To
TNO - WP3.5
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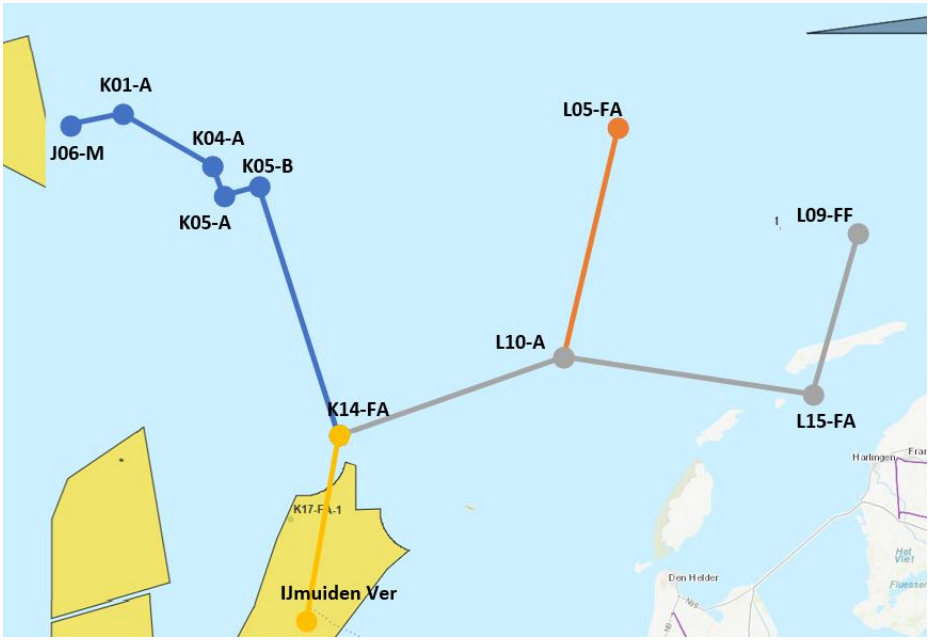
MEMO

NSE3 Powergrid - Estimation and assumptions - PUBLIC

INTRO

Boskalis Subsea Cables (BSC) joined the North Sea Energy consortium for a few years now and brought in their knowledge about offshore energy transportation by cables. BSC has made a preliminary design and non-binding cost estimation of the powergrid scenario based on available data. It concerns the *Scenario I: Expanding and using the grid for electrification of high potential platforms.*

This memo contains a budgetary proposal. Our proposal is only for the use of assessing the business case of the current powergrid scenario. This proposal based on a cable set up from IJmuiden Ver to a powergrid connection which starts at K14-FA.



Revision history		
Revision	**Section**	**Change**
1	3.0 Cable Design	Removed Connection K14 - K18-G from original scope.
1	4.0 Cost Estimation	Removed Connection K14 - K18-G from original scope.

1. MAIN ASSUMPTIONS AND PROVISIONS

General

- This proposal is based on the execution with our own vessels and burial spreads. Vessel costs are notoriously variable depending on their availability and the time of year. Also it is based on the current offshore operations market situation.
- This proposal is based on an uninterrupted installation period (24/7) of the whole powergrid in one campaign, as well as an uninterrupted access to all platforms in the project area.
- At this tender stage, Boskalis assumed Rotterdam as homeport for mobilization/demobilization of the vessels and other spreads. If the cable has to be loaded in a different port this might have consequences for the sailing durations and therefore to planning and price.
- Based on current prices of raw materials (e.g. steel and copper).
- Current fuel rates in Euro per Mt.
- No additional information related to the project area location and cable routes has been taken into account (e.g. water depth, geological and geotechnical conditions, location of J tubes, pull-in arrangements).
- No data available of the seabed around the platforms (e.g. scour protection, existing infrastructure)
- No view on interactions with existing pipelines or cables.
- Contractor has not allowed for any permitting or arranging any licenses and/or crossing agreements.
- CAR insurance is not included in our price and will normally be arranged by the Client.
- No allowance has been made for measures to be taken in case contaminated soil, unexploded ordnance, ammunition, wrecks or chemical waste are encountered during the works. It is assumed that the Employer will perform any removal work as may be necessary to avoid any risk to the installation equipment or cable, and prevent project delay wherever possible. ALARP certificate must be available and handed over to Boskalis prior the start of the works. In our offer, we have excluded UXO survey including reporting and approach and identification.
- This proposal does not include any delay due to weather limitations.
- It is assumed that employer will arrange for the management of interfaces between all parties involved.

Cable Route

- The needed kilometers are calculated based on a pathway in a straight line.
- Client shall be responsible for liaising with the owners of cables and pipelines to be crossed along the route, verifying the status of the cable/pipeline (i.e. in or out of service) and, where necessary, arranging for crossing agreements or permissions to remove cables taken out of service from the route.

Cable Design

- The scenario will assume one cable per connection which means there is no redundancy.
- Assumptions on cable type based on standardization program of Tennets offshore grid.
- Cable design is attached to appendix of this memo.

Soils & burial performance:

- Boskalis has assumed good jetable soils (i.e. medium dense sands) and a burial depth of 1.0m top of cable. No allowance has been made for pre-sweeping of sand waves.

Platform

- Assumption that a J-tube is present at platforms.
- It is assumed that J-tubes on the foundations will have only one bend, at the bottom, and that the bell mouth exit will approximately be 2m from the seabed/scour protection, with an exit angle of 45 degrees.

- Substations usually include medium and or high voltage transformers, switch gears and other electrical infrastructure. The electrical system hardware on the platform is excluded. Costs of termination is based on connection to available switch gear on platform.
- Sufficient space is available at the platform to create a safe working area for our personnel as well as a for easy routing of the cables in the platform structure. A straight pull-in over the J-tube is assumed to be possible and strongpoints are available at the platform. A maximum of 5 meter cable routing towards the termination point of cable and fiber optic is assumed.

2. SCOPE OF WORK

Pre-Survey and UXO survey	**Excluded**
PLGR – Pre Lay Grepnel Run	**Included**
Pre Lay Survey	**Included**
Post Lay Survey	**Included**
Boulder Clearance	**Excluded**
Pre Trenching	**Excluded**
Cable Storage	**Excluded**
Cable Transport	**Included**
Dredging	**Excluded**
Cable Lay	**Included**
Cable Lay & Burial	**Included**
Post Lay Cable Protection	**Excluded**
Cable Crossings	**Included**
Offshore Cable Joints	**Included**
Pull in at Offshore Sub Platform	**Included**
Termination and Testing	**Included**
Support Vessels	**Included**

3. CABLE DESIGN

The cable design is based on the supplied electrification scenario. The demand of every platform is taken into account. Based on this the total power is calculated per connection, to come to a powergrid scenario. Our proposal is to use two types of cables for this power grid. The voltage has been set on 66Kv, which is mainly based on the standardization program of Tennet's offshore grid. In this case there is no additional gear needed such as transformers or switch gears to lower the voltage. Lowering this voltage does not have any financial or technological benefits.

The connection in between platforms will be executed with an 150mm3 cable with aluminum cores (CSA1). The total power demand of the cable between Ijmuiden Ver and K14-FA exceeds the maximum power of CSA1. For this connection a cable is needed with a larger cross section. This cable (CSA2) is an 630mm3 cable with coper core elements.

The total demand per platform, as well as the total power per connection is shown in the table below. Also the total power which is transported per cable is shown.

						Scenario 1: single circuit 630-Cu to OSS			
Case 1: Connection to Ijmuiden Ver							CSA-1	CSA-2	Joints
From	To	Req. power at platform [MW]	Req. power in cable [MW]	Line current in Cable [A]	Estimated CSA [mm2]	Length [km]	150-Al	1x630-Cu	
J6-A-Markham	K01-A	14,7	14,7	135	150-Al	9,1	9,1		
K01-A	K04-A	2,4	17,1	157	150-Al	18,4	18,4		1,0
K04-A	K05-A	4,2	21,3	196	150-Al	6,3	6,3		
K05-A	K05-B	6,2	27,5	253	150-Al	6,3	6,3		
K05-B	K14-FA	2,9	30,4	280	150-Al	51,2	51,2		4,0
L09-FF	L15-FA	12,1	12,1	111	150-AL	32,9	32,9		
L15-FA	L10-A	3,1	15,2	140	150-AL	42,7	42,7		
L05-FA	L10-A	2,7	2,7	25	150-AL	46,4	46,4		4,0
L10-A	K14-FA	13,2	31,1	286	150-AL	41,1	41,1		3,0
K14-FA	Ten Ijmuiden Ver Beta	27,2	88,7	817	630-CU	36,9		36,9	4,0
Total Kilometers						291,4	254,5	36,9	16,0

Technical Limitations
There are some technical limitations in the maximum cable lengths of 66kv cables. Currently a maximum distance of 30km is taken into account due to the loss of power. Three cables are expanding this maximum distance (shaded in yellow). Currently there are technical developments to extend this range, but probably a new cable design is needed where the voltage will increase to 132Kv. This has a big influence on the total price, mainly for the additional electronic gear. This gear will both increase in costs as in the dimensions.

4. COST ESTIMATION

Scenario I: Expanding and using the grid for electrification of high potential platforms		
		Estimation
1 PROJECT MANAGEMENT AND ENGINEERING		
2 PRE-INSTALLATION SURVEY & PLGR		
3 CABLE CROSSINGS MATRASS INSTALLATION	(5 pcs/crossing x 3 crossings)	
4 MOBILISATION/DEMOBILISATION CABLE INSTALLATION		
5 LOAD OUT OF EXPORT CABLE		
6 TRANSIT FROM MOB PORT TO CABLE LOADING LOCATION		
7 CABLE LAYING & PULL-IN AT PLATFORMS		
8 OFFSHORE CABLE JOINTS		
8 CABLE BURIAL (POST LAY)		
9 SUPPLY & INSTALL CPS		
10 TERMINATION & TESTING WORKS		
11 SUPPORT VESSELS		
Total Sum Operations		**€ 92.840.500**

Cable Supply		
CSA1	3x150mm3 Al 66kV	
CSA2	3x630mm3 Cu 66kV	
Joints	18pc	
Additional Accesoires	10% of cable cost	
Total Sum Operations		**€ 49.582.951**

Total		**€ 142.423.451**
Cost per km	292	€ 487.752

- Transportation of the cable from manufacturer to Rotterdam is not taken into account. This amount can go up from one to five million, which depends on the location of the manufacturer. All manufactures are based in Europe. In distance this can go from Germany to the south of Greece.