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Power cut off and Power Blackout in India a Major threat- An Overview

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ABSTRACT

The Power is an essential commodity that is required for the routine life. Power cut off is a serious issue that needs to be overcome with immediate effect. Power and its generation, transmission, distribution and effective utilization are of considerable imporatance that plays a vital role in the Progress of a nation. The electricity requirements in India are increasing at a rapid rate and the power supply demand has been rising ahead of the supply. Energy crisis has been denting India quite badly, and suffers a huge deficit which must be recovered as soon as possible. The high demand but shortage in supply is one of the major reasons for intermittent power cuts in India. To address the present and future electricity demands effectively, governments, regulatory bodies and utility companies have to work with full dedication. Intelligent and proper investments should be made in transmission and distribution of electric power and development of new and advanced technologies like smart grid; smart meters are needed to transform the production, delivery and utilization of power. The state of the art presented in the paper is to show India suffering from frequent power cutoffs and very few times power blackouts. The adverse affects and reasons for power cut off and power blackout are also highlighted in the paper.The paper also deals with the preventive measures to overcome power cutoff and its ill effects.

Keywords : Energy crisis, Power, Power cut off, Power blackouts, high demand, shortage in supply, Smart grid.

1 INTRODUCTION

Electricity is one of the important and essential requirement that serves as the backbone of every industrialised society and economy. Uninterrupted power supply is a highly rated and debatable issue in every corner of the World, whether developed or under developed contries. Modern and developed countries are not used to having even very small power blackouts. Under developed and poor nations are used to experiencing power supply fluctuations as well as huge power blackouts which have several ill effects on the countries progress [2]. The increased dependency on continuous power supply in various domains like industrial production, shopping malls, big hotels, showrooms, manufacturing centres, electronics and lastly routine life for mankind makes the present society's scenario more vulnerable related to power supply interruptions. A brownout, that is a low voltage for a short time or a similar blackout, which is a complete power supply failure causes inconvinience and disturbs the daily life at home such as having the lights and other accessories switched off. A blackout for few hours or several days or even for a month will have a negative impact on the routine life as well as the entire economy. Critical infrastructure like communication and transport would be hampered, the heating of water for bathing and water supply for domestic and irrigation purposes would be stopped and the industrial sector including production processes and trading would cease. Hospitals would only work as long as the emergency power supply is supplied with fuel. Emergency services like fire, police and ambulance could not be called due to the breakdown of the telecommunication systems. Financial trading, cash machines, Business sectors and supermarkets would also be shutdown, leading to a catastrophic scenario [6], [7].

The rest of the paper is organized into sections as follows. Section 2 deals with India's Power sector. Section 3 focuses on the Power blackouts and its recent occurances in India. Section 4 explains India's electricity grids and approach towards Smart grids. Section 5 illustrates the causes of power shortages in India. Section 6 includes the preventive measures to power cutoffs. Finally section 7summarizes the paper and presents the concluding remark.

2 INDIA'S POWER SECTOR

2.1 Power sector overview

Since India's independence the quality of Power generation, transmission and distribution is poor. However in the present scenarios efforts are being made to improve and systemize the Power sector [1]. The power sector in India has been one of the most ignored sectors in the Indian economy. India has been dented quite badly from an acute shortage of electricity, even after being the fourth largest consumer of electricity and Power in the World following USA, China and Russia. According to the International Energy agency (IEA), India requires another US 135 billion $ in investment for the improvement of Power sector. The shortages translate into huge power cuts and intermittent supply issues, which in turn affects all sectors of Indian economy [3].

Due to fast progress in the industrialization sector, production of power from the power utilities has been on the backfoot to keep pace with the fast increasing demand. Therefore

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large numbers of captive plants have been developed by the industries in order to ensure a reliable and quality power supply.

Most of the power generation in India is from thermal power. Thermal power accounts for a major proportion of total power production in the country. The main raw material used to produce power through thermal process is coal. Gas and oil are the other possible sources of fuel that are used for the production of power. India also uses nuclear power to satisfy its energy needs. Development of nuclear power has been in controversies in public forums; however the requirement of this energy source is of paramount importance as its contribution to domestic power generation is modest at best and it is playing a vital role in India's economic development.

Owing to the limited reserves of coal and other drawbacks, India is now shifting focus towards renewable energy.Hydro electric power is another vital source of power that the nation uses. However this resource has not been explored to its full potential and accounts for only 19% of power production in the country [1], [8], [17], [18].

Wind energy is the World's fastest growing renewable energy resource [16]. By far it is largest renewable energy source in India. Apart from wind energy sources used for power production are solar, biomass. The contribution of renewable energy sources is modest but is increasing day by day [3].

2.2 India faces Daily Power outage of 30,000 MW.

Currently India is facing power crisis and lack nearly 80,000 million units of electricity per year. Availability of energy is one of the important factors that propels the prosperity and growth of nation. Moreover it has a direct impact on the performance of the states as industrial growth needs a continuous and reliable power supply which helps in enhancing the scale of production to obtain high economic output. The reasons for the shortfall of proper power supply in India are breakdowns and repairs and maintenance work of Power plants and hence large parts of the Country face a power shortage of nearly 30,000 MW.

Fig.1 India's per captia power sector consumption is around 940 kWh

India's per captia power consumption is among the lowest in the world with a figure of around 940 kWh or 780 units [3], [10].

This has attained serious attention as the economic growth, social development and inclusive growth is quite badly affected.With India facing a peak electricity shortage of 3.7% in June, daily power outages have become a cause of concern for the government and been flaged in the internal meetings of the power ministry. The southern regions which includes the states of Andhra Pradesh, Telengana, Karnataka, Kerala and Tamil Nadu and union territories of Puducherry and Lakhswadweep had a peak demand of 36,181 MW in June, of which 33,698 MW was met, according to the Central Electricity Authority (CEA), India's apex power sector planning body.

2.3 Challenges faced by India's Power sector

The energy scenario changes significantly with factors like, rising prices, unreliability and lack of availability of energy sources. The natural resource base is deteriorating continuously due to increased growth in population and unplanned and poorly organized developmental activities comprising of urbanization and industrialization [1]. This ultimately leads to exponential increase in consumption of fossil fuels. This compels the energy planning body to keenly focus on the provision of sustainable energy systems with the likes of development of renewable energy sources [3], [11], [18]. Energy conservation and Energy efficiency improvement can have a significant impact on India's energy consumption, as large amounts of energy can be saved [2]. Thus proper enhancement of energy supply should be must in order to balance the complexity and maintain the standard of Indian economy and minimize the gap between energy supply and demand. The challenges currently faced by India's Power sector are

1. Increasing growth in demand for power and the nation's fast economic growth and rising living standards.
2. Lack of uninterrupted and continuous power supply in rural and backward regions. The electricity from the national grids reaches over 93% of urban areas but more than half of rural population has no access to electricity.
3. Malfunctioning of the electricity grids. Distribution line losses in India are rated to be among highest in the World, averaging over 30%. The north western regions of the country and rural areas are dented quite badly.
4. Theft of electricity. Electricity theft is a major issue in all parts of the country.
5. Poor reliability of grids. Outages are frequent due to aging infrastructure, poor maintenance and demand outsripping supply.
6. Lack of good quality of coal and depletion of coal resources.
7. High prices of oil imports and natural gas demands.
8. Lack of highly efficient electric systems and improper electricity usage especially in agricultural sector. Irrigation pumping is energy intensive and holds a sub stantial amount of overall electricity consumption.
9. Scarcity of water and energy related degradation of

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land.

3 Power blackout and Recent power supply failures in India.

3.1 Power Blackout –A serious issue

Usually Power blackouts do not occur by a single event, but by a combination of various defeciencies and malfunctions. The basis for a high power outage risk is due to the following preconditions

a) High grid utilization or high power demand.
b) High power plant utilization.
c) Defects due to material ageing.

The Power blackout occurs, if the events listed below occur in combination with the above mentioned preconditions.

1) Power plant shutdown for revision or due to supply failures.
2) Unexpected simultaneous interruptions of several power plants.
3) Failure due to human errors during maintenance work or switching operations.
4) Sudden simultaneous high power demand, for example, continuous usage of air conditioners, especially during summer season.
5) Simultaneous grid interruptions caused due to short circuit caused by tree contact, excavation work, different materials like kites and balloons drifting into power lines, various means of transport colliding with the utility poles, provisional shutdown due to electrical overloading risks [7].

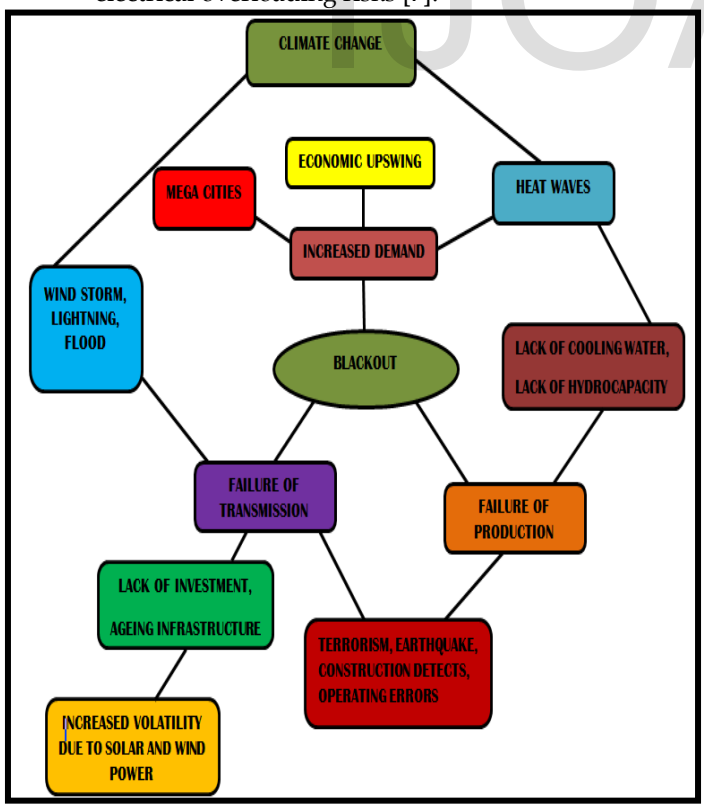

Fig.2 Potential causes of Power blackouts

3.2 Recent Power supply failures in India

Recently, India faced one of the worst, biggest and horrifying blackouts ever in the World. The blackout occurred on two consecutive days 30th and 31st July 2012. The blackouts have exposed the covert fragility of a big nation like India possessing one of the largest electricity grids in the world with more than 94,185 circuit kilometers network of central transmission lines, 1,31,025 MVA transmission capacity, 154 transmission level substations, more than 200 GW installed capacity of generation and an average daily load of approximately 137 GW . On 30th July 2012, there was a massive breakdown in the northern grid which is a transmission network that links nine Northern states. The affected states were Delhi, Uttar Pradesh, Punjab, Haryana, Rajasthan, Himachal Pradesh and Jammu and Kashmir. On 31st July 2012, the Northern, the Eastern and North eastern grid collapsed impacting about 22 states and Union territories [3],[11],[14]. The power blackout affected regions are depicted in figure 3.

Fig.3 Power blackout affected Areas.

It was the biggest ever power failure in India, which affected hundreds of trains and millions of People.

Fig.4 Passengers waiting for the train services to be restored in New Delhi railway station.

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Fig.5 New Delhi train passengers sit stranded in a blackened train due to massive power blackout.

Almost 600 million people were unable to receive power supply. Due to this worst power outage more than 8000MW of electricity capability was unavailable. People sweltered without fans and air conditioners and traffic lights were darkened leaving many people stranded at the streets. The students were in a bit of bother as there study was affected due to the occurance of this massive blackout. The figure 6 depicts a typical scenario where students studying in the absence of regular power supply and lighting up candles to cope up with the mishap.

Fig.6 Power blackout affecting Students studies

All sorts of routine activities were also halted which let the power blackout affected areas citizen's frustrated.The factors that are responsible for the failure of electricity grids between 30th and 31st of July 2012 can be attributed as

1. Weak inter-regional corridors due to multiple power outages. The power system was weakened by multiple power outages in the Northern grid-Western grid corridors as well as the Eastern grid- North eastern grid corridors.
2. High loading and loss of the Bina-Gwalior 400 KVA line which ultimately led the Northern grid regions and Western grid regions to separate effectively leaving the Northern grid dependent on itself and North eastern grid.

Fig.7 Barber facing the problem owing due to the occurance of Power Blackout.

Another massive breakdown in electricity supply occurred way long back on 2nd January 2001. This major blackout occured due to the failure of Northern grid which was caused due to a fault in the panki substation situated in uttar Pradesh. The blackout affected Delhi, Haryana and Punjab along with parts of Uttar Pradesh, Kashmir, Rajasthan and Himachal pradesh. Around 230 million people were affected for 16 hours. Railway services were affected as well as Delhi's international airport. Business sector was also affected by the breakdown. Poor and inadequate transmission equipment was blamed for failure [3], [11].

4 INDIA'S ELECTRICITY GRIDS

4.1 Grids overview

The electricity grids are very instrumental in India's electricity sector. India being one of the larger country geographical area wise, it is divided into five regions and hence has five national electricity grids that provide power supply to the entire country. These grids are maintained by the central authority and are primary sources of electricity in the country. The five grids are Northern grid, Western grid, Southern grid, Eastern grid and North eastern grid. These grids are spread over the entire country and cater mainly to their own region. On certain occasions the load is shared by some of the grids that are interconnected to each other. The Northern, Western, Eastern, North eastern grids are interconnected to cope up with the rise in demand during peak periods. These grids are connected synchronously and thus maintain the same frequency. The Southern grid remained isolated and hence has been rarely prone to power shortages and cutoffs. But nowadays the Southern grid is also interconnected asynchronously with other remaining grids through HVDC links.

The Northern grid is the largest grid in India in terms of area covered and spans about 31% of the total area. The Northern grid covers states including Punjab, Rajasthan, Haryana, Uttar

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Pradesh, Himachal Pradesh, Jammu & Kashmir, and Uttarakhand. The total power generated by the Northern grid is 50,000MW. The Western grid is also a large grid but not as large compared to the Northern grid in terms of geographical area. The Western grid covers states like Maharashtra, Chattisgarh, Madhya Pradesh, and Goa. The Western grid has an installed capacity of 66757MW. The Southern grid covers states like Karnataka, Andhra Pradesh, Tamil Nadu, Kerala and Pondicherry. The toatal installed capacity of Eastern grid is 26838MW and covers states namely Bihar, West Bengal, Jharkhand, Odhisa, Sikkim. The North eastern grid is one of the smallest grids in the country and supplies power to the smaller regions of the country. It covers regions like Arunachal Pradesh, Assam, Nagaland, Manipur, Meghalaya, Mizoram and Tripura. The installed capacity of this grid is around 2455MW. The figure 8 shows a map depicting all the power grids.

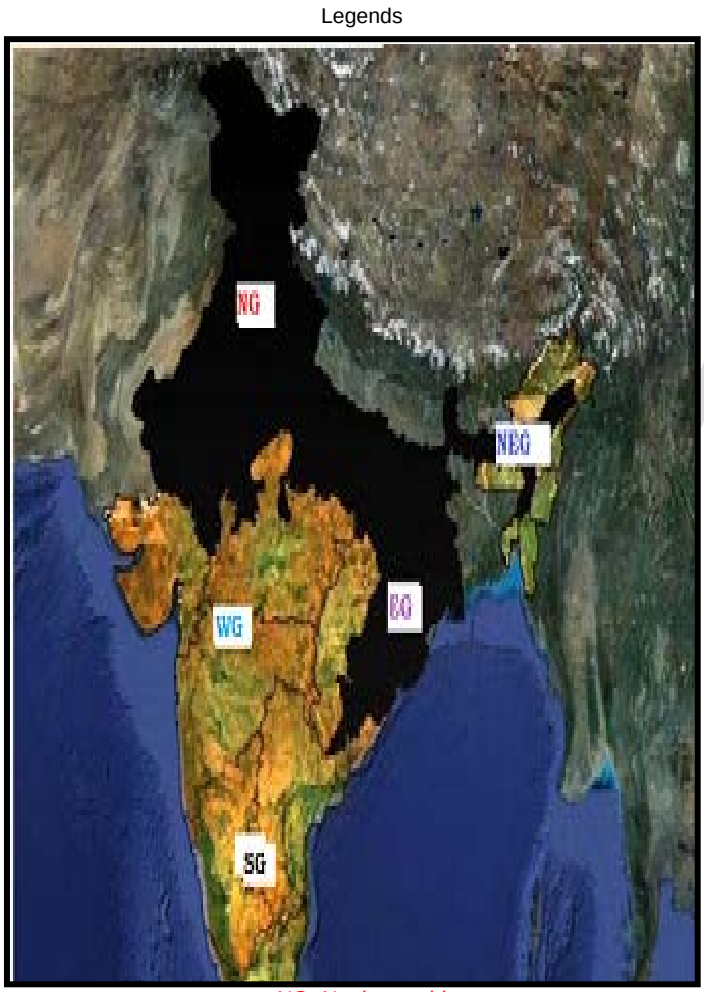

Fig.8 Indias Electricity grid map

Control of India's electricity grids is planned to be executed at four levels of hierarchy namely

1. National load despatch center (NLDC)
2. Regional load despatch center (RLDC)
3. State load despatch center (SLDC)
4. Area load despatch center (ALDC)

In India there are overall 5 national grids, 31 state grids, and more than over 100 area wise grids. Every grid has its own despatch center. To cope up with the imbalances of the grids, India has developed a mechanism through a competitive market mechanism implemented through unscheduled interchanges under Availability based tariff (ABT) which is based on the frequency deviation. Recently, this mechanism has been extended into intra state level. Currently all the states are the participants in this central ABT schedulding mechanism [3],[11],[14],[15].

4.2 India's approach towards Smart grid technology

A smart grid is an incremental process of applying information and communications technologies (ICTs) to the electricity systems, enabling more dynamic 'real time' flows of the information on the network and more interaction between suppliers and consumers. A smart grid can help deliver electricity efficiently and reliably from a more complex network of generation sources than the system does today. A smart grid can provide a more reliable and cost effective system for transmitting electric power from power stations to homes, industries, business sectors etc. with smart grids dynamic capabilities allow a greater information gathering and control can help companies operating electricity system to spot problems earlier, re-route the problems and get more from the existing wires. In the coming years the global demand for electricity is expected to increase by a considerable amount. This will lead to massive stress on the electricity grids throughout the world. For developing countries like India where population is increasing day by day, the necessity to provide clean, reliable and economical power is severe. Irrespective of the advancements in technology, India is still facing challenges such as Power shortages, power outages and other failures due to the consistent growth and overexertion of the nation's electricity grids. To counter these bottlenecks, India is making huge efforts in smart grid planning and development, leap frogging with the other countries. The India smart grid forum (ISGF), a public private partnership with The Ministry of Power and the India smart grid task force has been established to create a roadmap for the development and deployment of smart and intelligent grid technologies.

Smart grid vision for India is to ensure

1. Reliable power supply, enabled by robust, self healing systems. Improved monitoring is a fundamental step.
2. To provide power to the customers at a cheaper rate and to reduce grid losses.
3. Ending load shedding, by shifting peak load through a combination of direct control and DR/DSM.
4. To integrate renewable energy sources to enhance energy independence and thus yield more sustainable power.
5. Shifting the peak away from expensive power, through improved asset utilization. [12],[13],[14],[15]

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5 CAUSES FOR POWER SHORTAGES IN INDIA

Irrespective of the immense and praisable growth in power generation and large investment in power sector, issue of power shortage and problems in power sector continues in India because of the following reasons

5.1 High Aggregate Technical and Commercial Losses (AT&C Losses)

AT&C losses comprises of technical as well as commercial losses in the network. High technical losses occurs in the system due to inadequate investment on power transmission and distribution in comparision to power generation, numerous stages of transmission, overloading of system elements such as transformers and conductors, lack of upgradation of old lines and equipments. The commercial losses mainly occurs due to theft in electricity and pilferages, defective meters, errors in meter readings and in estimating unmetered supply of electricity, absence of energy accounting and energy auditing. Power distribution companies which are relying on state governments owe Rs 2 trillion to lenders. This has significantly reduced their ability to purchase power with ease. This is affected further by Indias AT&C losses which are at 26% of generation [3].

5.2 Poor financial health of DISCOMs

DISCOM stands for Distribution Company. The financial condition of the DISCOMs is very poor mainly because the cost of power is far below the average cost of supply particularly for the consumers from agricultural sector [3].

5.3 Shortage of fuels

Power generation in India is by far dominated by non renewable energy sources like coal, gas and diesel which accounts for a significant proportion of total power in the Country. With regard to coal, India is facing tough and massive challenges in its large plan for coal power expansion. Nearly 70% of India's electricity is yielded from coal. In governments most recent plan coal accounts for 75% of the new installed capacity. There is however limited reserve of coal in India. Due to lack of proper infrasture and poor management India is unable to produce sufficient coal to feed its power plants. This can be attributed directly to the Ministry of environment and forestry. The Ministry of coal is facing a massive problem as no permission is given by the Ministry of environment and forestry to transform forest areas into coal thus leaving only limited virgin coal blocks to be dominated by public sector companies like Coal India limited (CIL), Bharat coking coal limited etc. Coal is also a vital resource used in transportation sector for railways is another major drawback. State level management of coal also complicates the issue. Inadequate placement of rakes delays the delivery of fuels to the various generation sites, leading to piling of fuel in heaps at companies various mines.Thus the current scenario needs to be rationalized to create an optimum mix of electricity production through renewable energy resources to secure India's energy sector [1],[3],[10].

5.4 Transmission and Distribution issues

India also faces transmission and distribution defeciencies which has a significant impact on power sector Distribution of power also plays a key role with regard to efficient and economic use of power. At the distribution level, experts and utilities have made tremendous efforts to maintain and improve the reliability of supply but not in a systematic manner. However in today's modern era, where sophisticated analytical tools are used reliability levels can be quantified and cost benefit tradeoffs can be planned. Transmission system experiencing faults can affect the distribution system. Another worrying concern is the disparity between the types of distribution customers. A more reliable supply is expensive to provide in a rural area than in an urban area or cities.Moreover in densely populated areas it is quite difficult for the customers to select their desired level of reliability on tariff basis [1], [15].

5.5 Low plant load factor

Power in the Country is also affected by the plant load factor. The plant load factor is a measure of the actual output of a power plant compared to the maximum output it can produce. From the central electricity authority data for the sector wise plant load factor for the recent years it has been founded that the state sector has least efficient plant load factor whereas the private sector utilities and central sector utilities have managed to achieve competent efficieny rates for the plant load factor. Due to such bottlenecks, there is obvious shortage in electricity and poses a heavy demand on the national grids as well as public power facilities, India has faced two massive power blackouts in the recent years apart from the power cutoffs experienced throughout the country at any given time [3].

6 PREVENTIVE MEASURES TO OVERCOME POWER CUTOFFS

6.1 Implementing and integrating smarter and newer forms of supply

To enable a more impressive and efficient use of the present infrastructure, one should employ smarter networks, that can allow an increased amount of power to flow through the existing wires without reinforcement. This will certainly make it easier and faster to bring new renewable generation onto the grid.

Enhancing vast amounts of distributed generation like solar panels on individual buildings or small intensity wind farms would surely make a vital contribution to help meet demand at a local level, where the reinforcement is quite cumbersome. With most of the power consumed in close proximity to where it is generated, distributed generation also minimizes network loses. However distributed generation in a broader sense means small quantity of power outputs in a vast number of different locations, dealing with these numerous, independent and relatively unpredictable sources of supply is a big challenge. This requires the distribution networks to evolve from passive one way networks to systems that can potentially manage the flow of power in more than one direction. The best possible way is that it can enable this by the use of smart grids. A detailed explaination of smart grids is given in section 5 of this paper.

Smart metering is another smart grid technology that is open-

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ing up wide range of new services to consumers allowing them to exercise greater choice and control over the use of electricity, offering further savings on energy cost. These meters can be installed for residential and business purposes which will help the consumers to get accurate electricity bills along with faster and easier supplier switching. Apart from this, the smart meters can also provide the customers with accurate real time information on their electricity usage, thus making it possible for the energy supply companies to offer their customers varying tariffs through the day that reflects the overall pressures on the system [12],[13],[14].

Available planning methodologies possessing the potential to handle new complexities should be embraced. The methods should accommodate uncertainity and risk, statistical analysis should play a vital role and cost/benefit and customer impact should be factored in. Among other issues to be dealt with, generator siting techniques should be developed in order to include the effects of available resources, existing energy costs, available transmission and environmental acceptability [5].

6.2 Developing and exploiting Renewable energy sources and low carbon baseload technologies

By making use of renewable energy sources to a large extent can be a big boon as its impact is on environmental, social and economic oppurtunities, objectives and concerns [17],[18].

6.3 Energy efficient buildings

Since from the past few years, Energy efficient building schemes are in trend serving as a good level of energy conservation. Energy efficient buildings are those that utilize limited resources but provide the same level of services and functionalities and are more livable, luxurious improving the health standards of occupants and the productivity of workers. Furthermore, an energy efficient home will keep the family comfortable, while saving money. Whether we take simple steps or make larger investments to make our home more efficient, we will see lower energy bills. As the time goes on these savings will obviously for the improvements in cost and pay back the money with ease into our pockets. The home may also look attractive and to the buyers at the time of selling [9].

6.4 Cost effective energy savings

Various advanced methods and new emerging technologies for improving the efficiency of energy use are not often adopted as rapidly or as exclusively as might be expected based on cost effectiveness considerations alone. In few cases, more efficient models may not be available in combination with other features that consumers give more value; in other cases a company may forego efficiency improvements that would have very fast economic payoffs. Regulatory and market conditions may at times create additional impediments. Thus, institutional, behavioural, or other barriers to the adoption of

Cost saving, energy efficient technologies should be wide spread [8].

The role of institutional or other non economic barriers varies significantly between sectors. Large industries which are directly involved in energy production and conversion (such as the electric utility industry) and other industries that use energy intensively (such as steel, aluminium and cement industries) typically posses the institutional capacity to analyze their energy use, asses the potential impact of new technologies and implement cost effective improvements. Moreover, their motivation to understand and manage their energy needs is usually stonger because energy accounts for a large share of their overall production costs [12].

6.5 Properly educating and giving technically sound training to operators in power plants.

Plant owners should make sure that in order to integrate a power plant into a large scale electric power system a comprehensive and a sophicated analysis of transmission is required. A transmission system should be robust and highly efficient. There can neither be an open access nor cost savings to the consumers without a well equipped and robust transmission system. The generation and transmission reliability would be dented quite badly, if the transmission reinforcements and building of them is not properly planned. Transmission system security will be depleted by the complexity and lack of capacity. Proper operator training and advanced on line security assessment tools are necessary mainly because transmission capacity is more likely to lose ground. Apart from proper operator training development of enhanced software tools for operations should be implemented into the system.[7], [8]

The overall preventive measures can be illustrated in the simplified figure 9

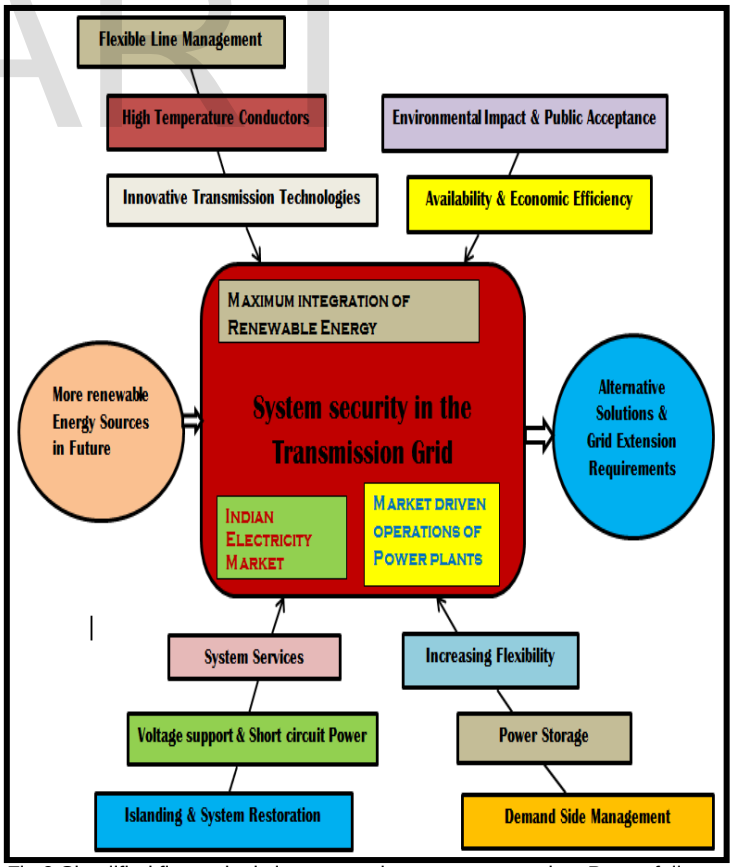

Fig.9 Simplified figure depicting preventive measures against Power failure.

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7 Conclusion

The current power scenario in India is a big tussle that needs to be carefully handled. The lack of affordable and quality power is hurting India's growth economically. With regard to the current state of power, the installed capacity in India is clearly lacking. The demand is on a much higher side compared to the supply, thus the Indian industry and its general society are experiencing frequent power shortages. For better integration of electricity supply, smart grids are a good option, which could deliver a more precise management of demand. A smarter electricity system is essential in bringing the demand management on a large scale. Electricity storage has a significant impact on the overall electricity supply system of a country. Hence proper electricity storage should be done consistently to ensure a reliable and uninterrupted power supply. Renewable energy generation should be to a larger extent, as it involves major economic and carbon benefits to demand management.

To improve and standardize the power sector and reduce the current power shortages, necessary steps and precautions should be taken to minimize and if possible to eliminate these problems. The steps should comprise of measures that not only dampens the impact of the power loses on production and revenue generation, but also stresses on cost reductions, advanced and efficient technologies in power generation, good management of the available power supply. Strict guidelines should be implemented and fines should be imposed for power wastage, theft and loses in transmission.

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