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Modelling microgrids

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Abstract: The business case development for privately operated microgrids requires modelling of both energy flows and return on investment. This poster sets out the modelling processes that have underpinned the successful implementation of microgrids in industrial and residential settings in Western Australia.

Microgrids in urban settings have often been constrained to land uses involving leases or strata titles as green title lots are conventionally serviced directly by electricity network operators. Recent innovations in land development in Western Australia by the government owned land developer DevelopmentWA have led to the successful implementation of network connected renewable energy microgrids in both industrial and residential greenfield developments. This poster outlines how modelling was used to develop business cases for private operators to provide electricity to the owners of green title lots in the industrial precinct known as the Peel Business Park near Mandurah, WA, and the mixed-use Ocean Reef Marina in Joondalup in Perth's northern suburbs.

The development of new land involves evaluation of the electricity capacity required to services the loads. Based on this assessment the network operator (in these cases Western Power) determines the necessary upgrades to transmission and distribution systems, assuming the default case that all energy will be supplied by the network. In the case of these projects the costs are fully met by the developer involving millions of dollars. The magnitude of these costs, combined with DevelopmentWA's commitment to emissions reductions led to a study for a microgrid at the Peel Business Park.

A system dynamics model was developed to simulate the energy flows arising from locating the entire development "behind-the-meter" and integrating onsite renewable energy and storage with minimal energy imported from the Western Power network. The model incorporated evaluation and sensitivity analysis around both the diurnal and seasonal industrial electricity loads from individual premises and the likely rate of development from the first lot to the final lot, around 20-30 years. The next step was the calculation of solar PV capacity that could be accommodated on the site from ground mounted and rooftop systems and the optimal capacity of centralised battery storage. The model then simulates the amount of energy potentially supplied within the precinct on an hourly basis over the life of the development, and the amount of energy required to supplement onsite energy with imports from, and exports to the network, including peak loads. In this scenario the microgrid operator becomes a customer of the network at the master meter and can cap the required capacity, thereby reducing the necessary network upgrades significantly. The solution involves the construction of a ground mounted PV array and initial battery storage to be supplemented over time by leasing roof space for solar PV from the microgrid customers and adding storage.

From the results of the simulations a business case was developed for a privately operated microgrid to provide energy supply, distribution and retail services to land owners in the Business Park. DevelopmentWA then went to tender to identify firms willing to invest in the development of the microgrid with the key metrics being the discount to customers and renewable energy content. A multitude of electricity regulation and land planning innovations was necessary to ensure the project's viability.

After an extensive three stage procurement process, DevelopmentWA appointed a consortium led by Peel Renewable Energy, a subsidiary of Zenith Energy, to develop Western Australia's first ever renewable energy microgrid to power an industrial estate. The initial infrastructure included a 1.2 MW solar array and 2.5 MWh battery storage system (BESS). Electricity tariffs were set to be around 30% lower than a comparable supply under government regulated tariffs. As the cost of renewable energy is lower than the escalating costs of network supply, the microgrid operator is incentivised to add onsite supply rather than import energy, gradually increasing the renewable energy content over time.

The Peel project has been replicated at DevelopmentWA's prestigious Ocean Reef Marina development project where Zenith Energy will again be the microgrid operator. The installed capacity is expected to 1.75 MW of rooftop and ground-mounted solar arrays and a 4.6 MWh BESS. Other developers are also implementing similar microgrids based on the DevelopmentWA template, including Cedar Woods at the Eglinton Village residential estate.

Integrated energy and financial modelling has been key to unlocking the potential of renewable energy microgrids in land development in Western Australia.

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