HANDBOOK OF ELECTRICAL POWER SYSTEM DYNAMICS

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HANDBOOK OF ELECTRICAL POWER SYSTEM DYNAMICS

Modeling, Stability, and Control

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FOREWORD

Electricity is the driving factor of the modern world. Humanity is demanding more and more energy as the demand for better life quality, and industry development is increasing. The history of modern civilization begun more than one century ago when electricity generators and infrastructure for electricity transmission were invented. As the demand for electrical power has increased, the electrical power systems have been expanded over large distances and become more complex. There has been, thus, a continuous need for innovation to create more efficient and reliable components.

Recently, the electrical power systems have gone through a deregulation process, and electricity market has been created aiming to stimulate competition, achieve fair electrical energy price, encourage the investments for modernization and commissioning new power plants, etc. However, the immediate effects of the electricity market were additional problems in power system operation.

The limited conventional energy resources and the need for environment protection, on one hand, and the advantages of actual robust simulation hardware and software tools, on the other hand, encouraged the humanity to successfully exploit the Aeolian, solar, and other nonconventional resources. The share of electricity generation from renewable energy sources has significantly increased in the last years, and the targets are very ambitious for the future. Large wind farms are developed onshore and offshore, resulting in significant change in the generation pattern and thus changes in the power flow. Moreover, under the increasing share of generation from renewables, changes in power flows may sometimes occur quite often during one hour. This problem, in effect, requires strengthening the transmission grid.

The power system operators are, thus, facing bigger challenges than that in the past, such as limitations in scheduling and handling generation resources due to the electricity market, operation of the transmission networks close to their technical limits due to difficulties in constructing new transmission facilities, and generation uncertainties due to the intermittency and less inaccurate forecasts of the renewable energy sources, or even due to natural forces like earthquakes and storms.

The major grid blackouts experienced in the last years prove that investments and innovation are always required in the power system infrastructure, management, and education. The operational manual of the ENTSO-E network has been updated in order to prevent major incidents that occurred in the past due to permissive rules. In a strongly interconnected continental power system, as it is the ENTSO-E network, collaboration between power system operators based on clear rules is critical.

As a reaction to the technical issues of power systems, new concepts are under development. It is expected that the new ideas for more intelligent electrical networks (Smart Grids) and creation of continental supergrids may improve the power system security while satisfying the customers' needs as regards the quantity and quality. This may be seen as a new era of electricity.

This book is a successful collection of theories and applications, from modeling for dynamic analysis, methods for stability assessment and control strategies that finally help the reader to understand the causes and effects of power system blackouts and, on one hand, to understand why some preventive actions are required in order to ensure appropriate security levels and avoid the blackouts. The authors of this book, both from academia and industry, are active specialists in CIGRE and IEEE-PES activities.

Education has been a critical ingredient for creating a sustainable electricity industry. Investment in education is the minimum condition to create professionals.

André Merlin
President of CIGRE

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