HVDC Operators Forum
DCCBs for an efficient DC grid

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Multi Terminal HVDC System (Need for DCCBs)

Increase in HVDC

Increase in RE: demand for HVDC links:

- Connection of offshore windfarms (far from shore)
- Interconnection of countries to improve system stability and energy exchange (balance)

Multi-terminal systems

MTDC systems will allow meshed network, similar to that of AC systems:

- Reducing equipment (#of converters, cables, etc.)
- Improving robustness of the system (reduce spinning reserve, etc.)

Point to point only

Points to point connections are the default presently, due to lack of DCCBs…

Present → **Future**

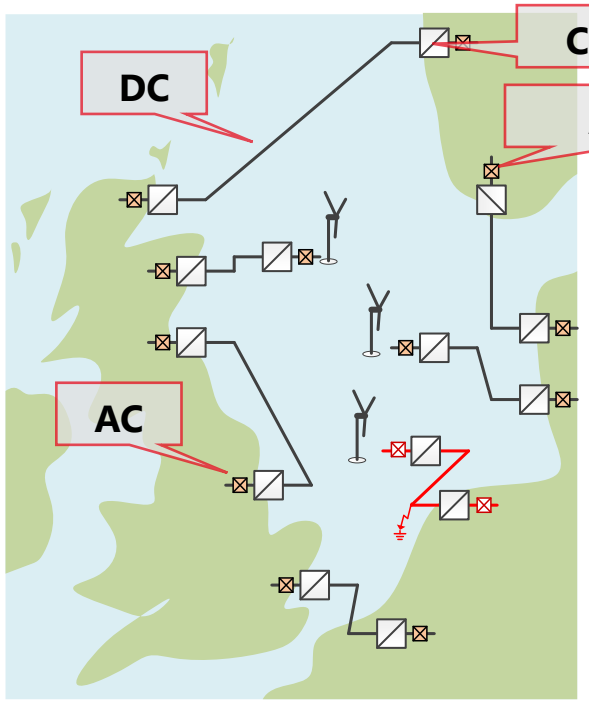


Fig1. Point to point connections

Fault is cleared by ac breaker (ACCB): dc link is out of service. Power loss is limited: acceptable. [Today's situation]

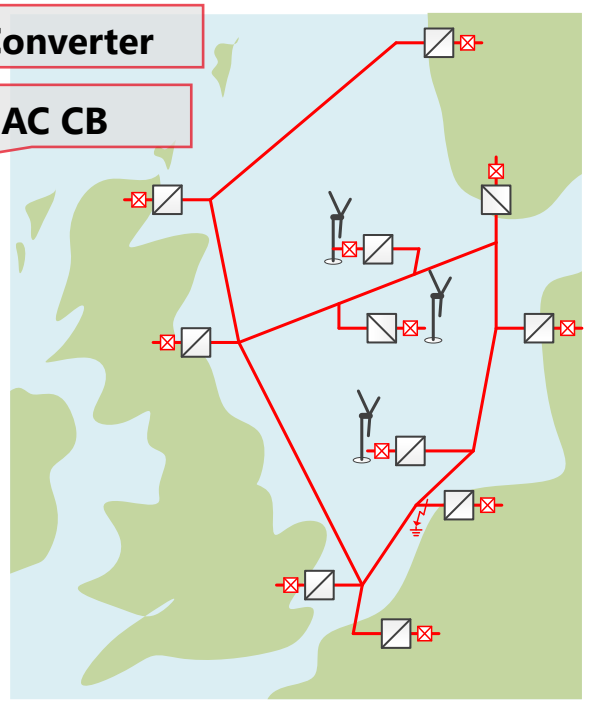


Fig2. Multi terminal (MT).

Fault is cleared by ACCB. *Total MT network is out of service.* → Not acceptable. Too much power loss over wide area.

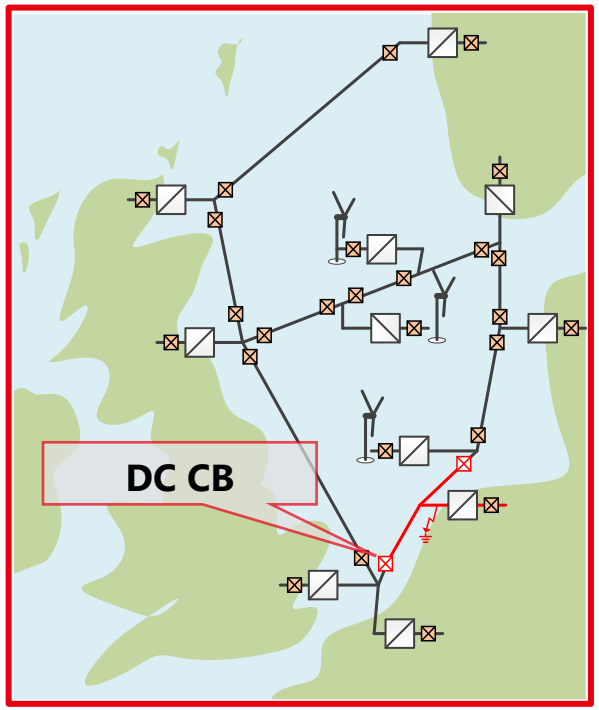
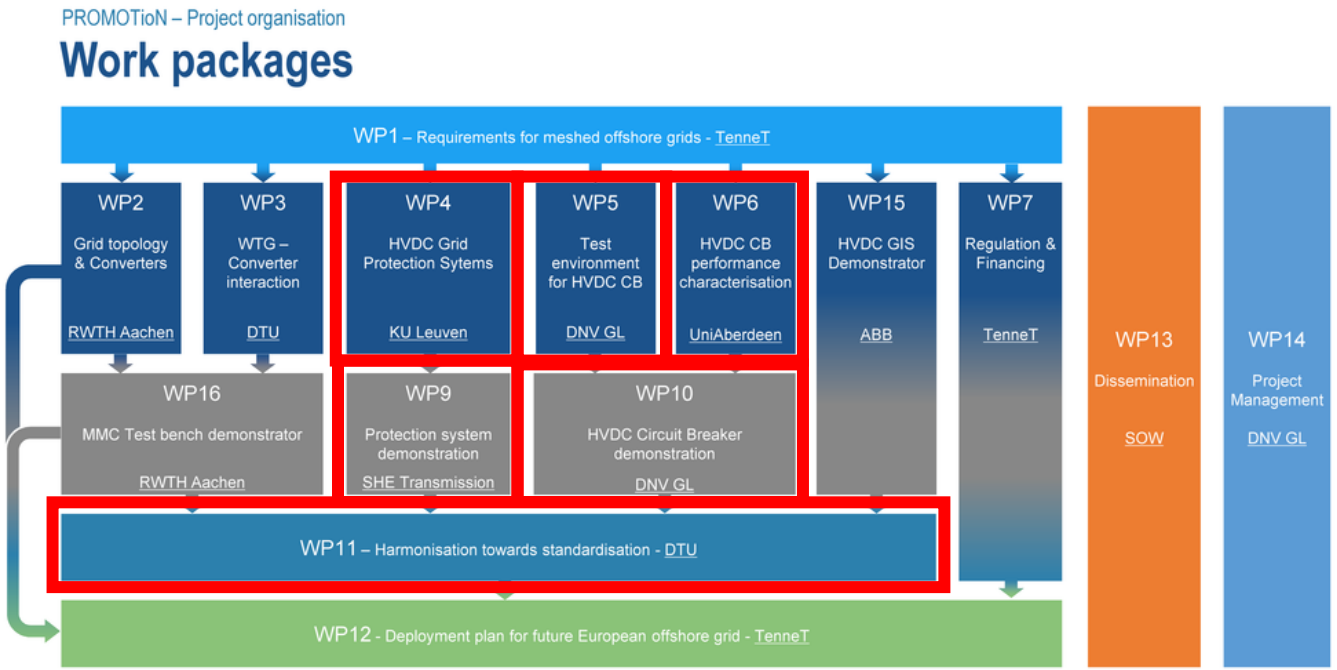


Fig3. Multi terminal (MT) + DCCB

Fault is cleared by ac breaker DCCB. Isolated part of network is out of service.
MT HVDC network can be achieved.

Horizon 2020: PROMOTioN Project



WP 4: HVDC Grid Protection System

Investigation of different system topologies and protection strategies.

WP 5: Test environment for HVDC DCCB

Investigation suitable testing methods for the DCCB.

WP 6: HVDC DCCB performance characterisation

Modelling of DCCBs

WP 9: Protection system demonstration

Use of protection strategies investigated in WP4 within a real-time environment, with control hardware in the loop testing.

WP 10: HVDC DCCB demonstration

Testing of breakers at KEMA labs.

WP 11: Harmonisation

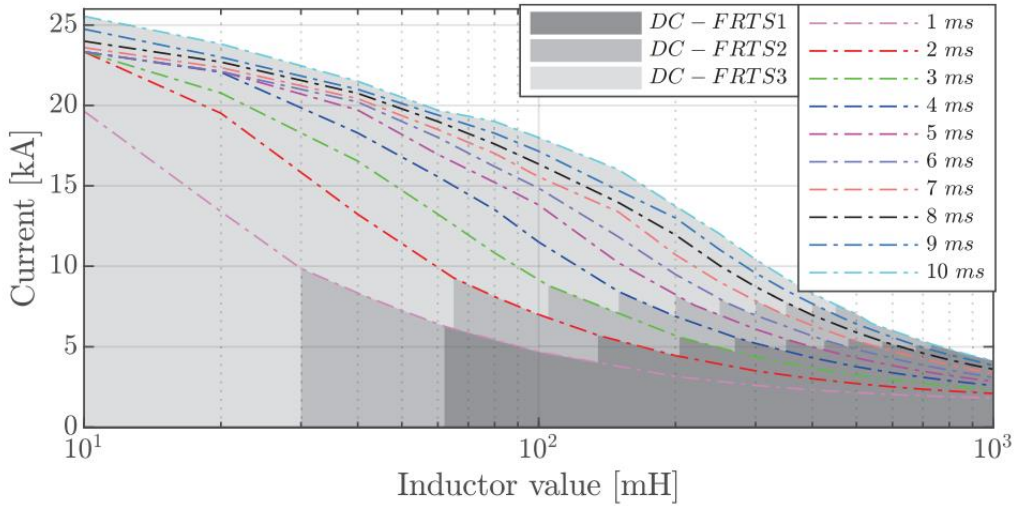
Pre-standardisation activities.

DC Reactor Implications

High speed DCCB

Small reactor

- **Lower loss / CAPEX**
- **Smaller footprint**
- **Less energy**
- **Reduced system coupling**



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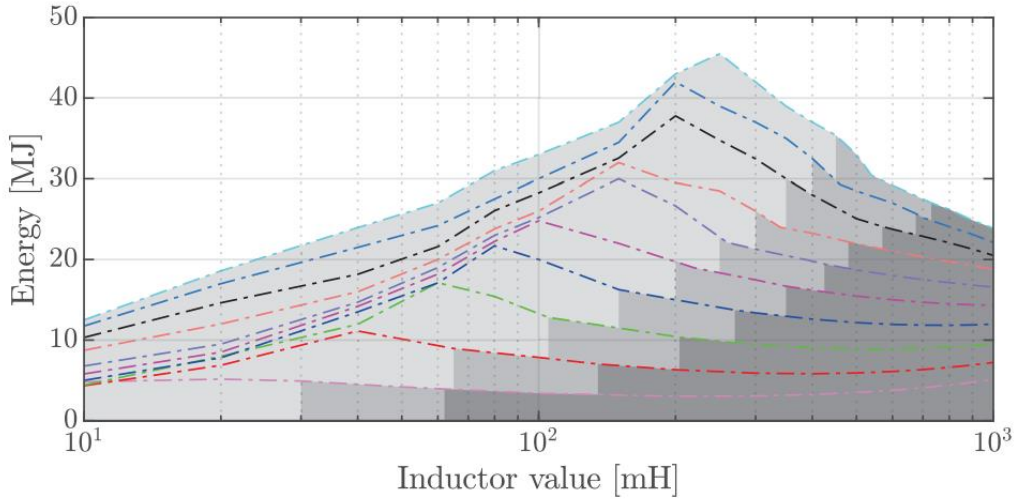


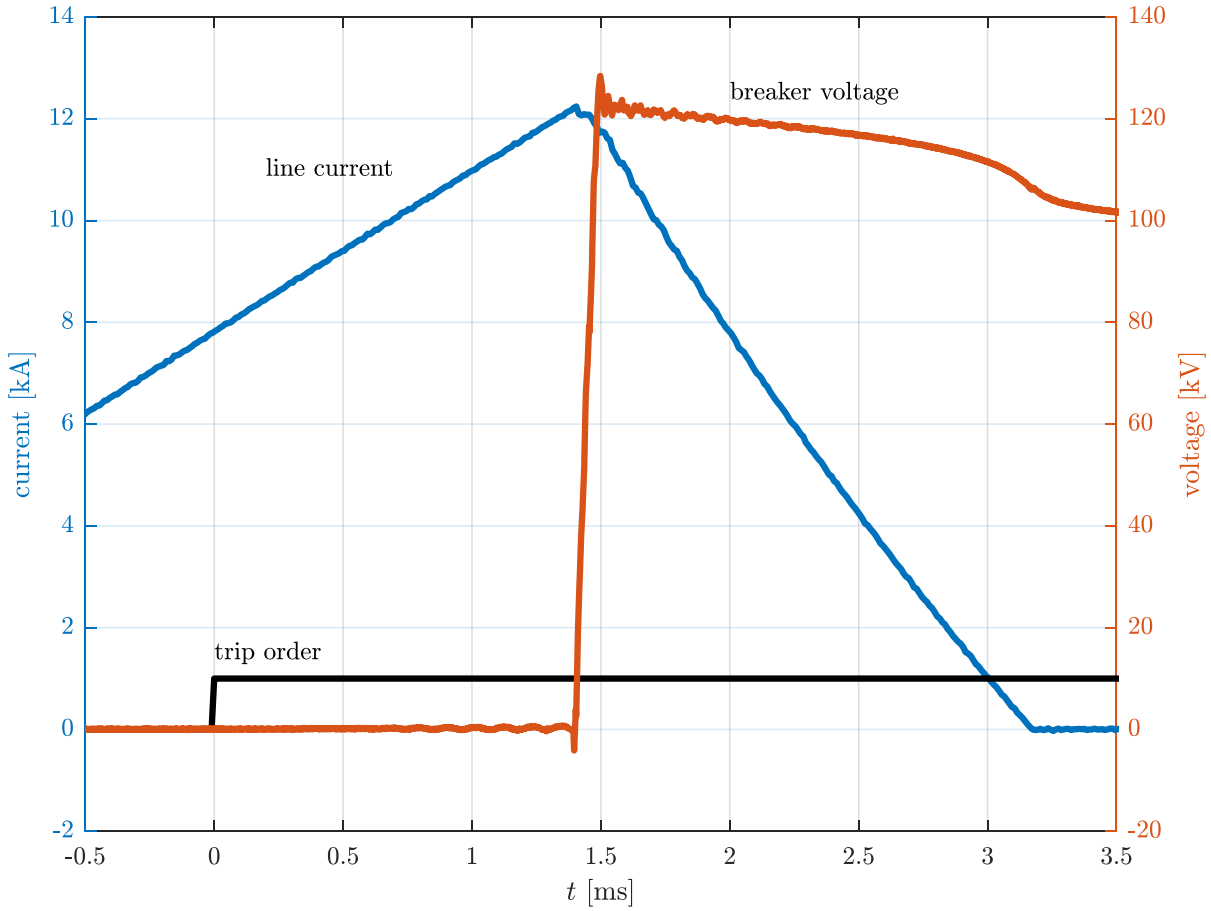
Systematic Approach to HVDC Circuit Breaker Sizing Mudar Abedrabbo, Graduate Student Member, IEEE, Willem Leterme, Member, IEEE, and Dirk Van Hertem, Senior Member, IEEE. Transactions on Power Delivery IEEE 2019

Mitsubishi Electric Acquires all shares of Scibreak, 16th Feb. 2023

20th Feb. 2023, HQ Tokyo.

Horizon 2020 Testing (VARC)

80 kV, 15 kA Scibreak VARC circuit breaker (3 modules in series)



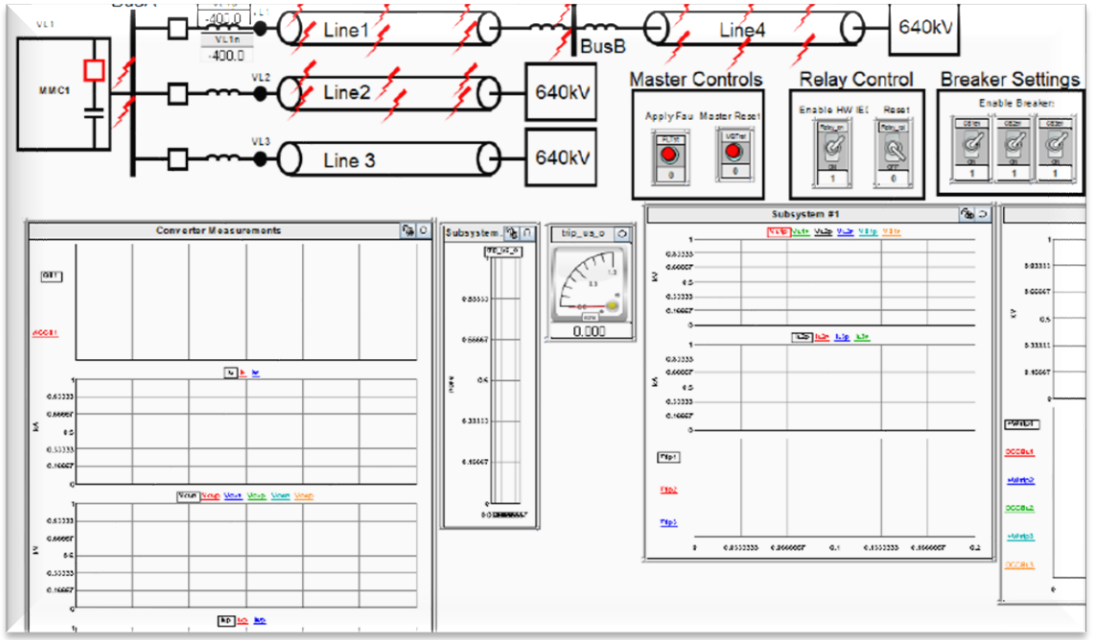
12 kA interrupted in less than 1.5 ms against 120 kV.
(15 kA in 2.0 ms)

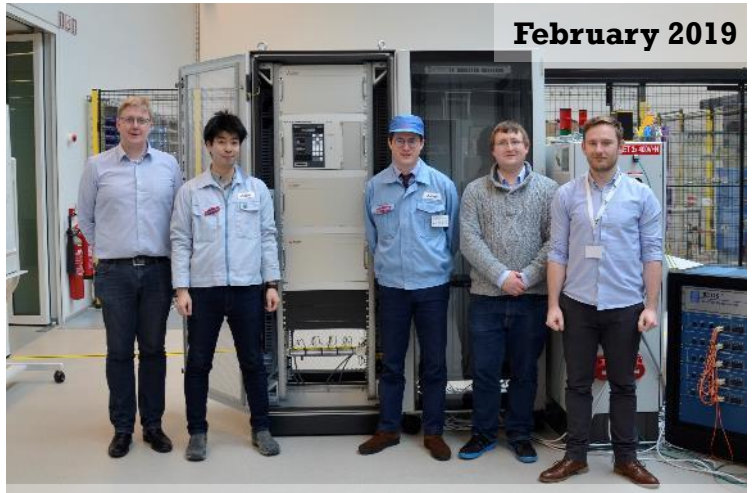
PROMOTioN
PROGRESS ON MESHED HVDC OFFSHORE TRANSMISSION NETWORKS

Unit testing within WP4 in collaboration with KU Leuven's Energy Ville laboratory

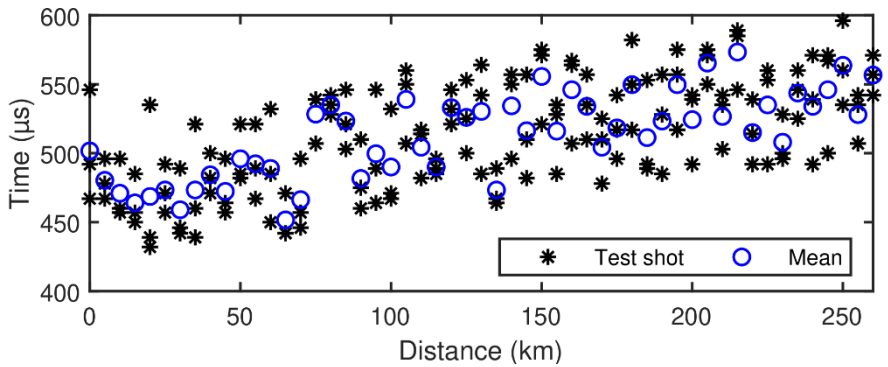
MITSUBISHI ELECTRIC
Changes for the Better

IED Testing Work Package 4





Installation in Energy Ville, Genk



IED operation time

PROMOTioN
PROGRESS ON MESHED HVDC OFFSHORE TRANSMISSION NETWORKS

KU LEUVEN

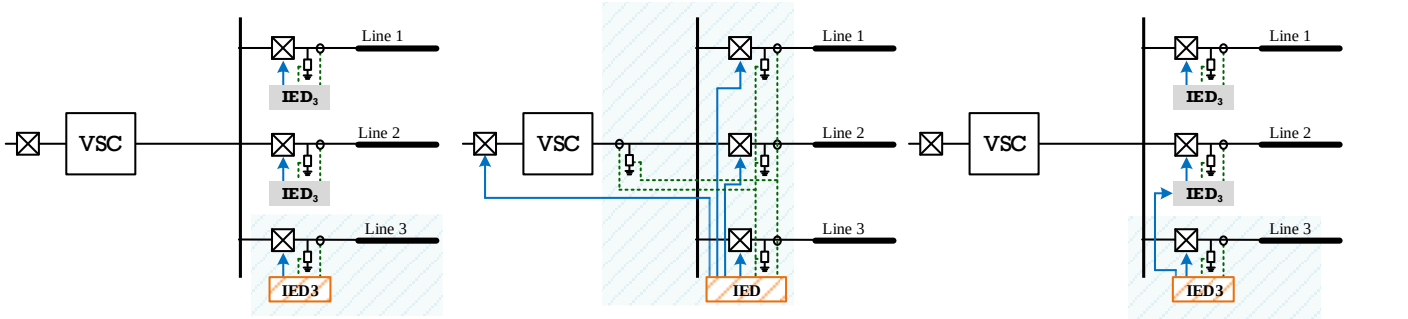
MITSUBISHI ELECTRIC
Changes for the Better

Energy Ville

High-speed DC IED (relay)

Key features

- Redundant architecture: duplicate systems
- Industrial-grade equipment - builds on HVDC/FACTS technology
- Speed: Multiple, high-speed DCCB trip-outputs
- Flexibility:
  - Software programmable to utilise a variety of algorithms
  - Can be used in a variety of system configurations



Example system configurations

Inter OPERA
Enabling multi-vendor HVDC grids

"Enabling interoperability of multi-vendor HVDC grids"
InterOPERA's main objective is to make future HVDC systems mutually compatible and interoperable by design, and to improve grid forming capabilities of offshore and onshore converters.

NEDO New Energy and Industrial Technology Development Organization

Research and development of a multi-purpose and multi-terminal hIGH voltage direct current Transmission system (RIGHT Project)