

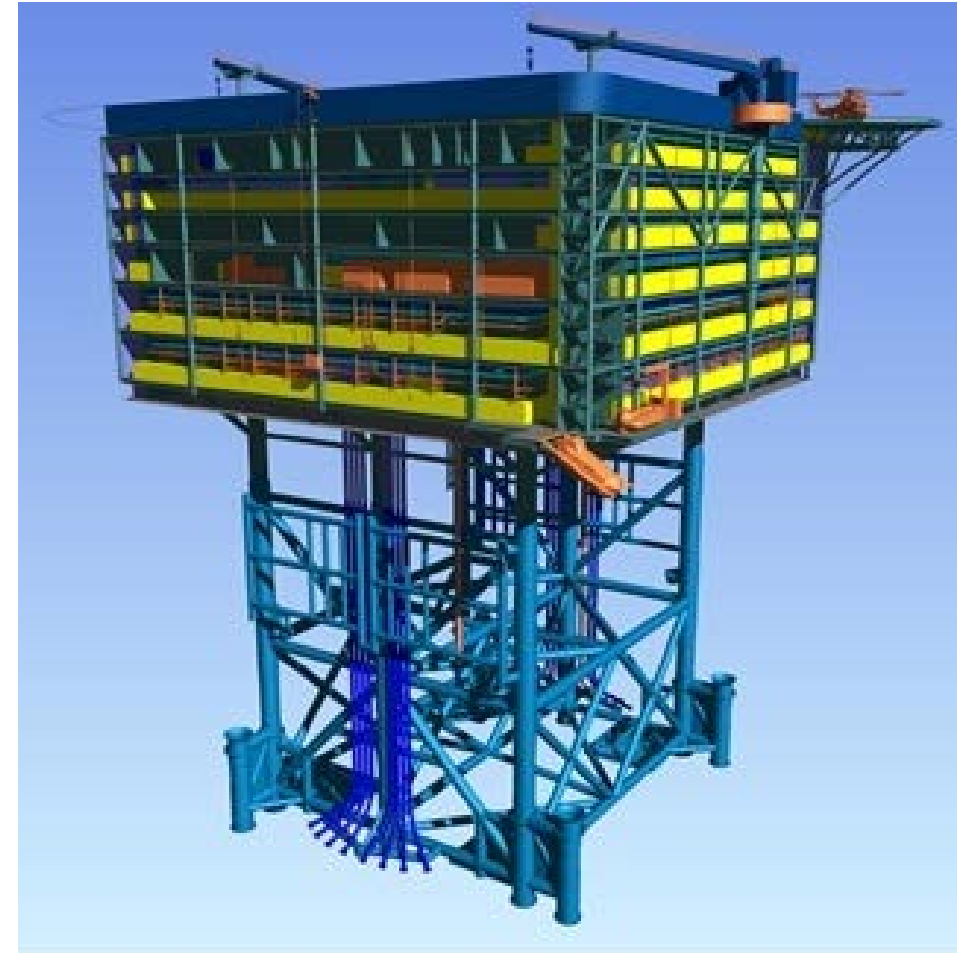
# Cost development in HVDC Circuit Breakers

01

Purpose

## Purpose

- The cost data collection report gives the cost of HVDC equipment in 2017 numbers.
- The intention with this analysis is to discuss the cost development towards 2050.



01

# Assumptions

## Cost drivers used in the model

Cost driver indexes	Description
Commodities	Commodities used in production (steel, aluminum, copper, power electronics) and in installation (energy).
Labour	Low-skilled labour, typically used for civil work and installation.
Engineering	High-skilled labour, typically used for project management and engineering.
Experience	Development reflects how mature the technology is today and how the learning curve will affect the price.

## Development in cost drivers

		2020	2030	2040	2050
Commodities	Aluminum	8 %	12 %	15 %	19 %
	Copper	7 %	13 %	21 %	28 %
	Steel (Iron)	-26 %	-26 %	-27 %	-27 %
	Power Electronics	-2 %	-5 %	-7 %	-10 %
	Oil	27 %	8 %	-8 %	-22 %
	Electricity	0 %	0 %	0 %	0 %
Labour	Labour	-1 %	-4 %	-7 %	-10 %
Experience	Cable (Sea and land)	-3 %	-12 %	-17 %	-20 %
	VSC Converter	-3 %	-9 %	-13 %	-14 %
	Platform	-5 %	-20 %	-30 %	-40 %
	DCCB	-5 %	-20 %	-30 %	-40 %
Engineering	Engineering	5 %	10 %	15 %	20 %

# Sources

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## Commodities:

- Price development of aluminium, copper, steel and oil is based on World Bank numbers for 2020-2030. Assumed similar development towards 2050.
- Price development of power electronics based on DNV GL expert opinion.
- Price of electricity is based partly on NVE and partly on DNV GL expert opinion.
- Based on the ETO, electricity consumption will more than double by mid-century to meet 45% of world energy demand. Have assumed constant increase towards 45% in 2050.

## Labour:

- Based on E-highway «Modular Development Plan of the Pan-European Transmission System 2050»

## Experience:

- Experience index for cable and VSC converter station is based on E-highway «Modular Development Plan of the Pan-European Transmission System 2050»
- Experience index for Platform and DCCB is based on DNV GL expert opinion.

## Engineering:

- Partly based on E-highway «Modular Development Plan of the Pan-European Transmission System 2050» and partly based on DNV GL expert opinion.

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Cost breakdown



## Cost Split - VSC Converter Station

Breakdown per component (% of investment cost)		Labour (LAB)	Energy (Oil and electricity)	Engineering (ENG)	Experience (EXP)	Commodity (CMD)
Equipment	53 %	0%	0 %	0 %	80 %	20 %
Installation	11 %	0 %	60 %	40 %	0	0
Civil work	22 %	50 %	50 %	0 %	0	0
PM	14 %			100 %		
CAPEX	100 %					

Assumptions:

- Electricity consumption will more than double by mid-century to meet 45% of world energy demand.
- Commodity mix will consist of 50% power electronics, 30% copper and 20% steel.

## Cost Split - Sea Cable

Breakdown per component (% of investment cost)		Costs for each component				
		Labour (LAB)	Energy (Oil and electricity)	Engineering (ENG)	Experience (EXP)	Commodity/Metal (CMD)
Equipment	59 %	0 %	0 %	0 %	80 %	20 %
Installation	16 %	60 %	40 %	0 %	0 %	0 %
Civil work	11 %	50 %	50 %	0 %	0 %	0 %
PM	14 %	0 %	0 %	100 %	0 %	0 %
CAPEX	100 %					

## Cost Split - Platform

Breakdown per component (% of investment cost)		Costs for each component				
		Labour (LAB)	Energy (Oil and electricity)	Engineering (ENG) (skilled labour)	Experience (EXP)	Commodity/ Metal (CMD)
Project management	15 %	0 %	0 %	65 %	35 %	0 %
Engineering - contractor (equipment part 1)	50 %	0 %	0 %	25 %	25 %	50 %
Construction (Installation)	35 %	40 %	35 %	15 %	10 %	0 %
CAPEX						

Assumptions:

- Assuming similar price development for jack-up, jacket and semi-sub (gravity based)
- Commodity mix will consist 100% of steel.

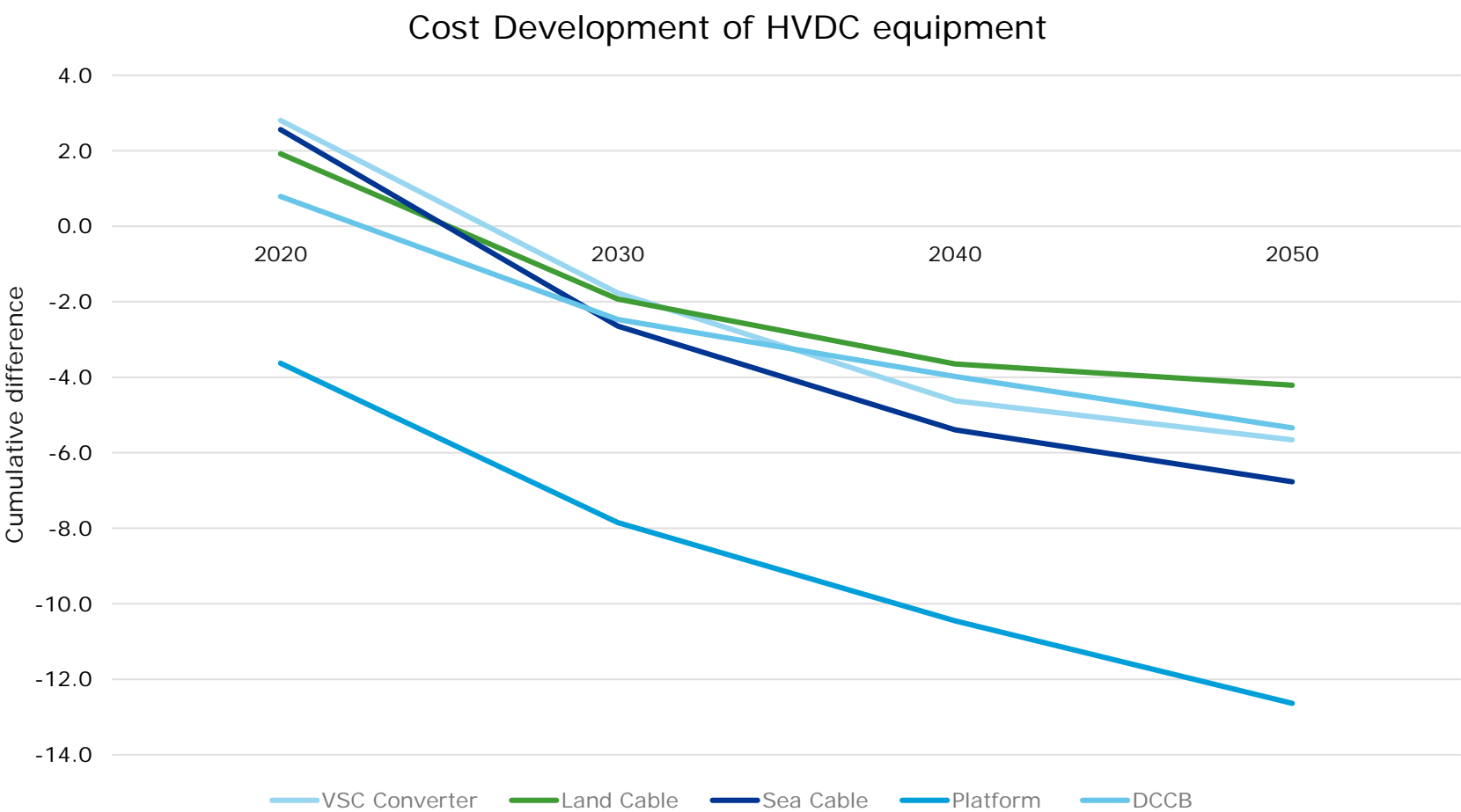
## Cost Split - DCCB

Breakdown per component (% of investment cost)		Costs for each component				
		Labour (LAB)	Energy (Oil and electricity)	Engineering (ENG)	Experience (EXP)	Commodity/Metal (CMD)
Equipment (direct cost)	65 %	0 %	0 %	30 %	30 %	40 %
Installation and commissioning	20 %	30 %	40 %	30 %	0	0
PM	5 %	0 %	0 %	70 %	30 %	0 %
Platform or civil work cost	10%	50%	50%			
CAPEX	100 %					

03

Results

# Cost Development of HVDC equipment



# Thanks for your attentions!

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