Preface

The fundamental technical challenge in integrating wind-generated electrical energy into future power supply portfolios stems from mismatches between the stochastic nature of wind resources and the exigent requirements associated with power system reliability in terms of frequency, voltages, harmonics, security, ramp rates, etc. Thus, utilization of a meaningful amount of wind energy calls for advanced control strategies that take into account the requirements imposed by both sides of the interconnection.

This monograph aims at advancing the subject of wind energy control from the individual wind turbine level to the wind farm level. The ensemble of wind farm control technologies should enable reconfigurable, supervisory regulation of aggregated active and reactive power outputs from a large number of grid-connected wind turbines. The ultimate objective of such technologies would be to expand the capabilities of wind electric conversion systems by allowing them to coordinate with other energy resources, follow dispatch instructions from power grid operators, and adapt automatically to various conditions to alleviate the negative impact of wind irregularities on power system reliability and the quality of power supply. To this end, conventional single-turbine control technologies, though sufficient for individual turbine operation, may not be adequate at the wind farm level, especially when the level of wind energy penetration is high.

The monograph addresses a number of major issues in wind energy control in the context of power system operation. Following an overview of the required and desired objectives of grid integration and operation, the monograph devotes one chapter to each of the following topics: reconfigurable nonlinear control of single-turbine active and reactive power outputs; approximate model of wind turbine control systems for wind farm power control; contemporary techniques for designing and analyzing controllers at the wind farm level (two chapters); and control of kinetic energy stored in wind farms for transient frequency stability and the associated open challenges.

Wind farm control technologies are still at an early stage of development despite the rapid growth of wind power around the world. This monograph is primarily

intended for control engineers/researchers who wish to apply their expertise to address key control issues that arise in the integration of wind farms into power grids. In addition, coverage of contemporary solutions to fundamental integration and operational problems in the monograph will benefit power engineers/researchers who wish to promote wind energy with its multi-faceted benefits. We hope that the monograph will stimulate the interest of graduate students and collaboration between practicing engineers and academic researchers.

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Norman, OK, USA — John N. Jiang
Norman, OK, USA — Choon Yik Tang
Stillwater, OK, USA — Rama G. Ramakumar
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Jiang, J.N.; Tang, C.Y.; Ramakumar, R.G.

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