

Appendix C

Design assumptions for Options 2 to 4

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The HVDC cable and circuit spacings as well as the cable conductor size were selected by performing ampacity calculations using the CYMCAP software. This software takes various soil characteristics such as temperature and thermal resistivity and determines how much electrical current can pass through the cables without causing them to heat up passed what they are capable of handling without damage. The conductor selection was based on ambient soil temperature of 25°C and soil thermal resistivity of 1.5 Cm/W. Sensitivity analysis for the thermal resistivity and thermal backfill was carried out but did not influence the selection of conductor sizes.

Cross-linked polyethylene cables (XLPE) were considered for the HVDC cables due to higher operating temperatures of the XLPE cables and the higher ambient soil and air temperatures and soil thermal resistivity values. Copper cables were considered in the ampacity calculations as they are capable of higher ampacity than aluminium conductors; however, the final determination of aluminium or copper would be done by the cable supplier during the bid preparation.

Only a flat formation was considered, as a vertical formation would result in larger spacing being required due to higher heat dissipation requirements.

It's common for land cable systems to need to pass by other infrastructure such as highways and railway lines, and in these circumstances, trenchless construction methods can be used so not to disturb the highway or railway line. Trenchless construction means that breaking of soil from the surface is not necessary. One such method commonly used is known as horizontal directional drilling (HDD). A drill rig is used to install conduits underneath the road or railway and the power cables are pulled into the conduits at a later time.

The spacing needed at the mid-point (i.e., the deepest location) of the HDD is larger than at the entry holes since the cables are deeper and it's harder for the heat to dissipate from the cables. The studies determined that at 6 m deep, cable spacings of 5 m and circuit spacing of 15 m is needed.

In each HDD borehole, a conduit for the power cable and another for the fibre optic monitoring cable will be pulled. Typically, the total borehole diameter is 1.5 to 2 times the total bundle diameter.

Separation between AC and DC cable circuits would need to be determined but would likely need to be greater than 6 meters, as two DC circuits had no mutual heating effects with 6-meter separation and AC cables have a maximum operating temperature 90 degrees Celsius, whereas most of the DC cable suppliers are limited to a maximum operating temperature of 80 degrees Celsius based on the insulation compound that is used in the cables.

There is possibility that in the future 90 degrees Celsius will become more available.

The tables below show the ampacity calculations for each of the preferred options.

HVDC Cable details for Options 2A-1, 3A-3, and 4A-5:

2000sq.mm Cu, Extruded, 800mm cable spacing, 3 m circuit spacing

Case Description	Power [MW]	Voltage [kV]	Cables per pole	Cond [sq.mm]	Current per Cable [A]			Circuit Spacing [mm]	Cable Spacing [mm]	Burial [mm]	Controlled [K.m/W]		Soil Temp [°C]	Soil TR [K./W]	Max Cable Temp [°C]
					P1	MR	P2				Bedding	Backfill			
Controlled Bedding with TR=1.0K.m/W	1713	525	1	2000	1632	1632	0	3000	800	1000	1	n/a	28	1	63.4
														1.5	73.1
														2	83.2
													25	1	60
														1.5	69.6
														2	79.6
Controlled Bedding & Backfill Layers with TR=1.0K.m/W	1713	525	1	2000	1632	1632	0	3000	800	1000	1	1	28	1	
														1.5	
														2	77.8
													25	1	
														1.5	
														2	

HVDC Cable details for Options 2B-1, 3B-3, and 4B-5

2000sq.mm Cu, Extruded, 800mm cable spacing, 3 m circuit spacing

Case Description	Power [MW]	Voltage [kV]	Cables per pole	Cond [sq.mm]	Current per Cable [A]		Circuit Spacing [mm]	Cable Spacing [mm]	Burial [mm]	Controlled [K.m/W]		Soil Temp [°C]	Soil TR [K./W]	Max Cable Temp [°C]
					P1	P2				Bedding	Backfill			
Controlled Bedding with TR=1.0K.m/W	1285	400	1	2000	1607	1607	3000	800	1000	1	n/a	28	1	62.4
													1.5	72.1
													2	82.2
												25	1	59
													1.5	68.5
													2	78.6
Controlled Bedding & Backfill Layers with TR=1.0K.m/W	1285	400	1	2000	1607	1607	3000	800	1000	1	1	28	1	
													1.5	
													2	77.4
												25	1	
													1.5	
													2	

HVDC Cable details for Options 4C-2:
 2200sq.mm Cu, Extruded, 800mm cable spacing, 3 m circuit spacing:

Case Description	Power [MW]	Voltage [kV]	Cables per pole	Cond [sq.mm]	Current per Cable [A]		Circuit Spacing [mm]	Cable Spacing [mm]	Burial [mm]	Controlled [K.m/W]		Soil Temp [°C]	Soil TR [K./W]	Max Cable Temp [°C]
					P1	P2				Bedding	Backfill			
Controlled Bedding with TR=1.0K.m/W	1870	525	1	2200	1781	1781	3000	800	1000	1	n/a	28	1	65.4
													1.5	76.1
													2	87.6
												25	1	61.9
													1.5	72.6
													2	83.9
Controlled Bedding & Backfill Layers with TR=1.0K.m/W	1870	525	1	2200	1781	1781	3000	800	1000	1	1	28	1	
													1.5	
													2	82.2
												25	1	
													1.5	
													2	78.5