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Blackouts in the power system

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Abstract: **In this paper we will discuss about what is power blackout, causes of power blackout, power blackout in India & affect of power blackout.**
Blackout: A blackout is the total loss of power to an area and is the most severe form of power outage that can occur.
Causes of blackout: There are many causes of power failures in an electricity network. Examples of these causes include faults at power stations, damage to electric transmission lines etc.
Power blackout in India: Two severe power blackouts affected most of northern and eastern India on 30 and 31 July 2012. The 30 July 2012 India blackout affected over 300 million people and was the then-largest power outage in history, counting number of people affected, beating the January 2001 India blackout.
Causes of power blackout in India: Weak inter-regional power transmission corridors due to multiple existing outages (both scheduled and forced).
Effect of power blackout in India: Twenty of India's 28 states were hit by power cuts, along with the capital, New Delhi, when three of the country's five electricity grids failed at lunchtime.

Keywords: **Causes and Effect of power blackout.**

1. INTRODUCTION

A power outage (also called a power cut, a power blackout, or a power failure) is a short- or long-term loss of the electric power to an area.

Power failures are particularly critical at sites where the environment and public safety are at risk. Institutions such as hospitals, sewage treatment plants, mines, and the like will usually have backup power sources such as standby generators, which will automatically start up when electrical power is lost. Other critical systems, such as telecommunication, are also required to have emergency power. The battery room of a telephone exchange usually has arrays of lead–acid batteries for backup and also a socket for connecting a generator during extended periods of outage. There are many causes of power failures in an electricity network. Examples of these causes include faults at power stations, damage to electric transmission lines, substations or other parts of the distribution system, a short circuit, or the overloading of electricity mains.

What is power blackout?

A blackout is the total loss of power to an area and is the most severe form of power outage that can occur. Blackouts which result from or result in power stations tripping are particularly difficult to recover from quickly. Outages may last from a few minutes to a few weeks depending on the nature of the blackout and the configuration of the electrical network.

Blackouts refer to a complete loss of a power to a geographic area and is the most severe form of power outage that occurs. Depending on the root cause of the blackout, restoring power is often a complex task that utilities and power stations must undertake and repair timeframes very greatly depending on the configuration of the affected electrical network. The following article touches on how essential diesel generators are for hurricanes and other related weather disasters.

Let's say that the grid is running pretty close to its maximum capacity. Something causes a power plant to suddenly trip off line. The "something" might be anything from a serious lightning strike to a geomagnetic storm to a bearing failure

and subsequent fire in a generator. When that plant disconnects from the grid, the other plants connected to it have to spin up to meet the demand. If they are all near their maximum capacity, then they cannot handle the extra load. To prevent themselves from overloading and failing, they will disconnect from the grid as well. That only makes the problem worse, and dozens of plants eventually disconnect. That leaves millions of people without power.

2. CAUSES OF POWER BLACKOUT

1) Cascade failure:

A cascading failure is a failure in a system of interconnected parts in which the failure of a part can trigger the failure of successive parts. Such a failure may happen in many types of systems, including power transmission, computer networking, finance, human bodily systems, and bridges.

Cascading failure is common in power grids when one of the elements fails (completely or partially) and shifts its load to nearby elements in the system. Those nearby elements are then pushed beyond their capacity so they become overloaded and shift their load onto other elements. Cascading failure is a common effect seen in high voltage systems, where a single point of failure (SPF) on a fully loaded or slightly overloaded system results in a sudden spike across all nodes of the system. This surge current can induce the already overloaded nodes into failure, setting off more overloads and thereby taking down the entire system in a very short time.

2) Natural cause:

The Edison Electric Institute states that 70% of power outages in the U.S. are weather related. Numerous power failures are caused by natural weather phenomena such as lightening, rain, snow, ice, wind, and even dust. While it is more difficult to safeguard from major power failure from natural calamities like floods and severe storms, it does not take much to safeguard your electrical systems from the effects of water and dust. Water can lead to short circuits and power failure. The damage caused due to water in electrical circuits can be very expensive so it makes sense to ensure that you are well protected from it. Electrical switchboards, wires, and circuits should be protected from exposure to water. Dampness and excessive moisture can also lead to serious damages. If you live in areas with high levels of humidity, you should consider investing in specially sealed circuit protection devices.

Natural disasters have historically been at the root of the world's most severe power outages. Hurricanes, floods, wind storms, earthquakes, tsunamis, and other severe weather can completely destroy critical power infrastructure and result in outages that leave expansive geographic regions without power for days, weeks, and even months.

3) Short circuit:

A short circuit is the most commonly used term to describe the cause of a power failure. Unfortunately, it is also a term that is bandied about without people having much knowledge of what it actually means. So, what is a short circuit, and how can you protect your equipment from its effects?

A short circuit occurs when an electric current travels along a path that is different from the intended one in an electrical circuit. When this happens, there is an excessive electric current which can lead to circuit damage, fire, and explosion. In fact, short circuits are one of the primary causes of electrical fires throughout the world.

4) Power surges:

Power surges are the bane of any electrical system. A power surge can lead to rapid overheating and loss of critical and expensive equipment. Fortunately, protection from such surges is available in the form of surge protectors and circuits breakers. Surge protection should ideally be integrated into your main power switchboard itself. Smaller setups, which have a limited number of critical pieces of equipment, can choose to utilize portable surge protection devices that plug in to the power grid

5) Electrical trees:

Electrical treeing is a phenomenon that affects high power installations such as high voltage power cables, transformers, etc. Any impurities or mechanical defects in the equipment used in high voltage installations can lead to partial electric discharges in the equipment. The damaging process manifests itself in a tree-like pattern, hence the name electrical treeing. Over a period of time, if it goes undetected, this phenomenon can lead to a continuous degradation of the equipment and eventually result in a total breakdown.

3. EFFECT OF POWER BLACKOUT

The effects of long term power outages will be very severe to our modern way of life. Our human civilization has only existed with the 'help' of electricity for a VERY small slice of its overall timeline. It, and other factors, have enabled enormous population growth on the planet… to the point where if it were not for electricity, a large percentage of us would cease to exist.

A worst case scenario such as an EMP attack (of the large variety, HEMP) would likely doom 90% of us, more or less. Imagine (if you dare) some of the following effects…

- Computers, radios, televisions and phones will stop functioning… modern communication ceases for the most part.
- Banks close, money systems fail, no more ATM.
- Complete economic collapse.
- Gas stations stop functioning and most transportation ceases.
- Food distribution systems cease.
- Food is no longer available in stores.
- No ability to cook with electric appliances.
- No ability to refrigerate food for most people.
- Toilets, sinks, and showers do not operate from lack of municipal water pressure.
- No safe drinking water without treatment.
- No furnace heat.
- No air conditioning cool.
- Hospitals close (in the modern sense) and modern medical care ceases to exist.
- Emergency response (Police, Fire, and Ambulance) will cease.
- Social Chaos and desperate violence.

Measures to prevent blackout: In power supply networks, the power generation and the electrical load (demand) must be very close to equal every second to avoid overloading of network components, which can severely damage them. Protective relays and fuses are used to automatically detect overloads and to disconnect circuits at risk of damage.

Under certain conditions, a network component shutting down can cause current fluctuations in neighboring segments of the network leading to a cascading failure of a larger section of the network. This may range from a building, to a block, to an entire city, to an entire electrical grid.

Modern power systems are designed to be resistant to this sort of cascading failure, but it may be unavoidable (see below). Moreover, since there is no short-term economic benefit to preventing rare large-scale failures, some observers have expressed concern that there is a tendency to erode the resilience of the network over time, which is only corrected after a major failure occurs. It has been claimed that reducing the likelihood of small outages only increases the likelihood of larger ones. In that case, the short-term economic benefit of keeping the individual customer happy increases the likelihood of large-scale blackouts.

4. POWER BLACKOUT IN INDIA

Background of power in India:

India is the world's third largest electricity producer and consumer of electricity after the United States and China; however, the electrical infrastructure is generally considered unreliable The northern grid had previously collapsed in 2001.An estimated 27% of energy generated is lost in transmission or stolen, while peak supply falls short of demand by an average of 9%.The nation suffers from frequent power outages that last as long as 10 hours. Further, about 25% of the population, about 300 million people, have no electricity at all. Efforts are underway to reduce transmission and distribution losses and increase production further.

Power blackout in 2001:

A massive breakdown in power supplies in India left millions of people in the capital, Delhi, and across the entire north of the country without electricity.

Engineers are now reported to be gradually restoring power across the region - home to some 230 million people.

The power failure began at 0430 (2300 GMT), after what officials described as a fault in the transmission system plunged much of north India into darkness.

Rail networks were hit, as well as Delhi's international airport.

Officials from Power Grid Corp, the government agency that runs the electricity network, said power would be restored in a few hours.

"We have been able to get almost 80% of the northern grid back up to normal," an official was quoted as saying.

The northern grid is a transmission network that links seven northern states.

A spokesman for the Indian Rail Ministry told the BBC that commuters travelling short distances to work were the worst affected.

The BBC's Jill McGivering says that by lunchtime dozens trains were still stranded between stations, blocking routes and causing considerable delays as the pressure built up.

Emergency services, utilities and telephone services were said to be affected in many states.

The official residences of the president, prime minister and senior government officials were also temporarily without power.

Huge loss:

The Indian power ministry has announced an enquiry into the collapse of the entire northern electricity grid.

Power Minister Suresh Prabhu said part of the problem was the mismatch between limited supply and increasing demand on the system.

"Unless we take direct steps... in terms of improvement of system, making enough investments into transmission and distribution... such problems can recur," he said.

The Confederation of Indian Industry said it was estimated that businesses had lost between 2.5-5 billion rupees ($107m) because of the breakdown.

Although occasional power failures are quite common in India, a failure on such a large scale is relatively rare.

The states of Punjab and Haryana were hit, along with parts of Uttar Pradesh.

Kashmir, Rajasthan and Himachal Pradesh were also reported to be without power.

The Press Trust of India said the disruption began with a fault in the Panki substation in Uttar Pradesh, which triggered a breakdown of the entire northern grid.

Many homes, businesses and emergency services in India have generators which provide back up power during a power failure.

Power blackout in 2012:

Two severe power blackouts affected most of northern and eastern India on 30 and 31 July 2012. The 30 July 2012 India blackout affected over 300 million people and was the then-largest power outage in history, counting number of people affected, beating the January 2001 India blackout. The 31 July 2012 India blackout was the largest power outage in history. The outage affected over 620 million people, about 9% of the world population, or half of India's population, spread across 22 states in Northern, Eastern, and Northeast India. An estimated 32 gig watts of generating capacity was taken offline in the outage. An article in *The Wall Street Journal* stated that of the affected population, 320 million initially had power, while the rest of the affected population lacked direct access Electric service was restored in the affected locations between 31 July and 1 August 2012

Sequence of event:

30 July

At 02:35 IST (21:05 UTC on 29 July), circuit breakers on the 400 kV Bina-Gwalior line tripped. As this line fed into the Agra-Bareilly transmission section, breakers at the station also tripped, and power failures cascaded through the grid. All major power stations were shut down in the affected states, causing an estimated shortage of 32 GW.Officials described the failure as "the worst in a decade".

On the day of the collapse, Power Minister Sushilkumar Shinde stated that the exact cause of the failure was unknown, but that at the time of the failure, electricity use was "above normal". He speculated that some states had attempted to draw more power than permitted due to the higher consumption. Spokesperson for Power Grid Corporation of India

Limited(PGCIL) and the Northern Regional Load Dispatch Centre (NRLDC) stated that Uttar Pradesh, Punjab and Haryana were the states responsible for the overdraw. PGCIL's chairman also stated that electrical service was restored "at a record time".

A senior director for an Indian power company described the outage as "a fairly large breakdown that exposed major technical faults in India's grid system. Something went terribly wrong which caused the backup safety systems to fail."

More than 300 million people, about 25% of India's population, were without power. Railways and some airports were shut down until 08:00. The busiest airport in South Asia, Delhi Airport, continued functioning because it switched to back-up power in 15 seconds. The outage caused "chaos" for Monday morning rush hour, as passenger trains were shut down and traffic signals were non-operational. Trains stalled for three to five hours. Several hospitals reported interruptions in health services, while others relied on back-up generators. Water treatment plants were shut down for several hours, and millions were unable to draw water from wells powered by electric pumps.

The Associated Chambers of Commerce and Industry of India (ASSOCHAM) stated that the blackout had "severely impacted" businesses, leaving many unable to operate. Oil refineries in Panipat, Mathura and Bathinda continued operating because they have their own captive power stations within the refineries and do not depend on the grid.

It took 15 hours to restore 80% of service.

31 July:

He system failed again at 13:02 IST (07:32 UTC), due to a relay problem near the Taj Mahal. As a result, power stations across the affected parts of India again went offline. NTPC Ltd. stopped 38% of its generation capacity. Over 600 million people (nearly half of India's population), in 22 out of 28 states in India, were without power.

More than 300 intercity passenger trains and commuter lines were shut down as a result of the power outage. The worst affected zones in the wake of the power grid's collapse were Northern, North Central, East Central, and East Coast railway zones, with parts of Eastern, South Eastern and West Central railway zones. The Delhi Metro suspended service on all six lines, and had to evacuate passengers from trains that stopped mid-journey, helped by the Delhi Disaster Management Authority.

About 200 miners were trapped underground in eastern India due to lifts failing, but officials later said they had all been rescued.

The National Disaster Management Authority (NDMA), not normally mandated to investigate blackouts, began to do so because of the threat to basic infrastructure facilities like railways, metro rail system, lifts in multi-storey buildings, and movement of vehicular traffic.

5. STATES AFFECTED DUE TO POWER FAILURE

The following states were affected by the grid failure:

- states on the northern grid: Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand
- states on the eastern grid: Bihar, Jharkhand, Odisha, West Bengal
- states on the northeast grid: Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim
- Narora, Renukoot and Simbhaoli in Uttar Pradesh
- parts of Delhi such as Badarpur
- areas served by Sterlite and Ib Thermal Power Station (most of western Odisha)
- most of the Kolkata municipal area (CESC system)

Cause of power blackout:

- Weak inter-regional power transmission corridors due to multiple existing outages (both scheduled and forced);
- High loading on 400 kV Bina–Gwalior–Agra link;

- Inadequate response by State Load Dispatch Centers (SLDCs) to the instructions of Regional Load Dispatch Centres (RLDCs) to reduce over-drawal by the Northern Region utilities and under-drawal/excess generation by the Western Region utilities;
- Loss of 400 kV Bina–Gwalior link due to mis-operation of its protection system.

Effect of power blackout:

More than 700 million people in India have been left without power in the world's worst blackout of recent times, leading to fears that protests and even riots could follow if the country's electricity supply continues to fail to meet growing demand.

Twenty of India's 28 states were hit by power cuts, along with the capital, New Delhi, when three of the country's five electricity grids failed at lunchtime.

As engineers struggled for hours to fix the problem, hundreds of trains failed, leaving passengers stranded along thousands of miles of track from Kashmir in the north to Nagaland on the eastern border with Burma.

Traffic lights went out, causing jams in New Delhi, Kolkata and other cities. Surgical operations were cancelled across the country, with nurses at one hospital just outside Delhi having to operate life-saving equipment manually when back-up generators failed

Elsewhere, electric crematoriums stopped operating; some with bodies left half burnt before wood was brought in to stoke the furnaces.

As Delhiites sweated in 89% humidity and drivers honked their horns even more impatiently than usual, in West Bengal the power cut left hundreds of miners trapped underground for hours when their lifts broke down. All the state's government workers were sent home after the chief minister announced it would take 10 to 12 hours for the power to return.

First to fail was India's northern grid, which had also collapsed the previous dayleaving an estimated 350 million people in the dark for up to 14 hours. It was quickly followed by the eastern grid, which includes Kolkata, then the north-eastern grid.

An estimated 710 million people live in the affected area, ever more of whom require electricity as they snap up the air-conditioning units, flat-screen TVs and other gadgets that have become status symbols among India's burgeoning middle class.

6. PRIOR DISASTER PROOFING

Before the grid collapse, the private sector spent $29 billion to build their own independent power stations in order to provide reliable power to their factories. The five biggest consumers of electricity in India have private off-grid supplies. Indian companies have 35 GW of private off-grid generation capacity and plan to add another 33 GW to their off-grid capacity.

Some villages that were not connected to the grid were not affected, such as Meerwada, Madhya Pradesh which had a 14 kW solar power station built by a United States-based firm for $125,000.

Reactions:

On the day of the collapse, Power Minister Sushilkumar Shinde ordered a three-member panel to determine the reason for the failure and report on it in fifteen days. In response to criticism, he observed that India was not alone in suffering major power outages, as blackouts had also occurred in the United States and Brazil within the previous few years.

The Washington Post described the failure as adding urgency to Indian Prime Minister Manmohan Singh's plan for a US$400 billion overhaul of India's power grid. His plan calls for a further 76 gigawatts of generation by 2017, produced in part by nuclear power.

Rajiv Kumar, secretary general of the Federation of Indian Chambers of Commerce and Industry (FICCI) said, "One of the major reasons for the collapse of the power grid is the major gap between demand and supply. There is an urgent need

to reform the power sector and bring about infrastructural improvements to meet the new challenges of the growing economy."

On 1 August 2012, newly appointed Power Minister Veerappa Moily stated, "First thing is to stabilize the grid and it has to sustain. For that we will work out a proper strategy." He declined to blame specific states, saying, "I don't want to start with the blame game."

Team Anna, the supporters of anti-corruption activist Anna Hazare, charged that this grid failure was a conspiracy to suppress the indefinite fast movement started on 25 July 2012 for the Jan Lokpal Bill and targeting Sharad Pawar.

Some technology sources and United States Agency for International Development (USAID) proposed that another widespread outage could be prevented by integrated network of micro grids and distributed generation connected seamlessly with the main grid via a superior smart grid technology, which includes automated fault detection, islanding and self-healing of the network.

7. INVESTIGATION

The three-member investigation committee consisted of S. C. Srivastava, A. Velayutham and A. S. Bakshi, and issued its report on 16 August 2012. It concluded that four factors were responsible for the two days of blackout:

- Weak inter-regional power transmission corridors due to multiple existing outages (both scheduled and forced);
- High loading on 400 kV Bina–Gwalior–Agra link;
- Inadequate response by State Load Dispatch Centers (SLDCs) to the instructions of Regional Load Dispatch Centres (RLDCs) to reduce over-drawal by the Northern Region utilities and under-drawal/excess generation by the Western Region utilities;
- Loss of 400 kV Bina–Gwalior link due to mis-operation of its protection system.

The committee also offered a number of recommendations to prevent further failures, including an audit of the protection systems.

8. CONCLUSION

From this paper we get to know about power blackout, its causes, effects & prevention methods. We also saw power blackout in India in 2001 & 2012.

REFERENCES

[1] www.google.com

[2] www.wikipedia.org

[3] www.news.bbc.uk.co

[4] www.researcgate.net