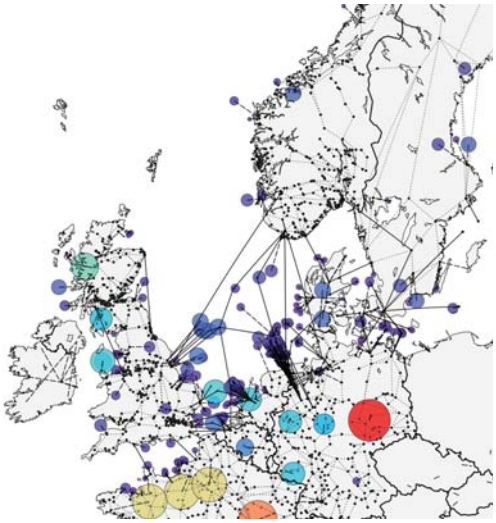
A DC-OPF Computation for Transmission Network Incorporating HVDC Transmission Systems

Phen Chiak See and Olav Bjarte Fosso

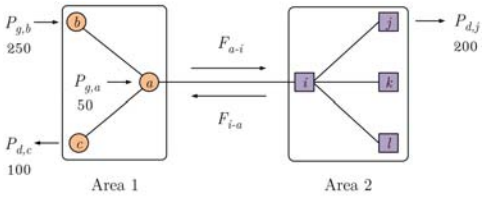
Department of Electric Power Engineering, Norwegian University of Science and Technology,
7491 Trondheim, Norway

phenchiak.see@gmail.com

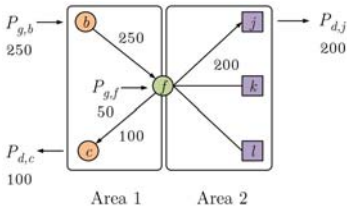
This paper presents a new method for computing the Direct Current Optimal Power Flow (DC-OPF) in transmission network integrated with HVDC transmission systems. The method is called the Fictitious Aggregated Node (FAN) model. Conceptually, the method flexibly forms aggregated nodes (when computing the OPF of transmission network) by combining buses connected with the HVDC lines. After that, the modified transmission network topology is subjected to regular DC-OPF computation. The resultant power flow between buses located within the aggregated node can then be calculated based on the results derived in DC-OPF. This simplified method is fast and intuitive. Besides, it is able to cover HVDC computation in DC-OPF without significantly increasing the computation time. The method can be applied in economic studies related to expansion of inter-region transmission network. Currently, the method is applied by the authors in game theoretic studies of offshore transmission networks.



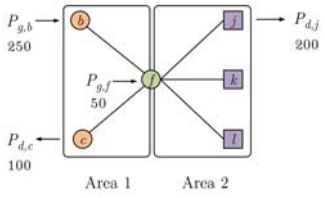
An offshore grid scenario in 2050 (Source: SINTEF).



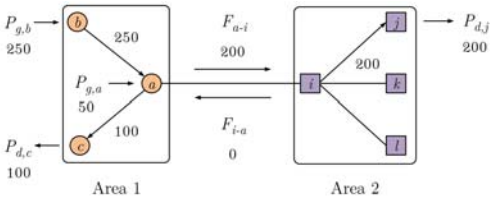
A transmission network with HVDC connecting bus a and i.



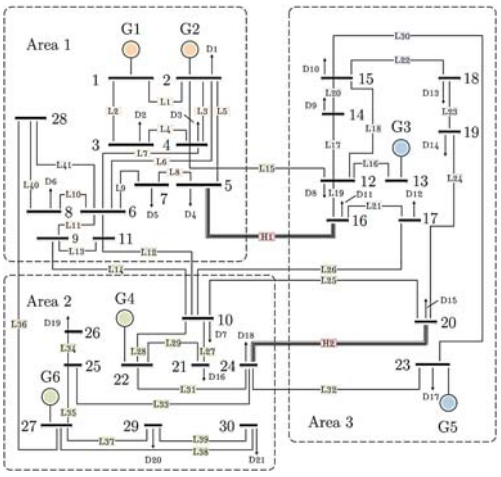
Power flow on the transmission lines computed with DC-OPF.



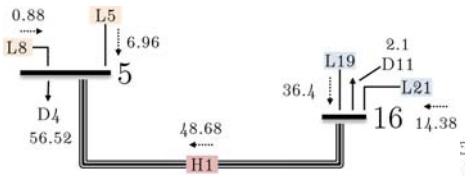
Formation of FAN. This transmission network model is called FAN model.



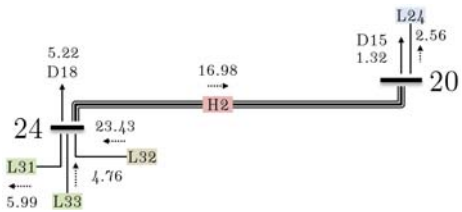
The resultant power flow on the HVDC lines.



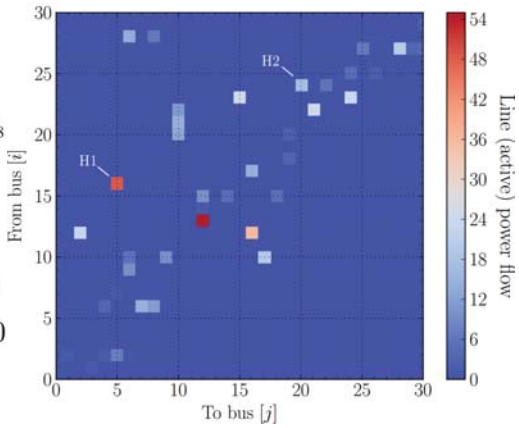
A slightly modified IEEE 30-bus test system connected with two HVDC lines.



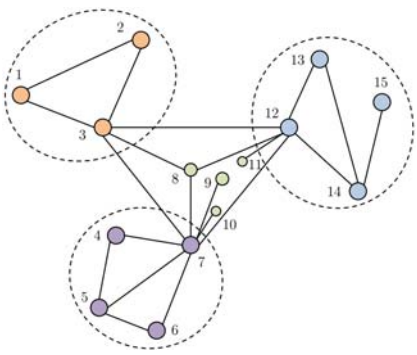
Power flow around FAN 1.



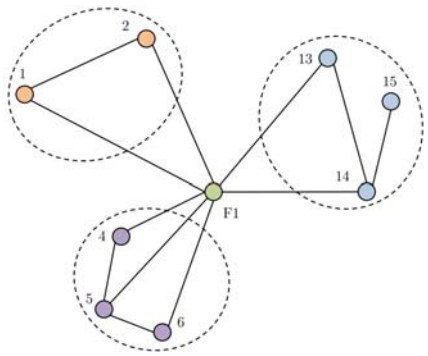
Power flow around FAN 2.



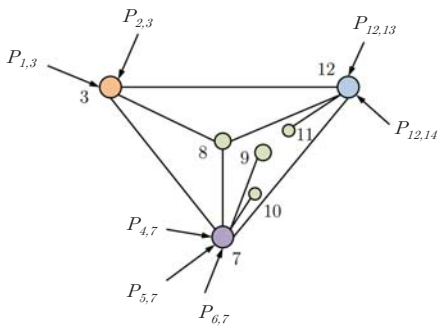
Power flow on transmission lines in the 30-bus model connected with HVDC.



A 15-bus transmission network model connected with four wind power generators and meshed HVDC grids.



The meshed grid is aggregated as FAN. The power flow in the model is then computed with DC-OPF.



The power flow on the HVDC grid can be computed based on power balance at node 3, 12, and 7.