بسم الله الرحمن الرحيم

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ENHANCING THE POWER SYSTEM TRANSIENT STABILITY BY USING STORAGE DEVICES WITH HIGH PENETRATION OF WIND FARMS

By

Mostafa Ismail Elsayed Ismail Kandil

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Electrical Power and Mechanics Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis: Enhancing the Power System Transient Stability by Using Storage Devices with High Penetration of Wind Farms.

Key Words: Power system stability, Wind power generation, Stability analysis, Wind turbines, Renewable energy sources, Batteries, Transient analysis.

Summary:
In this thesis, the energy storage devices were presented to be used in enhancing the power system transient stability under high levels of Wind power penetrations. Study was applied on a benchmark system and used PSSE explore as the simulation software. Different locations of the Energy storage were examined and the optimum location for the system under study was presented.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute. I further declare that I have appropriately acknowledged all sources used and have cited them in the reference section.

Name: Mostafa Ismail Elsayed Ismail Kandil. Date: 13 / 02 / 2022.

Signature:

Dedication

Dedicated to the soul of Prof. Magdy Mohamed Ahmed El-Marsafawy.
To my wife, my father, my mother, and my little girls Lougina & Lara. Without you all nothing would come out of this work.

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List of Symbols and Abbreviations

AC	Alternating Current
BESS	Battery Energy Storage System
CAES	Compressed Air Energy Storage
DC	Direct Current
DFIG	Doubly Fed Induction Generator
EEC	Electrical Energy Storage
EEHC	Egyptian Electricity Holding Company
EPRI	Electric Power Research Institute
FACTS	Flexible Alternating Current Transmission System
FEES	Flywheel Energy Storage System
GE	General Electric
GW	Giga Watt
HVDC	High Voltage Direct Current
IEEE	Institute Of Electronic And Electrical Engineers
IGBT	Insulated-Gate Bipolar Transistor.
KW	Kilo Watt
MW	Mega Watt
PCC	Point Of Common Coupling
PCS	Power Conditioning System
PHS	Pumped Hydraulic Stations
PMSG	Permanent Magnet Synchronous Generator
PSSE	Power System Simulator For Engineering
RES	Renewable Energy Source
SCIG	Squirrel Cage Induction Generator
SLD	Single Line Diagram
SMES	Superconducting Magnetic Energy Storage
SOC	State Of Charge
STATCOM	Static Synchronous Compensator
TES	Thermal Energy Storage
UPS	Uninterrupted Power Supplies
VSC	Voltage Source Converter
VSI	Voltage Source Inverter
WECC	Water Electricity Coordination Council
WRIG	Wound-Rotor Induction Generator
WRSG	Wound-Rotor Synchronous Generator