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Demand shocks from the gas turbine fleet in Australia's National Electricity Market

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The long run task of Australian power system planners is to identify the structural adjustment pathway associated with retiring Australia's coal fleet within the National Electricity Market (NEM). System planning models seek to do this at minimum cost subject to a reliability constraint. This involves the deployment of low-cost intermittent wind and solar resources with a mix of dispatchable, flexible 'firming' assets. Coal's energy-producing role is thus replaced by renewables, and firming duties by short duration batteries, intermediate duration pumped hydro and the last line of defence – gas turbine plant.

We examine outputs from 12 (anonymised) power system models for two future years 3035-3036 – a point in which it is presumed large parts of the NEM's coal fleet will have been retired and replaced by VRE. All models, and all modellers, signal sharp but episodic increases in gas turbine plant duties. Crucially, all modellers assume, at least implicitly, a gas market that is *endlessly flexible.* To be clear, the assumption of 'endlessly flexible gas markets' has proven to be entirely reasoned and reasonable over the past two decades in Australia's NEM.

However, when we examined model results for the post-coal 2030s environment in detail, we found a surprisingly intensive role played by gas turbine plant at common points in time - giving rise to a small number of very high peak daily demand events. The modelled output of gas turbine plant appears to surge in episodic periods of 5-10 days at a time during the winter months of June and July - implying extremely high peak daily flows of natural gas when solar irradiation is at its lowest and east coast wind output experiences its annual nadir.

This article therefore tests, ex ante, normative electricity market model assumptions by identifying the outer operating boundaries of the adjacent market for natural gas given known market conditions. We do so by relying on a nodal model of the Australian east coast gas market capable of identifying daily flow limits.

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To summarise our results, forecast gas turbine output (and associated daily demand for natural gas) during low renewable energy periods associated with winter months appears to be incompatible with the outer operating limits of Australia's eastern gas network functionality as we currently understand it. When we constrained pumped hydro plant developments to 'zero additional capacity commitments', conditions in our gas market model deteriorated very materially. We found gas demand shocks were amplified during winter, the extent of which proved *highly problematic* for our model of the east coast gas market.

The potential for episodic, unmitigated demand shocks from the NEM's emergent gas turbine fleet is not in anyone's best interests. Gas prices would be pushed higher, infrastructure capacity necessarily increases but utilisation rates may fall, and in worst-case scenarios, security of supply would be tested and likely breached in the markets for gas and electricity, simultaneously.

Diversifying the firming task across a fleet of low-cost batteries, pumped hydro and gas turbines improves conditions considerably. Yet even after doing so, gas turbine duties still placed residual pressure on the market for natural gas at certain times. No regrets policy solutions might commence with additional storages, storable fuels and fuel sources ideally located closer to the problem epicentre – Sydney and Melbourne. This may come in an array of formats including new gas storages, additional linepack, liquid (diesel) fuels, hydrogen and associated derivatives, and a requirement for all new gas turbines to be commissioned as 'dual fuel' plant. If there is any upside to our analysis, it is that sufficient time exists to reconcile otherwise intractable gas turbine dispatch duties using natural gas with these alternate supply options.

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