

EFFECTS OF INEFFICIENT STREETLIGHTS ON POWER CONSUMPTION OF THE KARACHI CITY.

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ABSTRACT—This study has been conducted to improve the street lighting system of Karachi and to estimate power loss due to inefficient lights installed at streets. In this study it is found that streetlights of Karachi city are very inefficient and are based on obsolete technology. Various areas of the city are surveyed to inspect street lighting technology and system. Even in this modern era, high-pressure sodium lamps are still being used to light up the streets and roads of Karachi, this old school technology not only consumes more electricity and burdens additional load on the power grid of the city, but is also less enduring than its successor, We used two-way survey to collect data about streetlights, That are field surveying, Satellite imagery digital analysis and general public surveying. We also evaluated the comparison between different technologies of street lighting. In this study we have calculated the estimated power that we can save by replacing the older technologies. Fortunately, some aspects have been found that can be taken into account to effectively conserve the energy of the city, and to lessen the energy deficiency problem.

Keywords— digital processing, field surveying, high-pressure sodium lamps, power grid.

I. INTRODUCTION

Street lighting system is a major requirement of any country. Citizens, rightly demand state of the art modern technology in street lights, however, it is a major consumer of electricity that depends upon some factors such as regulation, efficiency and maintenance. Enduring lighting system depends upon three factors:

- 1) It should be efficient.
- 2) It should be long lasting.
- 3) It should have high lumens.

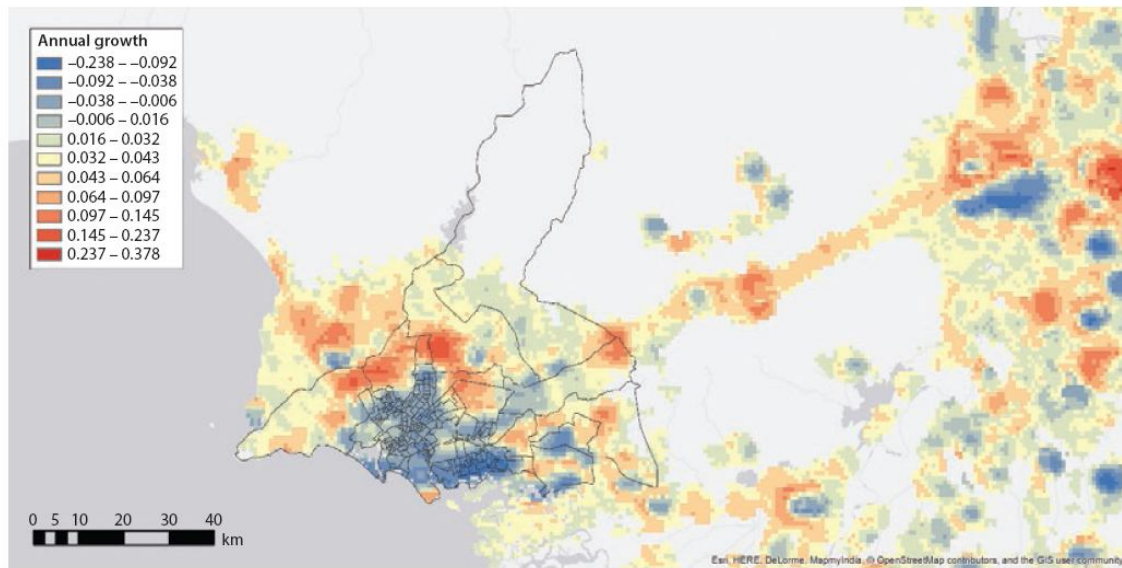
A lamp type meeting these three conditions will turn out to be the best choice for street lights. Lights in the Karachi city have grown rapidly with the population, The rate of growth are higher at edges of cities as they are newly populated [5]. The majority of lamps used in street lights of Karachi are sodium lamps which are inefficient and also have short life. An efficient and sustainable lighting source which is being presented are LED lamps [2] as they make a direct transfer of electrical energy into light unlike conventional light sources. Currently, in Karachi, LED lamps are not very common and majority of the city has sodium lamps installed. The minimum requirement for these lamps is that they provide enough light for the users to be satisfied without consuming much energy.

Since there is not much electricity production in Karachi [3] [4], so LED lamps will save a lot of energy consumption as well as electricity.

Throughout the Karachi, there are streetlights which are switched on in the day as well, this leads to energy consumption and shows unprofessionalism of the working body controlling these streetlights. Our aim is to install such streetlights which will be cost efficient as well as energy efficient. The best possible solution is to install LED lamps and remove the old technology that is sodium lamp. To cope up with the world and its modern technology, certain steps are needed to be taken for the betterment of not only Karachi but to Pakistan as well.

The rest of this paper is organized as follows:

Section I contains review on previous works, Section II, methodology, Section III outlines survey data & satellite imagery analysis and survey results. Later Section IV have discussion on results describes proposed solutions and steps, Finally Section V offers some conclusions.



Source: World Bank analysis based on Defense Meteorological Satellite Program–Operational Line Scan System nighttime lights data.
Note: Data show annual average growth in nighttime light intensity from 1999 to 2010.

FIGURE 1 - MAP [5]

II. LITERATURE REVIEW

A recent study carried out for the European Commission [1] has shown that around 50% of electricity used for lighting could be saved by investing in energy efficient lighting systems. Such investments will be beneficial and will prove out to be long lasting as well.

Another study we reviewed was conducted in India which also concluded that by replacing lights we can save half of energy consumptions [6]. To compare efficiency of lights various research papers and documents are reviewed. The table below indicating the data comparing LED with high-pressure sodium lights.

TABLE [SOURCE: [HTTP://WWW.ECOSOLENERGY.COM/DOCUMENTS/WHY_GO_FOR_LED.PDF](http://www.ecosolenergy.com/documents/why_go_for_led.pdf)]

LIGHT TECHNOLOGY	LUMENS PER WATT (AVERAGE)	COLOR TEMPERATURE	CRI (COLOR RENDERING INDEX)	IGNITION TIME	CONSIDERATIONS
HIGH PRESSURE SODIUM LIGHT	85	2,000K	25	up to 10 min	low CRI with yellow light, contains mercury and lead
LED LIGHT	150	3,200-6,400K	85 - 90	instant	relatively higher initial cost

But in Pakistan there is no data available to estimate the quantities in which lighting technologies are installed, hence therefore we used two way data collection method to calculate the ratio of LEDs and Sodium lights installed at streets of Karachi.

III. METHODOLOGY

Our research methodology follows the *Quantitative research method*. The research is based upon observational

surveys, Photographic digital analyses and computational techniques. The description of each segment of the study carried out is given below:

Observational Surveys

To inspect the technology and gather data, a surveying team was formed, its main objective was to survey as many areas of Karachi as possible and to gather all the random data mentioned below about streetlights. The data included:

- 1) Technology
- 2) Power rating
- 3) Condition of light

The team surveyed many areas of the Karachi city and tabulated data regarding streetlights.

Samples from Observational Surveys

FIGURE 2 - 2KW HP SODIUM LAMP STREETLIGHTS, NORTH NAZIMABAD .

FIGURE 3 - 2KW HP SODIUM LAMP STREETLIGHTS, HOSTEL ACCOMMODATION ROAD, NED UNIVERSITY.

FIGURE 4 - STREETLIGHT AT NAZIMABAD, RUNNING AT DAYTIME. DUE TO INATTENTIVENESS OF ADMINISTRATION. (PHOTO TAKEN DURING A SURVEY SORTIE)

FIGURE 5 - HPS LIGHTS BAHRIA TOWN KARACHI.

FIGURE 6 - STREETLIGHT RUNNING AT DAYTIME, NED UNIVERSITY.



Photographic Digital Pixel Analysis

Another way to count lighting technologies in the city is to take aerial imagery of the city at night and process it digitally to calculate the pixels of image with respect to the colour. Each pixel of satellite image at night represents the light. Moreover the sodium lamp have yellowish orange colour of pixel and LED light have whitish colour on image.



FIGURE 7 - PICTURE OF KARACHI TAKEN BY EUROPEAN ASTRONAUT, THOMAS PESQUET, FROM INTERNATIONAL SPACE STATION. [7]

IV. DATA ANALYSIS PROCEDURE & RESULTS

In field surveying of random places in the Karachi city we collected data of 15000 lights which yields the data given below:

S. No.	Technology	Quantity	Percentage
1	HP Sodium Lamp	12710	84.7%
2	LED Lamps	2290	15.3%
3	Total Samples Collected	15000	100%

Light illuminations have their own characteristic colour in the imagery hence we used this property to get our results.

We Used *Pixel Colour Summarizer v0.76* to calculate pixels of satellite imagery. The colour summarizer produces descriptive colour statistics for an image. Reported will be the average, median, minimum and maximum of each component of RGB, HSV, LCH and Lab. Average hues are calculated using mean of circular quantities.

The data from photographic pixel analysis give us approximately same results:

S.No.	Color Cluster HEX Code	Name	Pixels Percentage %
1	#ff6e14	Yellowish Orange shades	79.5%
2	#f7fffb	White Shades	20.5%
3	#xxxxxx	Total Pixels	100%



Satellite Image



Dots Showing Sodium light illuminations



Dots Showing LED lights Illuminations

Estimation of Energy Loss

From above data now we can calculate the energy we can save of Karachi city by replacing LED lights.

The Equation is as follows:

$$PL = \%SL \times P \times E$$

Power Loss = PL

Sodium Lights Percentage = %SL

Efficiency Ratio = E

From Data provided by ministry of finance, Pakistan, The total power consumption of streetlights of the Karachi city is 56MW (Mega Watts) [8].

From above equation we get the results:

S.No.	Survey Method	Power Consumption (MW) [8]	Sodium Lights %	Efficiency Ratio [1]	Power Loss (MW)	Power Loss %
1	Field Survey	56	84.7	0.5	23.71	42.35
2	Photographic Pixel Analysis	56	79.5	0.5	22.26	39.75

Results From both surveying procedures we get approximately same results which tell us that about 40% electricity consumed by streetlights can be saved if we replaced all the sodium lights by LEDs.

V. DISCUSSION

Hence the task of estimation of power loss due to inefficient streetlights is fulfilled. We used here two-way surveying methods to achieve greater accuracy in results. Both results supports each other. The first technique was of direct observation of samples. This give us estimation of how the light technologies are scattered in the city. We took 15000

random samples from Karachi city 84.7% of which are found inefficient sodium lights this give us population description of streetlights present in the city.

Other technique was of advance type, In which we uses software to estimate ratio of lighting technologies from aerial imagery, This technique have much lesser accuracy than direct observation but still gives results that can be taken into consideration. From this technique we get that 79.5% of lights in the city are sodium lights. From both results we calculated average power that we can save if we replace lights which is found to be 23.71MW and 22.26MW by Field survey method and photographic pixel analysis respectively.

VI. CONCLUSION

Inefficient streetlights burdens a considerable amount of additional load to the power grid of Karachi city, this factor play a significant impact in worsening the on- going energy crisis of Karachi. To minimize the current energy crisis of Karachi, We must immediately replace old school inefficient technology to save power. We found out that by replacing LEDs with the present-day street lighting technology our objective could be attained as the LEDs were more efficient, had better long term reliability and were even brighter than the presently being used technology.

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