



(RESEARCH ARTICLE)



An enumerative analysis of major power blackouts in Asian region in the last two decades

Charrusmitha R.S *, Ashok Kumar N and Anisha K

Department of Electrical, Electronics and Communication Engineering, Deemed University, Kanchipuram, Tamil Nadu, India.

World Journal of Advanced Engineering Technology and Sciences, 2024, 11(02), 522–528

Publication history: Received on 04 March 2024; revised on 17 April 2024; accepted on 20 April 2024

Article DOI: <https://doi.org/10.30574/wjaets.2024.11.2.0135>

Abstract

Power System represents an interconnected network, where generation, transmission and distribution of electrical energy takes place. They are complex systems constituting various components like synchronous generators, motors, transformers, circuit breakers, transmission lines etc. A power system is required to operate in a reliable manner, thus providing continuous power supply of good quality. This requires the power system to be stable. Blackouts can occur due to equipment failure, human errors, natural disasters, overloading / imbalance, cyber-attacks, lack of redundancy etc. When they act in a combined manner/ if one of those issues lead to the other issue, widespread and long - lasting blackouts happen. Severities of the blackouts depend on geographical extent, duration of its existence, financial repercussions, and initial services being broken, public safety. This paper discusses the major blackouts that have occurred in the Asian region, in the last two decades, along with their causes and consequences.

Keywords: Blackouts; Power System; Reliability; Severity; Stability

1. Introduction

Total power disruption; which is a complete loss of supply of electricity; that can occur anywhere unexpectedly; in a geographical area; is called as a Power blackout. If power outage becomes more severe; it results in a Power Blackout. Recovery of the power back to normal is usually quite a difficult task for the power stations and utilities; which depends on finding out the basic reason for the occurrence of the power blackout. The deadlines for the repair depending on the structure of the defaulted electrical grid [1]. The causes for these blackouts could be many; like errors from human end; natural calamities; sudden failure of equipment; and more [2]. Power blackouts may last from days to few months. Few factors on which the duration on which clearance of an occurred blackout depends are the reason for the blackout; the stretch or range of damage faced by the whole power framework; the quantity of assets which are available to be used in the process of repair; and the degree of efficiency of the emergency kickback techniques [3]. When it comes to the consequences of blackouts; it can be really acute; that could result in endangered public safety; social disintegration; financial losses; human losses and influence of environment [1][4]. These can rapidly and alarmingly affect the daily lives of innumerable people. Thus; it is very important to understand about power blackouts. Thus; it is mandatory to work towards keeping the power system stable; even when faults occur; by isolating the faulty component alone; hence allowing the healthy portion of the power system to operate. This will obviously help in preventing power blackout and cascaded failures [5]; [6] to [12].

* Corresponding author: RS Charrusmitha

2. Largest power blackouts identified

Table 1 Details of power blackouts in Asian region

S.no	Year	Country	Date	People affected (in millions)
1	2012	INDIA	JULY30-31	620
2	2023	PAKISTAN	JAN23	More than 220
3	2001	INDIA	JAN2	Almost230
4	2021	PAKISTAN	JAN9	200
5	2022	BANGLADESH	OCT4	140

2.1. India blackouts-2012

2.1.1. JULY30

The Bina – Gwalior is connected by a 400 KV transmission line. At 2.35AM (IST); this line tripped. This line was feeding Agra –Bareilly transmission section. This caused breakers to trip; at the station. This resulted in cascaded power failures in the grid; leading to shut down of major power stations in the states; enlisting huge power shortage [13]. This was assumed to be the worst of its kind in a decade [14]. Airport in Delhi; the busiest one in South Asia ; was able to continue its functioning; with the help of back –up power; in 15 seconds [15]. Traffic signals did not work. Passenger train operation was ceased [13]. Many hospital services were interfered; while few carried on with back-up generators [14]. Operation of water treatment plants stopped for hours [16]. People were unable to draw well water due to non –availability of electrical supply to pumps [17]. According to PGCIL (Power Grid Corporation of India Ltd) and NRLDC (Northern Regional Load Dispatch Centre); Uttar Pradesh; Haryana and Punjab were involved in overdraw. ASSOCHAM (Associated Chambers of Comers and Industry of India); declared that the blackout severely impacted businesses [18]. 80% of service restoration took about15 hours [14]. Power company reported that 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. [19]

Table 2 Details of power blackout in India on 30 July 2012

S.no	Parameters	Data
1.	Country	India
2.	Date of occurrence of the power blackout	30 July 2012
3.	Collapse time	2.35AM
4.	Restoration time	19.00PM
5.	Duration of power blackout	About 15hours
6.	Generation lost in MW	Greater than the load loss
7.	Load loss in MW	36000
8.	Number of people affected	More than 300 million

2.1.2. JULY31

This occurred in accordance of problem in area near Taj Mahal [19]. The system again failed at 13.02 IST; resulting in affected parts of the power systems of India going offline. NTPCL terminated 38% of generation capacity [20]. People were without power in 22 states out of 28 ones in India [21]. The northern; north central; east central and east coast railway zones were the most badly affected ones; due to the collapse of power grid [16]. About 200 miners who got trapped underground; in eastern India were found and rescued later. This occurred due to the failure of lifts [22]. In the Northern grid–Delhi; Haryana; Himachal Pradesh; Jammu and Kashmir; Punjab; Rajasthan; Uttar Pradesh and Uttarakhand; were the affected. In Eastern grid– Bihar; Jharkhand; Odisha; West Bengal; and Sikkim were affected. In North–eastern grid–Arunachal Pradesh; Assam; Manipur; Meghalaya; Mizoram; Nagaland and Tripura were affected

[23]. The day the collapse occurred; initiatives were taken to ascertain the cause of failure; to be reported in a timeline of 15 days [24]. It was found that four factors lead to this power blackout as found by the investigation committee. They are Multiple scheduled and forced outages; lead to weakening of inter- regional power transmission corridors. On Bina-Gwalior-Agra link; a high loading of 400KVA was spotted. Directives were given by RLDCs; to reduce over –drawing by utilities in the northern region; and under – drawing or excess generation in western region. These were not properly incorporated by SLDCs. Due to malfunctioning of the protection system; the Bina- Gwalior-Agra link was lost. Committee suggested a number of counsels to escape failures in future. It also stressed the need for audit of protection systems [25].

Table 3 Details of power blackout in India on 31 July 2012

S.no	Parameters	Data
1.	Country	India
2.	Date of occurrence of the power blackout	31 July 2012
3.	Collapse time	1 PM
4.	Restoration time	3.30 PM same day
5.	Duration of power blackout	2 and a half hours
6.	Total affected load	48000 MW
7.	Number of people affected	Morethan300million

2.2. Pakistan blackout-2023

This event is a Nationwide outage of power that occurred in Pakistan on 23rd January 2023 at 7.34 AM [26]. The blackout lasted for more than12 hours; while even longer in some areas. It is listed as the 2nd major grid crash in the last 2 years [27]. This occurred due to sudden drop in frequency of power transmission system; due to voltage fluctuation between Jamshoro and Dadu cities [28]. It resulted in an extensive blackout. The affected regions were found to be Islamabad; Karachi; Lahore; Peshawar; Quetta and; and also many small cities and towns [29]. Post the breakdown; more than 220 million people were hurled into darkness; in Pakistan. Hospitals informed that they managed by switching back-up generators; though interruptions continued. Internet services and mobile networks were affected. People lost access to withdraw money due to non-working of ATM's; because of non- availability of back-up power [30]. Textile industry lost 70 million dollars [31]. Water pumps also failed. Electricity infrastructure of Pakistan is quite delicate and complex. So; the issue in one portion of the grid would lead to collapse across the entire network. Energy shortages are also common leading to recurrent power outages.

Table 4 Details of power blackout in Pakistan on 23rd January 2023

S.no	Parameters	Data
1.	Country	Pakistan
2.	Date of occurrence of power blackout	23rd January2023
3.	Collapse time	7.34AM
4.	Restoration time	Around9PM
5.	Duration of power blackout	More than 12hours
6.	Number of people affected	More than220millionpeople

2.3. India blackout – 2001

This power blackout occurred on 2ndJanuary 2001; in India. Poor and in adequate transmission equipment; causing substation failure in Uttar Pradesh; was the trigger to this power blackout. This caused crashing of northern grid. It affected almost 230 million people in north India; who depended for power supply from this second biggest interconnected network in the country. This interrupted the railway services too [32]. It lasted for16 to 20 hours. The loss was calculated to be approximately 5 billion rupees.

Table 5 Details of power blackout in India on 2nd January 2001

S.no	Parameters	Data
1.	Country	India
2.	Date of occurrence of the power blackout	2nd January 2001
3.	Collapse time	10AM
4.	Restoration time	4AM of next day
5.	Duration of power blackout	About 16 to 20 hours
7.	Loss calculated	5 billion rupees
8.	Number of people affected	Almost 230 million

2.4. Pakistan blackout–2021

This blackout occurred on 9th January; 2021[33][34]; at 11.41 PM; local time. The outage was triggered by An Engineering Fault; in Guddu Power Plant in South Pakistan. This resulted in tripping of system and eventually the close down of the entire system [35][36]. Major cities like Karachi; Multan; Lahore; Rawalpindi; Peshawar; Quetta; Narowal; Bahawalpur and also the capital Islamabad [37]. 80%to90% of power was disconnected [38]. A fine of 50 million rupees was thrust on National Transmission and Dispatch Company (NTDC) by National Electric Power regulatory Authority (NEPRA); post an enquiry on this incident. The fine was found to be imposed due to improper provision of electricity supply [39].

Table 6 Details of power blackout in Pakistan on 9th January 2021

S.no	Parameters	Data
1.	Country	Pakistan
2.	Date of occurrence of power blackout	9th January 2021
3.	Collapse time	11.41PM
4.	Number of people affected	200 million

2.5. Bangladesh blackout–2022

On 4th October 2022; this power blackout had occurred throughout Bangladesh [40]. This situation had prolonged for about 7 hours [41]. Defective operation of the country's power grid around 2PM; resulted in this power blackout; as claimed by Bangladesh Power Board [42]. Power supply was broken in Dhaka and many huge cities; as the power plant stumbled [43]. The functioning of export – based garment industry was impaired in Bangladesh due to this power blackout. In this situation; as generator's ability to work was poor; Bangladesh Garment Manufacturers and export Association; had to close their offices [44].

Table 7 Details of power blackout in Bangladesh on 4th October 2022

S.no	Parameters	Data
1.	Country	Bangladesh
2.	Date of occurrence of power blackout	4th October 2022
3.	Collapse time	Around 2 PM
4.	Restoration time	Around 11 PM
5.	Duration of power blackout	More than 7 hours
6.	Number of people affected	140 million people

3. Interpretations

Cascaded events cause the electrical distance between generator and loads to increase; thus tripping the major transmission lines. This resulted in divergence of load angles of generators and insufficient coupling between the generating systems due to synchronizing power lag. When there is greater angle difference between two regions; the line between them will be sluggish with low voltage [45]. Thus; while operating the power system; it is vital to maintain flat voltage profile; which provides great security [46]. Most of the blackouts were found to have occurred due to voltage collapse conditions.

4. Conclusion

The present power status in India is a struggle and needs to be handled with care. The generated power supply seems to be much less than the demand that has to be met; which obviously results in shortage of power in industries in the country. Power blackouts are mostly a cause of sequence of events instead of one single issue. Still it is very much necessary to search that one single issue that commenced the entire process. Once the prior history of major and correctly reported power blackouts in the Asian countries is discussed and analyzed; that provides the required learning. This would positively help to assess and prevent blackouts and also provides knowledge to handle them during occurrence of power blackouts.

Compliance with ethical standards

Acknowledgments

I acknowledge all the researchers who have motivated me in working on this paper.

Disclosure of conflict of interest

There is no conflict of interest.

References

- [1] The consequences of blackouts: A Literary review journal: Energy Policy Volume: 38; Issue: 10 Year: 2010 Author(s): Davidson; Emma
- [2] Assessment of system Restoration and black start recovery Capabilities of Electric power Systems Journal: IEEE Transactions on Power systems; Volume: 22; Issue: 1; Year: 2007 Author(s): Makarov; Yuri.V; S. Massoud Amin
- [3] Consequences of Power Outages: A Literature Review of power Systems and their Dependence on Other critical Infrastructures Journal: Energies; Volume:14; Issue: 5; Year: 2021 Author(s): Andrea Mura; Francesco Petrillo; Francesco Flammini
- [4] International Journal of Electrical and Electronics Research ISSN2348-6988 (online) Vol.3; Issue 4; Year: 2015 Author(s): Sudeep Dattatraya Kulkarni Irlekar
- [5] <https://en.wikipedia.org/wiki/Power-System-Protection>
- [6] Blackout for 19 states; more than 600 million Indians. NDTV.com. July 31; 2012. Archived from the original on August 3; 2012. Retrieved August 11; 2016.
- [7] Hundreds of millions without power in India. BBC News. July 31; 2012. Retrieved August 11; 2016
- [8] Daniel; Frank Jack (July 31; 2012). Power cut hits millions; among world's worst outages. Reuters. Archived from the original on June 14; 2017. Retrieved August 11; 2016.
- [9] Mogul; Sophia Saifi; Azaz Syed; Rhea (January 23; 2023). Nearly 220 million people in Pakistan without power after countrywide outage | CNN Business. CNN. Retrieved January 23; 2023.
- [10] Massive power cut hits India. BBC News. January 2; 2001. Retrieved August 11; 2020.
- [11] World's Largest Blackout Ever Leaves 140 Million People Without Power. MSN.
- [12] Masood; Salman (January 9; 2021). Much of Pakistan Loses Power in Massive Blackout. The New York Times. ISSN0362-4331. Retrieved January 10; 2021.

- [13] Sujay Mehuddiaand SmritiRak Ramachandaran (30July2012).Worstoutage cripples north India. The Hindu. Retrieved 30 July 2012.
- [14] Sruthi Gottipatti and Niharika Mandhana(30July2012).Power Restored to Most of north India. The New York Times. Retrieved 30 July2012.
- [15] Kartikay Mehrotra and AndrewMacA skill(31July2012). Singh's\$400 Billion Power Plan Gains Urgency as Grid Collapses. TheWashington Post. Archived from the original on 5August 2012. Retrieved 31 July 2012.
- [16] PowercutcausesmajordisruptioninnorthernIndia.BBCNews.30July 2012. Retrieved 30 July 2012.
- [17] Powergridfailure:FAQs.HindustanTimes.31July2012.Archived from the original on 30 July 2012. Retrieved 31 July 2012.
- [18] Whentheightswentout.HindustanTimes.31July2012.Archived from the original on 30 July 2012. Retrieved 31 July 2012.
- [19] MitigationandPreventionofCascadingoutages:MethodologiesandPractical Applications; PES General Meeting; Vancouver; Canada; July 24;2013 Author(s)-AnishGaikwad; Suresh CSrivastava;VikasSinghvi;SudhirAgarwal .
- [20] Gardiner Harris and Heather Timmons(31July2012). Hal of India Crippled by Second Day of Power Failures. The New York Times. Retrieved 31 July 2012.
- [21] Kartikay MehrotraandRakteemKatake). India Blacks Out from New Delhito Kolkata as Grid FailsAgain. Bloomberg L.P. Retrieved by (31 July 2012 31 July 2012.
- [22] Powercrisisnowtrips22states;600millionpeoplehit.DeccanHerald.31 July 2012. Retrieved 31 July 2012.
- [23] HundredsofmillionswithoutpowerinIndia.BBCNews.31July2012. Retrieved 31 July 2012.
- [24] Indiafacesworstblackoutasgridscollapsehits20states;60crorepeople. IBN. 31 July 2012. Archived fromthe original on 2 August 2012. Retrieved 31 July2012.
- [25] 30-31stJulypowerblackoutinIndia –A Review (Compiled from the CERC investigation report)
- [26] Mogul;SophiaSaifi;AzazSyed;Rhea(23January2023). Nearly220millionpeopleinPakistanwithoutpoweraftercountrywideoutage|CNNBUSINESS.CNN. Retrieved 30 June 2023.
- [27] Shahzad;Asif(24January2023).Pakistanbeginsrestoringpoweraftersecond major grid breakdown in months. Reuters. Retrieved 30 June 2023.
- [28] Masood;Salman;Ur-Rehman;Zia(23January2023).PowerOutageSweepsPakistan; Dropping Millions into Darkness. The NewYork Times. ISSN0362-4331. Retrieved 20 January 2024.
- [29] Pakistan power cut: Major cities without electricity after gridbreakdown.BBCNews.23January2023.Retrieved 30June2023.
- [30] Masood;Salman; Ur-Rehman;Zia(23January2023).Power Outage Sweeps Pakistan; Dropping Millions into Darkness. The New York Times. ISSN0362-4331. Retrieved 30 June 2023
- [31] Pakistan'senergyandeconomicwoesintensifyasblackoutsrevealdeep-rooted issues. Asian Power. 29 March 2023. Retrieved 30 June 2023.
- [32] <https://www.power-technology.com/features/featurethe-to-worst-blackouts-in-the-last-50-years>.
- [33] Masood;Salman(2021-01-09).MuhofPakistanLosesPowerinMassiveBlackout. The New York Times. ISSN0362-4331. Retrieved 2023-06-28.
- [34] Saifi;Sophia(2021-01-10).PoweroutageplungesPakistanintodarkness. CNN. Retrieved 2023-06-28.
- [35] 'Countrywideblackout'plungesPakistanintodarkness.www.aljazeera.com. Retrieved 2023-06-28.
- [36] NationwidepowerblackoutplungesPakistanintodarkness.TheGuardian. agency France - Presse. 2021-01- 10. ISSN0261-3077. Retrieved 2023-06-28.
- [37] CitiesleftinthedarkamidmajorelectricitybreakdownacrossPakistan. www.thenews.com.pk. Retrieved 2023-06-28.

- [38] Parkin; Benjamin; Bokhari; Farhan (2021-01-10). Pakistan's power restored after massive blackout. Financial Times. Retrieved 2023-06-28.
- [39] NTDC fined Rs50m over 2021 blackout. The Express Tribune. 2022-05-06. Retrieved 2023-06-28.
- [40] Most of Bangladesh left without power after national grid failure. CNN. Reuters. 2022-10-04. Retrieved 2023-07-02.
- [41] Power back in Bangladesh after grid glitch forces 7-hour blackout. www.aljazeera.com. Retrieved 2023-07-02.
- [42] Most of Bangladesh plunged into darkness after failure of national power grid. France 24. 2022-10-04. Retrieved 2023-07-02.
- [43] Bangladesh faces power blackout after national grid fails. www.aljazeera.com. Retrieved 2023-07-02.
- [44] Paul; Ruma; Varadhan; Sudarshan; Varadhan; Sudarshan (202204). Bangladesh plunged into darkness by national grid failure. Reuters. Retrieved 2023-07-02.
- [45] Load flow and short circuit analysis using ETAP; International Journal of Innovation Scientific Research and Review Vol.05; Issue; 04; pp.4319-4323; April 2023. Author(s): Ashok Kumar N; Kannusami G; Prabakaran S; Govindarajan R
- [46] Steve Matthewman; Blackouts: a sociology of electrical power failure; social space journal.edu