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Grid integration and stability of 600MW windfarm at Kriegers Flak - the largest power plant in Denmark

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Abstract

The Kriegers Flak 600MW offshore wind power plant (OWPP) will become the largest electrical power generation unit in Denmark East, when completed by December 2018. Already in fair wind conditions, the wind power, decentralized combined heat-power (CHP) units and photovoltaics (PV) will cover the most of electrical power consumption, participation of central thermal power plants is significantly reduced, and the power and energy balance is maintained through interconnectors to foreign systems. This poster outlines results and main findings of a dynamic voltage stability study for the grid-connection of the Kriegers Flak OWPP to the Danish transmission system using near-future scenarios with no central power plants in-service and compares impact of different control regimes of the windfarm on the voltage recovery.

Transmission System of Denmark

Denmark is a small country, but two HVAC systems, Denmark West and Denmark East, which are asynchronous one to another and interconnected via the Great Belt HVDC link, Fig.1. The Kriegers Flak OWPP will be connected to Denmark East, which includes the main island of Zealand with the main consumption around Copenhagen, and the islands of Lolland and Falster with the largest share of onshore and offshore wind power, Fig.2, but low consumption. The worst case scenarios are present when superimposing high wind generation and transport throughout the East Danish system [1].

Objectives

1. Offshore wind power plant as the largest electrical power production unit in the transmission system of Denmark East.
2. Securing voltage and recovery stability without central power plants in-service and high wind power production after severe short-circuit faults.
3. Influence from requested control regimes on voltage recovery: (i) – reactive-power control; . (ii) – power-factor control; (iii) – voltage control.

Methods

Voltage Stability Assessment

Consider the full power transport through the Danish transmission system, which is either North → South or South → North, which is superimposed by high wind power production from the onshore wind turbines (90% of the installed capacity) and OWPP (100% of the installed capacity). There is some power production from PV and decentralized CHP, and the Great Belt HVDC link outbalances a difference between generation, consumption and power exchange with Sweden (in North) and with Germany (in South). No central power plants are in-service. In the assessment, the transmission system is subject to a short-circuit fault in 400kV substations with post-sequent outage of adjacent components (lines, transformers).

There are two synchronous condensers and a SVC unit in-service, which have been established in Denmark East. The system protection scheme of the Great Belt HVDC link is armed and activated in certain combinations of power transport and system events. Those preconditions are essential for keeping stability of Denmark East in the given operation preconditions.

The Kriegers Flak OWPP is with the requested LVRT in low-voltage operation [2] and can be in one of the requested control regimes in normal operation: (i) reactive-power control, (ii) voltage control [2]. In this assessment, Fig.3, the LVRT is essential and the voltage control regime is preferable at Kriegers Flak for keeping the OWPP from post-sequent disconnection and securing dynamic stability of the Danish transmission grid.

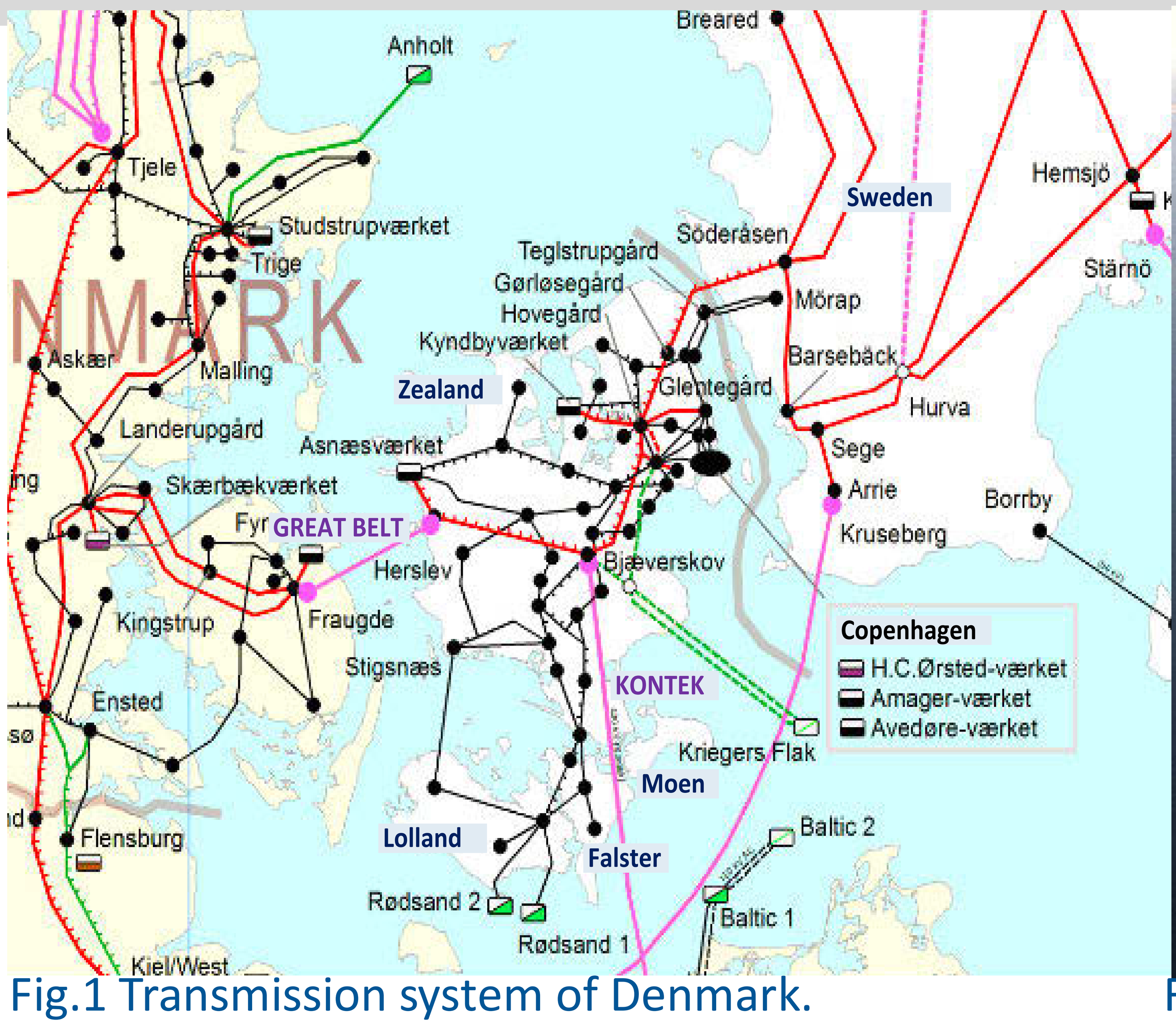

Fig.1 Transmission system of Denmark.

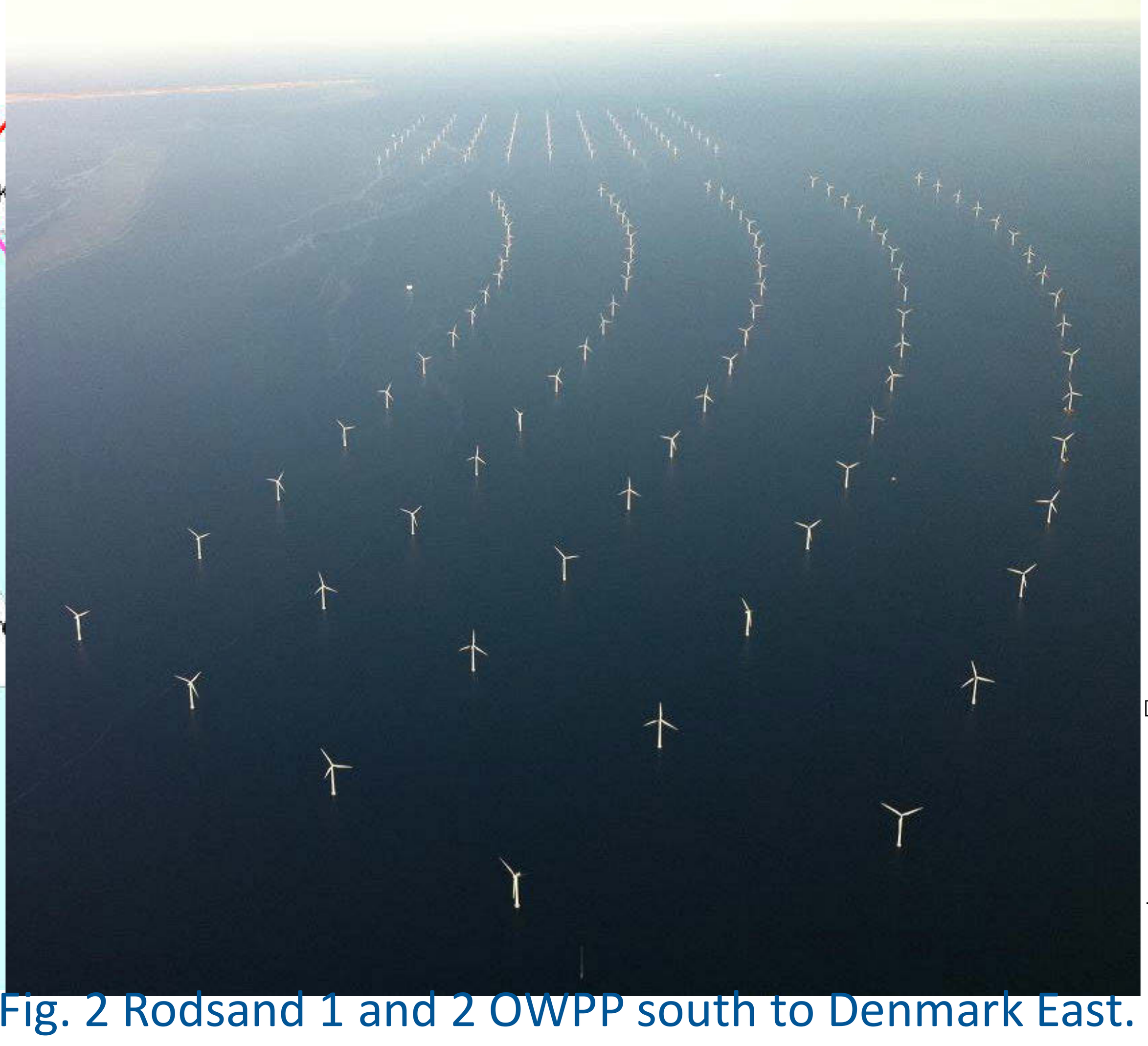

Fig. 2 Rodsand 1 and 2 OWPP south to Denmark East.

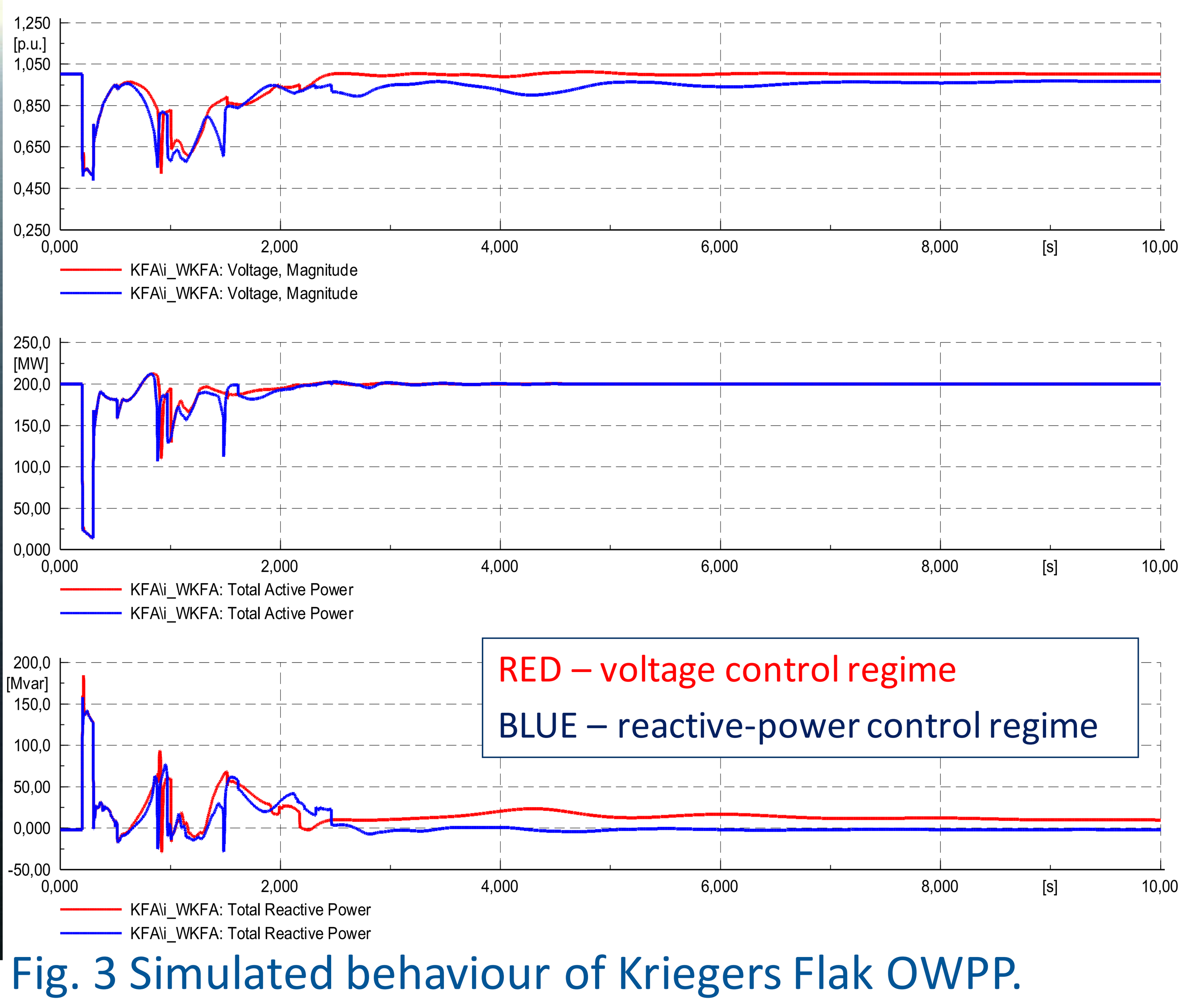

Fig. 3 Simulated behaviour of Kriegers Flak OWPP.

Conclusions

In a few years, the Kriegers Flak 600MW OWPP will become the largest power generation unit in Denmark East, while participation of central thermal power plants is much reduced. The requested LVRT is essential for maintaining uninterrupted operation and stability of the OWPP and the grid.

References

1. System stability of large wind power networks: A Danish study case, *International Journal of Electrical Power and Energy Systems*
2. Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators, *Official Journal of the European Union*