RP1036

DECENTRALISED ELECTRICITY MARKETS

Research Question (50 words)

Electricity networks are entering a period of disruption due to rapidly advancing new distributed energy technologies. This project aims to address the question of whether existing market arrangements can facilitate efficient investment and operation of distributed energy resources (DERs), and how different arrangements may help facilitate more efficient outcomes. As the advent of DERs may precipitate a transfer of ownership of electricity assets to from governments and corporates to individuals and smaller organisations, these questions are fundamental to the future social and economic wellbeing of our society.

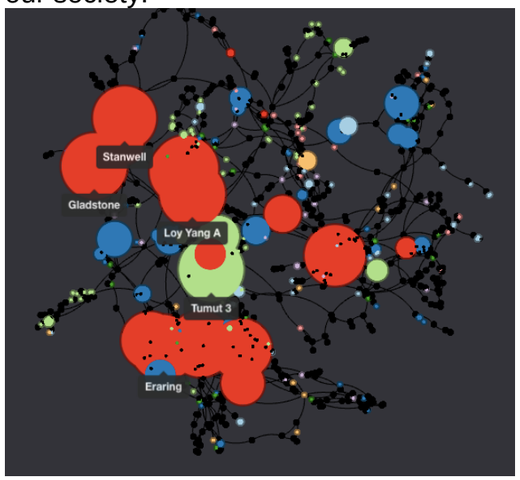

Figure 1: Emerging data processing tools can be used to explore and understand electricity networks in new ways.

Methodology (75 words)

This project uses an iterative methodology that will be repeated multiple times to conduct investigations into the retail, wholesale and forwards/futures markets of the Australian National Electricity Market (NEM).

This process involves identifying key market features using new developments in AI and machine learning to process large data streams from market operators. The next step is to build a model that simulates these markets. This model will be extended to include high-penetration DERs to measure the impact of distributed energy on existing competition indicators. These results are intended to determine recommendations for improvements in DER integration in the NEM.

A key feature of this research will be the application of algorithmic game theory to model oligopolistic competition in electricity markets, and determine the impact of adding near-zero marginal cost electricity (ie. distributed renewables) to existing and experimental market models.

Results (225 words)

A machine learning approach was taken to determine key variables linked to peak price events and market volatility in the NEM. The aim was to determine whether price volatility may have been correlated with times of constrained competition. The random forest feature selection method was applied to a database of constraints, competition measures and other market performance indicators. It was found that competition constraint was the most important factor for determining price volatility in the NEM. Demand was second, followed by interconnector flow limits. This shows that competition may be a greater determinant of peak price events than supply and demand, indicating that markets may not be efficient.

A further investigation of the wholesale market determined that by the Herfindahl-Hirschmann Index (HHI), a measure of market competition, there are relatively few periods where the NEM could be classified as operating in a competitive manner. For the vast majority of time periods, the market appears ‘moderately’ or ‘highly’ concentrated. Additionally it was found that counter to expectations, higher price periods correlated with more competition, while lower prices occurred during more oligopolistic time periods.

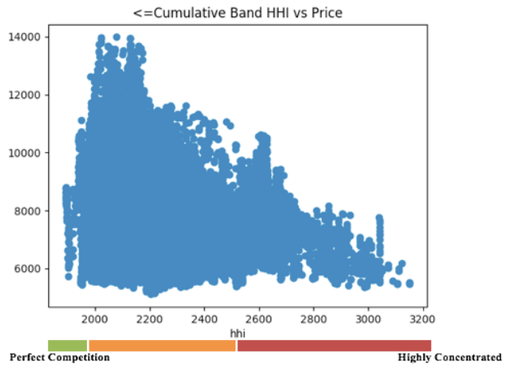

Figure 2: HHI Competition Indicator plotted against market price events.

Conclusions (50 words)

Existing market arrangements are expected to deliver beneficial outcomes in the long-term interests of consumers. It appears that these arrangements, are not performing as expected. It follows that if mechanisms are already functioning in unexpected ways, the addition of large amounts of DERs may have further unexpected consequences, and may lead to inefficient or detrimental outcomes.

This highlights the need for new models to facilitate investment in and operation of DERs within the Australian electricity network.

How will distributed renewables fit into the NEM? Are there other options?

Anticipated impacts (50 words)

A key deliverable of this project is a series of open-source modelling tools for determining the efficacy of existing market arrangements and modelling future electricity market structures in the presence of distributed renewables. Availability of auditable energy modelling tools is a major issue facing researchers, consultants and policymakers.

Further information

This project has resulted in the creation of a number of open-source DER and energy market modelling tools, which can be found at www.github.com/lukasmarshall

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