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doi:10.15199/48.2023.10.19

Voltage Stability Assessment at Integrated Electric Power System with Wind Power Generation in South Sulawesi Indonesia

Abstract: Today the use of renewable energy is being encouraged to overcome the limitations of fossil energy. One of the renewable energies utilized in South Sulawesi Indonesia is wind energy. The weakness of wind power plants is that the energy produced is not constant so that it can affect the stability of integrated conventional systems. This research discusses the stability of systems integrated with renewable energy generators. The method used is the New Voltage Stability Index. The results showed that the highest stability index occurred in the Sidera to Sidera 70 kV networks of 0.157433. The second stability index value on the network from Tello to 30 kV Tello is 0.153720. The third stability index value occurs in the network from 150 kV Powatu to Powatu 70 kV of 0.149948. The value of the simulation results of the system stability index below 1 or in a stable state.

Słownictwo: Obecnie zachęca się do korzystania z energii odnawialnej w celu przeciwdziałania ograniczeń energii kopalnej. Jedną z odnawialnych źródeł energii wykorzystywanych w południowym Sulawesi w Indonezji jest energia wiatrowa. Słabością elektrowni wiatrowych jest to, że wytwarzana energia nie jest stała, przez co może wpłynąć na stabilność zintegrowanych systemów konwencjonalnych. W pracy omówiono stabilność systemów zintegrowanych z generatorami energii odnawialnej. Stosowaną metodą jest nowy wskaźnik stabilności napięcia. Wyniki wykazały, że najwyższy wskaźnik stabilności wystąpił w sieciach Sidera-Sidera 70 kV wynoszący 0.157433. Drugi wskaźnik wskaźnika stabilności w sieci od Tello do 30 kV Tello wynosi 0.153720. Trzeci wskaźnik wskaźnika stabilności występuje w sieci od 150 kV Powatu do Powatu 70 kV wynoszącej 0.149948. Wartość wyników symulacji wskaźnika stabilności systemu poniżej 1 lub w stanie stabilnym. (Ocena stabilności napięcia w zintegrowanym systemie elektroenergetycznym z wytwarzaniem energii wiatrowej w południowym Sulawesi w Indonezji)

Keywords: new voltage stability index, wind power plant, South Sulawesi power system.

Słowa kluczowe: indeks stabilności napięcia, energetyka wiatrowa

Introduction

Power system analysis is of particular concern to electricity engineers, especially with regard to voltage stability. Voltage stability is currently a serious concern regarding the design, planning and operation of systems integrated with wind energy systems that produce intermittent power. Globally, the power system network develops due to the integration of several private power companies to the national electricity network (PT. PLN). This leads to the violation of stability limits of the system. As a result, voltage instability occurs and incurs high cost for both consumers and companies.

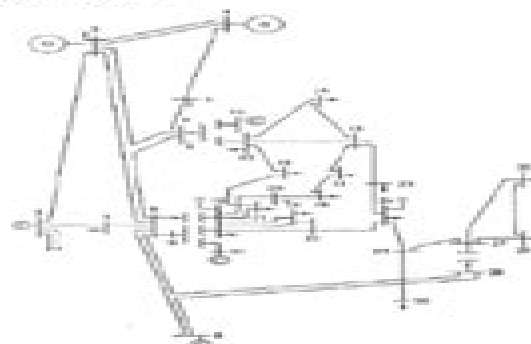
Increasing demand for electricity must be supported by the quality and reliability of the electric power system [1]. PT. PLN is a sole power company which constructs, manages, and maintains the whole Indonesian electric power system on one side and should guarantees the quality of electricity to the consumers on another side [2,3].

Voltage stability as defined by P. Kundur is the ability of a power system to maintain a stable and acceptable voltage on all buses in the system under normal operating conditions and after experiencing a disturbance [4]. It is desired that the power system remains in a state of equilibrium under normal conditions and is expected to react to return the system state to an acceptable state after the disturbance.

The causes of voltage instability are sudden load increase, external factors, and improper operation of the voltage control device. More importantly, voltage instability can arise where there is a mismatch between the reactive power supply and demand, i.e., the inability of the system to meet the reactive power requirements. Voltage instability due to overload on the power network can cause a decrease in system voltage and eventually a voltage collapse occurs. This has severe consequences on system security and jeopardizes essential services to provide customers with reliable and continuous power supply [5].

There are various methods to assess whether a voltage system is stable or not and how close the system is to instability by evaluating voltage stability index. The stability index should be simple and easy to implement in computing to help system planners and operators to examine the condition of voltage stability in the whole electric power system. The stability index can indicate the critical bus of the power system connected between one bus to another. In general, analysis of voltage stability problems in power systems is used to: 1) determine the voltage drop indicator, 2) determine when voltage instability occurs, 3) determine weak buses in the network, and 4) identify areas subjected to unstable systems [6].

Material dan Method



Source: Hadi Saadat book
Figure 1. Single line diagram of the IEEE 30-Bus system

Voltage Stability Of Electric Power Systems

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Yong Tang



Voltage Stability Of Electric Power Systems Voltage Stability Of Electric Power Systems:

Voltage Stability of Electric Power Systems Thierry van Cutsem, Costas Vournas, 2007-10-12 Voltage Stability is a relatively recent and challenging problem in Power Systems Engineering It is gaining in importance as the trend of operating power systems closer to their limits continues to increase Voltage Stability of Electric Power Systems presents a clear description of voltage instability and collapse phenomena It proposes a uniform and coherent theoretical framework for analysis and covers state of the art methods The book describes practical methods that can be used for voltage security assessment and offers a variety of examples

Power System Voltage Stability Carson W. Taylor, 1994 Provides solutions to everyday voltage stability problems increasingly faced by engineers in electric power plants Table of Contents General Aspects of Electric Power Systems What is Voltage Stability Transmission System Reactive Power Compensation and Control Power System Loads Generation Characteristics Simulation of Equivalent Systems Voltage Stability of a Large System Voltage Stability with HVDC Links Power System Planning and Operating Guidelines Appendices A Notes on the Per Unit System B Voltage Stability and the Power Flow Problem C Power Flow Simulation Methodology D Dynamic Analysis Methods E Equivalent System 2 Data F Voltage Instability Incidents Index Illustrations

Voltage Stability in Electrical Power Systems Farid Karbalaee, Shahriar Abbasi, Hamid Reza Shabani, 2022-12-28 Voltage Stability in Electrical Power Systems Explore critical topics and the latest research in voltage stability in electric power systems In Voltage Stability in Electrical Power Systems Concepts Assessment and Methods for Improvement three distinguished electrical engineers deliver a comprehensive discussion of voltage stability analysis in electrical power systems The book discusses the concept of voltage stability effective factors and devices and suitable system modeling offering readers an authoritative overview of the subject and strategies to prevent instability in power systems The authors explore critical topics such as load and load tap changer LTC transformer modeling and the impact of distributed generation and transmission distribution interactions on voltage stability They also present practical methods to improve voltage stability Readers will also find Thorough introductions to voltage stability effective factors and devices and suitable systems modeling Comprehensive explorations of voltage stability assessment methods including the continuation power flow methods and PV curve fitting In depth explorations of methods of improving voltage stability including preventive and corrective methods Fulsome presentations of measurement based indices and model based indices of stability assessment Perfect for engineers and other professionals designing electric power systems Voltage Stability in Electrical Power Systems Concepts Assessment and Methods for Improvement will also earn a place in the libraries of graduate and senior undergraduate students with an interest in power systems

Voltage Stability of Electric Power Systems Thierry van Cutsem, Costas Vournas, 1998-03-31 Voltage Stability is a relatively recent and challenging problem in Power Systems Engineering It is gaining in importance as the trend of operating power systems closer to their limits continues to increase Voltage Stability of Electric Power Systems presents a clear description of voltage

instability and collapse phenomena It proposes a uniform and coherent theoretical framework for analysis and covers state of the art methods The book describes practical methods that can be used for voltage security assessment and offers a variety of examples

Voltage Stability in Electric Power System Mir Sayed Shah Danish ,2015-02-01 The understanding of power system voltage stability has become increasingly important due to day by day increase in electricity demand and liberalization policy of electricity markets Therefore voltage stability has become significantly important during the past decades Both voltage stability formulation and indices are covered in this book along with an easily comprehensible manner and detailed exposition of the voltage stability indices fundamental However the content of this book is considered serviceable in advanced level The author combines his knowledge with reporting of accurate update information to illustrate the voltage stability indices and compared how to distinguish numbers of these indices in view of their similarity functionality applicability formulation merit demerit and overall performances This book will serve as a valuable guide for the typical reader That the readers had in mind were researchers engineers planners and other professionals involved in the assessment of voltage instability in electric power system The prerequisite for this book is suggested the basic knowledge of power system analysis and voltage stability subjects The authorship methodology of this book had been based on the reference book style

Voltage Stability Analysis of Power System Yong Tang,2021-04-07 This book describes comprehensively theories and methods of the power system voltage stability It first introduces the basic theory of the power system and the basic concept and classification of the power system stability and discusses the basic concepts of voltage stability including the mechanism of voltage stability and influencing factors of transient and medium term and long term voltage stability This book also describes the elemental characteristics and models of important power system in voltage stability analysis and discusses the theories and methods of analysis on steady transient and medium term and long term voltage stability analysis respectively Then this book introduces the measures to improve the voltage stability Finally two examples of voltage stability analysis in engineering applications are introduced This book is useful as a reference for engineers and technicians who are engaged in dispatching operation planning design and scientific research of the power system and teachers and students of electrical engineering major in colleges and universities

Voltage Stability in Electric Power Systems Josefa Batidreu,Queensland University of Technology. School of Electrical and Electronic Systems Engineering,1990

Applied Mathematics for Restructured Electric Power Systems Joe H. Chow,Felix F. Wu,James A. Momoh,2004-11-09 Applied Mathematics for Restructured Electric Power Systems Optimization Control and Computational Intelligence consists of chapters based on work presented at a National Science Foundation workshop organized in November 2003 The theme of the workshop was the use of applied mathematics to solve challenging power system problems The areas included control optimization and computational intelligence In addition to the introductory chapter this book includes 12 chapters written by renowned experts in their respected fields Each chapter follows a three part format 1 a

description of an important power system problem or problems 2 the current practice and or particular research approaches and 3 future research directions Collectively the technical areas discussed are voltage and oscillatory stability power system security margins hierarchical and decentralized control stability monitoring embedded optimization neural network control with adaptive critic architecture control tuning using genetic algorithms and load forecasting and component prediction This volume is intended for power systems researchers and professionals charged with solving electric and power system problems *Analysis, Monitoring and Control of Voltage Stability in Electric Power Systems* Miroslav M. Begovic,1989

Study of Long-term Voltage Stability in Electric Power Systems Per-Anders Löf,1991 *Voltage Stability of Power Systems* Saikat Chakrabarti,2025-01-02 This monograph discusses different types of voltage stability problems based on their time scales and the size of the disturbances The basic concepts of voltage stability are explained with the help of a simple two bus power system **Voltage Stability and Security for Electric Power Systems** Louis Parlai Shu,1984

Fundamentals of Electric Power System Dr. Sandeep Sharma,Richa Chaudhary,Dr. Prashant Mani,Dr. Sudha K, Electric power systems are at the heart of modern society powering homes businesses and industries around the globe As such a firm grasp of their fundamental principles is essential for anyone involved in the design operation or management of electrical infrastructure Throughout this book emphasis is placed not only on theoretical foundations but also on practical insights gleaned from real world engineering practices Case studies examples and illustrations are utilized to illustrate key concepts and demonstrate their relevance in solving real world problems **An Introduction to Voltage Stability in Electric**

Power System Mir Sayed Shah Danish,2014-11-27 The understanding of power system voltage stability has become increasingly important due to day by day increase in electricity demand and liberalization policy of the electricity markets Therefore voltage stability has become significantly important during the past decades The aforesaid reasons have forced the power systems to operate close to their stability limits Both voltage stability formulation and indices are covered in this book along with an easily comprehensible manner and detailed exposition of the voltage stability indices fundamental This two chapters are provided as sample chapters if you interest in the rest of the chapters can be found in *Voltage Stability in Electric Power System A Practical Introduction* book ISBN 978 3832538781 *On Static Analysis of Long-term Voltage Stability in Electric Power Systems* Per-Anders Löf,1995 **Voltage Stability Analysis of Electric Power System** Wahida

Tania,California State University, Sacramento,2010 Voltage Stability is becoming an increasing source of concern in secure operation of present day power systems There is a need to perform studies to ensure that the reliability of the power system is not decreases as a result of unstable voltage This project will analyze the voltage stability of a system and mainly focuses on the identification of critical power flow path critical bus and critical line in a power system **Power Systems and Power Plant Control 1989** U. Ahn,2014-06-05 The control of power systems and power plants is a subject of growing interest which continues to sustain a high level of research development and application in many diverse yet complementary

areas such as maintaining a high quality but economical service and coping with environmental constraints The papers included within this volume provide the most up to date developments in this field of research

Power Systems Operation with 100% Renewable Energy Sources Sanjeevikumar Padmanaban, Sharmeela Chenniappan, Sivaraman Palanisamy, 2023-10-24 Power Systems Operation with 100% Renewable Energy Sources combines fundamental concepts of renewable energy integration into power systems with real world case studies to bridge the gap between theory and implementation The book examines the challenges and solutions for renewable energy integration into the transmission and distribution grids and also provides information on design analysis and operation Starting with an introduction to renewable energy sources and bulk power systems including policies and frameworks for grid upgradation the book then provides forecasting modeling and analysis techniques for renewable energy sources Subsequent chapters discuss grid code requirements and compliance before presenting a detailed break down of solar and wind integration into power systems Other topics such as voltage control and optimization power quality enhancement and stability control are also considered Filled with case studies applications and techniques Power Systems Operation with 100% Renewable Energy Sources is a valuable read to researchers students and engineers working towards more sustainable power systems Explains Volt Var control and optimization for both transmission grid and distribution Discusses renewable energy integration into the weak grid system along with its challenges examples and case studies Offers simulation examples of renewable energy integration studies that readers will perform using advanced simulation tools Presents recent trends like energy storage systems and demand responses for improving stability and reliability

Electrical Power Systems C L Wadhwa, 2006 In A Clear And Systematic Manner This Book Presents An Exhaustive Exposition Of The Various Dimensions Of Electrical Power Systems Both Basic And Advanced Topics Have Been Thoroughly Explained And Illustrated Through Solved Examples Salient Features Fundamentals Of Power Systems Line Constant Calculations And Performance Of Overhead Lines Have Been Discussed Mechanical Design Of Lines HvdC Lines Corona Insulators And Insulated Cables Have Been Explained Voltage Control Neutral Grounding And Transients In Power Systems Explained Fault Calculation Protective Relays Including Digital Relays And Circuit Breakers Discussed In That Order Power Systems Synchronous Stability And Voltage Stability Explained Insulation Coordination And Over Voltage Protection Explained Modern Topics Like Load Flows Economic Load Dispatch Load Frequency Control And Compensation In Power System Nicely Developed And Explained Using Flow Charts Wherever Required Zbus Formulation Power Transformers And Synchronous Machines As Power System Elements Highlighted Large Number Of Solved Examples Practice Problems And Multiple Choice Questions Included Answers To Problems And Multiple Choice Questions Provided With All These Features This Is An Invaluable Textbook For Undergraduate Electrical Engineering Students Of Indian And Foreign Universities Amie Gate All Competitive Examination Candidates And Practising Engineers Would Also Find This Book Very Useful

Computational Techniques for Voltage Stability Assessment and Control

Venkataramana Ajjarapu, 2007-05-27 This book provides comprehensive details on continuation power flow and reviews concepts in bifurcation theory and continuation methods for assessing power system voltage stability. The author proposes a uniform framework that provides computational approaches for both short term and long term voltage stability phenomena. Readers can access the author's web based simulation tools which are based on the advice in this book to simulate tests of systems up to the size of 200 buses.

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