

An Impact of Power Generation on Electrification Net Working Process for Energy Supply and Consumption: Emerging Economic Opportunities and Challenges

Shaik Ahfaz Ahemmed¹, Jagadis Chandra Behera², Sangram Keshari Sahoo³, Rashmi Ranjan Das⁴

¹Assistant Professor –Cum-HoD, Department of Electrical Engineering and Electronics, Einstein Academy of Technology and Management, Bhubaneswar Approved by AICTE and affiliated to BPUT Rourkela, Odisha

²Assistant Professor, Department of Electrical Engineering Einstein Academy of Technology and Management, Bhubaneswar Approved by AICTE and affiliated to BPUT Rourkela, Odisha,

^{#3}Assistant Professor, Department of Electrical Engineering Einstein Academy of Technology and Management, Bhubaneswar Approved by AICTE and affiliated to BPUT Rourkela, Odisha,

⁴Assistant Professor, Department of Electrical Engineering Einstein Academy of Technology and Management, Bhubaneswar Approved by AICTE and affiliated to BPUT Rourkela, Odisha

Abstract: *Power generation and distribution is the two distinct features of industrial life which is mostly depend upon the nature of production of energy and utilization of communication technology, where power is the source of inspiration and motivation to perform any type of work and activities. Thus, it is the basic necessity for life. But for energy no form of life would have ever emerged. We all know energy for providing us light and comfort but also feeding us by providing our desired products for consume in our daily life. It spreads its arm in every aspects of human life such as infrastructure development, communication, Agriculture, industry, manufacturing, medicine, Engineering, Information technology, research, business and even product recycling for further usable etc. Besides that it can help us to cool down during summers and feel warm during winter's season. It also helps us to go from one place to another by the consumption of fuel, electricity.etc. Each and every company, factories needs to energy to operate various machines, motors through the supply of energy by which a company able to produce products, all automobiles need energy to run; but even otherwise all other means of transport need energy. Obviously we need to know as well as how power generation and its distribution system how influenced on the electrification to various sector for a better production and promotion of business opportunities for twenty five century. Thus, the researchers were trying to their level best to justified the said problem title taken by the Researchers in the following way of their findings and observations. i.e.*

Keywords: Power Generation and distribution (PGAD) Power Supply System (PSS) Power Generation and Electrification (PGE), Network System (NWS) Network - Application Technology (NWAT)

1. Introduction

Power Generation and its distribution is an important and necessary part of industrial life which facilitates a luxurious life to human beings. The power generation is the amount of electricity a generator produces over a specific period of time. For example, a generator with 1 megawatt (MW) capacity that operates at that capacity consistently for one hour will produce 1 mega Watt-hour (MWh) of electricity. If the generator operates at only half that capacity for one hour, it will produce 0.5 MWh of electricity. Many generators do not operate at their full capacity all the time. A generator's output may vary according to conditions at the power plant, fuel costs, as well as instructed by the electric power grid operator.

Net generation is the amount of gross electricity generation a generator produces minus the electricity used to operate the power plant. These electricity uses include fuel handling equipment, water pumps, combustion and cooling air fans, pollution control equipment, and other electricity needs.

Before Michael Faraday had discovered his famous law of electromagnetic induction, battery were the only source of

electric power. After that, DC generator was developed, but it could produce only a few hundred volts of electric power and naturally this low voltage power could not transmitted efficiently to a large distance. In the latter half of eighteen centuries, AC **electric power generation**, transmission and distribution came into the picture. In an AC system, it became possible to step up voltage of electric power to desire level for efficient transmission to a long distance. After that 3-phase induction motor was developed which was much simpler in construction. Generation, Transmission and Distribution of AC power were much easier than DC power; hence very fast AC power system became the most popular means of electric power.

2. Literature Review

In the literature review section of the invited paper “**An Impact of Power Generation and Electrification Net Working Process For Energy Supply and Consumption: Emerging Economic Opportunities And Challenges**”.

The researchers were feeling quite comfortable in the word “Impact of Power Generation on Electrification.” because the word “Power Generation” and “Power Distribution

“were used more loosely in Indian Companies and Offices .In official literature, it often includes tradable items such as steel, cement, fertilizers and petroleum products. The expansion of domestic supply of these items in that context has to be justified as part of an optimal production response to balance of payments problems, taking account of other possibilities of expanding production of exports and other import substitutes of high quality power, free of interruptions and voltage fluctuations. Similar up gradation of quality is relevant for other infrastructure services also. Construction of Smart cities must therefore be accompanied by a strategy for infrastructure development which can meet the increased demand for infrastructure services both in terms of quantity and quality. Does India's reform programme have such a strategy for infrastructure development? This paper analyses the approach to Power Generation and its scientific distribution are proceeds in a systematic process of Net working for providing better electrification to the consumers of various states, companies, offices of around the country and abroad.

3. Aim & Objectives of Research for Energy Electrification

- Providing Sufficient power and electrification to all valuable Consumers of various states in order to achieve better production and focused to achieve GDP growth rate of 8%
- Providing Reliable Power and Quality Power to the consumers with minimum cost.
- Save Optimum Power cost of expenditure
- Enhancing Commercial viability of power industry.
- To make adequate Strategies for a well power generation and distribution.
- Power Generation Strategy with focus on low cost generation, optimization capacity utilization, controlling the input cost, optimisation of fuel mix, Technology up gradation and utilization of Non Conventional energy sources.
- Transmission Strategy with focus on development of National Grid including Interstate connections, Technology up gradation & optimization of transmission cost.
- Distribution strategy to achieve Distribution Reforms with focus on System up gradation, loss reduction, theft control, consumer service

Orientation, quality power supply commercialization, Decentralized distributed generation and supply for rural areas.

- Regulation Strategy aimed at protecting Consumer interests and making the sector commercially viable.
- Financing Strategy to generate resources for required growth of the power sector.
- Conservation Strategy to optimise the utilization of electricity with focus on Demand Side management, Load management and Technology up gradation to provide energy efficient equipment / gadgets.
- Communication Strategy for political consensus with media support to enhance the general public awareness in order to enhancing Rural electrification

4. Electric Power Generation

The AC power is generated in 3 phase system as 3-phase AC electric power generation is most economical. 3 phase AC generator is commonly known as the alternator. An alternator has balanced three phase winding on its stator and an electromagnetic field is rotated inside the stator.

Due to this system, rotating magnetic field cuts the stator winding's conductor and as a result, electricity is induced in the stator windings. From terminals of the stator three phase power is obtained. In an alternator, rotating electromagnet is energized by the DC source. The rotor is driven by some external means with the help of thermal, Hydal, wind or other forms of energy. For example, in thermal power plant, the rotor of the alternator is rotated by means of a turbine shaft and the turbine is driven by means of high temperature and pressure steam.

The steam is produced in a boiler by burning coal in the furnace. As the stator winding is perfectly balanced, the three phase power produced in an alternator is also balanced that means phase difference between two conjugative phases is 120 degrees (electrical).

5. Frequency, Voltage and Interconnected System

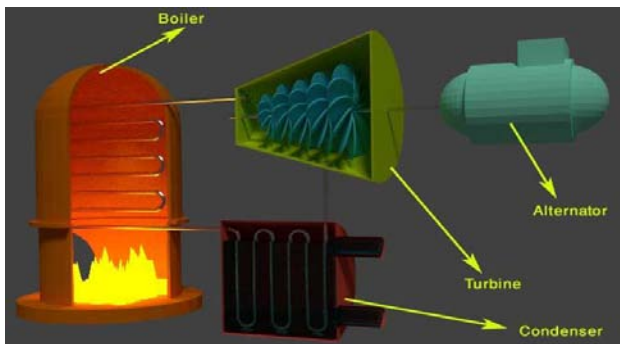
If p is the number of poles and N is the RPM of an alternator, frequency of the generated voltage will be $Np/120$. In India the frequency of generated power or simply power frequency is 50 Hz. In USA it is 60 Hz. In modern power plants there are generally more than one number of alternators run in parallel. Not only in a single Plant, may alternators, of other plants also be interconnected to run parallel. This arrangement improves flexibility and efficiency of the power system. When the power stations of different locations are interconnected by means of transmission lines, the total network is referred as a grid. In other word grid is a system by which alternators of all power plants connected to that grid run in parallel. If any of the alternators becomes out of service, still power can be fed by other alternators without affecting availability of the system. As many numbers of alternators are connected and run in parallel, the frequency and voltage of the system becomes much stable irrespective of degree of loading present in the system. The main drawback of the grid system is, when an alternator is connected to the grid, its frequency, voltage and phase sequence must match with that of the grid, and the process of matching the said parameters of alternator with the grid is not a simple task and the process is called synchronizing.

6. Conventional Source of Electric Power Generation

There are mainly three conventional source of electric power generation, and they are thermal Hydal, and nuclear energy etc.

(a) Thermal Power Generation

In thermal power plant coal or diesel is burnt to produce sufficient heat. This heat energy is utilized to produce high temperature and high pressure steam in the boiler.



[Thermal power Generation of heat energy from coal /diesel]

This steam is then passed through the turbine blades and the turbine shaft rotates due to this steam pressure. The rotor of an alternator is mechanically coupled with the turbine shaft and hence it also rotates. This rotation produces electric power.

(b)Hydal Power Generation

Here the water head is used to rotate the rotor shaft of an alternator. Water head can be naturally available or it can be created. In hilly region water head can be naturally available in the hill top natural lakes. In plain land, it can be created by constructing dams across suitable rivers. In comparing to a thermal power plant, Hydal plants are more eco-friendly as they are free from fuel combustion. Also the running cost of Hydal plant is much cheaper than that of thermal plants as there is no need of fuel to be burnt.

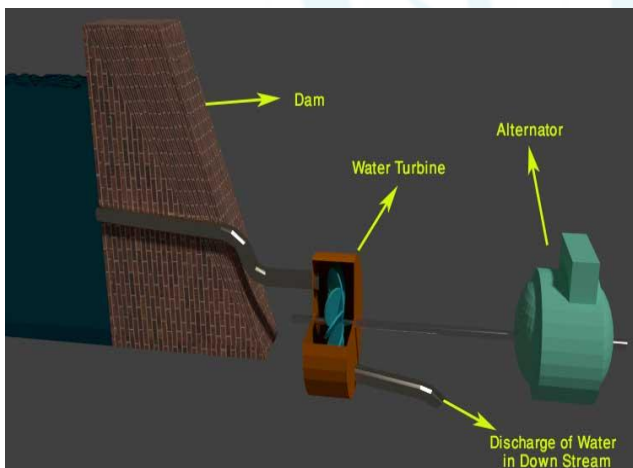


Figure 2: Hydal Power Energy form water

Although running cost of a Hydal power plant is quite low, but initial constructional cost of this plant is quite high as compared to thermal power plant. As because, there is huge involvement of money in construction of dams and other necessary civil buildings. Water turbine generally runs at a low speed, hence number of poles in the generator are higher to achieve fixed 50 Hz power Frequency. The number of pole in a Hydal alternator may be up to 20 or more.

(C) Nuclear Power Generation

It is estimated that, the coal reserve of our country will be exhausted within next 40 years if the coal is continued to be

consumed in present rate. The solution of this situation is a nuclear power plant as thought. In a nuclear power station, Uranium 235 is subjected to nuclear fission. In fission process, U 235 is bombarded by a beam of neutrons. The collision of neutrons with the nucleus of U 235 creates huge heat energy along with other neutrons. These newly created neutrons are called fission neutrons which again hit by other U 235 nuclear and create more heat energy and other fission neutrons. During fission process the nucleus of U 235 is divided into two parts. The fission process is commutative in nature. That is why, a nuclear reaction is a chain reaction and hence it should be allowed to be occurred in a controlled manner. The moderates and control rods are used to control this chain reaction.

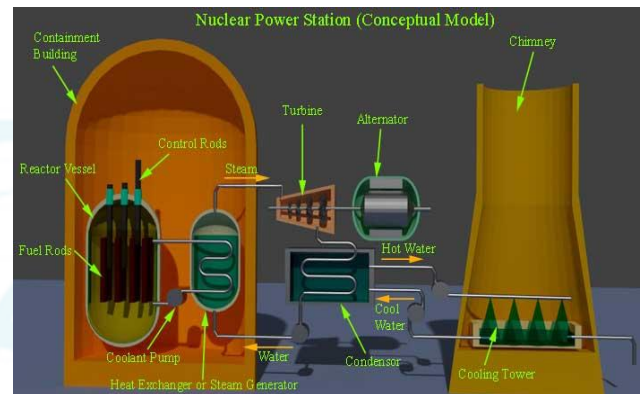


Figure 3: Nuclear energy from the nuclear sources

Moderates are used to reduce the velocity of neutrons and control rods are used to absorb neutrons for maintaining, required number of neutrons for the process. Moderates are made of heavy water or pure carbon and control rods are made of cadmium or boron steel. The speed of the nuclear reaction can be controlled by inserting control rods up to a desire deep into the reaction chamber. By pushing down and pulling up the Control rods, the output of the nuclear generating plant is controlled. Although this process is not manual, it is controlled by the automatic feedback control system. The heat generated during fission is taken out from the reactor by means of coolant consisting of liquid sodium or some gaseous fluids.

The coolant is circulated between heat exchanger and the reactor. It takes heat from the reactor and gives the heat to the water in the heat exchanger. Thus the water in the heat exchanger is converted to high pressure and high temperature steam. This steam then drives a turbine and exhausts into a condenser where it is condensed into water and cooled down for re-feeding to the heater changes again via a feed water pump. The main advantage of nuclear power plant is its minimum fuel consumption. It has been observed that for running a 1000 MW thermal power plant, nearly 6×10^6 kg of coal to be burnt every day, whereas in a nuclear power plant only 2.5 kg of Uranium to be consumed daily for getting same output. But the initial investment of nuclear power plant is quite high. It produces electricity without causing any air pollution, but, it has always a chance of radiation hazard because of leakage in reactor chamber. Another major disadvantage of this plant is its disposals, as because its disposals are not free from radioactivity.

(d) Non Conventional Source of Electrical Power Generation

Although the main sources of electric power generation are thermal, Hydal, and nuclear power plants, but still there are many other non conventional sources of power available. These non conventional sources, like wind power, solar power, MHD generation, fuel cell, etc. are becoming the promising alternative sources for electric power generation.

7. Difference in between Electricity Generation Capacity and Electricity Generation

Capacity is the maximum electric output an electricity generator can produce under specific Conditions. Nameplate capacity is determined by the generator's manufacturer and indicates the maximum output of electricity a generator can produce without exceeding design thermal limits.

Net summer capacity and net winter capacity are typically determined by a performance test and indicate the maximum electricity load a generator can support at the point of interconnection with the electricity transmission and distribution system during the respective season. There are two primary factors that affect or determine the difference in capacity between summer and winter months:

- The temperature of cooling water for thermal power plants or the temperature of the ambient air for combustion turbines
- The water flow and reservoir storage characteristics for hydropower plants.

8. Power Sector in India

The power sector in India is mainly governed by the Ministry of Power. There are three major pillars of power sector these are Generation, Transmission, and Distribution. As far as generation is concerned it is mainly divided into three sectors these are Central Sector, State Sector, and Private Sector.

The Central Sector or Public Sector Undertakings (PSUs) constitute 29.78% (62826.63MW) of total installed capacity i.e. 210951.72 MW (as on 31/12/2012) in India. Major PSUs involved in the generation of electricity include NHPC Ltd., NTPC Ltd., and Nuclear Power Corporation of India (NPCIL).

Besides PSUs, several state-level corporations are there which accounts for about 41.10% of overall generation, such as Jharkhand State Electricity

Board (JSEB), Maharashtra State Electricity Board (MSEB), Kerala State Electricity Board (KSEB), in Gujarat (MGVCL, PGVCL, DGVCL, UGVCL four distribution Companies and one controlling body GUVNL, and one generation company GSEC), are also involved in the generation and intra-state distribution of electricity

The Indian government has set an ambitious target to add approximately 78,000 MW of installed generation capacity by 2012. The total demand for Electricity in India is expected to cross 950,000 MW by 2030.



[Power generation from NTPC LTD]

India is the sixth largest in terms of power generation. About 65% of the electricity consumed in India is generated by thermal power plants, 22% by hydroelectric power plants, and 3% by nuclear power plants and rest by 10% from other alternate sources like solar, wind; biomass etc. 53.7% of India's commercial energy demand is met through the country's vast coal reserves. The country has also invested heavily in recent years on renewable sources of energy such as wind energy. As of March 2011, India's installed wind power generation capacity stood at about 12000 MW. Additionally, India has committed massive amount of funds for the construction of various nuclear reactors which would generate at least 30,000 MW. In July 2009, India unveiled a

\$19 billion plan to produce 20,000 MW of solar power by 2020 under National Solar Mission.

The per capita power consumption in India is 733.54KWh/yr, which is very minimal as compared to global average of 2340KWh/yr. Electricity losses in India during transmission and distribution are extremely high, about 28.44 % (2008-09). India needs to tide over a peak power shortfall of 13% between 5pm and 11pm by reducing losses due to theft and pilferage. Due to shortage of electricity, power cuts are common throughout India and this has adversely effected the country's economic growth. Theft

of electricity, common in most parts of urban India, amounts to 1.5% of India's GDP.

The condition of utilities are not good either, cumulative loss of 110 power utilities are estimated as Rs 86,136 crore which is expected to rise to Rs 1, 16,089 crore by 2014-15. Despite an ambitious rural electrification program, some 400 million Indians lose electricity access during blackouts.

While 84.9% of Indian villages have at least an electricity line, just 46 percent of rural households have access to electricity.

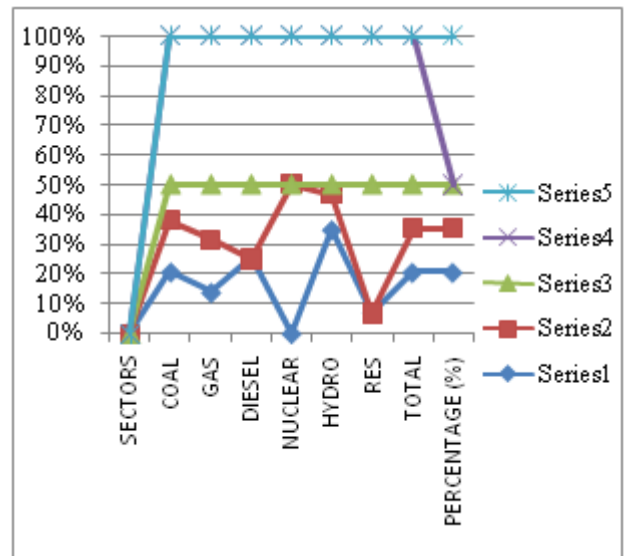
Electricity Generation and Electrification of India (Data Source CEA, as on 31/12/2015)

Grand Total Installed Capacity is 210951.72 MW. The data below are in MW

Table 1

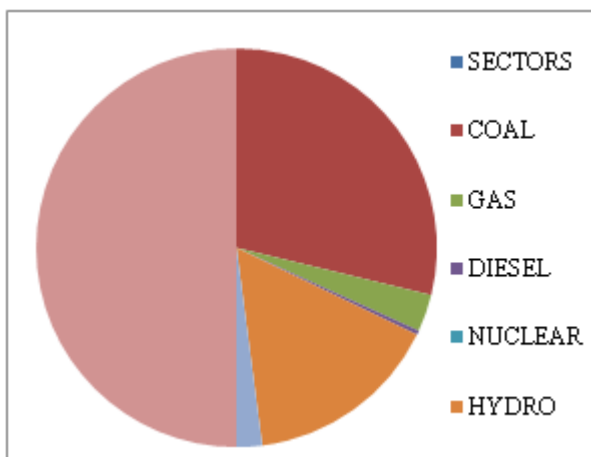
Sectors	Coal	Gas	Diesel	Nuclear	Hydro	Res	Total	Percentage (%)
State Sector	49933.00	5215.32	602.61	0.00	27395.00	3569.92	86715.85	41.10%
Central Sector	41995.00	6702.23	0.00	4780.00	9349.40	0.00	62826.63	29.78%
Private Sector	28945.38	6985.50	597.14	0.00	2595.00	22286.22	61409.24	29.11%
Total	120873.38	18903.05	1199.75	4780.00	39339.40	25856.14	210951.72	
Percentage (%)	57.29%	08.96%	0.57%	2.27%	18.65%	12.26%		100.00%

- Captive Generating capacity connected to the Grid (MW) = 34444.12
- The state of Maharashtra is the largest producer of thermal power in the country.
- India was one of the pioneering countries in establishing hydro-electric power plants. The power plant at Darjeeling and Shimsha (Shivanasamudra) was established in 1898 and 1902 respectively and is one of the first in Asia.
- R.E.S. Includes :- Ship – 2900 MW , Wind – 12000 MW, B.P. & B.G. – 2313.33 MW, U&I & Solar – 114.74 MW (SHP – Small Hydro Power, B.P. – Biomass Power, B.G.-Biomass Gasifier, U&I – Urban & Industrial Waste)



9. Hypothesis Testing

In this Section , the researchers are trying to examining the authenticity of the obtained result in relation with the above said taken variables of observed hypothesis (H₀) i.e Increase of Power Generation through various resources and Maximization of electrification of areas through the Power distribution system (Expected hypothesis (H_e)). From the said observation, we the researcher observed that increase of Power generation through resources will impact to enhancing the distribution process of Energy supply for electrification.



Semiotics Model in Pie chart: (Power Generation and Supply)

10. Electricity Transmission

10.1 A power transmission cable operated by BEST in Mumbai, India

Transmission of electricity is defined as bulk transfer of power over a long distance at high voltage, generally of 132kV and above. In India bulk transmission has increased from 3,708 ckm in 1950 to more than 166000ckm, out of which 75556ckm is transmitted by Power Grid Corporation of India (as on 30 Sep. 2010). The entire country has been divided into five regions for transmission systems, namely, Northern Region, North Eastern Region, Eastern Region, Southern Region and Western Region. The Interconnected transmission system within each region is also called the regional grid.

The transmission system planning in the country, in the past, had traditionally been linked to generation projects as part of the evacuation system. Ability of the power system to safely withstand a contingency without generation rescheduling or load-shedding was the main criteria for planning the transmission system. However, due to various reasons such as spatial development of load in the network, non-

Commissioning of load center generating units originally planned and deficit in reactive compensation, certain pockets in the power system could not safely operate even under

normal conditions. This had necessitated backing down of generation and operating at a lower load generation balance in the past. Transmission

Planning has therefore moved away from the earlier generation evacuation system planning to integrate system planning.

While the predominant technology for electricity transmission and distribution has been Alternating Current (AC) technology, *High Voltage Direct Current (HVDC) technology has also been used for interconnection of all regional grids across the country and for bulk transmission of power over long distances.*

Certain provisions in the Electricity Act 2003 such as open access to the transmission and distribution network, recognition of power trading as a distinct activity, the liberal definition of a captive generating plant and provision for supply in rural areas are expected to introduce and encourage competition in the electricity sector. It is expected that all the above measures on the generation, transmission and distribution front would result in formation of a robust electricity grid in the country. Electricity Distribution



Figure 6: Power Distribution for Electrification

The total installed generating capacity in the country is 210951.72MW, and the total number of consumers is over 146 million. Apart from an extensive transmission system network at 500kV HVDC, 400kV, 220kV, 132kV and 66kV which has developed to transmit the power from generating station to the grid substations, a vast network of sub transmission in distribution system has also come up for utilisation of the power by the ultimate consumers.

However, due to lack of adequate investment on transmission and distribution (T&D) works, the T&D losses have been consistently on higher side, and reached to the level of 28.44% in the year 2008-09. The reduction of these losses was essential to bring economic viability to the State Utilities

As the T&D loss was not able to capture all the losses in the net work, concept of Aggregate Technical and Commercial (AT&C) loss was introduced. AT&C loss captures technical as well as commercial losses in the network and is a true indicator of total losses in the system.

High technical losses in the system are primarily due to inadequate investments over the years for system improvement works, which has resulted in unplanned extensions of the distribution lines, overloading of the system elements like transformers and conductors, and lack of adequate reactive power support.

The commercial losses are mainly due to low metering efficiency, theft & pilferages. This may be eliminated by improving metering efficiency, proper energy accounting & auditing and improved billing & collection efficiency. Fixing of accountability of the personnel / feeder managers may help considerably in reduction of AT&C loss. With the initiative of the Government of India and of the States, the Accelerated Power Development & Reform Programme (APDRP) was launched in 2001. APDRP meant to upgrade the distribution system, minimize transmission and distribution losses, improve metering and assign responsibility for the realization of user charges —has not been able to bring down losses to 15% by the end of 2007, as originally targeted in 2000-01.

The APDRP programme is being restructured by the Government of India, so that the desired level of 15% AT&C loss could be achieved by the end of 11th plan. (estimated plan cost – Rs50000 crore).

The main objective of the programme was to bring Aggregate Technical & Commercial (AT&C) losses below 15% in five years in urban and in high-density areas.

The programme, along with other initiatives of the Government of India and of the States, has led to reduction in the overall AT&C loss from 38.86%

in 2001-02 to 28.44% in 2008-09. RGGVY, which had a target of providing electricity to 125,000 villages and connecting 23 million below-poverty-line households across the country by 31 March, has also been faltering.

The Government of India has an ambitious mission of POWER FOR ALL BY 2012. This mission would require that the installed generation capacity should be at least 200,000 MW by 2012 from the present level of 167278.36MW. Power requirement will double by 2020 to 400,000MW.

The government had earlier planned to add 78,000 MW of power capacity by the end of the 11th Plan, which the Planning Commission had scaled down to 62,000 MW. This may now be further curtailed to 58,000 MW (as on Dec' 2010).

10.2 Subsidies

Several state governments in India provide electricity at subsidised rates or even free to some sections .i.e kutir jyoti, Yojana , Gramiya Seva etc. This includes for use in agriculture and for consumption by backward classes. The subsidies are mainly as cross-subsidisation, with the other users such as industries and private consumers paying the deficit caused by the subsidised charges collected. Such

measures have resulted in many of the state electricity board becoming financially weak.

11. Research Findings

In the invited research article, we have done extensive research work by taking number of field study, observation from the plant site visit, collecting data's from various journals, article's, periodicals, as well as published and unpublished sources in order to complete the said task.

Finally, we got the following essences and hope that by these little works the professors, researchers, academicians, future young intellectual buds etc. will be benefited a little bit in order to enhancing their future research work.

- Power (Energy) is not only the source of inspiration but also it is a motivational factor or source to produce goods /products & providing services to the peoples something by utilizing it, the dreams of building Smart cities can be fulfilled.
- By producing more and more energy a country becomes self independent in energy of his own consumption in operation of industry, office power plant etc. the smart cities of India are looks more smartest in the eyes of world.
- Due to sufficient Power (energy) production a country becomes more and the country can sale to other country who needs it, by which a country's economic development in to a great extent.
- By building Smart cities, we are never becomes smart, until and unless we are not shows our smartness in all aspects of modern life. Such as intelligence, innovation, economic, life style etc.
- Power (Energy) should be used as per requirement of the smart cities, industry, domestic and official consumption .in connection with be remember the slogan "Save Energy Save Nation ".by the way we are becomes more smart.
- Emphasize more and more to consume solar energy, Bio-Energy, hydro –energy instead of power plant energy in smart cities. So that it is easy to maintain an eco-equilibrium climate in world.

12. Acknowledgement

We the researcher tender our gratitude with a hearty pray to the God lord Jagannath for seeking his blessings to complete this invited article .The first author has giving a hearty tribute to his beloved parents whose were given their love and affection and encouragement to the research work. My co-author has dedicated this research work to his beloved mother for her unforgettable love and affection as well as she serves an unselfish service to him from the moment of his conception to Intellectual inception. We cordially thankful to our all well wishers, staffs , students ,teachers because of their kind co-operation and encouragement from time to time, finally we will be oblige to our esteemed readers ,researchers if they shall respond their valuable feedback and suggestion in anticipation of the said research article.

13. Conclusion

In conclusion, we the researcher proceeds an eye catches conclusion by getting number of research findings and its recommendations.

Here, we admit that Power (energy) is the source of inspiration and motivation to start every type of production and action of various works such as manufacturing, transporting, management and power supply. In order to meet the requirement of consumers and customers either they may be domestic or industrialize consumers. But energy itself comes from two distinct resources such as natural resources (Solar, wind, tidal etc.) and artificial resources (Thermal ,Nuclear .Bio plant etc).Thus we may strongly recommend if more and more natural source of energy shall be used in different conventional & conversational form of energy then the energy crisis will be reduced and economically will be benefited.

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Author Profile



Prof. Shaik Ahfaz Ahemmed is an excellent professor in the field of Electrical and Electronics Engineering Since last seven years on the specialization are of PSPE. Prof. Ahemmed has done his Bachelor of Technology Degree (B.Tech.) from NMIT, Bhubaneswar Under affiliated to BPUT, Rourkela, Odisha and Approved with AICTE Govt of India, New Delhi in 2009, & M.Tech Degree from Gandhi Institute for Technology, Odisha. He had serve as a lecturer in the Department of EE &EEE at Einstein Academy of Technology & Management (EATM) Bhubaneswar, Odisha (India) from 2nd August 2010 to 16th August 2011, Assistant professor at department of EEE in Vivekananda Institute of Technology (VIVTECH) from 17th October 2011 to 25th June 2014.and served

as an Assistant Professor at Gandhi Institute for Technology from 26th June 2014 to 18th August 2018. At present, he is working as the Head of the Department (HoD) of Electrical & Electronics Engineering at Einstein Academy of Technology & Management (EATM), Bhubaneswar, Odisha (India) affiliated to BPUT, Rourkela and Approved by AICTE, Govt. of India, New Delhi



Prof. J. C. Behera is an excellent professor in the field of power system engineering and control system in last five years. Presently, he has acting is an Assistant Professor, at the Department of Electrical Engineering, Einstein Academy of Technology &

Management, Bhubaneswar Approved by AICTE and affiliated to BPUT Rourkela ,Odisha ,who had completed his B.Tech. Degree in Electrical Engineering from PKACE, Baragarh in 2010, under affiliated to Biju Patnaik University and Technology, Rourkela, Odisha and M.Tech. Degree from Raajdhani Engineering College (REC) in Power System Engineering.



Prof. S.K. Sahoo is an eminent academician in last 10 years in the field of technical education in Odisha. Presently he is acting as an assistant professor, in the department of Electrical Engineering, at Einstein

Academy of Technology and Management, Bhubaneswar, approved by AICTE and affiliated to Bijupatnaik University of Technology and Management (BPUT), Rourkela. Prof. Sahoo is an excellent research scholar in the field of Power generation and Supply, he has did his B.Tech degree from Konark Institute of Science and Technology (KIST) Bhubaneswar, under Utkal University and M.Tech. From Gandhi Institute of Engineering and Technology (GIET) Gunupur, affiliated to BPUT Rourkela Odisha, in the area of Specialization applied electronics and instrumentation.



Prof. Das has presently acting as an assistant professor, in the department of Electrical Engineering, at Einstein Academy of Technology and Management, Bhubaneswar, approved by AICTE and affiliated to

Bijupatnaik University of Technology and Management (BPUT), Rourkela. Prof. Das is an excellent research scholar in the field of Power generation and Supply, he has did his B.Tech degree from BPUT, and M.Tech Degree in the area of Power system and Power Electronics form Gandhi Institute for Technology (GIFT) Bhubaneswar.