Case study: Goldwind

Clean Energy Knowledge Sharing Initiative

Co-location as an innovative electricity infrastructure solution

In partnership with the NSW Government and AECOM, Goldwind investigated the feasibility of installing a bio-ethanol fuelled peaker plant at an existing wind and solar farm. After a broad review of potential sites in NSW, Goldwind chose BJCE Australia's Gullen Range Wind and Solar farm as the case study for initial concept investigation. This site is already one of the largest renewable energy generation hubs in NSW and has suitable terrain and sufficient spare grid capacity.

The power output from some renewable generation technologies, such as solar or wind, varies depending on the weather conditions. If two or more generators at the same location have different generation profiles, there may be benefits gained through the sharing of grid connection infrastructure—a concept known as co-location. By co-locating this bio-ethanol peaking plant, or 'peaker' plant, with existing wind and solar the concept aimed to increase generation to maximise grid connection utilisation.

Goldwind found that installing a peaking plant is technically feasible. However, high capital costs, bio-ethanol fuel costs, and the volume of bio-ethanol fuel required pose economic and logistical challenges.

Fast facts

Feasibility project cost	$73,000 ($30,00 from the NSW Government)
Current generation capacity **Current grid connection**	175 megawatts 180 megawatts
Spare grid connection capacity of more than 100 megawatts	70 per cent of the time

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Background

Goldwind Australia is a renewable energy company focusing on wind power solutions, including wind turbine manufacturing, investment, construction and ongoing operation. Goldwind Australia constructed the Gullen Range Wind Farm and obtained planning approval for the Gullen Solar Farm. BJCE Australia now owns both facilities, with Goldwind responsible for maintenance on the wind farm under a long-term agreement.

In 2018, the Gullen Solar Farm in Bannister, NSW, became Australia's first large-scale solar plant to be co-located with an existing wind farm. However, even at existing co-located solar and wind farms, there are times when the plant's grid connection is not used at its maximum capacity. As a case study, Goldwind investigated whether this spare capacity could be used, improving the flexibility of renewable energy supply to the grid. The case study explored the concept of adding another plant—a bio-ethanol peaking plant or 'peaker'.

Bio-ethanol is a liquid fuel made from biomass such as plant waste. Its net emissions are almost zero, making it an attractive renewable alternative to diesel or natural gas. The concept involved a plant generating electricity during 'peak' times when demand or prices are high, using clean bio-ethanol fuel, and delivering reliable energy when the market needs it most.

Benefits and drawbacks of co-locating power plants

Co-location allows multiple plants to share grid connection investment, leading to economies of scale.

The savings come from better knowledge of environmental conditions, an existing grid connection, access roads, services and existing relationships with the community. For consumers, co-location can lead to less spending on energy infrastructure, which reduces energy bills for everyone.

One challenge with co-location is that plants may have to artificially reduce or 'curtail' their output due to grid connection limitations on sunny and windy days. However, if the co-located plants are well designed this does not happen often.

> ***'Co-location has the potential to improve the business case for adding more renewable energy capacity to the grid.'***
>
> ***Michael Dasey, Innovation Development Manager at Goldwind Australia***

Table 1. Comparing peaker plants

Measure	Bio-ethanol peaker	Diesel peaker	Natural gas peaker
Cost of generation ($ / MWh)	$473	$391	$160
Capital cost ($M)	$143	$204	$117
Emissions intensity of fuel combusted (kgCO2 / GJ)[1]	0.27	70.2	51.53

[1] Department of the Environment and Energy, Australian Government (2018). *National Greenhouse Account Factors*. Accessed at www.environment.gov.au/system/files/resources/80f603e7-175b-4f97-8a9b-2d207f46594a/files/national-greenhouse-accounts-factors-july-2018.pdf on 02.08.2019

Journey

In partnership with AECOM and with support from the NSW Government's Clean Energy Knowledge Sharing Initiative, Goldwind carried out an initial study to determine if the concept would be theoretically feasible, and what additional research they would need to do.

To find a suitable concept site, Goldwind considered multiple factors such as grid connection capacity and surrounding terrain. Goldwind chose Gullen Range as the nominal location to investigate the concept further.

Using information from the owner of Gullen Range, Goldwind then investigated the available grid capacity based on data from previous years. They found that for 70% of the year, the substation has a spare capacity of more than 100 megawatts (MW) out of the 180 MW total capacity. This is because wind and solar typically generate electricity at different times of day—solar generates during the day, whereas wind typically generates more at night.

To make the best use of the spare grid capacity, the study suggested a peaking plant capacity of up to 100 MW.

An important consideration was the source of the bio-ethanol fuel. The study examined bio-ethanol fuel suppliers in Australia, the supply volumes and cost of fuel. Another consideration was the choice of turbine, its capital cost and efficiency. Finally, Goldwind made a high-level economic assessment, accounting for the cost of fuel, electricity prices and the available spare capacity.

Table 2 summarises some key challenges identified in the study and how to address them.

Table 2. Challenges and potential solutions

Challenges	Potential solutions
High fuel prices leading to high cost of generation	Mixing bio-ethanol with fossil fuels would lower fuel costs, but would increase net emissions
Few bio-ethanol producers in NSW	Negotiate a long-term bio-ethanol supply contract for security of supply
Risk of co-locating three technologies (solar, wind, biofuel)	• Detailed analysis of historical generation data and forecasting to not oversize the peaking plant • Consultation with TransGrid and AEMO at an early stage.

Figure 1. Goldwind's White Rock Wind and Solar Farm

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Outcomes

While it is technically feasible to connect a bio-ethanol peaker at the site, the high running costs mean the peaker would likely only operate when market prices are very high—approximately 10 to 15 hours per year—based on current electricity and fuel prices.

The study identified that grid connection challenges are likely in co-located projects of this nature and it recommended early engagement with TransGrid and the Australian Energy Market Operator (AEMO) at the next stage of feasibility to understand the impact to the existing generation facilities.

Finding a reliable and cost-effective fuel supply could be challenging, as the potential volume required is large and there are relatively few domestic producers of this scale.

The financial viability of the project is uncertain. A second-hand turbine or mixing in cheaper fossil fuels with the bio-ethanol could help. However, while this concept would provide low-emission generation, the plant would no longer be wholly renewable.

If the peaker was located closer to sea level, plant efficiency would improve with higher ambient air pressure, but there may not be a suitable site for co-location.

The study provided a comparison of different peaker plants, as described in Table 1. It shows moderate market changes could make bio-ethanol competitive with diesel generation, but natural gas is a far cheaper alternative fuel source.

Takeaway points

- Co-location of generation assets can reduce capital costs significantly and should be considered for any new renewable energy project.
- The main benefits of co-location are reduced design, planning, installation and grid connection costs.
- Electricity generation from bio-ethanol is still in early stages globally, but there are suppliers with sufficient production capacity.
- As fuel and electricity prices change and energy security and reducing emissions become more important, bio-ethanol peakers may be a viable alternative to diesel and gas peaking plants.

Next steps

To progress the bio-ethanol peaker concept, Goldwind would need to do further work, including market analysis and detailed assessment of the community and planning impacts. Early engagement with stakeholders such as local landowners, the community, TransGrid and AEMO will also form important elements of any further feasibility work. Buy-in from the asset owners—BJCE Australia —would be required.

Finally, further investigation is required to optimise the commercial strategy, including an in-depth study of the fuel market as well as various turbine models.

About the initiative

The NSW Clean Energy Knowledge Sharing Initiative supports the NSW Government's objective to achieve net zero emissions in the state by 2050. The Initiative gives innovators and early adopters an opportunity to test and trial new clean energy solutions. To find out more or learn about similar projects, visit www.energy.nsw.gov.au/clean-energy-initiative.