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Fortescue project summary

Demand response through hydrogen storage

Delivering cost savings and grid resilience for New Zealand

EECA
TE TARI TIAKI PŪNGAO
ENERGY EFFICIENCY & CONSERVATION AUTHORITY

Introduction

Fortescue is exploring the feasibility of developing a green hydrogen facility at Marsden Point in the Upper North Island of New Zealand. The proposed facility aims to produce synthetic Sustainable Aviation Fuel (eSAF) to help decarbonise the aviation sector, particularly for long-haul flights where other emission-reduction technologies might not be feasible. The facility is expected to supply 60 million litres of eSAF annually, displacing around 180,000 tonnes of CO_2e emissions per year and contributing to reducing New Zealand's reliance on imported jet fuel.

A key component of the project is the integration of demand response capability, using hydrogen storage to manage grid demand, reduce electricity costs, and enhance grid resilience.

The report evaluates different electrolyser technologies and the potential benefits of hydrogen storage in:

- addressing transmission constraints
- lowering electricity prices
- contributing to the integration of renewable energy.

Despite some implementation challenges, the demand response capability offers significant environmental and economic promise, providing both direct and broader benefits to New Zealand's energy sector.

Marsden Point, Whangārei Harbour, Northland, New Zealand

Figure 1: Project location. Credit: Fortescue

Hydrogen storage improves demand management

The key inputs for an eSAF plant are hydrogen and carbon dioxide. The proposed Fortescue facility will produce hydrogen from electricity on-site and import carbon dioxide from nearby industrial facilities. The hydrogen electrolysers are expected to require hundreds of megawatts of power, making them a very large energy user in the New Zealand context — similar to a city like Hamilton and second only to the Tiwai Point smelter.

A key aspect of the project is the inclusion of demand response capability, which uses hydrogen storage to manage electricity grid demand. The core eSAF plant requires a continuous supply of hydrogen gas as a process input. The hydrogen storage allows the electrolysers, which demand most of the power at the plant, to be turned down for several hours while the hydrogen storage supplies the eSAF plant. By reducing power consumption during peak periods, the flexibility provided by the hydrogen storage can help lower electricity costs and enhance grid resilience.

The choice of electrolyser technology is a key decision for the hydrogen production project. The report examines four main electrolyser types:

- High-Pressure Proton Exchange Membrane (PEM)
- Low-Pressure Proton Exchange Membrane (PEM)
- High-Pressure Alkaline Water Electrolysis (AWE)
- Low-Pressure Alkaline Water Electrolysis (AWE).

PEM technologies are more flexible and capable of adjusting output quickly from 100% down to 10% within a few minutes. In contrast, AWE technologies have limited flexibility, typically only turning down to about 50% and require ten minutes to adjust.

These differences affect how well each system can respond to changes in demand and impact the hydrogen storage design. Choosing the optimal electrolyser type and sizing is essential for delivering demand response capability in this application.

There are also trade-offs to be made in terms of the length of demand response that is available. A larger hydrogen storage facility can offer a longer demand response period, but at increased cost, for both the storage itself and surrounding plant and processes. Demand response using storage also means larger electrolysers are needed to maintain average hydrogen production over time. This can mean higher capital costs, additional footprint and maintenance, a higher maximum site load, and larger site electrical connection capacity (as even though this extra power would be used at off-peak times, it still needs to reach the site).

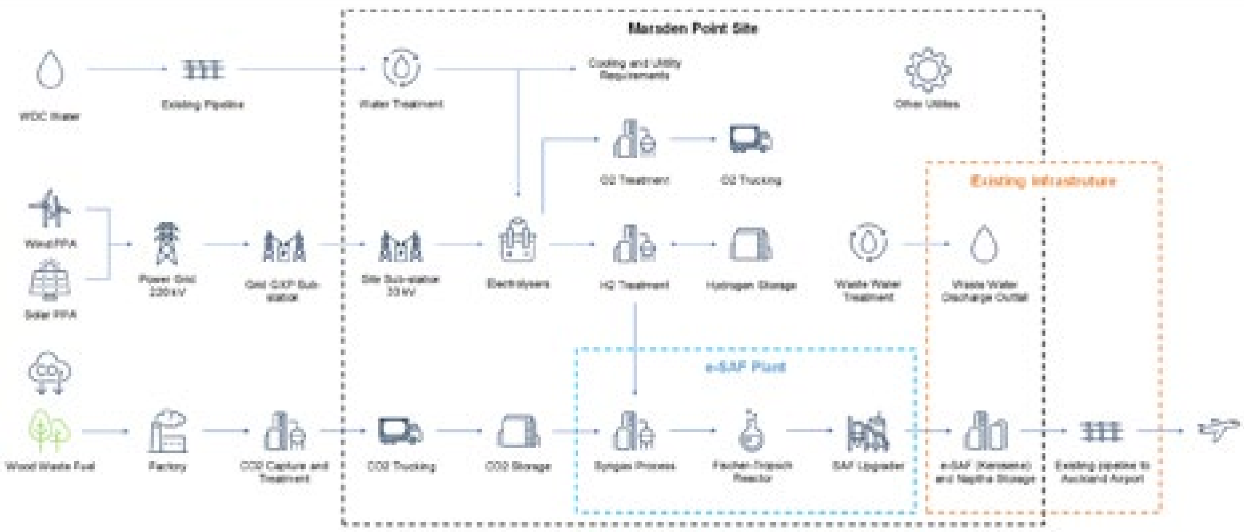

Figure 2: Project schematic. Credit: Fortescue

Demand response delivers huge savings

This report highlights that the demand response capability could offer considerable investment benefits by deferring costly transmission upgrades. It can also reduce price differences between Northland and the rest of New Zealand by avoiding constraints on this grid section.

The proposed eSAF plant site is located in an area with limited local power supply, relatively low load, and limited capacity to import the amount of power the plant will need. Without upgrades to the transmission line, the extra load from the plant could cause transmission constraints and result in a significant price difference between Northland and the rest of the country.

The use of demand response capability could be used to reduce demand in instances where the total power may exceed the existing grid capacity, for example, on hot days when line droop reduces line capacity. This may defer the need for multimillion-dollar upgrades to transmission lines.

Additionally demand response could help lower electricity price increases in Northland by reducing transmission constraints into the region. The study undertaken indicated a transmission deferral benefit of up to $100 million, depending on the upgrades chosen.

Incorporating the demand response capability through hydrogen storage would also benefit the wholesale electricity market. By shifting load away from periods of tight supply to more plentiful supply, the hydrogen storage would reduce the need for higher-priced energy supplies, like peaking thermal plant or more expensive dispatchable demand. The result would be lower average spot prices for electricity consumers.

The impact of the modelled demand response capability on annual load-weighted average electricity prices in 2030 is modest. However, by 2040 and 2045 the energy market could see major benefits — when variable renewable energy makes up a greater share of the generation mix, and opportunities for intra-day arbitrage are expected to grow. The report estimates up to $800 million in annual savings for electricity consumers by 2045, because of the plant's ability to respond during peak price periods. While generally only large consumers are directly exposed to the wholesale market, retail prices generally follow market trends. Lower wholesale prices ultimately mean savings for retail consumers.

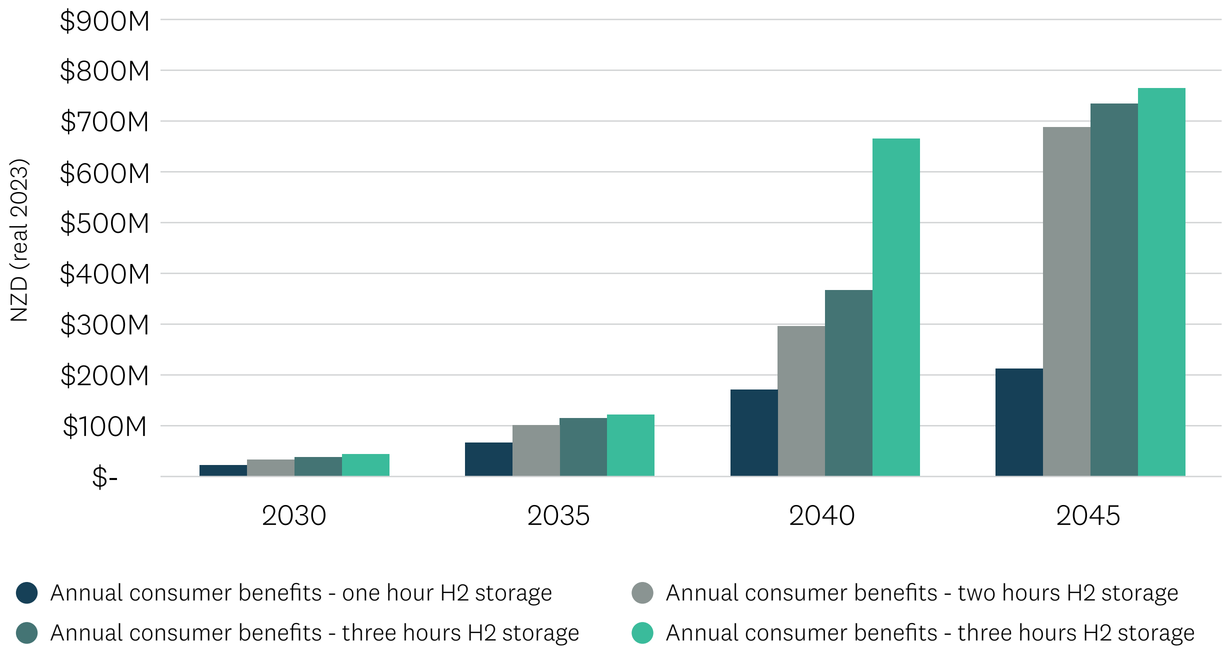

Figure 3: Expected annual consumer electricity savings. Credit: Fortescue

Barriers remain to implementation

Despite its clear benefits, demand-side management faces barriers to implementation for many participants. These include issues like:

- fixed-price tariffs
- stable electricity prices
- high cost of market participation
- limited flexible contracts.

Recent reports from the Market Development Advisory Group (MDAG) suggest measures to address these issues like improved information sharing, support from government agencies like EECA (Energy Efficiency and Conservation Authority), and introducing standardised flexibility contracts and an ahead market.

While the Electricity Authority has prioritised some of these measures, implementation timelines remain uncertain, and resourcing may delay progress. These barriers highlight the importance of demand response from participants able to overcome them, such as large energy facilities like the proposed e-SAF plant.

Benefits outweigh the costs

The report finds that the benefits to Fortescue, like reduced energy purchase costs, are likely to outweigh the costs and risks of investing in demand response capability. Additionally, the potential benefits to New Zealand energy buyers are expected to be even greater.

How Fortescue optimises its own energy purchases can significantly impact the benefits for other buyers. These findings suggest it may be in the public interest to create a value exchange between Fortescue and other energy purchasers to maximise wider benefits. Arrangements of this nature are rare in energy markets globally and may require innovative solutions to implement.

The report also explores different ways to operate the demand response capability, including maximising the use of hypothetical renewable energy power purchase agreements. This scenario shows the added benefits of flexible industrial loads in supporting renewable energy integration and incentivising new renewable projects.

Northland has considerable renewable energy resources and development potential. Combining new flexible industrial loads and appropriately-sized and timely transmission upgrades could support the development of these resources and their efficient integration with the wider energy system.

The pre-feasibility study concludes there are no technical constraints that would restrict the plant's ability to incorporate demand response capability. The project holds significant potential to deliver substantial environmental and economic advantages, including reduced emissions, improved grid resilience, and lower electricity prices. While there are challenges to overcome in implementing large-scale demand-side management, the project has identified practical solutions, making it a valuable contribution to the New Zealand's energy sector.

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