

POWER SYSTEM SECURITY ASSESSMENT IN ELECTRICAL OPERATION
SYSTEM

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DEDICATION

This project report is dedicated to my Father Digol Maikale, my mother Fatima Digol Maikale, Family and well-wishers for their prayer and support.

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ABSTRACT

Power system security and assessment are important tasks in modern energy management systems. The present trend towards deregulation and the need for new transmission expansion due to load growth or generation expansion has forced modern electric utilities to operate their systems under stressed operating conditions closer to their security limits. The purpose of security assessment is to provide information to the system operators about the secure and insecure nature of the operating states in the event of any contingency, so that proper control/corrective action can be initiated within the safe time limit. Power system security must be concerning all the time to ensure that the system always operate in a good condition. To make sure that the system operates in a good condition, security assessment must be done on the current system. Thus, this project performed power system security and assessment on 14 Buses, the work is done to identify faulty Buses and lines in order to take prompt action to sure that there is no problem occurs at the transmission line such as power overload and no voltage violation occurs at Bus when one or two of the transmission lines are eliminated. If there is a power overload in the system, contingency analysis must be done on the system to secure back the system. To secure back the system, transmission line of the system must be rank first according to its severity level by using appropriate assessment method. (N-1) contingency analysis has been used to assess the security level of the test system. In this project, Matlab software is used for the analysis and IEEE 14-Bus system is used as the test system. This project only focusses on the transmission line capacity in the system and the voltage changes at the Bus. The system was tested 4 different conditions, these include normal conditions, 5% Overloaded, 10% overloaded, 15% overloaded, 20% overloaded. The project was successfully done with all contingencies analysed. Hence, this project has conducted security assessment on 14 Bus power system and will provide reliable data for future power system assessment and operation.

ABSTRAK

Keselamatan dan penilaian sistem kuasa adalah tugas yang penting dalam sistem pengurusan tenaga moden. Trend semasa ke arah deregulasi dan keperluan pengembangan transmisi baru kerana penambahan beban atau pengembangan generasi telah memaksa utiliti elektrik moden untuk mengendalikan sistem mereka dalam keadaan tekanan operasi yang lebih hampir dengan had keselamatan mereka. Tujuan penilaian keselamatan adalah untuk memberikan maklumat kepada pengendali sistem mengenai kondisi selamat dan tidak selamat dari keadaan operasi sekiranya berlaku kemungkinan, sehingga tindakan kawalan / pembetulan yang tepat dapat dimulai dalam batas waktu yang selamat. Keselamatan sistem kuasa perlu sentiasa diperhatikan untuk memastikan sistem sentiasa beroperasi dalam keadaan baik. Untuk memastikan bahawa sistem beroperasi dalam keadaan baik, penilaian keselamatan mesti dilakukan pada sistem sentiasa. Oleh itu, projek ini ingin melakukan keselamatan dan penilaian sistem kuasa pada 14 bus, kerja-kerja dilakukan untuk mengenal pasti bus dan saluran yang rosak agar dapat mengambil tindakan segera untuk memastikan bahawa tidak ada masalah yang berlaku di saluran penghantaran seperti beban berlebihan dan tidak ada pelanggaran voltan berlaku di bus apabila satu atau dua saluran penghantaran dihapuskan. Sekiranya terdapat beban berlebihan dalam sistem, analisis kontingensi mesti dilakukan pada sistem untuk mengamankan kembali sistem. Untuk mengamankan sistem, saluran penghantaran sistem mesti berada di peringkat pertama sesuai dengan tahap keparahannya dengan menggunakan kaedah penilaian yang sesuai. (N-1) analisis kontingensi telah digunakan untuk menilai tahap keselamatan sistem ujian. Dalam projek ini, perisian Matlab digunakan untuk analisis dan sistem IEEE 14-Bus digunakan sebagai sistem ujian. Projek ini hanya memfokuskan pada kapasiti saluran penghantaran dalam sistem dan voltan berubah di dalam bus. Sistem ini diuji 4 keadaan yang berbeza, ini termasuk keadaan normal, 5% Terlampau, 10% berlebihan, 15% terlalu banyak, 20% berlebihan. Projek ini berjaya dilaksanakan dengan dianalisis semua kemungkinan. Oleh itu, projek ini telah menjalankan penilaian keselamatan pada 14 sistem kuasa bus dan akan memberikan data yang boleh dipercayai untuk penilaian dan operasi sistem kuasa pada masa hadapan.

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LIST OF ABBREVIATIONS

MATLAB	-	Matrix Laboratory
SSA	-	Static Security Assessment
CA	-	Contingency Analysis
KCL	-	Kirchhoff's Law
DC	-	Direct Current
AC	-	Alternating Current
PI	-	Performance Index
IEEE	-	Institute of Electrical and Electronic Engineers

LIST OF SYMBOLS

Σ	-	Summation of the Risk
P	-	Real Power
Q	-	Reactive Power
S	-	Apparent Power
MW	-	The Unit for Real Power
MVA _r	-	The Unit for Reactive Power
MVA	-	The Unit for Apparent Power
p.u	-	Per Unit
R	-	Resistance
X	-	Reactance
B	-	Susceptance
N-1	-	Contingency Analysis

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The power system security is assessed to determine whether a network is reasonably safe against possible contingencies happening during its operation, today, everything depends on electrical source to do daily work [1]. These can be seen at all places in the world such as house, supermarket, factory, universities and many more. Therefore, continuous supply of electrical energy to the consumer is a must to make sure consumer's daily activities will be smooth. This phenomena also has made the demand of electrical supply increase. Power system security is very important. In power system, security is when the system is free from any risk and can provide continuous supply of the electricity to the consumer without any problem. The definition of risk in ISO 31000 is the effect of the uncertainty upon objectives where on effect is a deviation from the expected either positive or negative [2]. Lack of power system security knowledge will make the power system become more risky and can become very dangerous. Continuous electricity is also important to the consumer especially factory. This is because, factory can lose a lot money just from a short time breakdown. That is why in almost all big factory, they have a backup power in case of breakdown of power system. Security assessment is an analysis that can be done to check whether the system is safe from any problem that can affected its operation [3]. Therefore, many data from the test system is required to perform security assessment. In power system operations, the security of a system has always been an important issue, which is related to the ability to continue normal operation in post-contingency conditions. Power system security assessment is an effective tool for checking the security of power systems, which aims to determine whether, and to what extent, a power system is reasonably safe from serious interference to its operation [4].

1.2 Problem Statement

Security assessment is concerned with factors related to the insecurity situation. Where viable approach to accurately determine specific is challenging. However, such challenge could be overcome by adopting contingency selection and ranking based accurate checking of overload and overvoltage via load flow calculation of the power system in post-contingency condition. Power system security is very important to determine the continuous electrical supply. Therefore, we must find ways in determining the level of power system security. Load flow analysis is one of the methods that can be used in determining the level of power system security. But, load flow analysis method is also an iterative method, which is time consuming in determining the level of the power system security. Because of the technologies in computer is very advanced, many software that can be used in determining the level of power system security [5].

In an event the security challenge is imminent, in cooperation of virtual power plant is a viable solution. The virtual power plant is incorporation of renewable energy to grid system to compensate or supplement the in case of blackout or under voltage supply. It is also interesting to note that excess power supply could be sold back to the grid. This is important since there is a need to calculate the security level of system quickly. One of the software that can be used in determining the security level of power system is MATLAB and RETScreen. MATLAB can be used to do the mathematical works quickly than using conventional method. This also, will make the results of the security level of power system is more accurate. One way to determine the level of power system security is by doing line outage contingency analysis for the system. By using this method, the transmission line can be ranked and the most dangerous line can be determined. So, improvement of the system can be achieved by using some method such as introducing new back up line [6].

1.3 Objectives

The main objectives of this research are

- To investigate traditional method for power security assessment.
 - To evaluate available data from another project
 - To simulate the available data using MATLAB software
- To incorporate security assessment results into Virtual Power Plant (VPP).

1.4 Scope of Study

- Assess the power system security of 14 Busses.
- A 100MW power system was analysis by Hadi Saadat (Power flow analysis Algorithms).
- Load flow analysis conditions of normal conditions, 5% overloaded, 10% overloaded, 15% overloaded, 20% overloaded were analysis
- A 100MW renewable system was considered in this study to be installed at Maiduguri, Nigeria to analysis the VPP.

1.5 Significance of Study

This study helps in analysing security of power system size optimization techniques considering the uncertainty of the solar irradiance. The use of DE algorithm helps in appropriate sizing of PV system and also help in reducing computational and convergence time.

1.6 Report Organization

The project report is outlined in the following manner

Chapter 1 is Introduction where the background of the study is presented, this chapter present the problem statement of this project and also objectives that need to be achieved by the end of this project. Some limitation was provided to reach goal of

this project. The scope and research methodology of the project also includes in this chapter.

Chapter 2 contains Literature Review. The literature contains the knowledge used to complete this project. This is including the knowledge about security assessment, load flow analysis, contingencies analysis, and performance index method.

Methodology is defined as a plan of a project as discussed in Chapter 3. This chapter provides the way or step that needs to be taken while conducting this project. The flowchart of procedures has been provided to ensure this project will be completely done.

Chapter 4 provides the results and explanation about the results in the project. The results in this chapter includes the load flow analysis results, contingencies analysis results, calculation of performance index, ranking of the system and results on how to improve the test system.

Chapter 5 will present the summary of this project and proposed the future works that need to be done.

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