

# Blackout: Its Causes and its Prevention

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**Abstract**— This paper is a discussion on several disturbances which lead to a blackout in the power system. In this, we analyze the causes of blackout in power system and the preventive measures to avoid this disturbance in the operation of the power system. Such measures avoid a development of the power system collapse. A case study of California blackout is also presented in the paper.

**Keywords**— *Blackout; Power system failures.*

## I. INTRODUCTION

The word blackout means a power outage. This means that there is no supply of electricity to a part of a power system. A blackout is a complete interruption of power in a given service area. These occur without any warning; last for determine periods, and are typically caused due to equipment failure or it may be also due to several changes. Blackout also may occur due to human failing. Blackout leads to many problems, including heavy economic losses, power system equipment damage and has a wide effect on livelihood. This is so because the living is fully dependent or reliable and quality power system. In this paper, we discuss the reasons for the cause of blackout in a power system, its effects and the preventive measures to avoid its occurrence.

The organization of the paper is as follows. In the next section, we discuss some of the major blackouts in the history that occurred across the world. In the the the third section the cost and consequences of the blackout are presented, followed by the reasons for blackouts in the fourth section. In the fifth section the preventive measures are suggested. The case study of California Blackout is presented in the sixth section. Finally, conclusions are presented in the seventh section.

## II. MAJOR BLAKOUTS IN HISTORY

- 1) In the year 2003, the part of central Canada. Europe and USA faced a major blackout which affected more than 100 million people.
- 2) On September 28 in Italy, 57 million people were affected and take 4 hours for restoring the power supply.
- 3) On august 14, the northeastern USA and central Canada, where 62GW power outage and affected 50 million people and it took several days for getting restored. This happened due to high voltage power line in northern Ohio getting cut due to overgrown trees.
- 4) On January 2<sup>nd</sup> in the year 2001, a 12-hour power outage caused by the failure of an Uttar Pradesh substation triggered India's northern grid to collapse. This affected 226 million people of the country.

- 5) Another blackout occurred on July 30<sup>th</sup>, 2012. It is the largest electrical outage till now, in history and this affected 670 million people, which is around 9% of the world's population. Interconnected western power grid collapsed for several areas, affecting 22 states. This was caused due to overloading and human error.

## III. COST AND CONSEQUENCES OF BLACKOUT

The electric power supply is essential for life in the society. It is like the blood in the body. The increasing electric energy demand, modern lifestyle and energy demand pattern have made the world fully dependent on the power system. If there is no continuous supply of the power, then it will cause disturbance to the people and may also lead to the damage of many equipment. It is very challenging and uneconomic to make the system be stable for all kinds of disturbances. Without power supply there are devastating consequences for daily life, the breakdown of public transportation system, traffic jams, computer outages as well as still stand in factories, shopping malls, hospital etc.

## IV. REASONS FOR BLACKOUT

It is important to know about the possible causes of blackout in order to better prevent it. The causes are:

### A. Natural causes

Natural disasters have always been the root of world's severe power outages. Floods, earthquakes, etc. can fully destroy critical power infrastructures and result in a power outage.

According to the Edison institute, nearly 70% of power outage in the U.S are weather related. The power failures are also caused by natural factors such as rain, wind, heightening and even dust. Water may also lead to short circuit and power failure. Dampness and excessive moisture can also lead to serious damage.

Dust also creates havoc and leads to power outage. Sealed circuit boxes can help in protecting critical electrical equipment and can help in preventing unplanned power outage.

### B. Other causes of outages

The Edison electric institute study also indicated that animals coming into contact with the power lines, such as large birds, accounted for 11% of outages in the U.S. The other causes were primarily man made outages that show up in the form of vehicle and construction accidents with power poles.

## V. PREVENTIVE STEPS

- 1) A smarter power grid that automatically responds to problem could reduce the rising number of debilitating blackouts.
- 2) In addition to inconveniences, blackouts cause major economic losses. The trouble gets worse, until the entire transmission system that moves power from generating plants to neighborhood substation is overloaded. So, higher voltage lines must be built to catch up with the rising demand imposed by ever increasing air conditioners, computer and rechargeable gadgets.
- 3) A self-healing smart grid can best be built if its architects fulfil three primary objectives. The most fundamental is real time monitoring and reaction. The last objective is the isolation. If failures were to occur, the whole network should be broken into isolated parts, each of which must fend for itself. Although this might cause voltage fluctuation or even small outage, it would prevent the occurrence of major blackout. As soon as power flow gets restored, the system would again start to self-optimize.

## VI. CASE STUDY: CALIFORNIA BLACKOUT

In USA, California ranks 2<sup>nd</sup> in total energy demand because of its large population. Here, over half of electricity is being fuelled by natural gas. It generates power using non-hydroelectric renewable energy resources than any other state in the USA. About 14% is being generated from hydroelectric plant, 11% comes from renewable resources and some percentage from nuclear power. To satisfy its demand, California imports more electricity than any other state. The imported electricity comes from southwestern state.

*A. Problem:* In the year 2000 & 2001, California suffered a series of rolling Blackouts. Due to this, it had to suffer a lot of financial loss. So, California could not invest any new power plant for a decade and had to import electricity from its surrounding states.

The Southern state, i.e. Pacific Northwest, suffered from drought and due to this, the cost of electricity increased in the market and the amount of electricity available for the purpose of import, decreased.

Under Rolling Blackouts, Bay Areas were affected first, followed by Northern & Central California and by March 2001 the entire state got affected. The problem in

major transmission lines & rupture of a critical pipeline supplier of natural gas constrained supply during this time.

By 2003, emergency measures had reduced the effect in California. But, again in 2005 the state suffered a Blackout due to failure in transmission line which affected 0.5 million customers.

In September 2011 a minor short circuit that occurred during repairing at a substation in Arizona, resulted in Blackout, affecting 1.4 Million people in the San Diego area. San Diego receives about 1/3<sup>rd</sup> of its electricity from Arizona & another half from the San Onofre nuclear plant.

A surge, which occurred from accident in Arizona caused all power cut off along one of the main transmission line from Arizona to California. Then, the electric load was supplied to other lines which also tripped due to high demand. The San Onofre Nuclear Generation Station (SONGS) was cut from grid for safety reason & eventually shut down.

### B. Problem Mitigation

Due to the crisis caused in the year 2000 – 2001 in California, an Energy Action Plan was created by the State Government to ensure the security for its future.

This plan aimed at encouraging conservation, upgrading the grid infrastructure. In 2006, the state enacted a requirement that 20% of California's electricity should come from renewable resources by 2010. In 2009, a new goal of 33% by 2020 was set. Electric companies are incorporating smart meters, which provide more accurate data than traditional electric meters. They are doing so that they can charge more for energy during peak times and less during non-peak times to alert customers and to identify problems. These may be costly, but save money in the long run by increasing the efficiency of the electrical system.

## VII. CONCLUSION

This paper is a review on the cause of the blackout and the measures that have to be taken to prevent it. A case study of the California blackout was also presented.

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