SUBSEA CONNECTIONS TO HIGH CAPACITY OFFSHORE WINDFARMS: ISSUES TO CONSIDER

Roman SVOMA, PowerSure Technology Ltd., (UK), Roman.Svoma@PowerSureTechnology.com
Mark DICKINSON, PowerSure Technology Ltd., (UK), Mark.Dickinson@PowerSureTechnology.com
Craig BROWN, PowerSure Technology Ltd., (UK), Craig.Brown@PowerSureTechnology.com

ABSTRACT

The AC subsea transmission options have been considered for a nominal 1GW offshore windfarm positioned 60km from subsea cable landing point. Incidence and cost of cable failures as well as ohmic and charging current losses have been assessed. Technological issues have been highlighted. The overall scheme costs were remarkably close. 400kV SC XLPE connection appeared to be slightly cheaper than the 132kV 3C XLPE solution if transfer capacity issues were ignored

KEYWORDS

Subsea Cable, Offshore Windfarms

INTRODUCTION

The scale of the UK offshore windfarm generating industry is increasing. By 2005, just over 200MW of shared capacity between 4 offshore UK windfarms had been installed. It is anticipated that by 2010 1GW of generated power shall be provided by 13 and a further 7GW by 15 windfarms. The plans are for the power in these large arrays to be collected at an offshore substation stepped up to a suitable voltage and transmitted via HV or EHV cables to the mainland substation. This discussion paper considers the AC options for these connections.

EXPORT CABLE OPTIONS

Offshore windfarms developed in the UK have up to now been at or below 100MW. The connection to the land network has been by way of 33kV and 132kV three core XLPE cables. In the planning stage are windfarms capable of generating 1GW or more. For these power transfer amounts the range of cable connection options can be expanded:

- 132kV 3C XLPE cables
- 220kV 3C XLPE cables
- 400kV 3C XLPE cables
- 220/275kV SC XLPE cables
- 400kV SC XLPE cables

Due to the windfarm size, the connection distances of up to 60km are under consideration. HVDC options as well as fluid filled options although viable have not been considered in this study.

ISSUES RELATING TO LARGE OFFSHORE WINDFARM CONNECTIONS

Project viability is dependent on the capital and operating costs as well as the projected revenues. Due to the vibrant oil and gas market as well as the subsea market, subsea cable prices have increased due to insufficient capacity in the market. This makes project budgeting even more complicated.

Export subsea power cables of 132kV and above sit at the cusp of a technological cross-road. The new polymer technology is not fully proven at voltages above 110kV. Fluid filled technology, although reliable, is unsuitable in most applications due to environmental concerns from cable fluid leaks.

Three core XLPE designs are preferred at up to 132kV [1], however the weight and diameter of the cables as well as complex jointing procedures have to be offset against the ease of single core manipulation and higher ohmic losses [2], [3]. There are potentially more suppliers of single core XLPE subsea cables as the laying up process is avoided.

Ratings of cables are always compromised by solid bonding on subsea projects. Windfarm locations are in most cases near to estuaries where high tidal water currents can lead to substantial sediment movement. Local scour can mean that seabed datum can move by several meters leaving cables exposed in deep water channels or buried underneath meters of sand with unfavourable thermal resistivity. Thermal rating sensitivities at pre contract stage as well as Distributive Temperature and Strain Sensing are necessary if such risks exist.

EXPORT CABLE CONSIDERATION

As large windfarms of between 500-1500MW are being considered, a nominal power of 1GW was chosen as an example. A 60km route with 1.5m burial and seabed thermal resistivity of 0.7 K.m/W.

The total loss figures favour the multiple three core HV cables or the large single core EHV cables. The charging current, although compensated from both ends, makes an appreciable difference to circuits with relatively low current carrying capability. The joint technology of subsea 3C EHV designs is also immature in comparison to land and fluid filled technologies. In our view the risk in single core technology is less as the pressure on keeping the outside diameter small is less than for three core designs. Lower dielectric screen stress can be employed and capacitance