Assessing the Renewable Energy Sources Integration Through a Series of Technical Performance Indices

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CERTIFICATE

We accept the work contained in this report as a confirmation to the required standard for the partial fulfilment of the degree of MS (EE).

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DEDICATION

I dedicated my thesis to my beloved parents, who have been our source of motivation and gave us strength when we thought of giving up, who continually provide they are moral, spiritual, emotional, and financial support.

To our brothers, sisters, relatives, teachers, friends, and classmates who shared their words of advice and support to finish this thesis. And lastly, we dedicated this thesis to the Almighty Allah thank you for the guidance, strength, power of the wisdom, strength, and abilities and for providing us a healthy life.

DECLARATION OF AUTHORSHIP

I ADIL QADEER Enrolment no # 01-244162-001 of MS EE declare that content of this thesis is my own work and that it is the result of work done during the period of registration. To the best of my knowledge, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

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ABSTRACT

Currently, there is a significant increase in the development and operation of the Renewable Energy Sources all-around the world due to the increasing environment uncertainties. PV and Wind are the most capable alternative sources to the conventional energy sources. These sources are rapid operational and easily integrated into the power system over the last few decades and are predictable in the development of the further upcoming decades. with concerning to the PV and Wind energy sources in the power system is the instability and irregularity, which create the protection problem in the power system reliability. Such energy sources depending upon various factors in the power system reliability. The size and site of the RES, the penetration of intermittent RES in the power system, the point common coupling in the grid-connected network, the relationship between the availability of multiple sites and the relationship among load and RES. Such factors are considered in the analysis of the power system reliability and impact of reliability on the Hybrid PV-Wind. In addition to the economic benefit of the supply power to the consumers.

To addresses such challenges, this thesis first analyzed the technical performance indices, in an attempt to harness the maximum possible benefit. These indices are attempting to quantify some operational impacts for long-term planning tool in the evaluating the renewable energy penetration in transmission networks. The CIGRE Medium-voltage Benchmark Model is used as a test system throughout this thesis to analyze the factor affecting the adequacy analysis. generally, the analysis of the RES integration in the power system acquiring the stochastic nature of the load and RES to satisfactory the RES penetration level in the system. For such purpose, the probabilistic method is implemented. The modeling and simulation are performed by powerful grid simulator DIgSILENT Power Factory. Which qualifies for fast and reliable performance of a wide range of calculating procedures.

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ABBREVIATIONS

CDF	Cumulative density function
CES	Conventical energies sources
CIGRE	International Council of Large Electric Networks
CPD	Cumulative Probability of Distribution
DG	Diesel Generator
DLF	Deterministic Load flow
EC	Energy Cost
EDNS	Energy Demand Not Supply
EMS	Energy Management System
ICC	Initial Capital cost
HL	Hierarchical level
LCC	Life cycle cost
LFA	Load Flow Analysis
LOLE	Loss of load expected
LOLP	Loss of load Probability
MCS	Monte Carlo Simulation
MSSM	Markov State Space Model
OPF	Optimal Power Flow
PF	Power Flow
PDF	Probability Density Function
PLF	Probabilistic Load Flow
PV	Photovoltaic
RES	Renewable Energy Sources
SLF	Stochastic Load flow
TEA	Techno-Economic Analysis
TPI	Technical Performance indices
WTG	Wind Turbine Generator