

Stakeholder Kick-off

ABB contribution

Jenny Josefsson, ABB, 2016-06-29



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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691714.

CONTENT

- ↗Future Grids with HVDC
- ↗HVDC Breaker
- ↗Protection Systems for DC
Grids
- ↗Converter and system
topology



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Future Grids with HVDC



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Rationale



▪ Typical HVDC Grid Applications

Today

- ❑ Interconnectors
- ❑ Embedded HVDC in AC grids
- ❑ Offshore wind connections
- ❑ Remote generation

Next steps

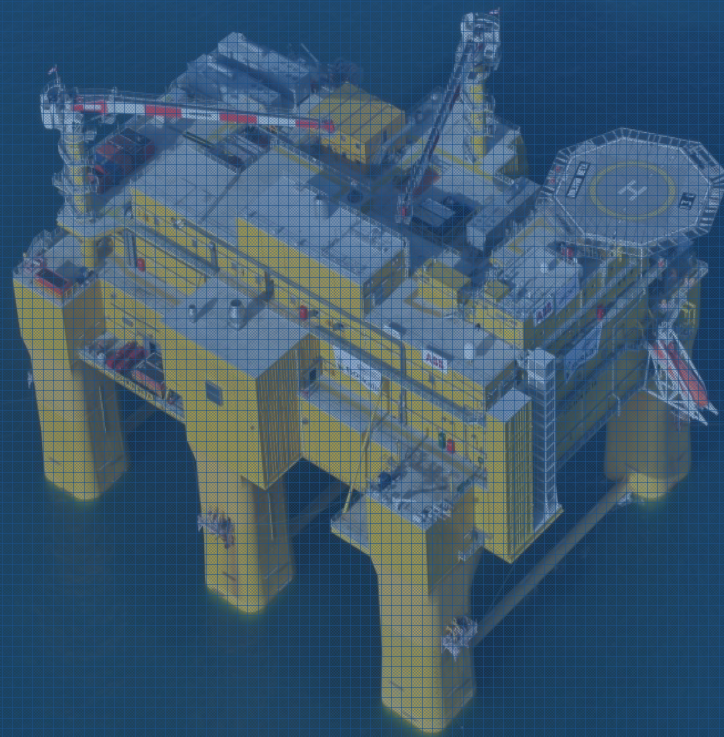
- ❑ VSC Multi-terminals
- ❑ Larger penetration of HVDC in AC

▪ Why

- ❑ Integration of power markets
- ❑ Integration of remote wind (offshore)
- ❑ Collection of large volumes of solar power
- ❑ Support AC networks
- ❑ Transmission of excess renewable energy to remote loads is more cost efficient than storage at each load or generation center
 - ❑ Lower capex
 - ❑ Optimization of storage capacity
 - ❑ Multiple transmission capacity usage

HVDC voltage source converters, cables, OHL, fast C&P, HVDC breakers,...





HVDC Breaker



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Goals and Contribution

↗Goal:

- ↗Develop a test circuit for HVDC Breakers
- ↗Develop **type tests** for the Hybrid HVDC Breaker

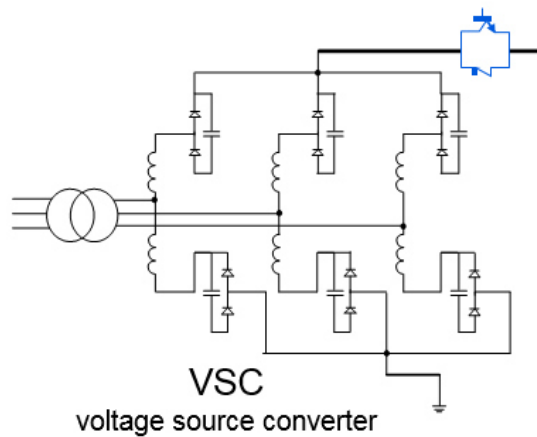
↗Contribution:

- ↗Knowledge of the Hybrid HVDC Breaker, and testing of the same Breaker.
- ↗Knowledge of testing of HVDC components such as converter valve cells
- ↗Review models and study results

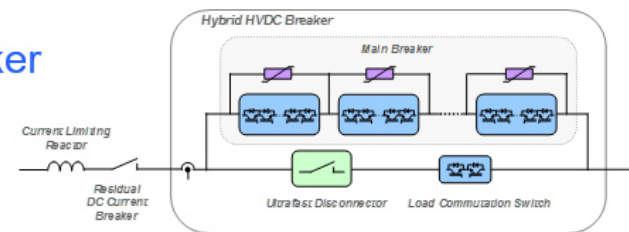


Hybrid HVDC Breaker - The ultrafast low-loss solution

- Fault clearance < 5 ms. Losses < 0.01%. Scalable concept. First 320 kV, next level 500 kV



▪HVDC Breaker



- Hybrid concept: Mechanics and power electronics

▪Artist impression

- **Flexible multiple protection zone HVDC can be designed and planned for**

Protection Systems for DC Grids



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Goals and Contribution

↗Goal:

- ↗ Develop **robust** and **fast** protections for multi-terminals and meshed grids offshore

↗Contribution:

- ↗ Experience from real life protection system for HVDC.
- ↗ Experience from real time simulations of fast DC line protections
- ↗ Studies
- ↗ Support developing new protection algorithms if needed



Converter and system topology



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Goals and Contribution

↗Goal:

- ↗ Technical comparison between DRU and VSC

↗Contribution:

- ↗ Knowledge of the newest VSC technology throughout the project



Key components of HVDC transmission systems - ABB's unique position in converters, semiconductors & cables

Converters



- **Conversion of AC to DC and vice versa**

▪ High power semiconductors



- **Silicon-based devices for power switching**

HV Cables

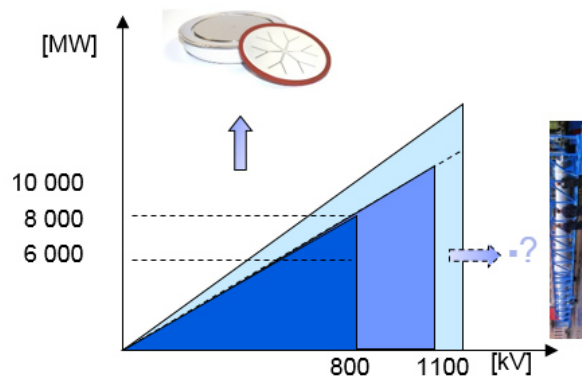


- **Underground and marine transmission of power**

HVDC. More power by higher voltage and current - Extreme LCC powers available. VSC moving up rapidly

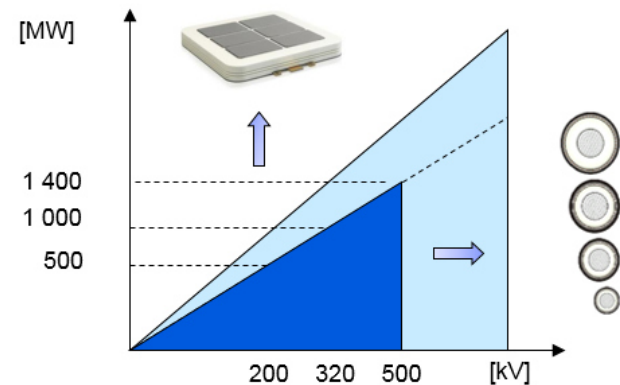
- LCC UHVDC (Classic). 8-13 GW / bipole
>150 links since 1954

- Voltage increase up to 1100 kV
- Current increases 4.5-5.0-6.25 kA.
- Further increase in peak power?
- Reactive power consumption may be challenging



- VSC HVDC (HVDC Light) >20 since 1999

- First 500 kV bipoles with cables
- Voltage increase for converters straightforward
- Current increase would be beneficial
- Cables at 2.6 kA, 525 kV



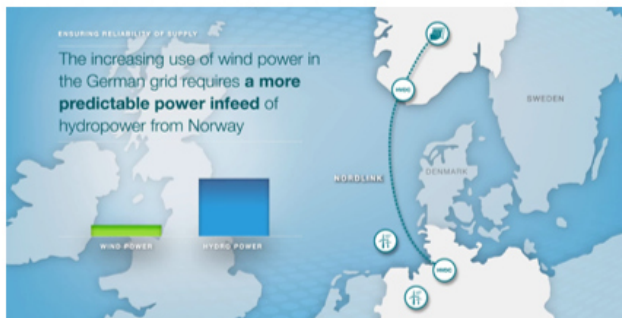
- **Loss minimization is always important. At higher currents also for cooling design**

1. Dark blue in construction or operation. Light blue released
2. Examples Hami-Zhengzhou 8 000 MW (LCC, 2014). EWIC NordLink 1400 MW (VSC, award 2015)

The North Sea is being interconnected – NordLink connecting TenneT and Statnett grids

Interconnecting Germany-Norway

- German wind and solar can be balanced with Norwegian hydro
- VSC to support grid connection points in Tonstad and Wilster



▪ 1400 MW Bipole

- 2 x 700 MW VSC-HVDC
- ± 515 kV IGBT-based converter valves
- ± 525 kV mass impregnated (MI) marine and underground cable system, 623 km



▪ Renewable power supply to 3.6 million German households by 2020

Fig. 1. <http://spectrum.ieee.org/video/energy/renewables/nordlink-a-landmark-project-enabling-a-more-interconnected-europe>

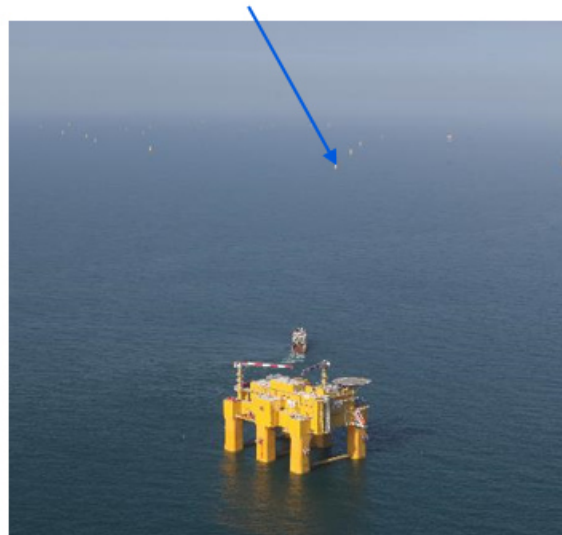
Fig. 2. Skagerrak 700 MW VSC-HVDC valve



Converter and system topology

Dolwin beta, 916 MW offshore converter power

The wind turbines are seen far in the distance.



- 70 x 100 x 100 (w x l x h). 23000 tonnes
World's largest offshore connection platform



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APPENDIX

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