A Novel Way to Stabilize Electricity Demand-Supply Ratio in Market

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Abstract: *Presently, the demand-supply gap in electricity is very monstrous and the common man can use only a few percentage of the generated electricity. A decentralized approach has been taken in this study to understand the prevalent demand-supply gap in electricity in the Indian market. The roots of this gap have been thoroughly viewed from every possible angle. Circumnavigating the entire electricity market readily brings out the flaws and drawbacks in it resulting in a very bleak scenario. Quality control factors are also considered to the minutest detail. So, a new method of supply chain marketing in the electricity sector is proposed.*

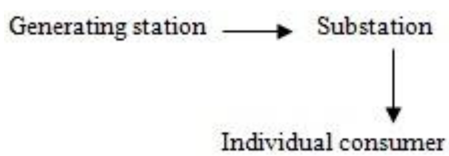
Keywords: *Capacitor banks, Insulator, LASER technology, Optical Sensors, Spatial coherence.*

I. Introduction

The first demonstration of electric light in Kolkata was conducted on 24th July,1879 by PW Fleury & Co. followed by Bombay in 1882.[1] The first hydroelectric installation in India was in Darjeeling in 1897[2]. After 115 years of first installation of hydroelectric plant in India in Darjeeling in 1897, the electricity sector in India has an installed capacity of 207.85 Gigawatt (GW) as of September 2012, the world's fifth largest [3]. Thermal power plants constitute about 66% of the installed capacity, hydroelectric about 19% and rest is a combination of wind, small hydro, biomass, waste-to-electricity, and nuclear. If we compare the scenario with other countries of the world, we will find that in India the coal-fired plants account for 56% of India's installed electricity capacity; the same is 92% of South Africa's, 77% of China's and 76% of Australia's. The renewal hydropower constitutes 19%, renewal energy about 12% and natural gas about 9% [4,5].In December 2011, it was estimated that over 300 million Indian citizens had no access to electricity. Over one third of India's rural population lacked electricity, as did 6% of the urban population. Those who had access to electricity in India, the supply was intermittent and unreliable. In 2010, blackouts and power shedding interrupted irrigation and manufacturing across the country [6,7]. The per capita consumption of electricity in India is reported to be 778 kWh [4] which is quite less compared to worldwide per capita annual average of 2600 kWh and 6200 kWh in European Union [7]

India currently suffers from a major shortage of electricity generation capacity, even though it is the world's fourth largest energy consumer after United States, China and Russia. The International Energy Agency estimates India needs an investment of at least $135 billion to provide universal access of electricity to its population. Gap between peak electricity demand and supply is 12%. Though 80% of rural areas have been connected to electricity, less than 45% of rural households have access to electricity. The transmission and distribution losses are 35-45% compared to the world average of less than 15%. In simple words, out of every 100 units produced, 33 units are lost during transmission and distribution.

In the present electricity distribution system, a grid (power transmission system) consists of two infrastructures: the high-voltage transmission systems, which carry electricity from the power plants and transmit it hundreds of miles away, and the lower-voltage distribution systems, which draw electricity from the transmission lines and distribute it to individual customers.



High voltage is used for transmission lines to minimize electrical losses; however, high voltage is impractical for distribution lines. Electricity distribution is the penultimate process in the delivery of electric power, i.e. the part between transmission and user purchase from an electricity retailer. It is generally considered to include medium-voltage (less than 50kV) power lines, low-voltage electrical substations and pole-mounted transformers, low-voltage (less than 1000V) distribution wiring and sometimes electricity meters. This interface features transformers that "step down" the transmission voltages to lower voltages for the distribution systems. Transformers located along the distribution lines further step down the voltage for household use. Thus, transmission and distribution losses need to be minimised in order to achieve high efficiency.

II. Objective

For the past two decades, India had to face increasing deficit in power supply, both for meeting its normal energy requirements as well as its peak load demand. The problem is acute during peak hours and summers, and necessitates planned load shedding by many utilities to maintain the grid in a healthy state. The average all-India shortages in 2009-10 were at 10 per cent in terms of normal energy requirement and about 13 per cent in terms of peak load[9]. With the shortage at both the normal and the peak levels, Indian power industry does not exhibit much cyclicality. Further, with assured returns, the margins of players and their profitability is almost independent of the economic cycles. Electricity is the most important component of primary energy. India's electricity consumption has grown at an average rate of 7.3 per cent during the period 2002-07. Consumption has increased at a faster rate since 2002-03, reflecting buoyant industrial demand. Industrial consumers are the largest group of electricity consumers, followed by the domestic, agricultural and commercial consumers, respectively. In April 2012 according to Central Electricity Authority (CEA), the gap between electricity generation and demand in India touched 8.2% and the highest shortfall was observed in Meghalaya at 28.1% whereas the shortfall witnessed by western region was 11.4% and South India was 15.5% respectively [10]. In India, electricity losses during transmission and distribution were 24% in 2010 and losses due to consumer theft or billing deficiencies added another 10-15% [11]. In 2004, it has been reported that theft of electricity in India caused a nationwide loss of $4.5 billion [12]. India's per capita electricity consumption increased from 178 kWh in 1985-86 to 704.4 kWh in 2007-08. Over the period, 2001-08, per capita consumption has increased at an average rate of 4.45 per cent. It is still much lower compared to the international standards. The aim of our paper is that according to our proposed system, the gap between demand and supply will be reduced.

III. Actual Method

Here, as we see in the present system, it requires a two step process for its completion. Usually copper wires are used for conduction. Our proposed system is:

3.1 Use of LASER to detect power theft

A laser is a device that emits light (electromagnetic radiation) through a process of optical amplification based on the stimulated emission of photons. The term "laser" is an acronym for Light Amplification by Stimulated Emission of Radiation. The emitted laser light is very useful for its high degree of spatial and temporal coherence, unattainable using other technologies. Spatial coherence is detected through the output being a narrow beam which is diffraction-limited, often called as "pencil beam." Laser beams can be focused to very tiny spots, achieving a very high irradiance or they can be launched into a beam of very low divergence in order to concentrate their power at a large distance. [13][14]

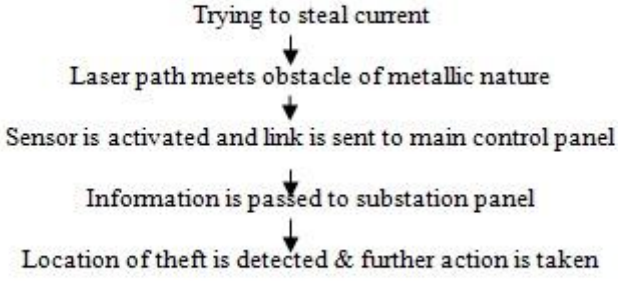
An Infrared (IR) LASER emits light with a longer wavelength than visible light, measured from the nominal edge of visible red light at 0.74micrometres (µm), and extending to 300 µm. These wavelengths correspond to a frequency range of approximately 1 to 400 THz [13] and include most of the thermal radiation emitted by objects near room temperature. Microscopically, IR light is typically emitted or absorbed by molecules when they change their rotational-vibrational movements. Far infrared laser (FIR laser, terahertz laser) is a laser with output wavelength in far infrared part of the electromagnetic spectrum, between 30-1000 µm (300 GHz - 10 THz). It is one of the possible sources of terahertz radiation.

FIR lasers can be used in terahertz time-domain spectroscopy, terahertz imaging as well in fusion plasma physics diagnostics. They can be used to detect explosives and chemical warfare agents, by the means of infrared spectroscopy or to evaluate the plasma densities by the means of interferometry techniques. But near infrared Lasers have wavelengths of 1-5µm. [15]

Initially at the electricity generating plant, infrared laser generators are connected around the bus bars. The bars are kept as an axis; Infrared laser is generated at the starting point of the bus bar which can go upto a very large distance. Here, near infrared laser is used because for its short wavelength, large distance can be covered by it.

3.1.1 CROSS-SECTIONAL VIEW OF OUR PROPOSED MODEL

Thus in this arrangement (Fig.1), the laser beams surround the conductors carrying the electric current. The Laser generators will be connected to optical sensors which in turn will be connected to a control panel. The laser selected is such that it will only detect a metallic object and nothing other than that. When somebody connects a wire to the conductor for stealing electricity, the path of the Laser will be blocked by that wire. So, the some sensor becomes activated and goes into operation. It sends information about the fault and location of theft to the personnel sitting in the main control panel. He will pass this information to the substation control panel.



The LASER generated by one arrangement can travel only a definite amount of distance. So, after some distance, recharging is required. Thus, after few kilometres we require another laser operator to generate the next beam of light. In this way, the invisible laser beam will cover the entire length of conductor.

3.2 Use of dielectrics to reduce transmission losses

A dielectric is an electrical insulator that is polarized by an applied electric field. When a dielectric is placed in an electric field, electric charges do not flow through the material, as in a conductor, but only slightly shift from their average equilibrium positions causing dielectric polarization. Because of this dielectric polarization, positive charges are displaced toward the field and negative charges shift in the opposite direction. This creates an internal electric field which reduces the overall field within the dielectric itself. If a dielectric is composed of weakly bonded molecules, those molecules not only become polarized, but also reorient so that their symmetry axis aligns to the field.

Although the term "insulator" implies low electrical conduction, "dielectric" is typically used to describe materials with a high polarizability. The latter is expressed by a number called the dielectric constant. A common, yet notable example of a dielectric is the electrically insulating material between the metallic plates of a capacitor. The polarization of the dielectric by the applied electric field increases the capacitor's surface charge. The dielectric properties are concerned with the storage and dissipation of electric and magnetic energy in materials. It is important to explain various phenomena in electronics, optics, and physics. To increase the efficiency of electricity transmission we have to increase the power factor. For increasing the power factor we can use capacitor banks. Capacitor banks (Fig.2) contain dielectric material. As we know that by the property of dielectric materials we can reduces the transmission losses. So if we use good quality of dielectric material, we can reduce the transmission losses. [16]

IV. Figures and Tables

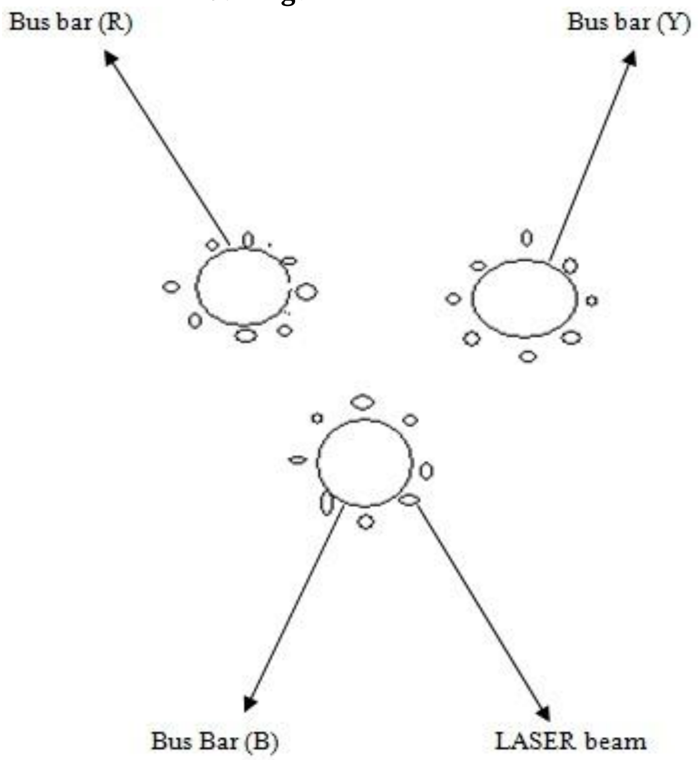


Fig.1. Proposed Model

Fig.2. Capacitor Bank

V. Summary

The laser technology used here provides an ideal model for the security of electric current against possible stealing threads. Power thefts constitute a large proportion of the total yearly losses.

Electricity Demand and Supply Source: CEA

FY	Energy				Peak Demand			
	(MU)				(MW)			
	Demand	Availability	Shortage	%	Demand	Met	Shortage	%
2002-03	545,983	497,890	48,093	8.8	81,492	71,547	9,945	12.2
2003-04	559,264	519,398	39,866	7.1	84,574	75,066	9,508	11.2
2004-05	591,373	548,115	43,258	7.3	87,906	77,652	10,254	11.7
2005-06	631,024	578,511	52,513	8.3	93,214	81,792	11,422	12.3
2006-07	693,057	624,716	68,341	9.9	100,715	86,818	13,897	13.8
2007-08	737,052	664,660	72,392	9.8	108,866	90,793	18,073	16.6
2008-09	777,039	691,038	86,001	11.1	109,809	96,785	13,024	11.9
2009-10	830,594	746,644	83,950	10.1	118,472	102,725	15,747	13.3

By the use of capacitors the expected I^2R losses con be reduced. Here the capacitors store charge and increases the active component of power. In capacitor banks the dielectric materials are used to reduce the transmission losses. If we use high purity dielectric material, the losses can be minimized to a very very low value.

VI. Conclusion

Now in the present market scenario we can see that the economics of power distribution is not viable for sustained long term growth and development. On one hand the demand always goes on increasing while on the other, the supply cannot keep pace with the rising demand. Thus the demand supply gap goes on increasing. This is further aggravated by the situations like fuel shortages, strikes, non-operating units of the power plant etc.. But the disadvantages are also to be taken into account. It includes the cost of production of LASER beam, special equipments required to maintain it and its applicability in dense areas. But it can be applied on a trial basis in selected markets and the maintenance costs should be calculated. If it becomes feasible, it can be expanded to other areas. Thus our proposed method presents an idea to reduce the losses, so that the supply becomes almost proportional to demand. Hence, the market can be stabilized to a great extent.

References

[1] "Let there be light"(http://www.telegraphindia.com/1090426/jsp/calcutta/story_10866828.jsp). The Telegraph April 26, 2009.
[2] Darjeeling Hydro Power System (http://www.theiet.org/resources/library/archives/featured /darjeeling.cfm)
[3] "ALL INDIA REGIONWISE GENERATING INSTALLED CAPACITY OF POWER" (http://www.cea.nic.in/reports/monthly/executive_rep/jun12/8.pdf) Central Electricity Authority, Ministry of Power, Government of India, June 2012. http://www.cea.nic.in/reports/monthly/executive_rep/jun12/8.pdf
[4] Power Sector at a Glance ALL INDIA. (http://www.powermin.nic.in/indian_electricity_scenario/introduction.htm) Ministry of Power, Government of India, June 2012. http://www.powermin.nic.in/indian_electricity_scenario/introduction.htm
[5] World Coal Institute – India "The coal resource, a comprehensive overview of coal" (http://www.worldcoal.org/pages/content/index.asp?PageID=402) World Coal Institute, March 2009 (http://www.worldcoal.org/pages/content/index.asp?PageID=402)
[6] "For India, a Power Failure Looms" http://online.wsj.com/article/SB10001424052970203550304577136283175793516.html) The Wall Street Journal. 2 January 2012. http://online.wsj.com/article/SB10001424052970203550304577136283175793516.html)
[7] Uwe Remme et al. (February 2011). "Technology development prospects for the Indian power sector" (http://www.iea.org/papers/2011/technology_development_india.pdf)
[8] "World Energy Outlook 2011: Energy for All" (http://www.iea.org/papers/2011/weo2011_energy_for_all.pdf) International Energy Agency. October 2011. http://www.iea.org/papers/2011/weo2011_energy_for_all.pdf
[9] http://www.spartastrategy.com/blog/2011/07/indias-energy-dem-and-supply-deficit/
[10] http://economictimes.indiatimes.com/articleshow/13395891.cmc
[11] Yoginder Alagh, Former Minister of Power and Science Technology of India (2011). "Transmission and Distribution of Electricity in India Regulation, Investment and Efficiency" (http://www.oecd.org/dataoecd/35/33/46235043.pdf) OECD http://www.oecd.org/dataoecd/35/33/46235043.pdf
[12] "Reforming the Power Sector: Controlling Electricity Theft and improving Revenue" (http://rru.worldbank.org/documents/publicpolicyjournal/272bhatia_Gulati.pdf) (PDF). The World Bank http://rru.worldbank.org/documents/publicpolicyjournal/272bhatia_Gulati.pdf
[13] Gould, R. Gordon (1959). "The LASER, Light Amplification by Stimulated Emission of Radiation". In Franken, P.A. and Sands, R.H. (Eds). The Ann Arbor Conference on Optical Pumping, the University of Michigan, 15 June through 18 June 1959. p.128
[14] "Laser" Reference.com. Retrieved May 15, 2008.
[15] en.wikipedia.org/wiki/Far-infrared laser.
[16] en.wikipedia.org.wiki/Dielectric.