

# HVDC Pole 3 inter-island link project

## FACT SHEET

*Keeping the energy flowing*



Electricity flows between the South and North Islands of New Zealand over the high voltage direct current (otherwise known as the HVDC) inter-island link that connects Benmore substation in the South Island and Haywards substation in the North Island.

During periods of normal rainfall patterns in the South Island, power generated at Benmore tends to flow north. But, during periods of low South Island rainfall or when South Island generators want to conserve water (which often happens overnight), power flows south.

The HVDC link consists of 571 km of transmission line and 40 km of submarine cables that make up two separate circuits with major converter systems at each end. These converter systems are called Pole 1 and Pole 2. They convert electricity from alternating current (AC), which runs through most transmission lines in New Zealand to direct current (DC), and then back again to AC at the receiving end. DC is used over the HVDC link because it is more efficient for transporting power over long distances.

### The Pole 3 Project

A new Pole – Pole 3 – is presently being built to replace the 45 year old Pole 1 equipment at both substations with state of the art thyristor valve units. Pole 3, worth up to \$672 million and with a capacity of 700MW, will be completed in two stages resulting in an increase in the capacity of the HVDC link to 1000 MW from 2012 and 1200 MW from 2014. 1200 MW is about the same amount of electricity that is used on a cold winter's evening in the Nelson, Marlborough, West Coast and Canterbury regions combined.

The Pole 3 project involves not only constructing new buildings and installing new valves, but also replacing the control systems for Pole 2 and expanding the 220 kV switchyards at both Benmore and Haywards. New dynamic reactive power equipment is being built at Haywards, and a project to refurbish the existing synchronous condensers is underway. Earthquake strengthening has been undertaken at Haywards, with minor strengthening work to be implemented soon at Benmore.

The eight synchronous condensers at Haywards Substation are being refurbished in a project related to the Pole 3 works. Synchronous condensers are vital for the HVDC link, supporting electricity transfer between islands, especially when power is flowing north to south. They also help to maintain voltage and stability of the electricity system in the Wellington region.

The synchronous condenser project has several other large components besides refurbishing the machines. The starting equipment on at least two machines will be replaced, as will the control, protection and excitation systems, now that some of the existing parts are obsolete. The area will also be made safer by the enhancement of the fire detection and suppression systems of the associated equipment and buildings.

The transformers and associated equipment connected to four of the synchronous condensers will be replaced, and the protection systems used on each will be upgraded.

The majority of the Pole 3 work will occur within the Haywards and Benmore substation sites. The 40km long Cook Strait Cable that runs underwater across the Cook Strait, a short but important part of the HVDC link, isn't being upgraded at this stage. However, future plans for the HVDC include adding new undersea cables that will eventually increase the link's total capacity to 1400 MW.



## FACTS AND FIGURES

- Total estimated cost is **\$672 million**
- Capacity of Pole 3 is **700 MW**
- Total capacity of the HVDC link will be increased to **1000 MW** in 2012
- Total capacity of the HVDC link will be increased to **1200 MW** in 2014
- The total length of HVDC transmission line **571km**
- The length of HVDC submarine cable is **40km**
- The HVDC was first commissioned **1965**
- The weight of each new transformer is **330 tonnes** when operating

## Challenges

As with any large infrastructure project, the Pole 3 project team faces several tough challenges. Key among these are logistics, building to meet rigorous seismic standards and the challenge of working in a live substation.

The HVDC transformers needed at Benmore and Haywards are very large pieces of equipment - weighing around 250 tonnes when transported. To get to their final destinations, they will be shipped to Wellington and Timaru and then transported on specially reinforced 26 axle truck and trailer units. Much planning is involved in deciding the routes trucks must take to avoid all low and weight restricted bridges, traffic and tight turns. Specialist heavy haulage companies are needed to do the job.

Another challenge is to design Pole 3 so that it can still operate after a sizeable earthquake – in this case, a one in 2,500 year earthquake. A number of measures are used, but the key seismic protection measure is base isolation. Base isolators do what they say – they isolate the

building above from the ground below. When the ground shakes, the base isolators absorb much of the side to side movement, reducing the frequency and degree of shake the building experiences. This protects the building and the people and equipment inside it.

Beyond the buildings themselves, detailed planning has gone into how the actual electrical equipment will be affected by earthquakes. The equipment used in Pole 3 is tested by manufacturers to establish how it would be affected by earthquakes of different levels. The data from these tests guide the team in designing the necessary support features to ensure equipment can move safely in an earthquake without touching other equipment and structures.

The three state-of-the-art thyristor valves at each end of the HVDC link each weigh 17 tonnes and are the key components used to convert electricity from AC to DC and back again. The 19 metre tall building they are housed in – called the valve hall – has base isolators and the

valves are suspended from the ceiling so they can sway in an earthquake without being damaged.

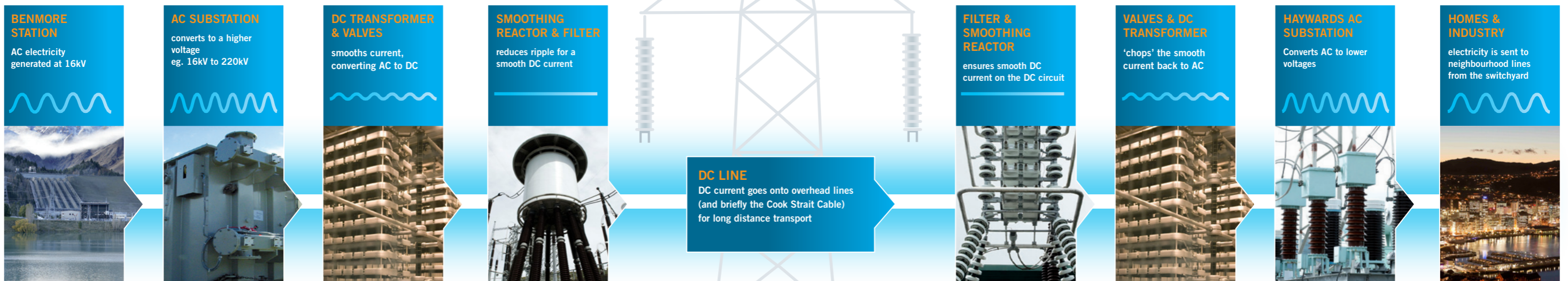
The valve hall also houses the cabinets and control systems that automate the operation of Pole 3. So it's important to the operation of the HVDC that the valve halls at each substation are well protected.

Pole 3 is being constructed within the existing Haywards and Benmore substations. Having a construction site within a live substation poses unique risks and hazards. A site with high voltage lines and equipment requires construction staff to work differently as it presents additional hazards to the normal construction risks. It is also critical that no outages to operating equipment are caused by the construction.

Additional challenges include the detailed and long term planning that is needed on such a complex project, including the variability and severity of the weather, and recruiting the highly trained and experienced personnel required for such specialised work.

## HOW AC CURRENT IS CONVERTED TO DC CURRENT FOR TRANSMISSION

AC → DC: SMOOTHS CURRENT SO IT CAN TRAVEL EFFICIENTLY ON A LONG DISTANCE LINE



## History of the inter-island link

The HVDC inter-island link was first commissioned in 1965 after overcoming several significant hurdles, such as laying undersea cables and using very modern technology of that time. It was the world's longest HVDC link.

The plan in the 1950s was to build more generating capacity in the South Island, where hydro resources were plentiful, and transmit the power to the southern half of the North Island. This would leave the North's existing stations, mainly concentrated on the Waikato River, to supply the island's northern half.

In 1976 the link was modified to allow up to 400 MW to flow southward from Haywards to cater for increased demand in the South Island during periods of low inflows into the southern lakes.

A major upgrade to the inter-island link commenced at the end of the 1980s. Three new submarine cables were laid to supplement the originals to increase the capacity of the whole system to 1240 MW.

This included adding a new 700 MW thyristor converter at Benmore and Haywards, effectively adding a second higher powered Pole to what became a hybrid system. The hybrid system incorporated increases in transmission voltages and currents and combined old and new technologies of mercury arc valves and thyristor valves.

The integration of the thyristor system with the original mercury-arc valves was considered to be unique among HVDC systems worldwide at that time.

## The Demise of Pole 1

By the late 1990s the system was carrying up to a third of the North Island's total power needs and had proven generally reliable. However, age took its toll on some of the original equipment and the last of the original cables were decommissioned in 1997, which reduced the capacity of the system to 1040 MW. Much of the original equipment remained, including the mercury arc valves - by this time the world's oldest to be in continuous service.

## The Future

Transpower is looking beyond the Pole 3 project, with another stage to upgrade the HVDC link planned. It will see additional undersea cables added, some Pole 2 equipment upgraded to bring it into line with Pole 3 and additional voltage support equipment added at Haywards.

Pole 1 is now over 45 years old. It uses equipment and technology that present a number of risks and are no longer supported by manufacturers. Transpower has decommissioned half of the existing Pole 1 and the remainder is only available for limited north flow operation during peak demand periods.

Without Pole 1, the capacity of the link with Pole 2 operating is presently 700 MW, which is insufficient to meet New Zealand's demand for electricity. Two fully operational poles are needed to maintain security of supply and stability of the electricity market. Pole 3 is urgently needed and will be well utilised by the time it is commissioned in 2012.

## Contracts awarded

Converter stations at Benmore and Haywards	Siemens
Site improvement works at Haywards	Brian Perry
Synchronous condenser refurbishment	Transfield
Synchronous condenser transformers	Pauwels
Synchronous condenser subsystems	Siemens

For more information on the HVDC inter-island link Pole 3 project, please call 0800 33 88 66 or visit [www.gridnewzealand.co.nz](http://www.gridnewzealand.co.nz)

