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ISSUE 17 MARCH 2015 £12.50

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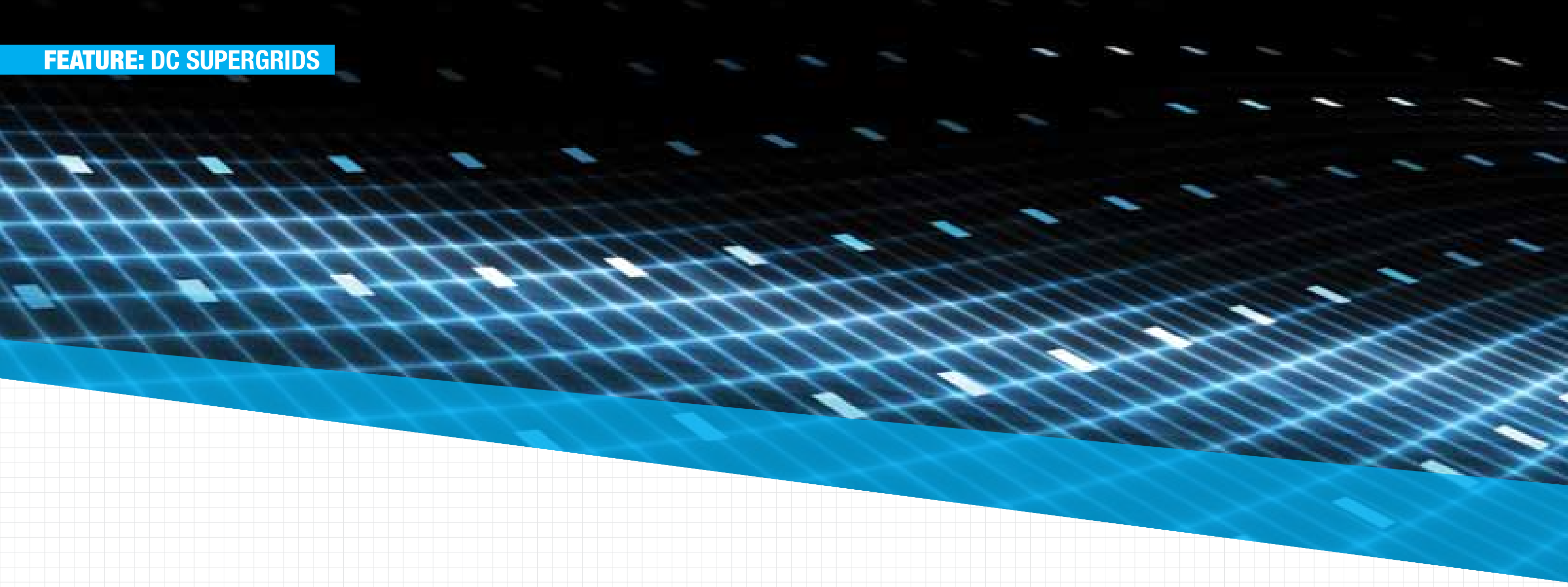

MEDOW: MULTI-TERMINAL DC GRID FOR OFFSHORE WIND

Words:
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Wind power is well established in Europe. Statistics from the European Wind Energy Association state that, by the end of 2013, there was 117.3GW of installed wind energy capacity in the EU: 110.7GW onshore and 6.6GW offshore. This installed wind power capacity would, in a normal wind year, produce 257TWh of electricity, which would cover 8 per cent of the EU's electricity consumption – a rise from 7 per cent in 2012.[1]

It's expected that a large number of new wind farms will be installed offshore, where wind speeds are higher and the turbines are less intrusive than they are on land. As offshore wind power is generated a long way from where it ends up being used, we need to find more efficient ways of connecting these wind farms to the mainland so that electrical power can be transported over long distances and fed into the onshore grid. Increasing our use of wind power will also support the future electrification of heating and transport as we'll be able to run them using low carbon electricity rather than gas or oil. Given that heating and transport represent a significant proportion of most European countries' energy use, this could make a big difference to both carbon emissions and reliance on fuel imports.

What's more, our onshore grids are ageing and their upgrade and reinforcement is all the more important given that we hope to generate an increasing amount of our electrical power from renewable sources such as wind and solar. Many renewable energy sources are intermittent and partially unpredictable (i.e. we cannot control or always predict when the wind will blow) so the grid of the future needs to be able to cope with power that is generated further away (e.g. out at sea) and which may be generated intermittently.

Plans to use DC technologies for the interconnection of multiple renewable power sources, loads and AC grids underpin an interesting and promising transmission concept: HVDC grids.

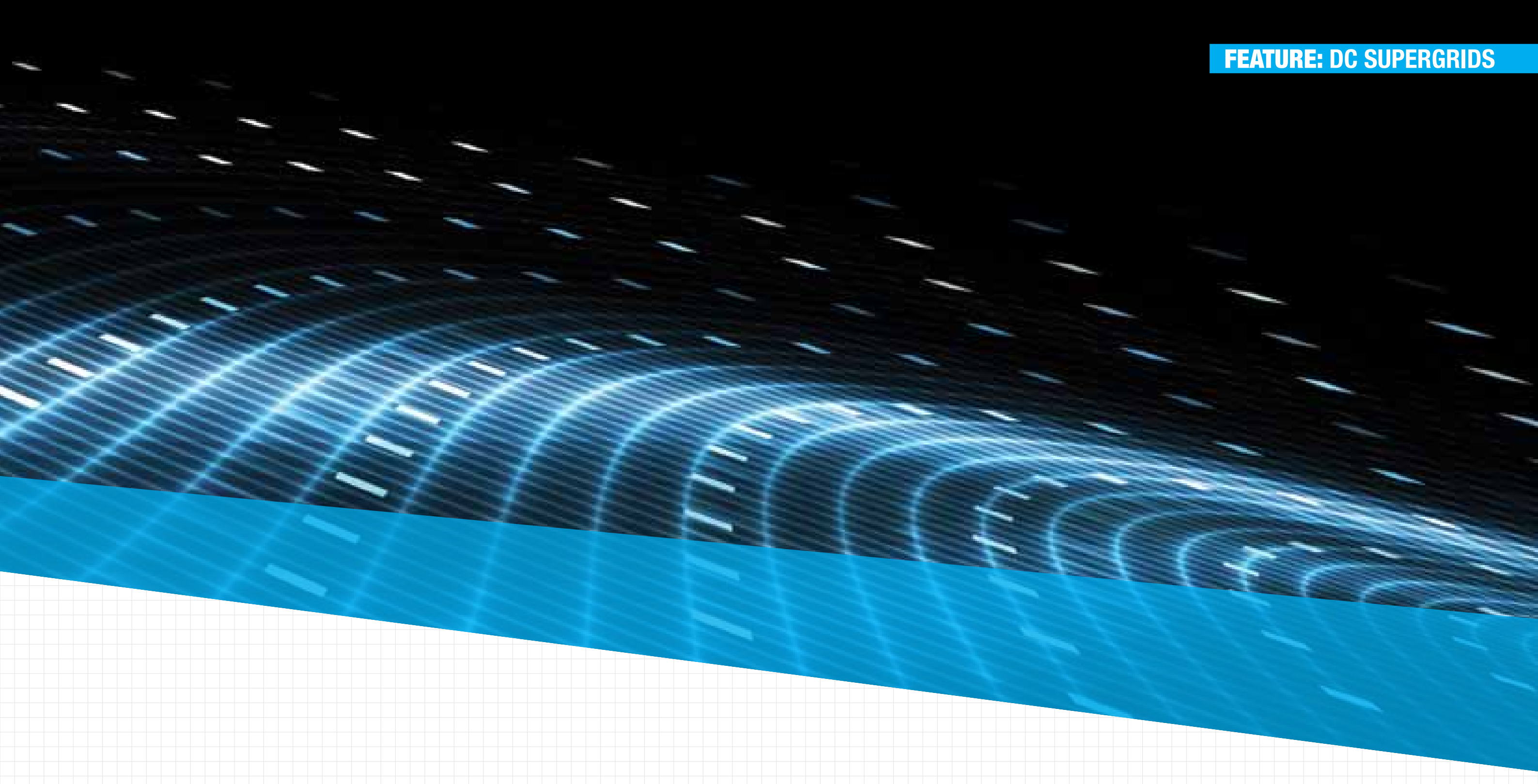
The development of DC (direct current) transmission is gaining momentum, largely due to modern power conversion technology (voltage source converter) and to the need for transmission of offshore wind power. Plans to use DC technologies for the interconnection of multiple renewable power sources, loads and AC (alternating current) grids underpin an interesting and promising transmission concept: HVDC (high voltage direct current) grids.

The European Commission-funded 'MEDOW' (Multi-Terminal DC Grid for Offshore Wind) project is investigating DC grids for transmitting offshore wind power: DC is more efficient than AC transmission – less of the power gets lost along the way – but we hope to develop a grid, rather than rely on single point-to-point connections, as grids are the best way to balance supply and demand of electrical power and to ensure reliability of the system when something goes wrong.

Researchers in the MEDOW consortium are working on the technologies that we hope will make a significant contribution to the development of a European 'Supergrid',[2] a pan-European electricity transmission network which will support the integration of large-scale renewable energy, facilitate a single European electricity market and allow the EU to export sustainable energy technology and to create skilled new jobs.

They are investigating some of the major technical challenges of transmitting offshore wind power through DC grids with multi-terminal voltage source converter technologies. They are studying DC grid topologies, DC power flow, DC relaying protection, steady state operation, dynamic stability, fault ride-through capability, and impacts of DC grids on the operation of AC (onshore) grids. Operation and control are being evaluated using various simulation platforms and experimental test rigs.

At the moment, there is a shortage of operational experience and of skilled engineers in DC grids in Europe. Therefore, as a Marie Curie Initial Training Network, MEDOW aims not



only to address technical challenges but also to train and develop 17 promising early-career researchers so as to form a pool of expertise in the field and to develop researchers with technical and transferrable skills, private sector experience and an established network of contacts. This will give them the opportunity to undertake successful research careers with impact in a field which is shaped by industry demand. It will also help to address the current and future skills shortage in power and energy engineering.

The consortium

The MEDOW consortium is coordinated by Cardiff University and consists of 10 full beneficiaries and one associated partner: Cardiff University (UK; Coordinator); Universitat Politècnica de Catalunya (Spain); Control Intel.ligent de l'energia (Spain); Alstom Renovables España (Spain); Universidade do Porto (Portugal); EFACEC Energia – Máquinas e Equipamentos Eléctricos (Portugal); Katholieke Universiteit Leuven (Belgium); Elia System Operator (Belgium); Danmarks Tekniske Universitet (Denmark); China Electric Power Research Institute (China); and National Grid (UK; Associated Partner).

The network's combination of academic and private sector partners not only contributes to the individual researchers' training and development but also serves to foster greater ties between industry and academia in this important development area.

MEDOW researchers are investigating some of the major technical challenges of transmitting offshore wind power through DC grids with multi-terminal voltage source converter technologies.

Main research areas

MEDOW's research covers four broad areas:

- **Connection of offshore wind power to DC grids**
  This includes the design and analysis of topologies of offshore DC grids; determining of steady state operation characteristics; and the development of dynamic control systems for offshore DC grids.

- **Investigation of voltage source converters for DC grids**
  This includes the design and comparison of various voltage source converters; the investigation of converter configurations and power flow control in DC grids; and the development of tools for analysing and simulating converter stations.

- **Relaying protection**
  This involves the analysis of DC grid faults and DC circuit breakers; the development of DC protection algorithms and post-fault restoration schemes; and investigation of AC protection with DC grids.

- **Interactive AC/DC grids**
  This includes the development of simulation and experimental platforms for integrated DC/AC systems; investigation of the impact between AC and DC grids; recommendation of AC and DC grid codes; and validation of integrated DC/AC systems using simulation and experimental platforms.

For more information on the projects and its results, please see our website: www.medow.engineering.cf.ac.uk/; connect with us on Facebook and LinkedIn.

MEDOW is funded by the Seventh Framework Programme of the European Union. This document reflects only the author's views; the European Union is not liable for any use that may be made of the information contained herein.

References

1. www.ewea.org/fileadmin/files/library/publications/statistics/EWEA_Annual_Statistics_2013.pdf

2. Further information on the SuperGrid concept can be found on the website of Friends of the Supergrid, an organisation supported by, amongst others, National Grid, Elia System Operator, Siemens, Alstom and ABB: www.friendsofthesupergrid.eu/

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