

Best Paths

27 October 2016

Transmission for sustainability

DEMO 1

DEVELOPMENT OF A DC FACILITY TO SIMULATE OFFSHORE MULTITERMINAL HVDC GRIDS AND THEIR INTERACTION WITH WIND TURBINE GENERATORS

"INNOVATIVE NETWORK TECHNOLOGIES AND THE FUTURE OF EUROPE'S ELECTRICITY GRID"

BEST PATHS DISSEMINATION WORKSHOP

BERLIN, 26 NOVEMBER 2016

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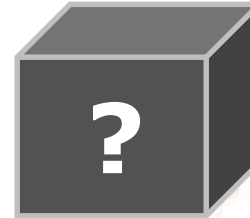
Iberdrola Renewables



BEST PATHS stands for "BEyond State-of-the-art Technologies for rePowering Ac corridors and multi-Terminal HVDC Systems". This project has received funding from the European Union's Seventh Framework Programme for Research, Technological Development and Demonstration under grant agreement no. 612748.


DEMO 1: Overview

HVDC equipment manufacturers provide "black boxes"






IBERDROLA
Demo leader
Utility & RES operator knowledge

We intend to use open models

System operation knowledge


Definition of models and simulation of scenarios

Detailed models
Simulation & validation

Knowledge on WTG & Power Electronics models




DEMO 1: Objectives

1. To investigate the electrical interactions between the HVDC link converters and the wind turbine converters in offshore windfarms
2. To de-risk the multivendor and multiterminal schemes from the point of view of resonances, power flow and control
3. To demonstrate the results in a laboratory environment using scaled models (4-terminal DC grid with 60 kW MMC VSC prototypes and a Real Time Digital Simulator system to emulate the AC grid)
4. To use the validated models to simulate a real grid with offshore wind farms connected in HVDC



DEMO 1: Activities

WP 3: R&D

Task 3.1 - Development of models: WTG, offshore wind farm HVDC links & TSO grid

Task 3.2 - Development of WTG and associated converters control algorithms and strategies

Task 3.3 - Simulation of WTG interaction scenarios

Task 3.4 - Technical assessment of the simulation results

D3.1 - Models of WTG, HVDC links, offshore grid. Control algorithms, models and strategies.
(Tecnalia, M15) → **Already delivered**

D3.2 - Results and conclusions from the simulations and studies. (Cardiff, M24) → **Delayed to late Nov.**

WP 8: Demonstration

Task 8.1 - definition, model and engineering of the scaled equipment

Task 8.2 - Procurement and construction of test facility

Task 8.3 - Definition of tests

Task 8.4 - Demonstration

D8.1 - Detailed specification of the demonstrator. (SINTEF, M27)

D8.2 - Specification of tests and documentation of results. (Iberdrola, M39)



DEMO 1: Status

➤ Models and Control Algorithms

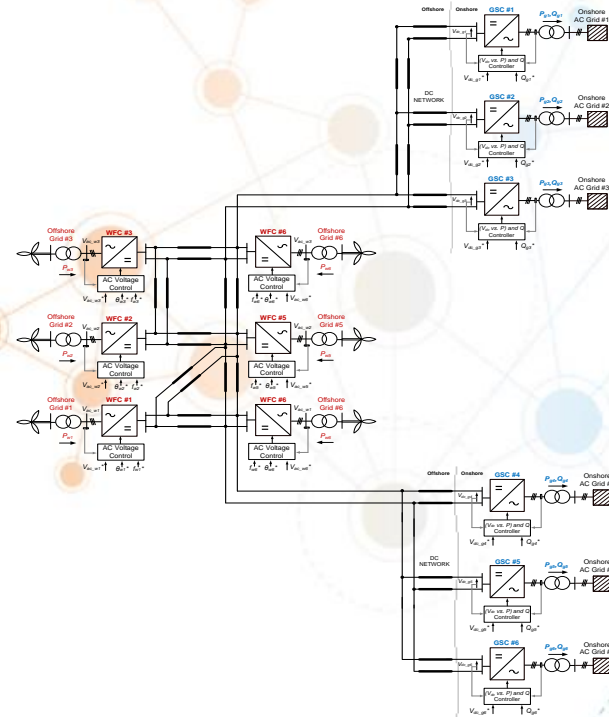
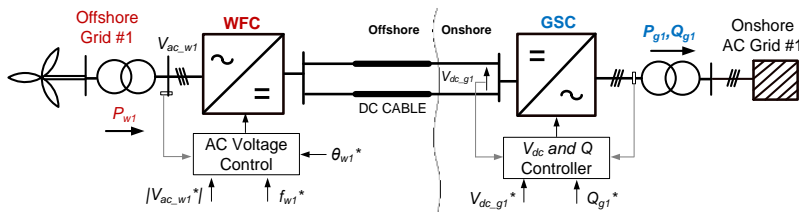
- A **set of models and control algorithms** has been developed, simulated and assessed. The models have been implemented in a MATLAB/Simulink.
- To maximise dissemination and impact, the models will be published in the BEST PATHS website as ***open access toolbox***.
- Specific blocks include models of:
 - Converter stations;
 - High level controllers;
 - AC grid;
 - DC cables;
 - Wind farm.
- Documentation of these models has been already produced. Details can be found in **Deliverable D3.1**.



DEMO 1: Status

➤ Models and Control Algorithms

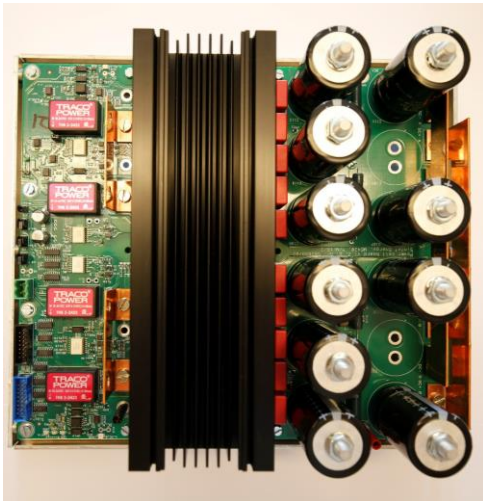
- A number of **topologies** has been **modelled, simulated and analysed**.
- The topologies considered constitute **likely scenarios** to be adopted for the transmission of offshore wind energy in future years.
 - Point-to-point
 - Three terminal
 - Six-terminal with AC coupling
 - Six-terminal with DC coupling
 - Twelve-terminal meshed grid
 - DC interarray
- The **performance of the models is currently being evaluated** with a set of Key Performance Indicators. The results will be presented in D3.2



DEMO 1: Status

➤ Demonstrator

- Demonstration will be carried out in SINTEF laboratory in Trondheim, Norway.
- The design of the power and control boards was finished and most of the parts to build the demonstrator have been ordered or already received. The assembly of components is ongoing.



DEMO 1: Status

➤ Demonstrator



Assembly ongoing



DEMO 1: Status

➤ Demonstrator

- Converter cabinets will be installed in the recently upgraded SINTEF laboratory.



DEMO 1: Next Steps

➤ Deliverable D3.2 – Results and conclusions from simulation studies

- The date for submission of this deliverable was postponed → **Sept. to late Nov.**
 - All **simulation topologies** have been finalised and validated.
 - A **general methodology for KPI assessment** applicable for all topologies has been defined, with contributions from all partners.
 - **KPI assessment** is being carried out. Tests performed so far show **KPIs are met**.
 - The analysis and simulation of **power electronic solutions** to habilitate the **connection of wind turbines to DC collector systems** is currently being carried out.
 - A summary of the results obtained in DIgSILENT PowerFactory from the **Western Danish grid studies** will be included in D3.2.

➤ Deliverable D3.1 – Models of WTG, HVDC links, offshore grid, control algorithms, models and strategies

- There have been changes to the models reported previously in this deliverable, so it needs to be updated.



DEMO 1: Next Steps

➤ Demonstrator

- Full demonstrator built by the end of 2016 → **Full specification in D8.1**
- Tasks that will be carried out during 2017
 - Commissioning of the demonstrator → **milestone M8.1**
 - Specification of tests to validate software models
 - Model validation tests and analysis of results → **Deliverable 8.2**



DEMO 1: Expected Results & Impact

- **Improve the knowledge** on the **integration of OWFs via HVDC links** or future **multi-terminal DC (MTDC) grids**
- **Identify possible interactions** between **wind turbines, converters, HVDC links** and/or **grids**, and the **onshore grid**
- **Reduce uncertainties** from OWFs connected to MTDC and **multi-vendor HVDC schemes**, and, consequently, **de-risk the use** of these technologies
- **Provide open models** to the industry, that are **validated in a demonstrator**
- **Provide access to a laboratory** with scaled-down MMC converters that will **allow the industry to test their controls and equipment**



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