# NOWITECH

# Lab-scale implementation of a multi-terminal HVDC grid connecting offshore wind farms

## Objective:

- ❑ This work presents a lab-scale implementation of a multi-terminal HVDC system connecting an offshore wind farm

## System:

- ❑ The system is composed by four voltage-source converters (VSC) replicating a future North Sea HVDC grid, where Norway, Germany and UK are interconnected together with an offshore wind farm.
- ❑ DC voltage droop is implemented on all terminals, except the wind node.
- ❑ The VSCs are built using FPGA-control. Opal RT and Labview is used for supervisory control and monitoring.

## R&D topics:

- ❑ Operation and control, converter interoperability, system stability, fault handling and system services.

## Smart grid laboratory SINTEF/NTNU

### Main equipment:

- 55 kW wind turbine emulator with induction generator
- 50 kW low speed wind turbine emulator with PMSG
- 17 kW synchronous generator
- 60 kVA VSC units with in-house developed FPGA control
- Real time "hardware in the loop" simulator (Opal RT)
- Short circuit emulator
- Transformer substation model with protection relays
- Line models (RLC) and controllable loads
- Overall monitoring and control (Labview)

### The laboratory is suitable for experiments within a wide range of fields:

- Smartgrid systems
- Wind power integration
- Multi-terminal HVDC systems
- Distributed energy production systems
- Weak grids and island mode grid operation
- Fault and transient handling

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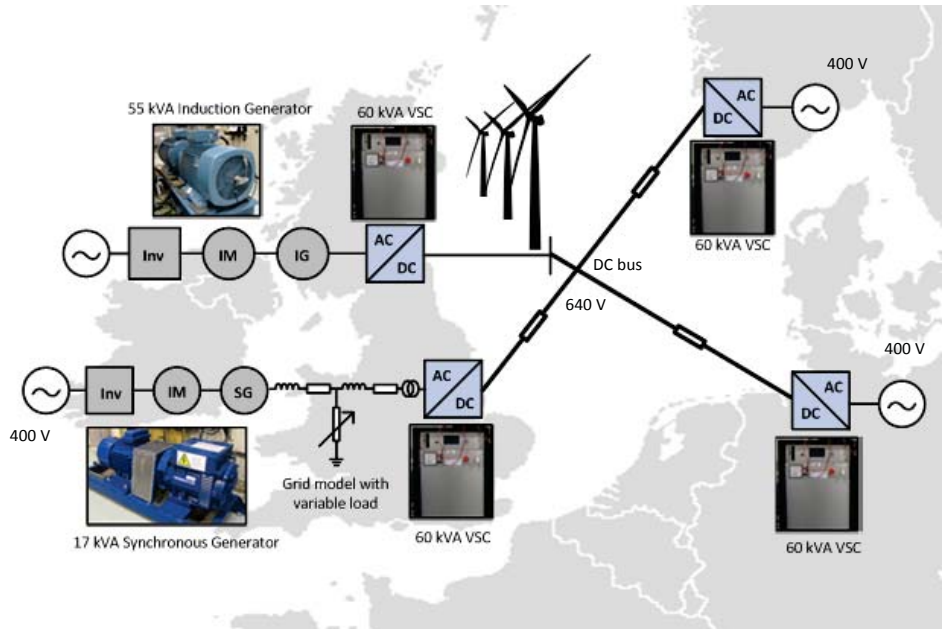
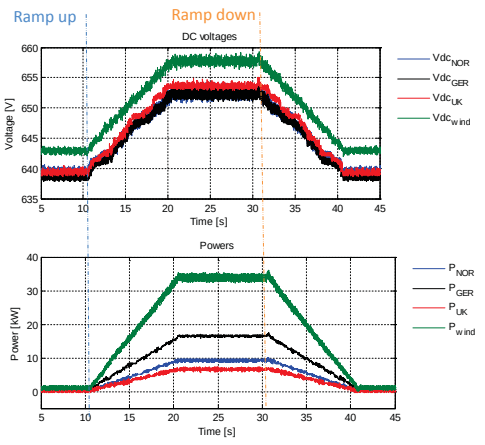


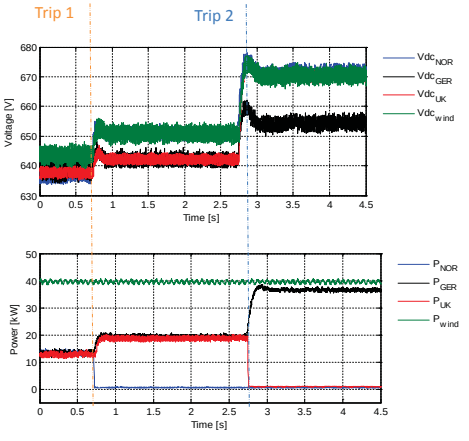

## Results

**A) Variation in wind production with different droop constants.** Experimental results show that the wind power is distributed proportionally to the droop constants.

**B) Loss of two terminals during full wind production.** When one terminal is disconnected the power is shared between the remaining terminals.




A)




B)