

Connection to Shore Reliability

Reliability of the HVDC Connection to Shore

Many Round 3 offshore wind farms are located a distance from the shore where high voltage direct current (HVDC) transmission is preferable to high voltage alternating current (HVAC) transmission. The reliability of the HVDC transmission system, as well as its effect on both the connected windfarms and the AC grid, is the focus of my research.

Offshore Windfarm



Offshore HVDC Converter



Submarine HVDC Cable



Onshore HVDC Converter



Figure 1 – HVDC Transmission Scheme for an Offshore Windfarm [1,2,3,4]

Multi-terminal HVDC Protection

The ability to interconnect HVDC transmission systems has many benefits including improved network security and reduction in offshore asset requirements. However, the lack of HVDC circuit breakers is a major stumbling block without which a single dc cable fault could paralyse the power flow for all of the interconnected systems. The first objective of my research has been to assess candidate HVDC circuit breaker topologies.

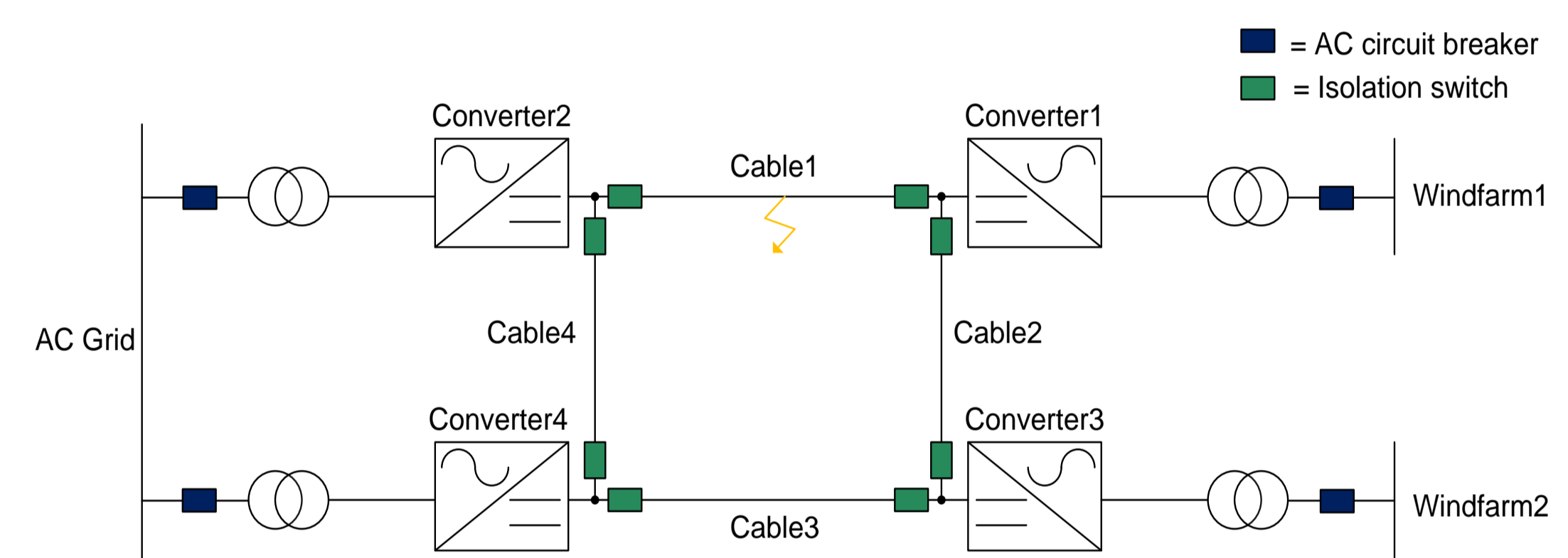


Figure 2 – Simplified Diagram of a Small Multi-terminal HVDC Grid

HVDC Circuit Breaker Topologies

A number of topologies have been assessed and the two most promising types of circuit breaker (CB) are shown below:-

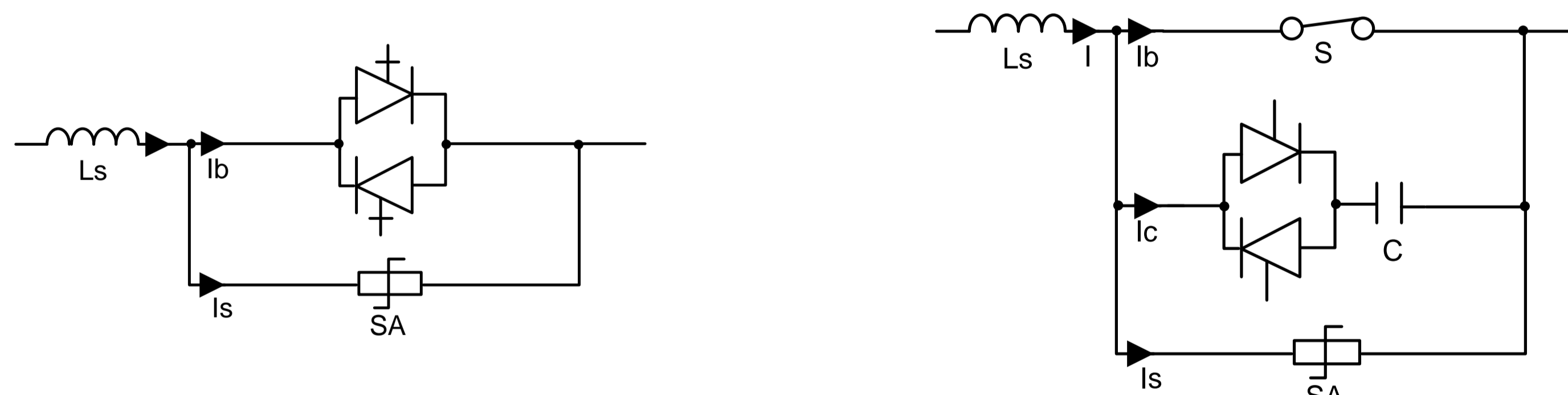


Figure 3 – Solid-state Circuit Breaker (Left) Hybrid Circuit Breaker (Right)

The solid-state circuit breaker (SSCB) offers very fast interruption speed, but has high on-state losses, whereas the Hybrid circuit breaker has low on-state losses, but a relatively slow interruption speed. Currently the SSCB is the preferred candidate since faster interruption is of greater importance than on-state losses.

New HVDC Circuit Breaker Design

The New HVDC Circuit Breaker design has been shown to have vastly lower on-state losses than an Solid-state Circuit Breaker, combined with a fast interruption speed in comparison to the Hybrid Circuit Breaker. The new design is currently patent pending and therefore cannot be exposed at this stage. However simulation results from one embodiment of the design is shown in Figure 4.

Courtesy of: [1] Prysmian [2] Tennet [3] Nexans [4] ABB

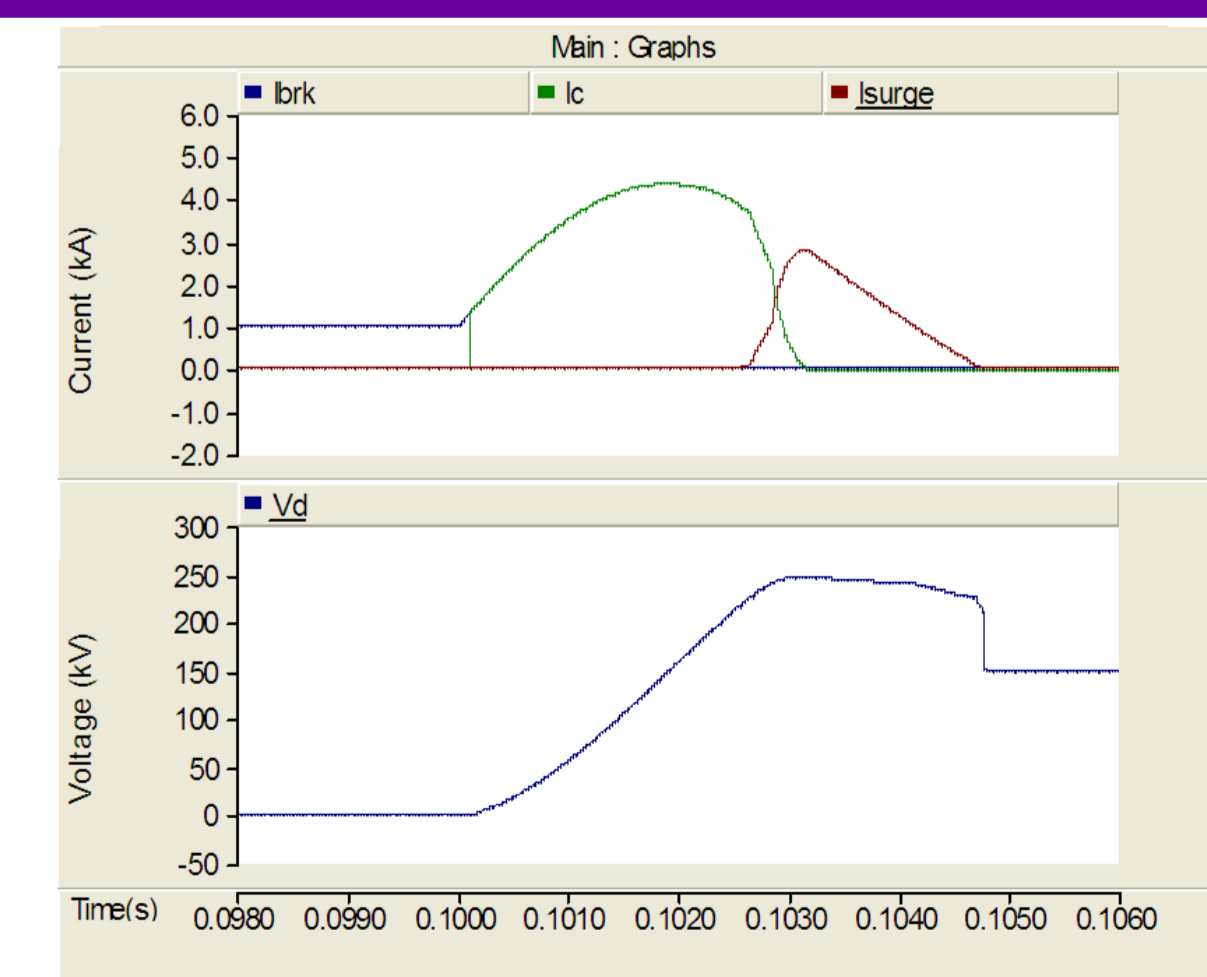


Figure 4 – New Design Simulation Results