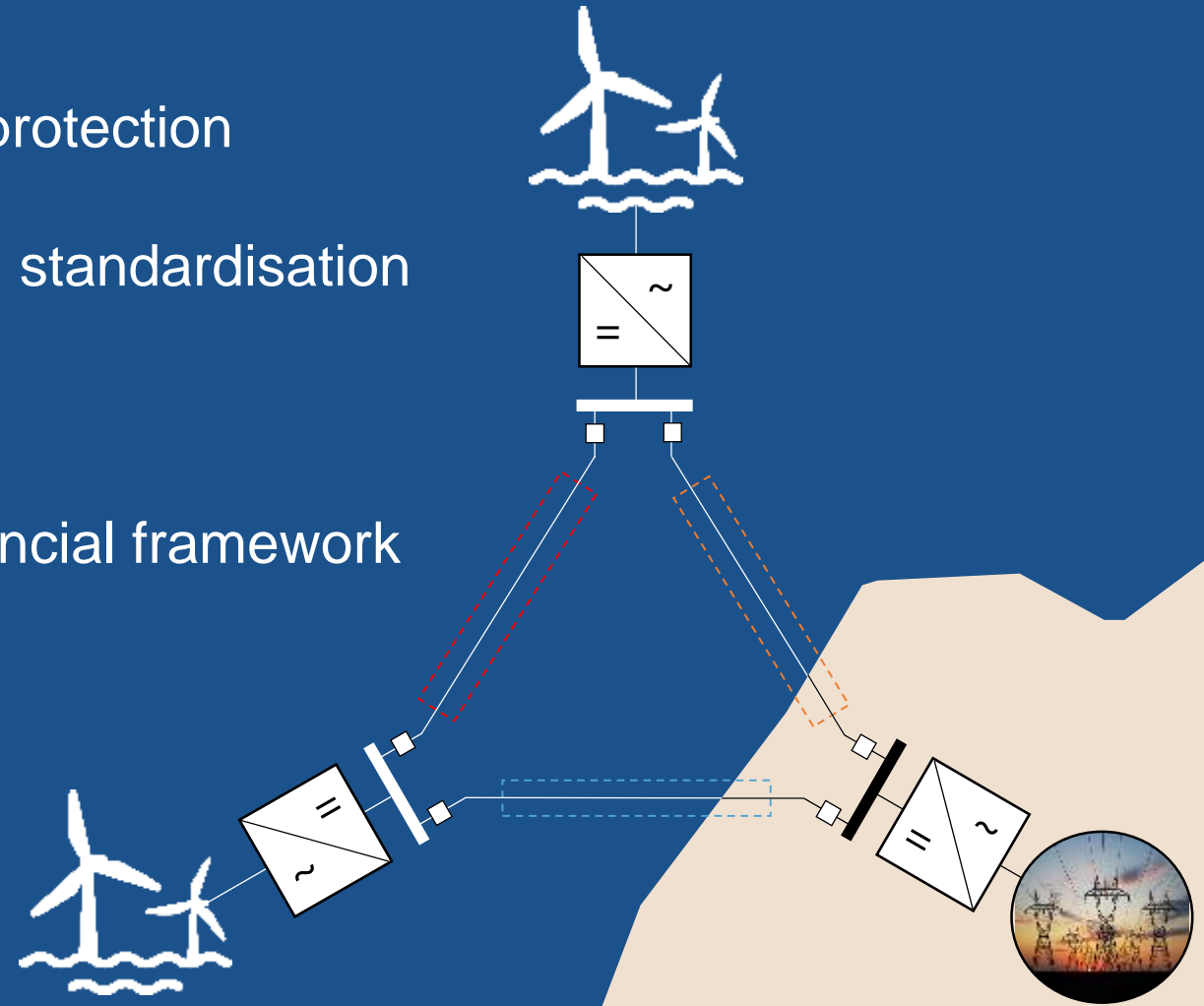


Progress On Meshed HVDC Offshore Transmission Networks

Hybrid HVDC circuit breaker demonstration | Arnhem | 27th of February 2020

Enabling the North Sea power house

- Develop cost effective & reliable control & protection
- Achieve technology interoperability through standardisation
- Full scale technology demonstrations
- Recommendations for EU regulatory & financial framework
- Short & long term deployment plan



Backbone grid structure

- 29 lines
- 35 nodes (19 offshore and 16 onshore nodes)
- 7 double lines:
 - DK_OFF01 , DE_OFF01
 - Meeden , NL_OFF16/NL_OFF17
 - NL_OFF16/NL_OFF17 , NL_OFF09/NL_OFF12/NL_OFF13
 - NL_Bleiswijk , NL_OFF28/NL_OFF29
 - Bramford , UK_OFF11
 - Grimsby , UK_OFF16/UK_OFF20
 - West Burton , UK_OFF16/UK_OFF20

Legend

 Danmark connections

 Germany connections

 Interconnectors

 Netherlands connections

 Norway connections

 Offshore windfarms

 Onshore nodes

 United Kingdom connections



Deployment

Example topology



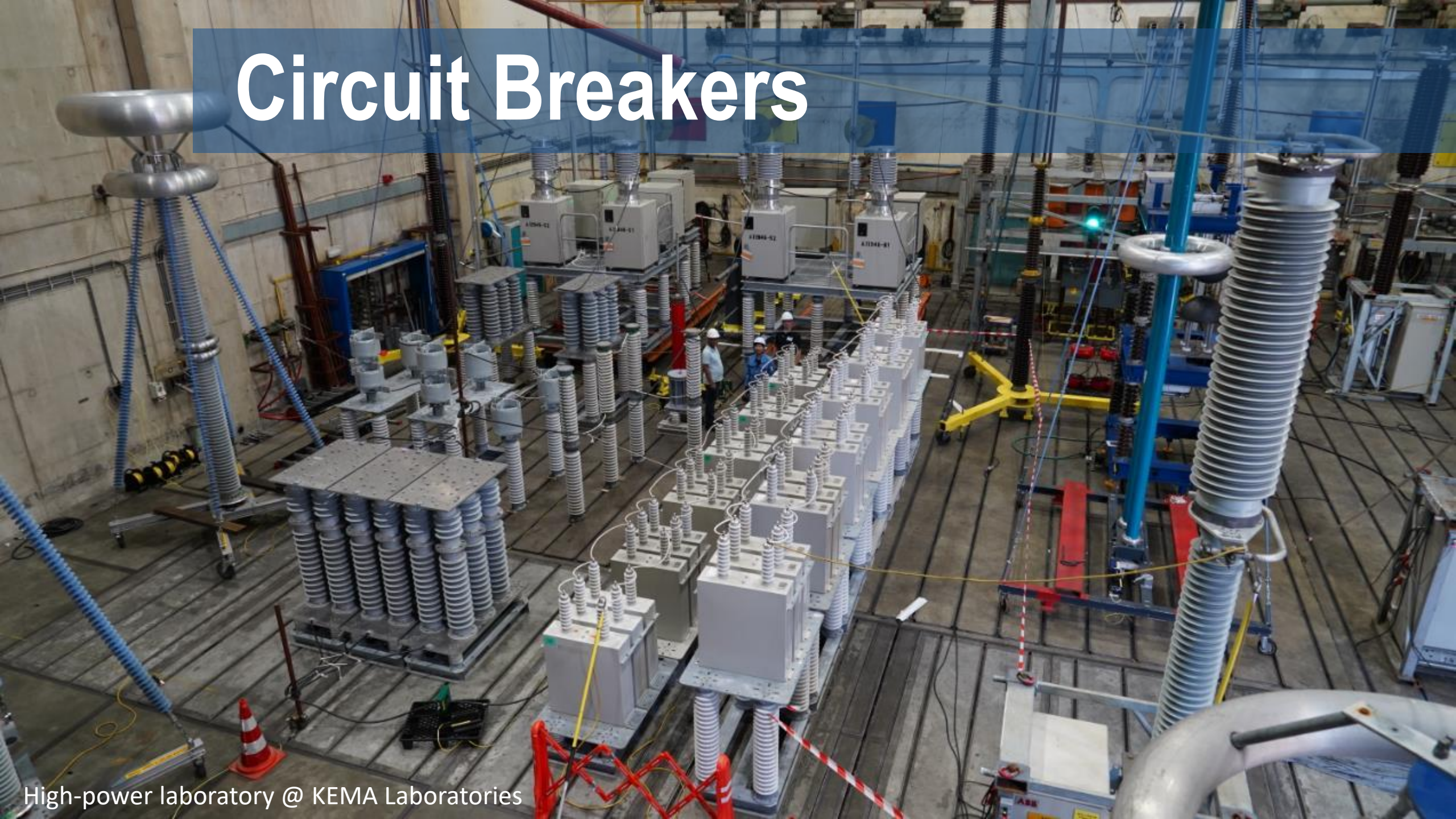
Grid Control

MMC Test Bench Lab
@ RWTH Aachen University

© Martin Braun

Grid Protection

Circuit Breakers



High-power laboratory @ KEMA Laboratories

Gas Insulated Systems



High voltage DC laboratory @ KEMA Laboratories

Technical Recommendations

Agree on common HVDC grid characteristics

- Standardisation of voltage classes!
- Enable TSOs and developers to procure single converter station
 - Agree on how to specify DC side behaviour
 - How to deal with contractual requirements such as availability guarantees?
- As much as possible avoid need for exchange of technical information between OEMs
- Develop HVDC system grid code - Minimum requirements for future compatibility

Need for pilots – intermediate steps to DC grid development

- Full-scale first-of-a-kind technology applications
- PROMOTioN Short term projects:
 - South-West Link - Hansa Power Bridge DC Connection
 - WindConnector DC Circuit Breaker
 - Bornholm Island DC hub – CleanStream



Further research

- HVDC grid & **hub topology** & infrastructure
- Multi-vendor **interoperability** of controls and protection
- Offshore wind farm advanced capabilities – enhancement and **system integration**
- Integrated **AC/DC system** studies – Generator to consumer
 - Development of **tools** for analysis of large HVDC systems and integrated system studies
 - Analysis of AC and DC system **interaction** for different time frames and contingencies
 - Development of **control concepts** for integrated system operation
- DC **switchgear** development: faster, lighter, cheaper



Upcoming PROMOTioN Events

Demonstrations

- Wind Turbine Grid Forming Control Hardware-in-the-Loop testing for black-start operation
 - 31 March 2020, UPV, Valencia
- SF6 alternative for HVDC GIS
 - 28 April 2020, ABB, Zurich
- VARC Mechanical HVDC circuit breaker
 - 30 April 2020, KEMA Laboratories, Arnhem
- HVDC Protection Demonstration
 - 5 – 7th May 2020, National HVDC Centre, Cumbrenault, Scotland

Final Conference 26 & 27 May 2020, Brussels

North Sea Grid for a European Green Deal – *How to unlock Europe's Offshore Wind potential - a deployment plan for a meshed HVDC grid*





PROMOTioN

PROGRESS ON MESHED HVDC
OFFSHORE TRANSMISSION
NETWORKS



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APPENDIX

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The opinions in this presentation are those of the author and do not commit in any way the European Commission

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