

Technische Universität Dresden

**Optimal Operation of Wind Power Plants with
Doubly-fed Induction Generators under Considerations to
Network Operator Regulations**

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von der Fakultät Elektrotechnik und Informationstechnik
der Technischen Universität Dresden

zur Erlangung des akademischen Grades eines

Doktoringenieurs

(Dr.-Ing.)

genehmigte Dissertation

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Gutachter: Prof. Dr.-Ing. Wilfried Hofmann

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Tag der Einreichung: 31. März 2016

Tag der Verteidigung: 30. Juni 2016

Dresdner Schriftenreihe zu elektrischen Maschinen und
Antrieben

Band 10

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Shaker Verlag
Aachen 2017

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

Zugl.: Dresden, Techn. Univ., Diss., 2016

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Printed in Germany.

ISBN 978-3-8440-5281-7

ISSN 1869-8190

Shaker Verlag GmbH • P.O. BOX 101818 • D-52018 Aachen

Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9

Internet: www.shaker.de • e-mail: info@shaker.de

Acknowledgements

I completed this dissertation during my time as a research assistant at the Department of Electrical Machines and Drives of the Dresden University of Technology.

Firstly, I would like to gratefully thank Prof. Dr.-Ing. Wilfried Hofmann for his supervision, motivation, and support during this work. I also would like to acknowledge his countless contribution to this dissertation through our intensive discussion.

I would like to thank Prof. Dr.-Ing. Peter Schegner, Prof. Dr. Marco Trapanese, and Dr. Dr.-Ing. Ralf Jacobs for the appraisal of this dissertation.

I also would like to thank my department colleagues and students for friendly working environment and their technical support during this work.

I also wish to acknowledge DAAD (German Academic Exchange Service), Graduate Academy of TU Dresden, and Electrical Engineering Institute of TU Dresden for their financial support during this work.

Finally, I dedicated this work to my lovely father, mother, wife, Maria Ulfa, and children, Zidni-Kanza-Fatih.

Dresden, 1st July 2016

Rahmat Suryana

Abstract

The goal of this research is to develop control methods of wind power plants with doubly-fed induction generators in contribution to the network frequency and voltage stabilities. Beside of that, the wind power generator have to be controlled in the optimal operation point by implementing the maximum power point tracking (MPPT) method, distributing reactive power generation for getting the minimum power losses, and exploiting the kinetic energy.

Two power system models for frequency analysis based on an isolated and an interconnected power system were developed. The network operator regulations were summarized. The wind power plants are not allowed to be disconnected from the power system immediately during network frequency and voltage disturbances. Then, they have to contribute to the network frequency and voltage control.

A frequency control method of wind power plant combining two control methods based on pitch control and kinetic energy was developed, simulated, and investigated experimentally. This method is able to act very fast and support the frequency control in long period. Wind power plants are able to control the network frequency without supporting from conventional power plants. All wind power plants are coordinated by a wind farm supervisory control. They are divided into two groups. The first group will discharge kinetic energy and the second group will deliver their reserve power to the network if the frequency disturbance happens.

A power system model for voltage analysis was developed. A voltage control method of wind power plant was developed, simulated, and investigated experimentally. All wind power plants deliver additional reactive power for controlling the network voltage.

Simulations using Matlab/Simulink Power Systems were done. Experiments using a wind power plant simulator were completed. A 15 kW induction motor represented an emulator of wind turbine. A 4 kW doubly-fed induction generator was controlled interactively in PC using dSPACE controller board 1103. Simulation and experimental investigation results proved the effectiveness of frequency and voltage control methods of wind power plant with doubly-fed induction generator.

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