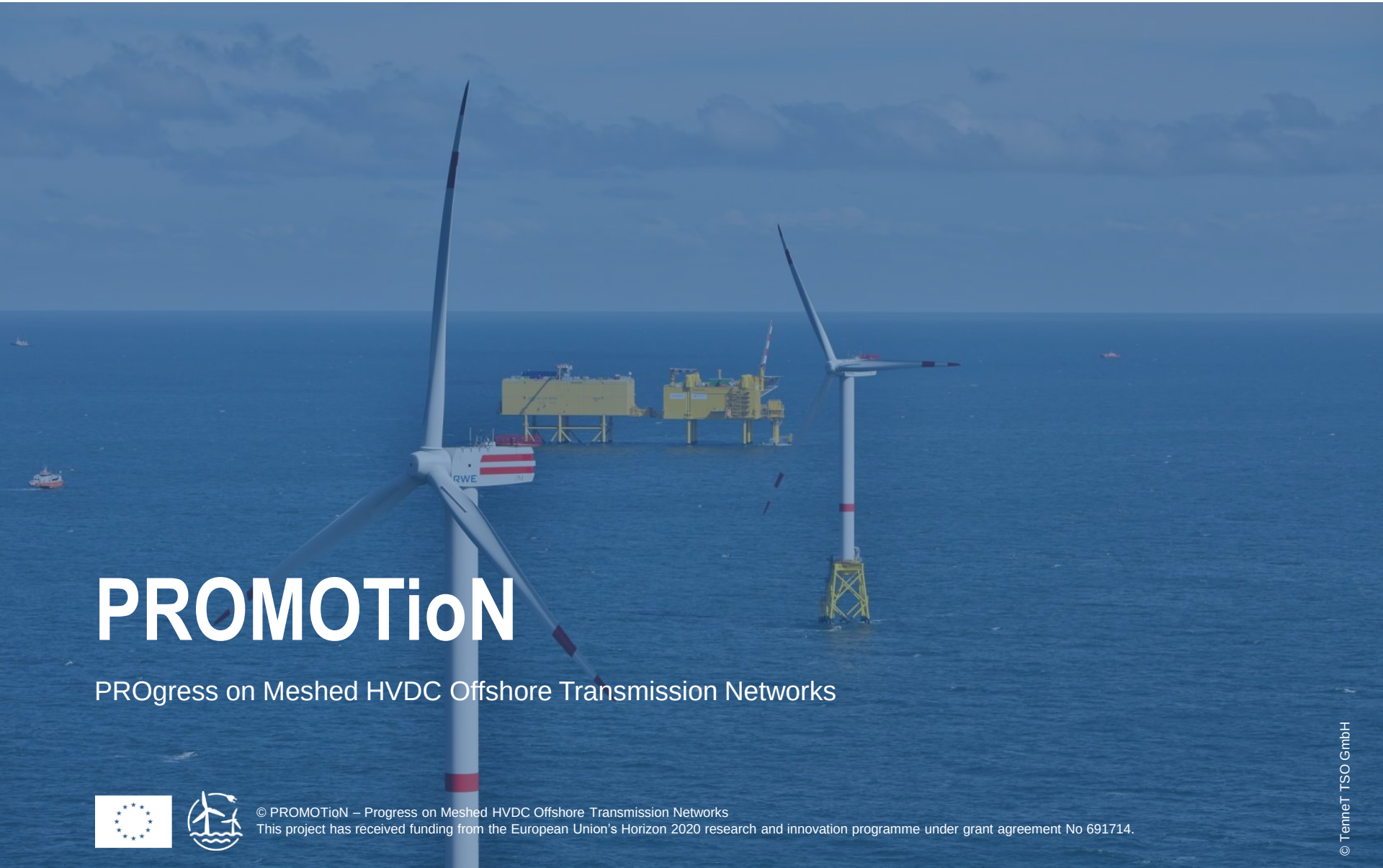
PROMOTioN
PROGRESS ON MESHED HVDC
OFFSHORE TRANSMISSION
NETWORKS



PROMOTioN

PROgress on Meshed HVDC Offshore Transmission Networks

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

↗PROMOTioN

↗HVDC Circuit Breaker Testing

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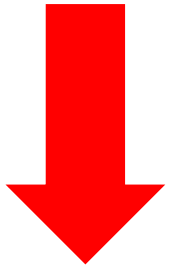
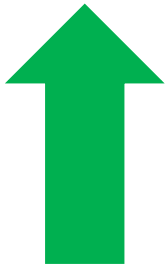
European Commission energy strategy

By 2030…..



40%

cut in greenhouse gas emissions compared to 1990 levels

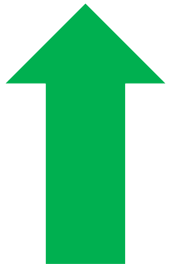


27%

share of renewable energy consumption

27%

energy savings compared with the business-as-usual scenario



15%

electricity interconnection target

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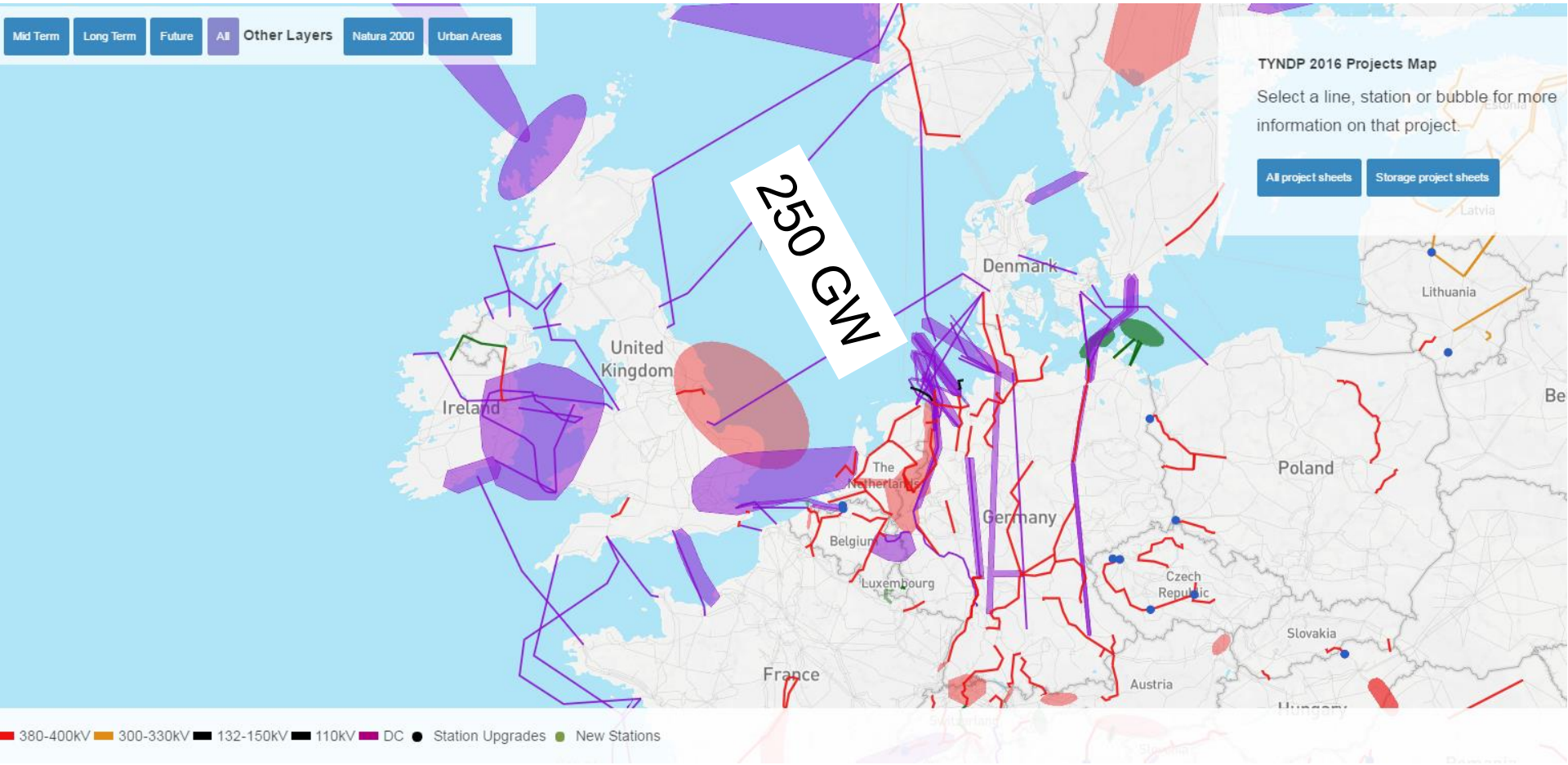
ENTSO-E vision 2030 for the North Sea



Source: www.entsoe.eu

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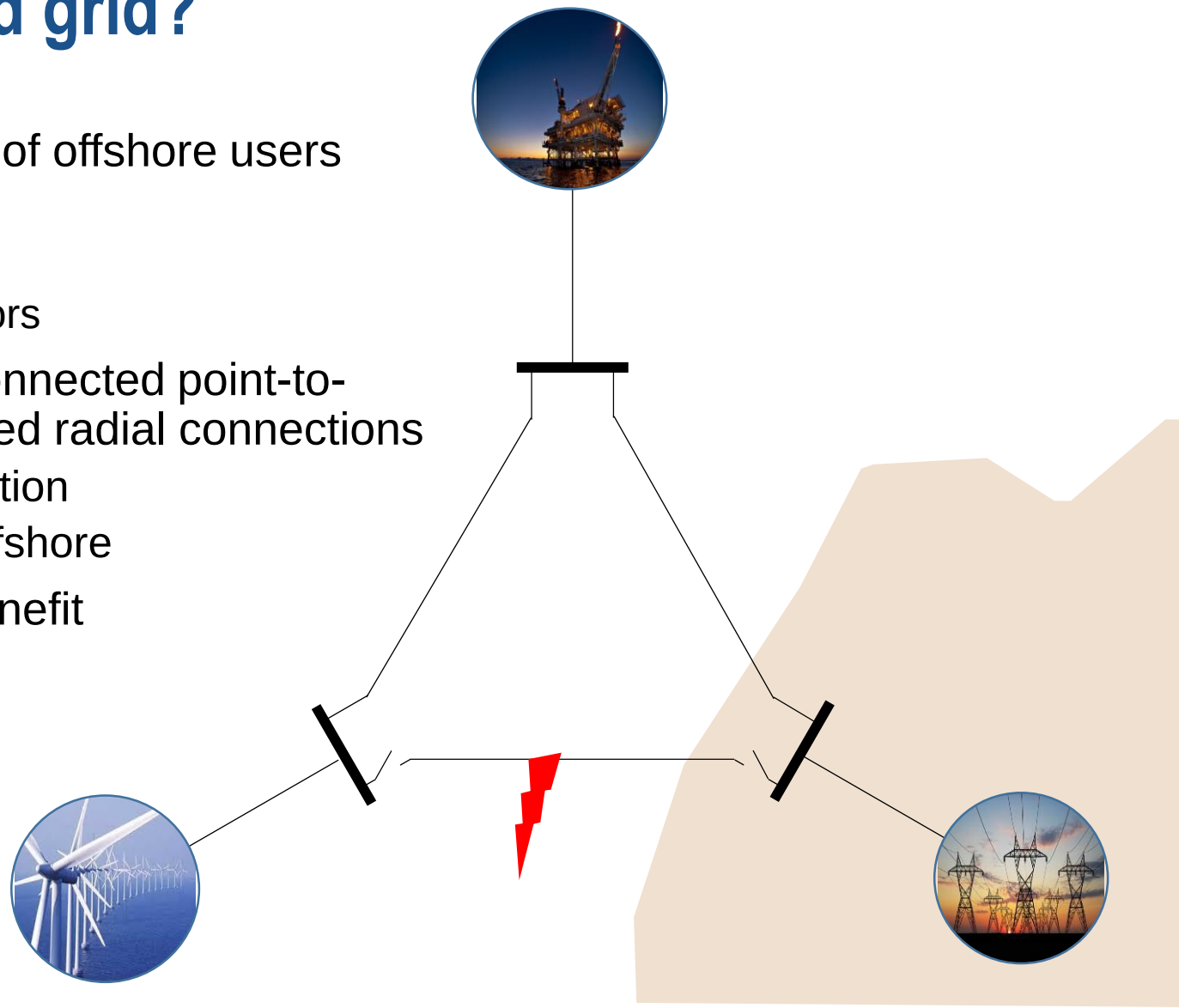
Why meshed grid?

- Different types of offshore users
  - Consumers
  - Producers
  - Interconnectors
- Traditionally connected point-to-point - Dedicated radial connections
  - Lower utilisation
  - Reliability offshore
- Mesh offers benefit



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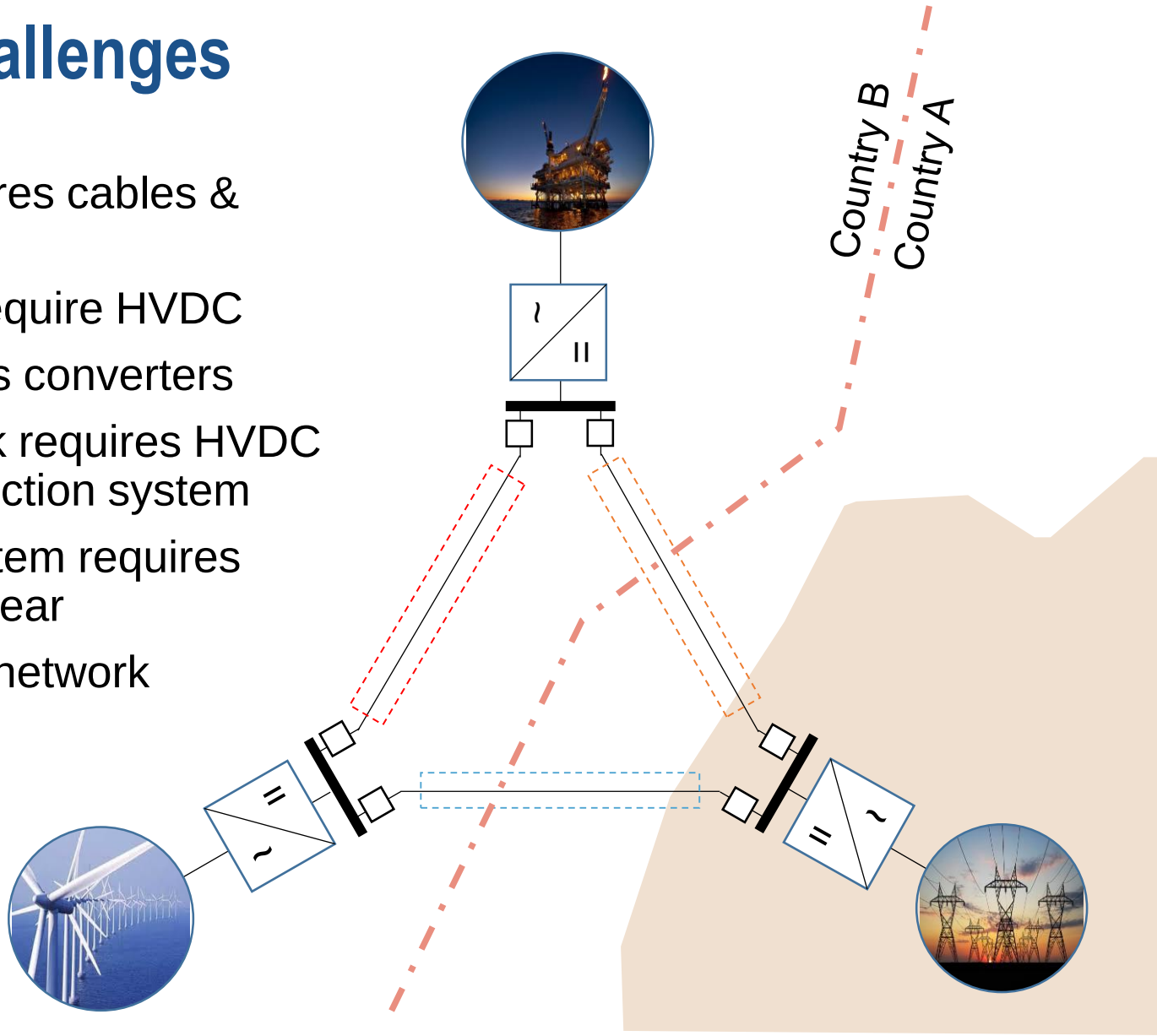
Offshore challenges

- Offshore requires cables & platforms
- Long cables require HVDC
- HVDC requires converters
- HVDC network requires HVDC control & protection system
- Protection system requires HVDC switchgear
- Transnational network



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Objectives

- Identify **technical requirements** and investigate possible **topologies** for **meshed HVDC offshore grids**
- Develop **protection schemes** and **components** for HVDC grids
- Establish components' **interoperability and initiate standardisation**
- **Demonstrate cost-effective** offshore HVDC equipment
- Develop recommendations for a coherent EU and national **regulatory framework** for HVDC offshore grids
- Develop **recommendations for financing mechanisms** for offshore grid infrastructure deployment
- Develop a **deployment plan** for HVDC grid implementation

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Partners

ABB

MITSUBISHI ELECTRIC

SIEMENS

ALSTOM

Prysmian Group

SCiBreak
Enabling the Supergrid

MHI VESTAS OFFSHORE WIND

Adwen
AN AREVA GAMESA COMPANY

TenneT
Taking power further

sse

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DTU

KU LEUVEN

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University of Strathclyde

DNV·GL

TRACTEBEL Engineering
GDF SUEZ

DEUTSCHE WINDGUARD

STIFTUNG OFFSHORE WINDENERGIE

CARBON TRUST

T&D europe

FGH

SuperGrid Institute

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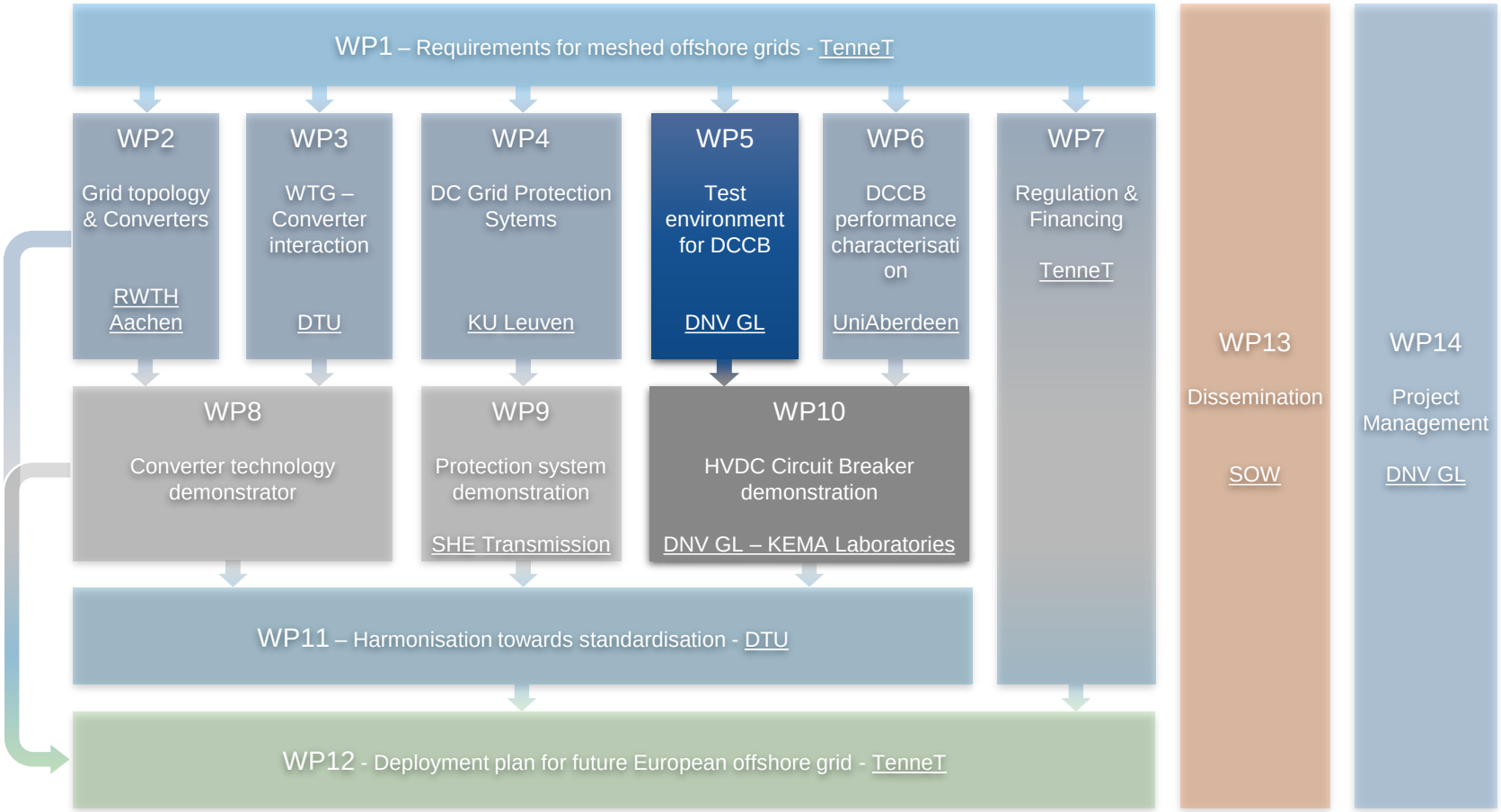
HVDC circuit breaker testing

Work Package 5 – Objectives & Interfaces



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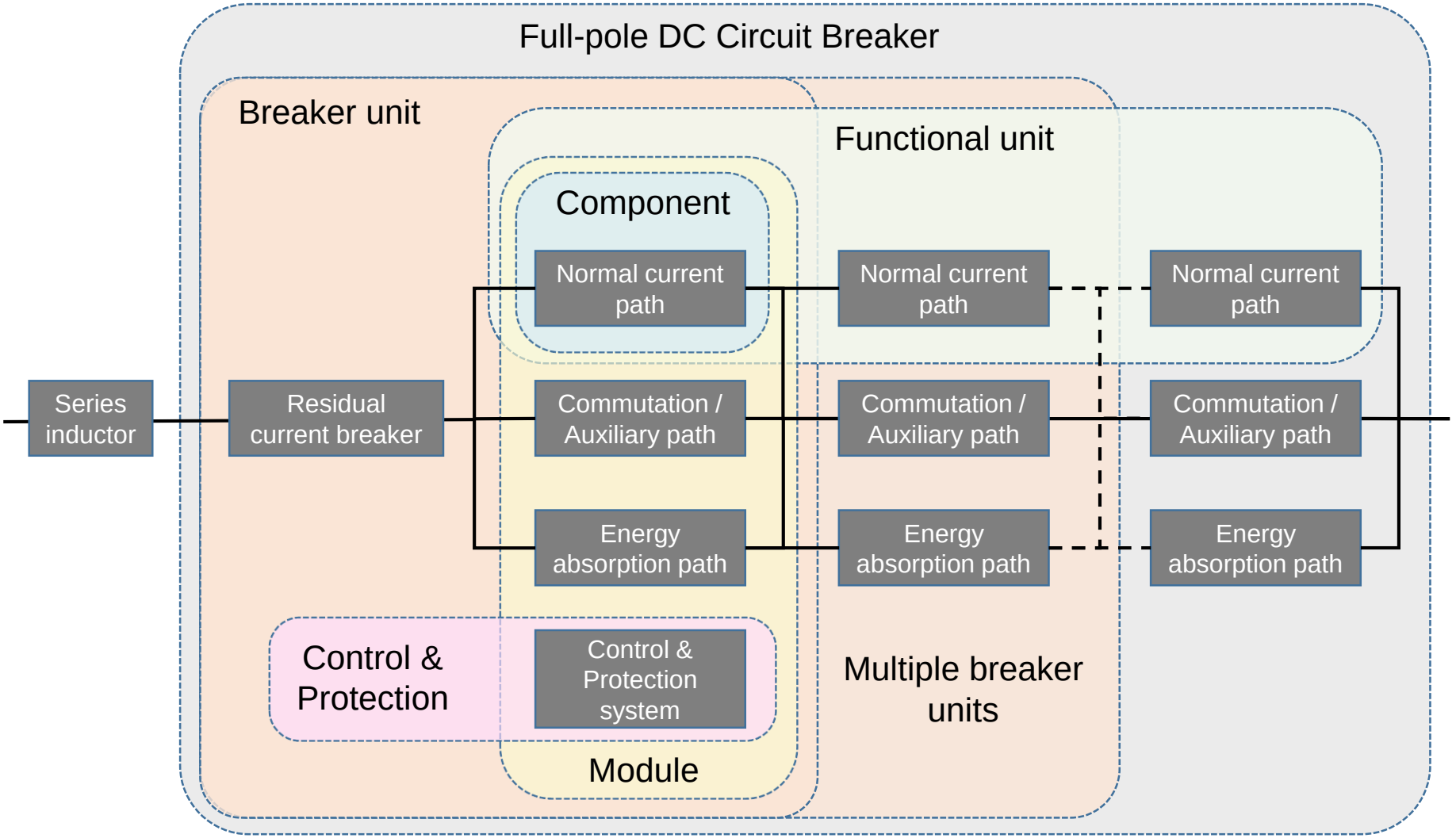
HVDC circuit breaker terminology & modularity



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HVDC circuit breaker test requirements

- ↗Dielectric testing
  - ↗Between terminals
  - ↗Support structure
- ↗Operational testing
  - ↗Loss / resistance measurement
  - ↗Temperature rise
  - ↗Current withstand
- ↗Current interruption testing
  - ↗Breaking
  - ↗Re-closing
- ↗Special
  - ↗Current limiting
  - ↗Soft closing

Standard test circuits

Non-standard test circuits

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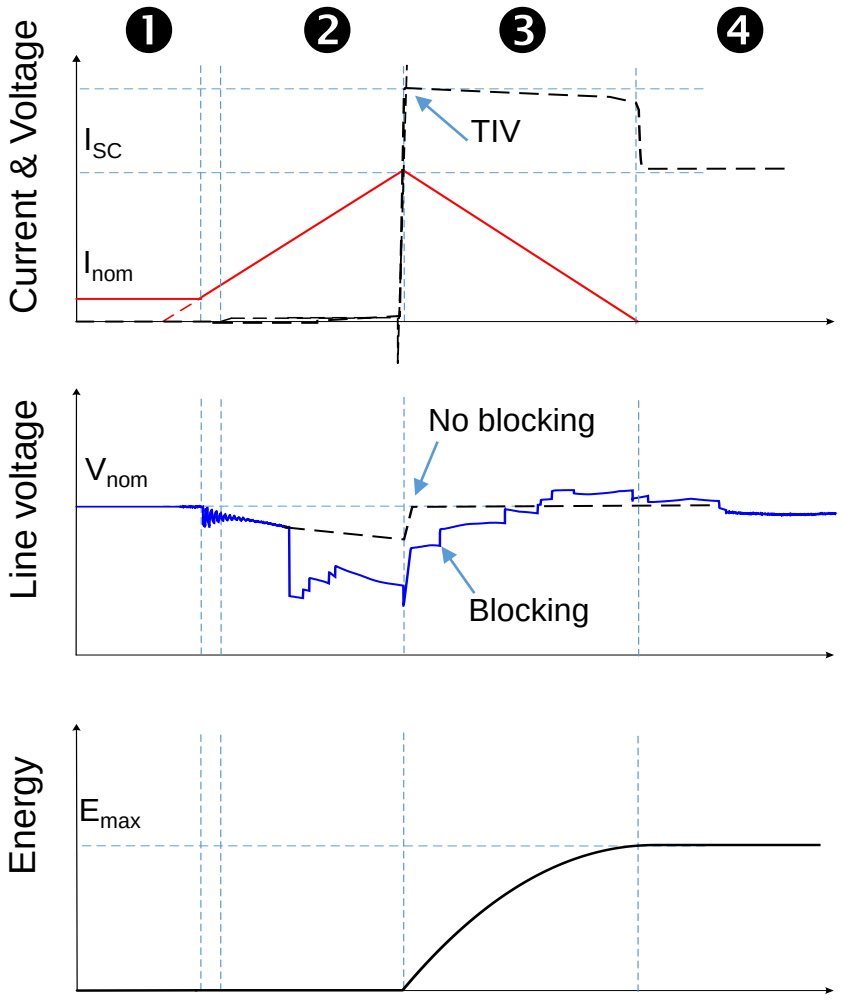
Current interruption test circuit requirements

1. Normal operation
   - ↗ Apply heating – Pre-condition
   - ↗ Supply power to line-charged parts
2. Current commutation time
   - ↗ Supply sufficient di/dt
   - ↗ Bidirectional, different duties
3. Fault current suppression time
   - ↗ Supply sufficient energy
   - ↗ Withstand Transient Interruption Voltage
4. Post suppression
   - ↗ Apply DC voltage stress
5. Protection of test-circuit and test object



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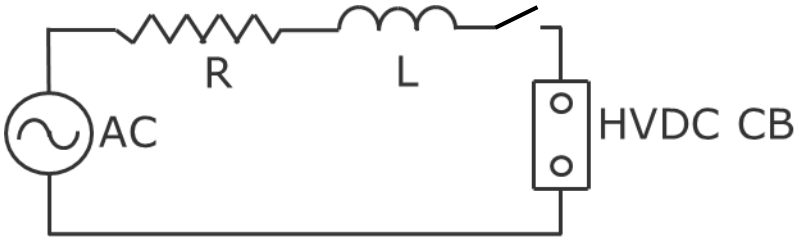
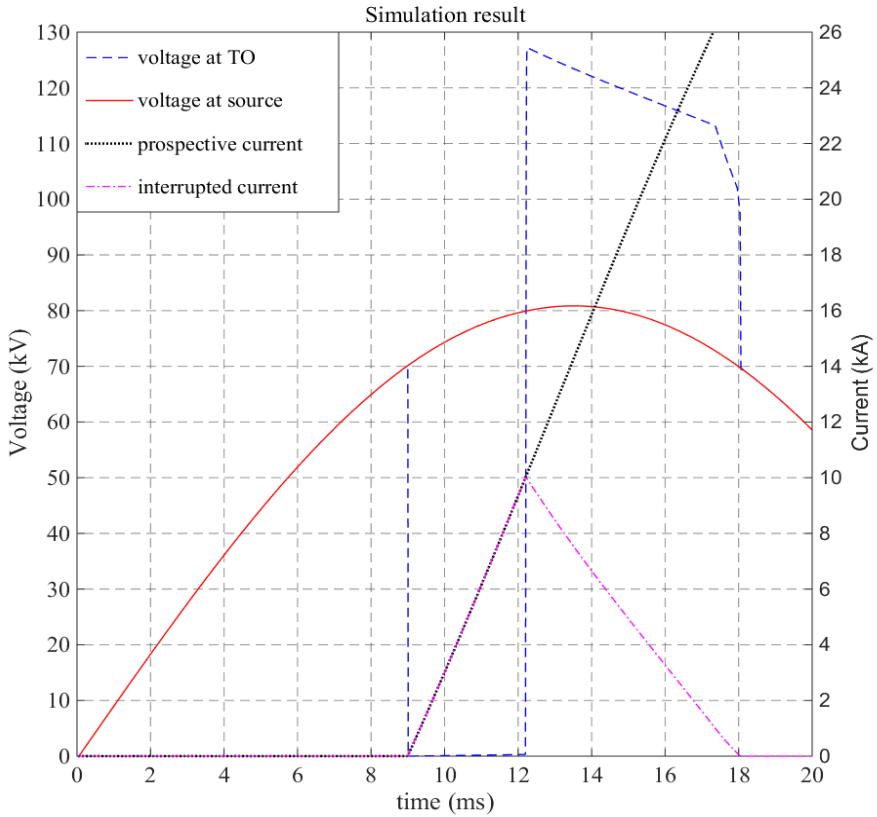
Reduced frequency AC short-circuit generator based test circuit





- Test circuit parameters
  - Generator frequency
  - Circuit inductance
  - Magnitude of source voltage
  - Making angle

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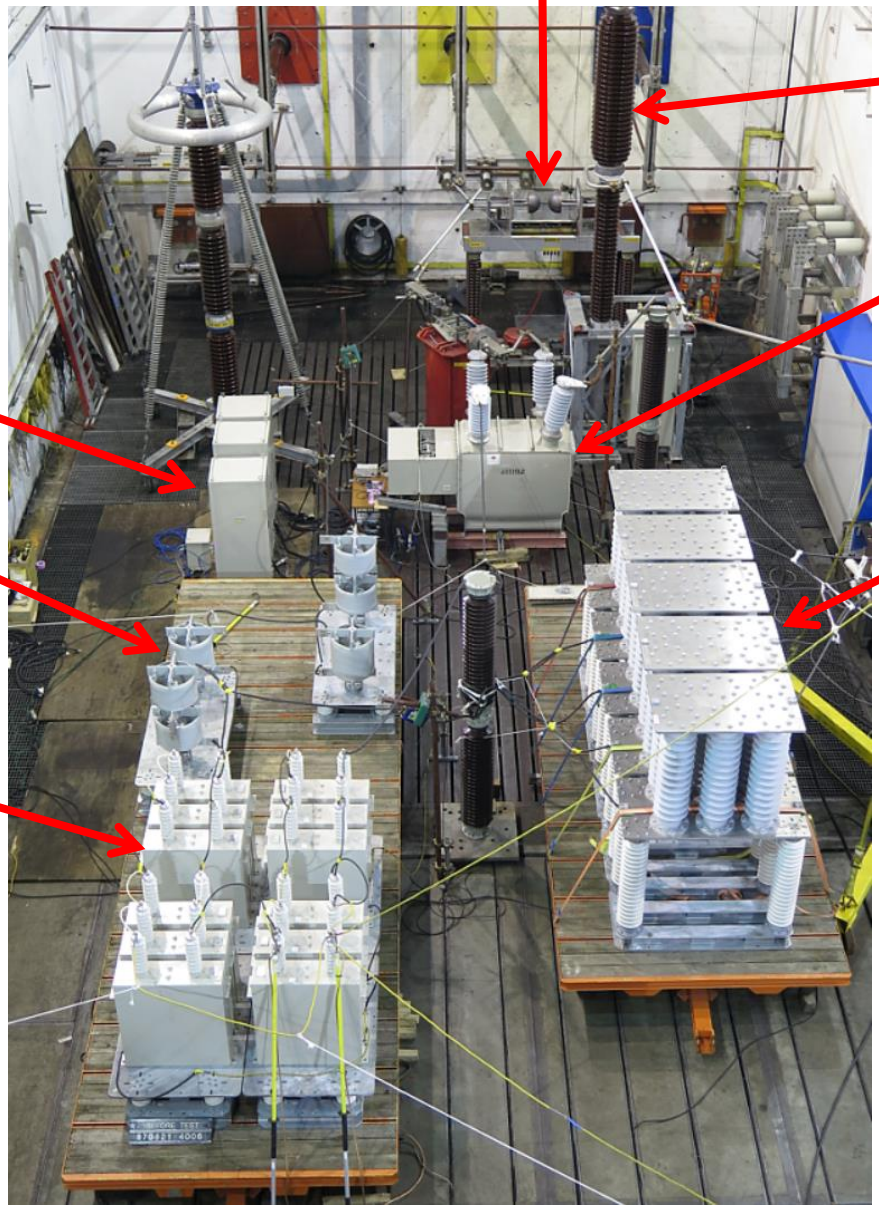
Test set-up



MITSUBISHI ELECTRIC

KEMA Laboratories

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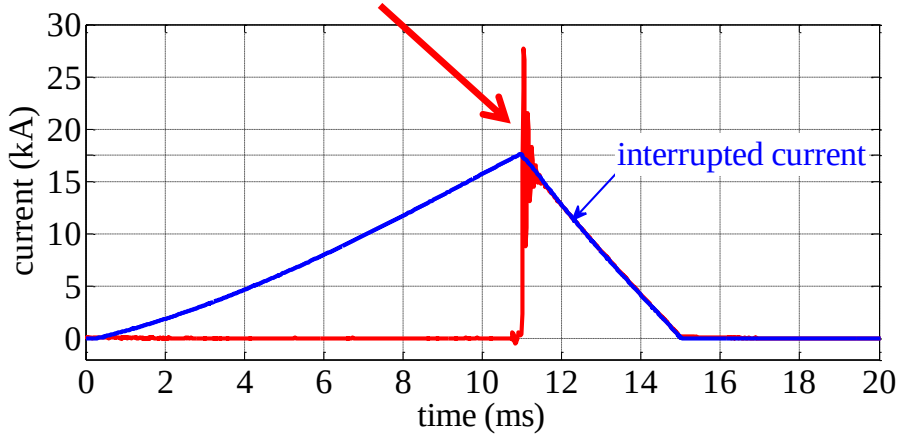
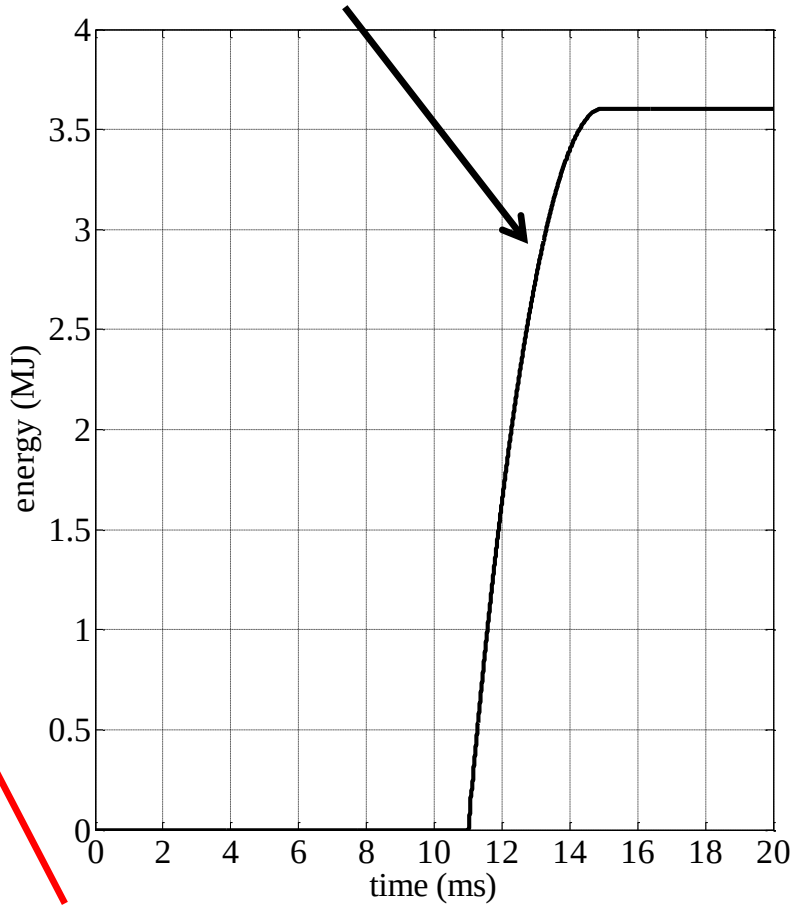
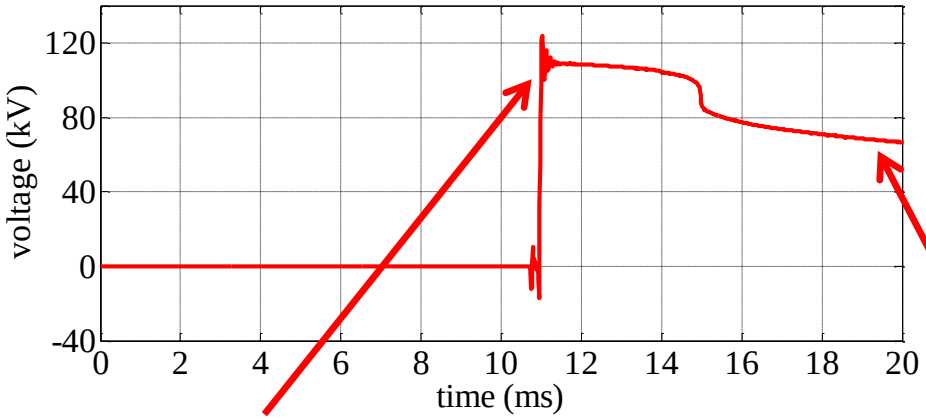
16 kA interruption (positive) + dielectric stress

current through MOSA



Energy absorbed by HVDC CB





Counter voltage generated by HVDC CB

Dielectric stress

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Conclusions

- ↗Meshed HVDC offshore network is a promising candidate for flexible transmission of offshore wind power
- ↗EU-funded consortium ‘PROMOTioN’ addresses technical, regulatory & economic barriers to implementation
- ↗HVDC circuit breakers enable flexible & resilient power transmission
- ↗HVDC circuit breaker design allows for modular testing
- ↗Reduced frequency AC short-circuit generators and synthetic voltage injection source capable of testing DC current interruption
- ↗Current interruption of Mitsubishi Electric HVDC CB prototype successfully demonstrated at KEMA Laboratories

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Thank you, any questions?

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APPENDIX

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