

Article Info

Received: 25 Jan 2017 | Revised Submission: 20 Feb 2017 | Accepted: 28 Feb 2017 | Available Online: 15 Jun 2017

Forecasting of Power System Blackouts

Sushil Kumar Gautam*, Ishta Garg**, UK Choudhury***, Shivam Gupta**** and Sushant Kumar*****

ABSTRACT

Increasing electrical energy demand, modern Lifestyles and energy usage patterns have made the world fully dependant on power systems. This instigated mandatory requirements for the operators to maintain high reliability and stability of the power system grid. However, the power system is a highly nonlinear system, which changes its operations continuously. Therefore, it is very challenging and uneconomical to make the system be stable for all disturbances. Blackouts of electric power often result in huge economic losses to power grid enter prices and society. To indicate the losses of accidents, this paper introduces the concept of the accident cost of distribution network failure, analyzes the various factors affecting it. In this paper we use power simulator to forecasting for power system black out. Simulation performed on 9 bus system.

Keywords: Power System; Forecast; Blackout.

1.0 Introduction

Electric power transmission networks are complex systems that are commonly run near their operational limits. Major cascading disturbances or blackouts of these transmission systems have serious consequences. Individually, these blackouts can be attributed to specific causes, such as lightning strikes, ice storms, equipment failure, shorts resulting from untrimmed trees, excessive customer-load demand, or unusual operating conditions.

However, an exclusive focus on these individual causes can overlook the global dynamics of a complex system in which repeated major disruptions from a wide variety of sources are a virtual certainty.

We analyze a time series of blackouts to probe the nature of this complex system dynamics[1,2]. the catastrophic disruptions of large power systems often occur due to cascading failures due to the interconnected power systems are usually operated near critical loading, which tend to yield cascading failure. From August to September 2003, the world experienced a series of large blackouts

happening in US and Canada (14 Aug.), in London (28 Aug.), in Sydney and Malaysia (1 Sept.), and in Italy (28 Sept.). On the other hand, many factors, including system engineering, economic concerns and operational policies, organize the system towards criticality which means the system is operating at its stable boundary. Thus, the study of criticality of interconnected power systems has been paid more and more attention[3,7].

1.1 Voltage stability

According to A CIGER Task Force:

Small disturbance voltage stability : it is related to steady state stability and can be analyzed using small signal (linearised model of the system) Voltage stability : the concept of voltage stability is related to transient stability of a power system. The analysis of voltage stability normally requires simulation of the system modeled by non linear differential algebraic equation.

1.2 Voltage collapse

A power system undergoes voltage collapse if the post disturbance equilibrium voltages near loads

*Corresponding Author: Department of Electrical and Electronic Engineering, Delhi Technical Campus Greater Noida (U.P.), India (E-mail: sushilsushil07@gmail.com)

**Department of Electrical and Electronic Engineering, Delhi Technical Campus Greater Noida (U.P.), India

***Department of Electrical and Electronic Engineering, Delhi Technical Campus Greater Noida (U.P.), India

****Department of Electrical and Electronic Engineering, Delhi Technical Campus Greater Noida (U.P.), India

*****Department of Civil Engineering, Delhi Technical Campus Greater Noida (U.P.), India

are below acceptable limit. voltage collapse may be total(blackout) or partial

1.3 Power system stability

Power system stability is the ability of an electrical power system, for a given initial operating condition, to regain a state of operating equilibrium after being subjected to a physical disturbance, with most system variables bounded so that practically the entire system remain intact (CIGRE & IEEE define the power system stability).

1.4 Black out to line

If we include transmission line we can consider two types of blackouts and each having different dynamic properties, first type includes loss of load due to transmission limit reaching their load limit but no line outages. Second type blackout is associated with multiple line outage which include failure of circuit breaker, lightning arrester, due to unbalance in active and reactive power, due to unbalance in frequency, which will take place depending on operating conditions.

2.0 Methodologies Forecasting of Blackout

A cause of blackout in power system Firstly, let's give a brief review on cascading failure mechanisms of large blackouts, which is utmost important to the cascading failure modeling. As we know, bulk electrical power transmission systems are complex networks composed of large numbers of components that interact in diverse ways.[4,5] When the component's operating limits are exceeded, the control and protection equipments will act but some component fails in the sense of not being available to transmit power, because of their disoperation's or damage due to aging, fire, weather, poor maintenance or incorrect design or operating settings. In any case above, the related fault will cause a transient process and further cause the power flow to be redistributed according to circuit laws, and subsequently redistributed according to various kinds of automatic and manual control and protection actions.

Although the transients and readjustments of the system can be local in effect but may separate some key components from the system, so that a component disconnection or failure can effectively increase the loading of some other components throughout the network. This situation will lead the propagation of failures can't be limited to adjacent

network components. The interactions involved are diverse and can cause deviations in power flows, frequency and voltage as well as operation or misoperation of protection devices, controls, operator procedures and monitoring and alarm systems. Furthermore, all the interactions between component failures tend to produce serious results if the components are highly loaded. For example, if a more highly loaded transmission line fails, it will produce a larger transient, then there is a larger amount of power to redistribute to other components, and failures near protection devices more likely arise. Moreover, if the overall system is more highly loaded, the components have too small stable margins to tolerate a little increase in load before failure. Especially with the increase of the system's nonlinearities and dynamical couplings, the system operators have fewer options and more stress. Generally speaking, a typical large blackout has an initial disturbance or a trigger event followed by a sequence of cascading events. Each event further weakens the structure stability of the system and makes subsequent events more likely arise. Examples of an initial disturbance are short circuits of transmission lines through untrimmed trees, protection device misoperation, and bad weather. The events and their interactions causing blackouts are often rare, unusual or unanticipated because the likely and anticipated failures are already routinely accounted for in power system design and operation. The complexity is so large that it usually takes months to sift through the records, establish and reproduce the events occurring and propagation process in computer simulations after a large blackout.[6,8]

3.0 Forecasting Of Power Blackout Using 9 Bus System

In figure 1, 9 bus system 3 generators are taken, at bus number 5, 6, & 8 load is taken initially 125MW, 90MW & 100MW. system is running in normal condition and system is in balance condition. Any way this system will not lose its synchronism

Now in figure 2, load is increased on bus number 8 from 100MW to 300MW. Now active power and reactive power is balanced by slack bus and slack bus power is increased from (72MW, 27Mvar) to (277MW to 59Mvar). Due to increase on load whole system is affected but system is in balance condition.

In figure 3, system load in increase on bus number 8 further 300MW to 400MW . Now active power and reactive power is balance by slack bus and slack bus power is increased from (277MW to 59Mvar)to (329MW to 129Mvar) .Now whole system is effected and system efficiency is increased.

In figure 4, system load in increase on bus number 8 further 400MW to 500MW . Now active power and reactive power is balance by slack bus and slack bus power is increased from (329MW to 129Mvar)to (529MW to 370Mvar) .Now whole system is effected and system efficiency is increased and work on maximum efficiency any further increase in load on any bus cause system will cause higher transient instability .this is the situation to carefully monitor whole power system network

Fig 1: 9 Bus System 3 Generators in Initial Condition

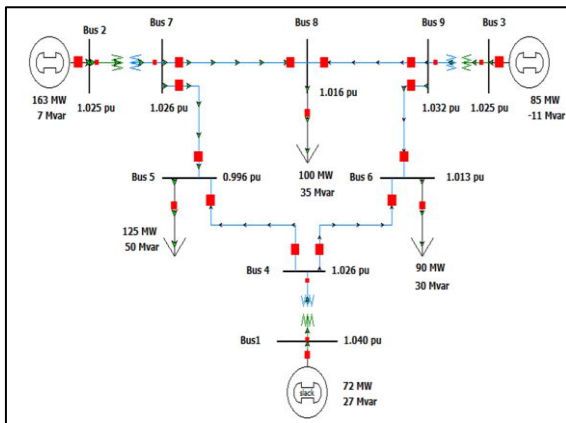


Fig 2: 9 Bus System 3 Generators with Increase Load

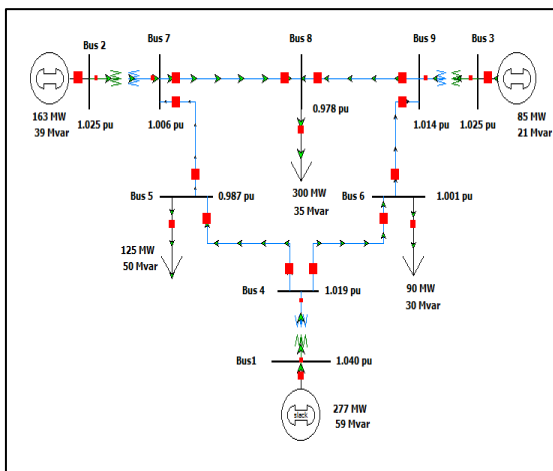


Fig 3: 9 Bus System 3 Generators with Further Increase Load

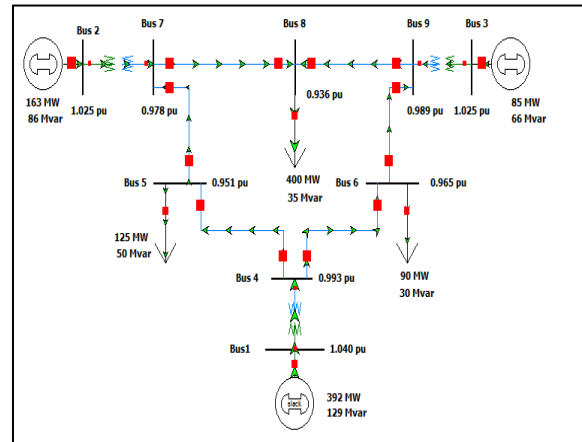


Fig 4: 9 Bus System 3 Generators with Further Increase Load

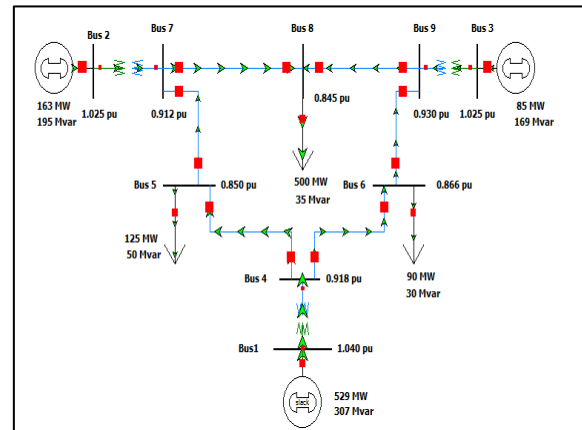
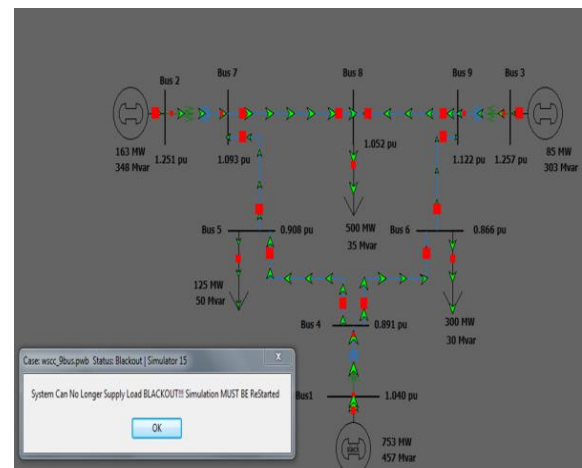
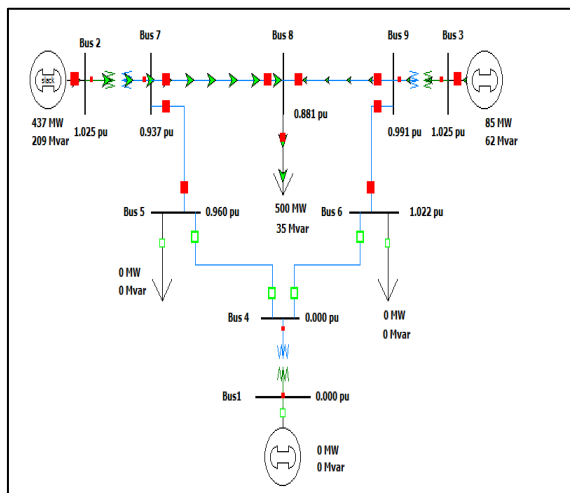


Fig 5: Sudden increase Load on Bus No 6, Removal of Line



Load is suddenly increase on bus number 6 from 90MW to 300MW now system goes in total blackout this is clearly shown in figure 5. When load is increased on bus number 6 above from 100MW at that time we have to start to trip the line connected to bus number 5, and finally we remove bus number 6 also to maintain stable power system this we forecasting power blackout that is shown in figure 5.

Fig 5: Normal System Opreation on Redused Load



4.0 Conclusions

This study give introduction & technical region for blackout in AC power system in, this paper provide basic idea about load increment, efficiency, removal and adding of lines in system. to avoid black and maintain stability To maintain power system stability and forecasting Blackout in power system we consider a system with initial condition and then increase the load further and further to obtain maximum efficiency. then we predict situation of blackout ,start removing the lines from bus before blackout occurred his way we maintain the stability in some part of system, to minimized the losses

Acknowledgment

We take this opportunity to express our thanks to all who have in various ways helped us to attain our objective of successfully completing our paper related to Forecasting of Power System Blackout. We would specially like to thank Prof. FA Sheikh who have encouraged and supported us during the various phases of our minor project. Last but not least we

would like to thank our teachers and friends for supporting us in all possible ways.

References

- [1.] T Kumar, SA Atputharajah. Power System Blackouts- Literature review, Fourth International Conference on Industrial and Information Systems, Sri Lanka. ICIIS 2009, 28 – 31.
- [2.] IEEE Transactions On Circuits And Systems—I, September Evidence For Self-Organized Criticality In A Time Series Of Electric Power System Blackouts Regular Papers, 51(9), 2004
- [3.] M Shengwei, X Ancheng, W Xiaofeng, H Fei. Modeling Collapse and Blackout of Power System via AC-Based Model.
- [4.] S Mei, G Wang. Power System Blackout Model via OPF and Its Self-organized Criticality.
- [5.] K Morison, L Wang, P Kundur. Power system security assessment, IEEE Power and Energy Magazine, 2(5), 2004, 30 - 39.
- [6.] DP Kothari, IJ Nagrath. Power System Engineering second edition ,TMH
- [7.] P Gomes. New strategies to improve bulk power systems security: lessons learned from large blackouts, in Proc. IEEE PES General Meeting, Denver, CO, 2004.
- [8.] CL Wadhwa. Electrical power system, eight editions.