Providing green energy to mainland Australia – the Basslink HVDC Interconnector

The Basslink HVDC Interconnector is a major Australian energy initiative allowing the exchange of electricity between the island of Tasmania and mainland Australia.

The History
The Tasmanian Government carried out the first studies to examine the possibility of linking Tasmania’s electricity system with mainland Australia in the 1960’s. In the 1990’s further investigations were carried out by the State Electricity Corporation of Victoria and the Tasmanian Hydro Electric Corporation and finally the Tasmanian Government committed to build the Basslink Interconnector. The Basslink Development Board (BDB) was established in 1998 to facilitate the development of the Basslink Project. After nearly two years of evaluating the original 14 bids, the BDB awarded the contract to build, own and operate Basslink to National Grid in February 2000. This contract has since been novated to Basslink Pty Ltd (now National Grid Australia Pty Ltd), which was set up by National Grid, the world’s largest independent operator of power transmission systems. Already in the run-up to the decision Basslink Pty Ltd has decided for a consortium compromising Siemens (acting as consortium leader) and Pirelli (now Prysmian) as EPC Contractor for the turnkey delivery of the HVDC Interconnector. (For further information please take a closer look at our newsletter in April 2003.)

The Interconnector
Crossing Bass Strait required a submarine cable with a length of 290km, which now is the longest of its kind world-wide. The charging current of such a cable makes an HVAC solution impossible and therefore HVDC transmission was the only feasible solution.

The Basslink HVDC Interconnector consists of a monopolar metallic return scheme, with a rated DC voltage of 400 kV, a rated DC current of 1250 A and a rated continuous power of 500 MW defined at the DC terminal of the rectifier converter station. Both HVDC converter stations, located at Loy Yang (Victoria) and George Town (Tasmania), are designed to transmit rated power in either direction. Additionally, the HVDC system has a dynamic power transfer capacity of up to 630 MW from Tasmania to Victoria to meet Victorian peak demands.

The point of connection at the Tasmanian end is the 220 kV Transend substation at George Town and at the Victorian end the 500 kV SPAusnet substation at Loy Yang (Figure 1).
Especially for the relatively weak AC system of Tasmania an important feature of the Basslink HVDC system is to provide the capability that enhances the stability of the AC system in case of disturbances / contingencies. Under fault conditions the HVDC frequency controller can rapidly control DC power to prevent frequency deviation beyond a certain limit. This frequency control feature can also be used to participate in the frequency regulation of the network on either side.

The construction
Siemens were responsible for the turnkey delivery of:
- Two HVDC converter stations
- Two transition stations
- Augmentation of two existing substations
- Two AC overhead transmission lines with a total length of 5km
- Two DC overhead transmission lines with a total length of 66km

Siemens recognizes the requirement to consistently nurture relationships with our workforce and the unions and strive to develop a productive culture and stable labour relations through the formation of certified agreements. Siemens is accustomed to deal with and manage unique local circumstances in industrial relations (IR). Also for Basslink more than one year was invested to set up certified agreements with the unions. This process involved briefings of key government ministers, advisors and trade unions on the project, discussions with legal advisors on strategies, research on existing agreements, drafting the model agreement and subsequent negotiations with all unions involved in the works. The ongoing management of Industrial relations on the sites in line with the agreements was then of utmost importance for a timely completion of the Project. In its pro-active approach Siemens has dedicated considerable resources to manage IR issues on the construction sites and from Bayswater. It showed that this strategy was very successful. Compared to other major projects only negligible delays occurred, which has to be considered as a benchmark for major Projects in the Victorian power sector and confirms Siemens strong IR record in our long association with industries throughout Australia and New Zealand.

Occupational Health & Safety was for National Grid, Prysmian and Siemens of utmost importance from the very first day on the Project (Figure 2). Siemens safety advisors inducted all contractors working on the sites, developed safe working methods together with the workforce on site and monitored the safety performance. All parties involved can now be proud of the achieved safety record, which can be considered a benchmark for such projects. Siemens and National Grid acknowledged this safety performance also by awarding each of the contractors on site with a safety award. “The safety culture embraced by all our contractors and site personnel demonstrates a standard of professionalism which is evident each day this project progresses,” said Dr Wanninger. “From the simple hosing down of a slippery concrete surface through to the complex unloading of a 200-tonne transformer, each and every action requires a presence of mind to consider the safety implications.

As demonstrated throughout the extensive approval process of the project the environmental management was also one of the key aspects during the construction of the Interconnector. The Construction Environmental Management Plan (CEMP) includes all recommendations from the approval process and consists of various environmental management plans. These explain how environmental issues have to be managed during construction – including aspects like air quality, traffic, noise, flora and fauna. One example is the weeds and pathogen management. In order to prevent the spreading of declared noxious weeds or pathogens, the high risk areas had been identified in surveys.

Figure 2: Safety is of utmost importance
and subsequently washdown facilities have been established to clean and disinfect tools, footwear and clothing before leaving these identified areas. All people and vehicles had to be subjected to this procedure, which was recorded in a corresponding register.

During the execution of the works, Siemens also worked very closely with the aboriginal communities in Victoria and Tasmania. In order to protect the cultural heritage of these groups at all stages Siemens had employed aboriginal monitors who observed all excavation works and ensured that any artifact that was discovered was dealt with in the appropriate way, which had been agreed upfront. Areas where an artifact was found had been protected until the further procedure was defined.

**The technology**

The converter stations are equipped with the latest high-voltage semiconductor technology, direct-light-triggered thyristors (LTT) with integrated overvoltage protection. LTT’s with integrated overvoltage protection do not require auxiliary energy or electronic logic circuits for protection at high potential. Siemens is the world’s only manufacturer of this technology, which helps also reduce the number of electronic components in the HVDC converter valves by about 80 percent. This means an improvement of the converter station reliability and the costs.

The HVDC transformers are single-phase units with three windings. Taking the actual conditions of the local network into account, each of the HVDC transformers for Georgetown has a rated power of 194 MVA (primary winding) and the two others a rating of 97 MVA each (secondary windings). For an impedance voltage of 14%, each of the HVDC transformers for Loy Yang has a rated power of 196 MVA (primary winding) and the two others a rating of 98 MVA each (secondary windings). The transformers are installed close to the valve hall (Figure 3) so that the dry-type bushings for the valve side project through the walls of the hall.

The AC filters for George Town converter station had been designed for the special network conditions in Tasmania - very low short-circuit power and high harmonic distortion. Five AC filters, each with a fundamental-wave reactive power of 43 MVAr and a 98 MVAr bank, provide the necessary filtering capacity for harmonics and enough fundamental-wave reactive power for converter compensation and for supporting the network voltage. All the 43 MVAr filters are tuned for the characteristic 12th and 24th harmonics and also for the existing non-characteristic 3rd, 5th and 7th harmonics.

At Loy Yang converter station in Victoria, five AC filters, each rated for 102 MVAr and tuned to the characteristic harmonics (12th and 24th), satisfy the filtering requirements for harmonics and the necessary power factor correction. In addition, these filter circuits are also tuned to the 5th and 7th harmonics of the 500 kV network so as to make extra filtering capacity available for existing critical harmonics in the 500 kV network.

Basslink is the first HVDC Interconnector equipped with Siemens’ new control and protection system, Win-TDC. The system is based on the WinCC HMI system and the SIMATIC TDC control system. Both systems are already in operation for other industrial applications e.g. for drive controls. This new development results in a much more compact design with 50 % reduction in space requirements. Furthermore, the integrated structure leads to a reduced component count, which also contributes to improved reliability. SIMATIC TDC is the latest development in the Siemens family of Programmable Logic Controllers and is the first controller where both open and closed-loop controls can be programmed using the same programming tools.
The completion of the Project
In early 2005 the Project was challenged significantly after six converter transformers had been damaged during the shipment from Europe to Australia. Being aware of the importance of Basslink for National Grid, Hydro Tasmania and the Australian electricity market Siemens immediately undertook all actions to limit the impact on a timely completion and safe operation of the system. Six new transformers needed to be manufactured without having a suitable planned time slot in the factory. However, an optimized schedule for logistics, erection and commissioning had been initiated giving preference to such a case of emergency. As a result the link was energized for the first time still in 2005, shortly after the originally planned date for commissioning, i.e. November 29, 2005. System testing was completed in January, 2006 and Basslink was taken over by National Grid in April this year.