

New Techniques for Prevention of Power System Collapse

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Abstract

There is an international trend to increase the power transmit limit in the network and to increase the competence of existing power plants. From voltage stability point of analysis, upper limit acceptable loading limits must not be exceeded in the operation of power systems. The risk of cascading outages in power systems manifests itself in a number of ways. Electric power systems are increasingly being operated close to their limits. When a power system is subjected to large disturbances control actions need to be taken to turn the system away from severe consequences and to limit the extent of the disturbance. This instability often results in voltage collapse of the system, which in turn causes massive losses in the system as well as monetary losses. This paper deals with some newer techniques for the prevention of the voltage system collapse for voltage system collapse, which may have a very large monetary impact on the society.

Key Words: Voltage stability, voltage collapse, power system

Introduction

The reason are on the one hand the huge economical cost for new investments and the growing environmental concern, and on the other hand the considerable economic benefit be gained. This will raise the requirements for more sophisticated plan and models and there will be ongoing efforts to maintain and to improve the reliability in the power system. Therefore the need to improve planning and operation in power system, underline the importance of future work in voltage stability field. Voltage control problems are not new to the utility industry but the problems in the past were primarily associated with the transfer of power from remote generation sites to load centers. These problems were addressed by specific control and/or protection schemes dedicated to the particular transmission systems. After analyzing the various blackout causes, it was noted that cascading failures may occur due to the loss of generation units, breaker failures, common tower and common right-of-way circuit outages, combination of system conditions and events. The common cascading processes consist of system state before blackout, cascaded events, and

post-blackout state. A voltage experiences a state of voltage instability when there is a progressive or uncontrollable drop in voltage magnitude after a disturbance, increase in load demand or change in operating condition. The main factor, which causes these unacceptable voltage profiles, is the inability of the distribution system to meet the demand for reactive power. Under normal operating conditions, the bus voltage magnitude (V) increases as Q injected at the same bus is increased. However when V of any one of the systems buses decreases with the increase in Q for that same bus, the system is said to be unstable.

CURVES:

Considering voltage stability, relationship between transmitted P and receiving end V is of interest (as shown in figure 1). The voltage stability analysis process involves the transfer of P from one region of a system to another, and monitors the effects to the system voltages, V. This type of analysis is commonly referred to as a PV study. It represents the variation in voltage at a particular bus as a function of the total active power supplied to loads or sinking areas

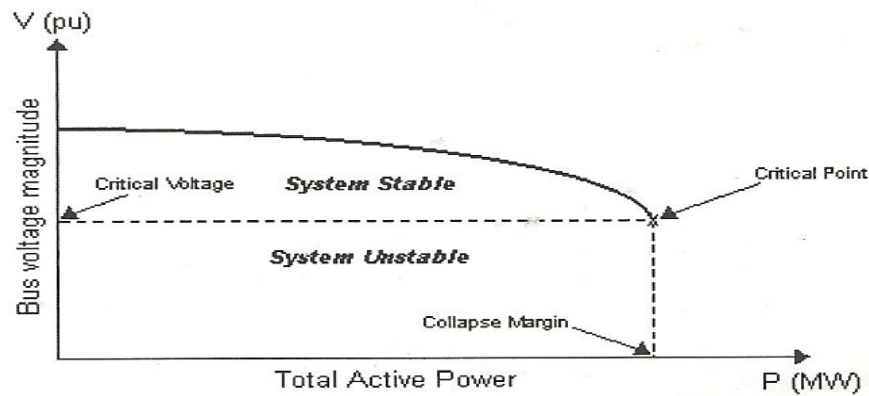


Figure 1 : Typical PV Characteristics

QV CURVES:

The influence of reactive power characteristics of devices at the receiving end (loads or compensating devices) is more apparent in a QV relationship (as shown in figure 2). It shows the sensitivity and variation of bus voltages with respect to reactive power injections or absorptions. Figure shows a voltage stability limit at the point where the

derivative dQ/dV is zero. This point also defines the minimum reactive power requirements for a stable operation. An increase in Q will result an increase in voltage during normal operating conditions. Hence, if the operating point is on the right side of the curve, the system is said to be stable. Conversely, operating points in the left side of the graph are deemed to be unstable.

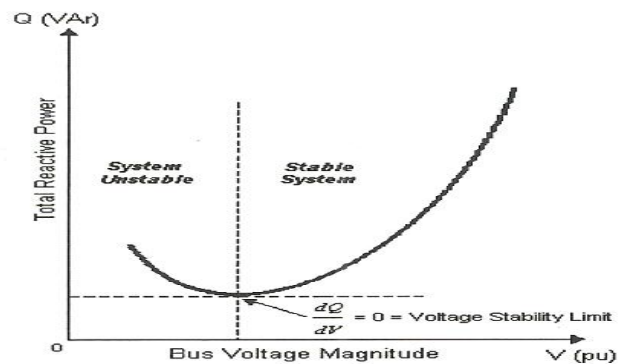


Figure 2 : Typical QV Characteristics

VOLTAGE COLLAPSES

The main warning sign of voltage collapse are- low voltage profiles, heavy reactive flows, inadequate reactive support, and heavily loaded systems. The collapse is often precipitated by low-probability single or multiple contingencies. The consequences of collapse often require long system restoration, while large groups of customers are left without supply for extended periods of time. Schemes, which prevent against collapse, need to use the symptoms to

diagnose the approach of the collapse in time to initiate corrective action.

There are several power system changes known to contribute voltage collapse. They are as follows

- Increase in loading
- Generators, synchronous condensers, or SVC reaching reactive power limits
- Action of tap changing transformers
- Load recovery dynamics
- Line tripping
- Generator outages

Table 1: Some Major Voltage Collapses

S.NO	DATE	LOCATION	LOAD INTERRUPTED
1	November 9, 1965	Northeast	20,000 MW
2	July 13, 1977	New York	6,000 MW
3	December 22, 1982	West Coast	12,350MW
4	January 17, 1994	California	7,500MW
5	December 14, 1994	Wyoming, Idaho	9,336MW
6	July 2, 1996	Wyoming, Idaho	11,743MW
7	August 10, 1996	Western Interconnection	30,489MW
8	June 25, 1998	Midwest	950MW
9	August 14, 2003	Northeast	61,800MW

CONTROL ACTIONS:

Some of the control actions used as counter measures against voltage collapse are as follows.

- Switching of shunt capacitors
- Blocking of tap-changing transformers
- Redispatch of generation
- Rescheduling of generator and pilot bus voltages
- Secondary voltage regulation
- Load shedding
- Temporary reactive power overload of generators

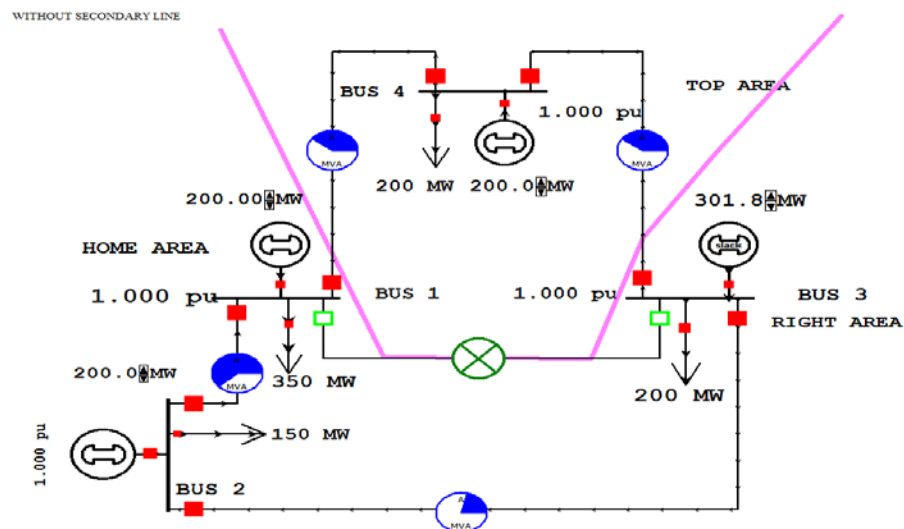


Figure 3: Four generator controlled current flow system

CORRECTIVE MEASURES

In the example (figure 3) we find that load of the industries are set to 900MW. All the lines are under controlled current flow. The 4 generators share the

load of 900MW. The generator of the bus 1 is the prime generator, which is supplying the power demands of the load of bus 2. The system continues to work normally. This load causes a stress on the line between the bus 1 and bus 3 but as long as the load

changes slowly there is no problem. All the 4 generators are adequate for supplying continuous power to the loads of the system.

In (figure 5), the secondary line added between the bus 1 and bus 3 is done so as to facilitate the flow of current from the generator of the bus 1 easily so as to reduce the stress on one line. The secondary line also facilitates the flow of reactive power with more

number of capacitor banks for providing the reactive power.

As seen in the diagram we can see that the load of current on the line is between the bus 2 and bus 4 are highly reduced but the addition of the secondary line. The secondary line is added between the bus 2 and bus 1 so as to bring the second generator into play.

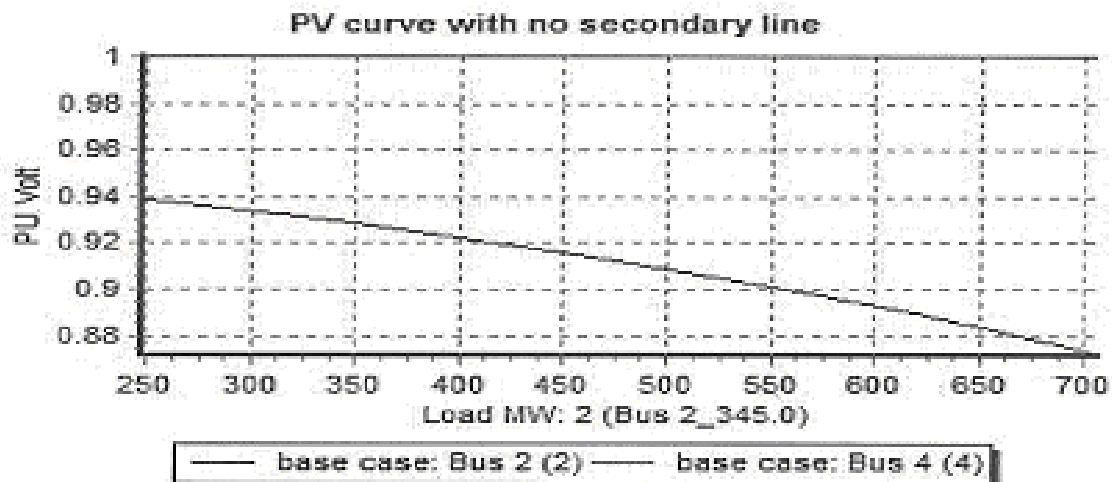


Figure 4 : PV Curve without Secondary Line

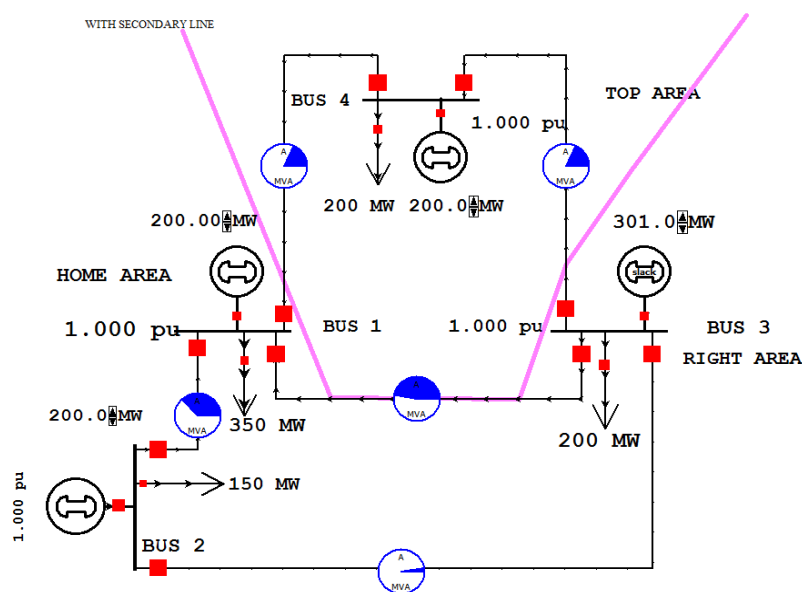


Figure 5: The secondary line added between the bus 1 and bus 3

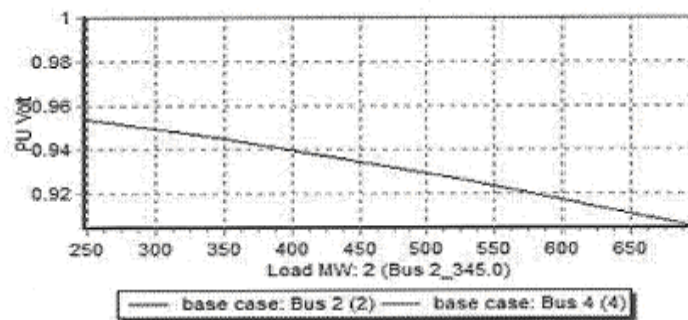


FIGURE 6: PV CURVE WITH SECONDARY LINE

LOAD SHEDDING:

Load shedding is an option that is becoming more widely used as a final means of avoiding system wide voltage collapse. This option is only considered when all other effective means of avoiding collapse are exhausted. This option may be the only effective option for various contingencies especially if the collapse is in the transient time frame, and if load characteristics result in no effective load relief by transformer load taps changer control. Load shedding results in high costs to electricity suppliers and consumers; therefore, power systems should be designed to require such actions only under very rare circumstances. Load may be shed either manually or automatically depending on the rate of voltage drop.

CONCLUSION:

This paper provides a plan to minimize the chances of failure in the power system as possible. To identify the system vulnerability in the network, the power system simulations are performed. Many aspects are analyzed to understand the constraints on the system and select the appropriate methods to solve the problem efficiently. This paper is a case study of power system study and implementation on the preventive measures to enhance the stability, reliability and security of the power system.

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