

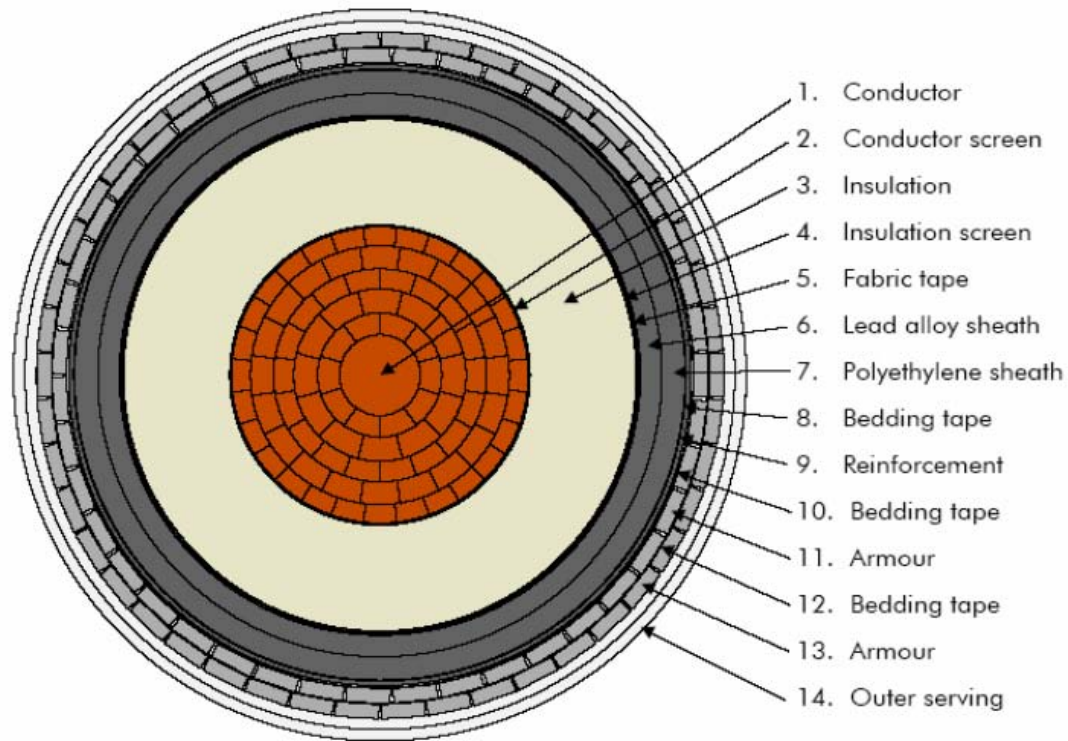
HVDC UNDERGROUND CABLE

ECC, Inc.

MANITOBA HYDRO BIPOLE III POTENTIAL USE OF UNDERGROUND CABLE SECTIONS IN THE PLANNED OVERHEAD LINE



**500 KVDC MASS-IMPREGNATED CABLE
SUBMARINE CABLE**



Conductor 2100 mm² Diameter 134 mm Mass 60 kg/m

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LINK	DATE	VOLTS kV	POWER MW	LENGTH KM
Norned	2007	± 450	700	580
Neptune	2007	500	660	106
SAPEI	2010	± 500	1000	2 x 420
Storebaelt	2010	400	600	58
Fennoskan 2	2011	500	800	200
Britned	2011	± 450	1000	2 x 200
Cometa	2011	± 250	400	2 x 250
Jindo-Jeju Korea	2012	± 250	400	2 x 122
Estlink 2	2013	450	650	157
Skagerrak 4	2014	500	700	215
Western Link UK	2016	600	2000	400
Strait of Belle Isle	-	± 350	-	3 x 36
Montenegro	-	± 500	1000	2 x 415

HVDC MI CABLE LINKS IN SERVICE OR PLANNED SINCE 2007

HVDC MI UNDERGROUND CABLE SYSTEM DESIGN

500 kVDC MI Cable Design Data	
Nominal DC Voltage	500 kVDC
Corresponding DC Voltage U_0	1000 kVpeak
Max. Conductor Temperature	55°C
Max. Ground temperature	14°C (MH Data)
Cable Burial Depth	1.0 m
Cable Spacing Option 1	0.5 m
Cable Spacing Option 2	1.5 m
Assumed Cable Route Length	65 km

500 KVDC MI CABLE SYSTEM DESIGN

OPTION A: 2 CABLES PER POLE IN SEPARATE TRENCHES

OPTION B: SINGLE CABLE PER POLE SINGLE TRENCH

Cable Parameters	Option A	Option B
Diameter mm	94	114
Mass kg/m	24.3	43.9
Cu Conductor mm ²	850	2500
Ampacity A	1010	2019
Power MW/cable	505	1010

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HVDC MI UNDERGROUND CABLE OPEN CUT TRENCHES



A



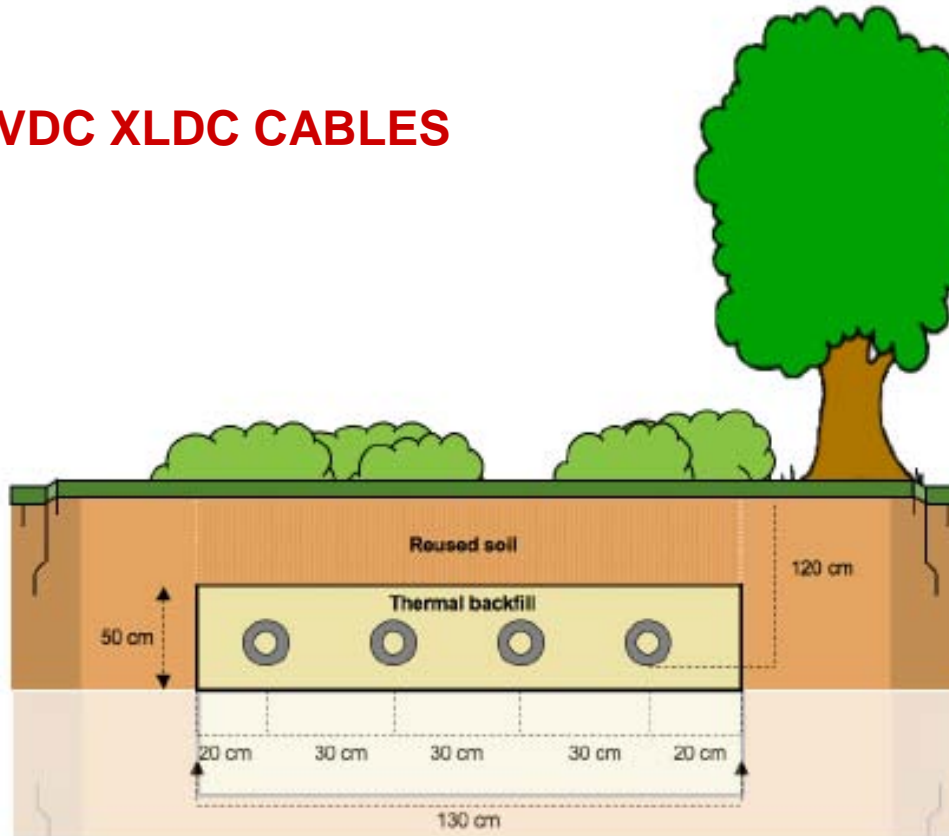
B

A: Neptune 500 kV Long Island NY B: Baltic 400 kV Sweden

HVDC UNDERGROUND CABLE

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± 320 KVDC XLDC CABLES

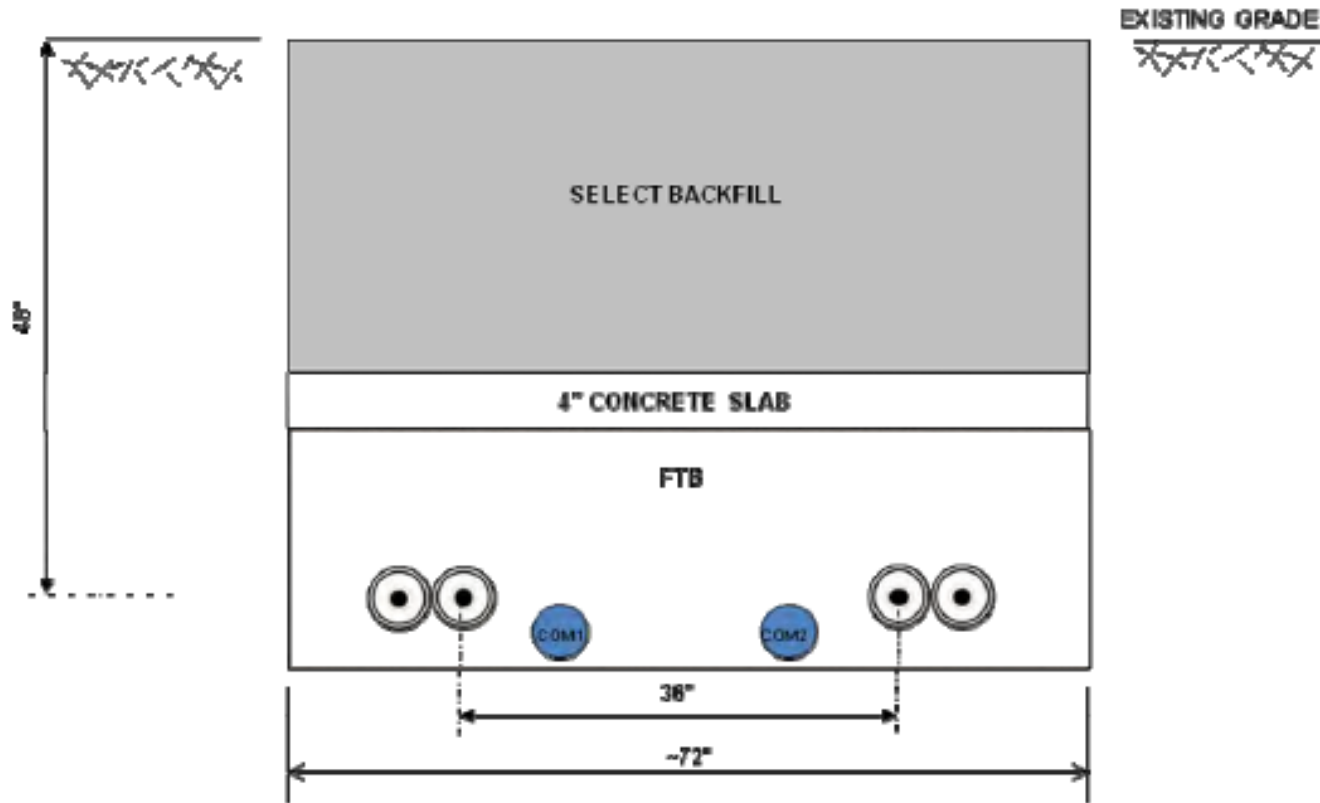


EUROPACABEL 320 KV, 2000 MW OPEN-CUT TRENCH DESIGN

HVDC UNDERGROUND CABLE

ECC, INC.

± 500 KVDC MI CABLES



ALBERTA ENERGY 500 KV, 2000 MW OPEN-CUT TRENCH DESIGN

NEPTUNE CABLE REELS BEING UNLOADED FROM A BARGE



**CABLE REEL DIMENSIONS: FLANGE 4.3 M WIDTH 6.0 M
NUMBER OF REELS = 26 AVERAGE REEL LENGTH 700 – 800 M**

HVDC UNDERGROUND CABLE

ECC, INC.

**NEPTUNE SPARE CABLE REEL FOR PERMAMENT STORAGE
CABLE LENGTH 1000 TOTAL MASS ~ 55 TONNES**



500 KVDC, 2000 MW BUDGETARY COSTS

Estimate 1: Based on 2007 costs for a 500 KVDC MI land cable project escalated using the average annual inflation rate of 2.3 % to provide 2012 prices. The Budgetary Estimate obtained in this way for Option B is **\$ 4.35 million (USD) per route km.**

Estimate 2: This cost estimate was provided by a supplier via a private communication and was based on current prices. The Budgetary Cost provided for Option B was **\$ 5.0 million (USD) per route km.**

Estimate 3: Based on Alberta Energy (Ref. in the Report). **\$4.5 million (USD) per route km.**

THE INELFE ± 320 KVDC, 2000 MW VSC PROJECT



The 65 km, 320 KVDC, 2000 MW INELFE Project will use XLDC cables. Two Bipoles (4 cables) will be installed in separate trenches along the main portion of the route. A number of HDD sections will be required. An 8.5 km tunnel will be built to cross the Pyrenees Mountains.

COSTS:

Cable: \$ 2.30 Million USD / km

Civil Works \$ 1.24 Million USD / km

Tunnel: \$ 2.5 Million USD / km

Total Cost: \$ 6.04 Million USD / km

THANK YOU

