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The Energy Centre's research team targets top international peer-reviewed journals as their benchmark. The Energy Research Briefings series translates their work into plain language summaries for businesses, government agencies and the community, highlighting the impacts for practice and policy.

How Hydro and Wind Co-Affect New Zealand's Electricity Prices: A Seasonal Spatial Analysis

New Zealand's (NZ's) target of 100% renewable electricity generation by 2035 may require quadrupling wind's contribution from its current 5%. How can we offset wind's intermittence and unpredictability, which cause price spikes? Can hydropower, itself variable from dry to wet periods, help? And where might a counterintuitive proposal to repeatedly pump water uphill to a reservoir then harness its downhill release fit in?

New research* combining seasonal and "spatial" effects helps answer such questions by estimating the likely price effects if wind capacity grew. It's finding that the wind-hydro nexus can reduce price volatility should attract the attention of the system of the operator, policy makers, investors and ultimately electricity users, especially industry.

NZ's electricity system is idiosyncratic in climate, geography and market structure. Wet, windy, and geographically spread, it is some 60% hydro-generated but holds promise for more wind farms. Crucially, stored hydro can be turned on in seconds like a tap, quickly substituting wind on doldrums-still days; but hydro storage capacity is inadequate. The Cook Strait cable shunts power as needed between the relatively populous North Island, which alone has the thermal capacity, and the South Island, with richer hydro resources but lower demand. Wholesale prices are set by bids from 244 "nodes", brought on in "merit" order (prioritising the cheapest technology generation, such as wind). Unlike continguous nations, NZ cannot import or export electricity to balance supply and demand; importantly, though, nearby nodes do exchange it. Thus, estimated price effects must account for nearby spill-over effects, not just local blusteriness. Finally, an unusual absence of subsidies for renewables makes for an ideal "free-market" research testbed.

Recognising these idiosyncrasies, the researchers adopted a simplified simulation of just 19 nodes and innovated by analysing price effects of the wind-hydro nexus with a spatial (and seasonal) model. Transmission cost turned out to decide spill-over more than geography, while ignoring spatial effets would have demonstrably distorted results. Seasonally, juxtaposing NZ's wet 2011 and dry 2012 showed that lifting wind capacity by 10% would have cut wholesale nodal prices by $0.48/MWh in winter 2012 and fully $3.05/MWh in spring, but also made prices more volatile, particularly in dry seasons. Moreover, if the weather is not only dry but still, demand spikes require to resort to thermal generation, exacerbating volatility. So, while a wind-hydro system is a good low-carbon combination in wet seasons, without backup generation, it currently risks sharply zigzagging prices.

Resulting policy options are expanding wind generation in South Island sites that complement southern hydro yet remain viable to transmit north and/or pumped hydro storage, now under study at Central Otago's Lake Onslow. The secret there is timing: pumping cheaply at off-peak times using wind energy and releasing when demand is high. Either way, without subsidies or grid access priorities, low nodal prices may depress renewable investment returns, disincentivising wind farm growth. But further electrifying the economy, including industry and transport, would incentivise growth by boosting demand.

**For the full article by Le Wen, Kiti Suomalainen, Basil Sharp, Ming Yi, Mingyue Selena Sheng see "Impact of wind-hydro dynamics on electricity price: A seasonal spatial econometric analysis", Energy 238 (2022) 122076.*