project delay.

What that means in plain language is that the proposed 10,000 km of proposed transmission lines and 16GW of new pumped storage (8 times more than now underway at Snowy 2) is bound to meet with strong community resistance from many sources, despite being badged as needed to support the renewable revolution. Proposed mitigation measures include.

- early engagement with affected parties or communities;
- financial compensation for affected landowners;
- a stronger jurisdictional move to an “integrated land use planning approach”; and
- bringing forward critical projects ahead of anticipated need to compensate for the risk of delays.

As an old, fully paid-up tree hugger myself, I observe that “integrated land use planning” and “multiple-use land use planning” are in fact long-established euphemisms wheeled out when established land-use patterns turn out to be inconvenient in the face of development pressure. I am not alone in this observation.

Do not expect social licence to be readily granted.

The Optimal Development Path

All this consultation on preferred scenarios and consequential modelling leads to the critical output of the process; the Optimal development (ODP) scenarios. The ODP has many elements but we can summarise the basis for it and its main elements as follows.

- Coal plant will shut down faster than currently announced, for reasons that are not clear other than some concept of momentum toward lower emissions.
- The energy gap will be filled by large volumes of VRE, both solar and wind in roughly equal proportions, as well as behind-the-meter solar. The amount and rate of construction of Renewable Energy Zones (REZs) and supporting project development required is impressive.
- Backing this up for daily operation will be grid-scale and behind-the-meter battery storage (including EVs at some stage).
- To deal with longer-term "energy droughts" spanning days and weeks, "deep" pumped storages like Snowy 2 are proposed.
- Critically also, AEMO has convinced itself, based on fragile modelling and data innocent of recent climate observations, that greatly expanding interconnector capability to allow the VRE in different regions to support other regions (exploiting diversity) is a cost-effective approach to help firm regional VRE.
- The ODP recognises gas turbines as an option, but only as a backup in the case of project slippage and also to be used after all practical pumped storage options have been developed, very late in the planning horizon.

The ODP is not an ODP for the whole system, but for transmission and publicly-sponsored firming capacity similar to Snowy 2. That, is, it is a plan for things not funded on a merchant, at risk basis, but on a basis of regulated returns supported by customers, the budget or, in the case of Snowy 2, by market power i.e. paid for by other parties. In a very real sense, projects in the ODP pre-empt whatever the market might have done.

What the 2022 ISP Portends

The 2022 ISP contemplates and advocates a very large transmission infrastructure program, supplemented with pumped storage projects many multiples of the troubled Snowy 2 in size. The document anticipates community resistance at the project level. It's a risky strategy at best. At worst, these projects could crowd out (through both labour and capital markets) wind and solar projects that would generate the energy the system needs.

New transmission to support the proposed REZs is necessary, but one wonders how some of the interconnector and pumped storage options stack up against a program of gas turbine construction with suitable supply arrangements, possibly through LNG. Under the ODP, gas is simply a fallback option, to be used when all else has failed. Gas plant would be better used before that failure is staring us in the face. Costs would be lower, risks much less and emissions would be 90% lower than now by 2050. Surely that is still success.

I find it hard to fathom from the main report why gas plays such a minimal role in the 2022 ISP. The up-front decision to run with a "step change" go-for-broke net zero scenario must be part of it. Another is the veneer of "optimality" associated with the modelling that supports the strategy, which cannot legitimately claim that property. The distaste for gas is evident on page 64 of the report which argues that its use in an alternative strategy would require carbon capture and storage. No wonder gas doesn't figure!

To be sure, the strategy in the ISP has many supporters. The ideological branch of the green movement will love it (but the tree hugging branch will come to hate it when the pumped storage and transmission lines start rolling out). TNSPs will of course love it in spades. And investors drool over these infrastructure asset classes as the report notes on page 27. The current federal government and our PM in particular are very fond of infrastructure spending, especially those with catchy slogans such as "re-wiring the nation" and "battery of the nation". In fact, a collection of these interests seems to have driven the choice of the favoured "step change" scenario choice with its consequential heavy spending on transmission and pumped storge infrastructure and its pigeon-holing of gas.

It is sad to see a lower cost, lower risk, emission-friendly solution gazumped by ideology and special interests. However, reality will trump ideology in the end. The prospect of reliable and low-cost supply will rapidly dim as coal plant retires and the huge infrastructure spend falters under the burden of regional labour shortages and community opposition. It won't be cheap to fix things at

this point. Expect generous last-minute hand-outs to coal plant to keep them running – hardly a good outcome for net zero, or the budget.

Yes, we have a plan, but as heavyweight boxer Mike Tyson has famously observed, everyone has a plan until they get punched in the face.

Conclusion

The 2022 ISP lays out a high-cost, high-risk strategy for achieving net zero by using very little gas. It will elicit strong project-specific opposition over time, burning goodwill toward the achievement of a net zero goal. It will jeopardise the achievement of a low cost, reliable and secure system that the renewable energy revolution has for so long promised but so far failed to deliver.

AEMO planning to-date has neglected the judicious use of gas turbine capacity to firm renewables, further affirmed by the politically expedient decision to exclude the gas option from the proposed capacity mechanism. This bias against the judicious use of gas should be revisited and removed in the next ISP, now underway.

The political challenge is much harder. Many in the community hold an ideological view that using gas to support the electricity grid in its transition to a net zero is inherently evil. Minister Chris Bowen will eventually need to mount a heroic, Keating-esque campaign to explain the virtues of gas turbines to voters. He should start on that task now. If he waits until the system is faltering, the only remaining option to keep the lights on will be to pay old coal plant to stay online.

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