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Fault Tolerant Power Grids

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SUMMARY

This special issue contains article on fault detection and isolation and fault tolerant control methods applied to different aspects of modern power grids, both for accommodating faults in the power grid, and for accommodation of faults in power generating units. Copyright © 2014 John Wiley & Sons, Ltd.

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In the recent years a high focus has been drawn to making power grids smarter for a number of reasons. The main reason is to ensure grid stability and power quality in power grid, which has changed its nature from being dominated by a few large generating units to a grid dominated by many smaller generating units, with an increasing number of renewable generating sources like wind turbines and photo electric units. This has lead to a high research level in (Smart) Power Grids in general and as well in control of these grids. In the process of ensuring grid stability and quality it is important to detect, isolate and accommodate faults occurring in the physical grid or in the generating units.

The focus of this special issue on fault tolerant control in power grids is to draw research interest into different aspects of fault detection and isolation as well as fault tolerant control of power grids and power generating units. These methods plays an important role in the general handling of faults which could in the worst case result in stability problems in the grid.

This special issue contains a broad spectrum of contributions dealing with faults in wind turbine to a number of different aspects of fault detection and isolation and fault tolerant control in the actual power grid. These works apply a number of different methods. One trend can, however, be seen. Most solutions proposed for fault detection, isolation and accommodation in power grids are distributed solutions, which are beneficial as the grids are dominated in a higher and higher degree of smaller geographically distributed units.

Simani and Castaldi, [1], present a fault tolerant control solution for a wind turbine connected to a power grid. They focus on accommodation of faults in hydraulic pitch actuator, by using adaptive filters designed using a nonlinear geometric approach. The proposed approach is evaluated on known wind turbine fault tolerant control benchmark model.

Segundo Sevilla, et. al., [2], present both passive and active fault tolerant control approaches for inter area damping in a power grid. A combination of local and remote sensors are used in the design. The schemes are tested on both a linear and nonlinear models of the Nordic equivalent power grid.

Juelsgaard, et. al., [3], present a fault tolerant for portfolio balancing control approach. It consists of a distributed power optimization scheme for grid balancing, which provides tolerance to the grid in the way that it accommodates changes in the portfolio either due to faults or reasons. It also

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includes controllable users in the distributed optimization. The work is evaluated with a numerical example.

Huang and Wu, [4], deal with the problem of inclusion of additional Phase Measuring Units (PMU) into the power grid control structure, and as well communication with these PMUs. The design is made tolerant towards random communication faults between the PMUs and the grid controller. The scheme is tested on the IEEE 118-bus test model.

Yadykin, et. al., [5], analyze power grid stability using finite and infinite Gramians to solve the differential and algebraic Lyapunov equations in the time and frequency domains which are used to model the power grid. The proposed scheme is applied to the Kundur four machine two area system model.

Tedesco and Casavola, [6], presents distributed supervisory control strategy for load and frequency set point distribution for the power generators in a power grid. This solution accommodates unexpected changes in the power balance in the grid, by changing the set points for the active generating units. The scheme is evaluated with a model of a four area power grid.

Zhang, et. al., [7], suggest a distributed fault detection and isolation method for detecting and isolating islanding faults in smart (power) grids. It is a distributed approach in which each power generating unit in the grid detects and isolates the faults, based on local measurements. It is evaluated on simulation study of a two machine power grid.

Wu, et. al., [8], propose an active fault detection and isolation scheme for islanding faults. It is a distributed scheme, in which each generating unit in the grid introduces the active detection signals and detects and isolates the faults in the grid, which is obtained using a Set-Membership filter. The scheme is evaluated with a simulation study.

Knuppel, et. al., [9], present a structural approach for fault detection and isolation in a power grid. The scheme is designed to adjust itself to changes in the grid, such that the most efficient analytical redundancy relations are used. The scheme is evaluated by using PowerFactory simulation tools.

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