Energy Audit of Street Light

Jhansi Nagar Nigam JHANSI U.P.

GANGES CONSULTANCY
KANPUR-U.P.

NOVEMBER - 2016

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- Sh. Arun Prakash - Nagar Ayukt
- Sh. R.K. Verma - Chief Engineer
- Sh. Amit Kumar Sharma - Executive engineer
- Sh. Aoop Sood - Public Health & Environment Engineer
- Sh. S. Rijwan Haider Jaida - A.E Technical

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The following member of audit team were engaged in Energy Audit task,

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Abbreviation

◊ A.Cs	◊ Air Conditioners
◊ Ah	◊ Ampere Hour
◊ APFC	◊ Auto Power Factor Correction
◊ BOM	◊ Bill of Material
◊ BEE	◊ Bureau of Energy |Efficiency
◊ CFL	◊ Compact Fluorescent Lamps
◊ DSM	◊ Compact Fluorescent Lamps
◊ Cons.	◊ Consumption
◊ CD	◊ Contract demand
◊ CT	◊ Current Transformer
◊ DVNNL	◊ DAKSHINANCHAL VIDYUT VITRAN NIGAM LIMITED
◊ DTL	◊ Double Fluorescent tube lamps
◊ ECOs	◊ Energy Conservation Opportunities
◊ ECO	◊ Energy Conservation Opportunity
◊ EE	◊ Energy Efficiency
◊ ESCOs	◊ Energy Saving Companies
◊ FY	◊ Financial Year
◊ FT	◊ Fluorescent Tube lamps
◊ FDA	◊ Free Air Delivery
◊ GWh	◊ Giga watt
◊ GOI	◊ Government of India
◊ GT	◊ Grand Total
◊ GHG	◊ Green House Gases
◊ Athd	◊ Harmonics Threads in current
◊ Uthd	◊ Harmonics threads in Voltage

◊ HSD	◊ High Speed Diesel Oil
◊ hr	◊ Hour
◊ INR/ Rs.	◊ Indian Rupees
◊ IEEE	◊ Institute of Electrical and Electronics Engineers
◊ IEC	◊ International Electrotechnical Commission
◊ km	◊ kilo meter
◊ kVAr	◊ Kilo Volt Ampere (Reactive)
◊ kV	◊ Kilo Volts
◊ kW	◊ Kilo Watt
◊ kVA	◊ Kilo Watt Ampere
◊ kWh	◊ Kilo Watt Hour
◊ LED	◊ Light emission diode
◊ LT	◊ Low Transmission
◊ lm	◊ Lumen
◊ MW	◊ Mega watt
◊ MoUD	◊ Ministry of Urban Development
◊ PT	◊ potential transformer
◊ P.F / pf	◊ Power Factor
◊ P & M Cost	◊ Project & Management cost
◊ R,Y,W,1, 2, 3	◊ Red, Yellow, Blue phase
◊ RMS	◊ Root Mean Square
◊ STL	◊ Single Fluorescent tube lamp
◊ SPV	◊ Solar Photovoltaic System
◊ SFC	◊ Specific Fuel Consumption
◊ U1/2/3	◊ Three Phase Voltage Red/Yellow/ Blue
◊ TOD	◊ Time of Day
◊ TR	◊ Tone of Refrigeration

◊ TL	◊ Tower Light
◊ Aunb	◊ Unbalancing in current
◊ Vunb	◊ Unbalancing in phase to neutral voltage
◊ Uunb	◊ Un-balancing in phase to phase voltage
◊ UT	◊ Union Territories
◊ VAT	◊ Value Added Tax
◊ Wp	◊ Watt Power

Content

Executive Summary

Energy is one of the most important building block in human development, and, as such, acts as a key factor in determining the economic development of all countries. The Indian energy sector has witnessed a rapid growth. However, resource augmentation and growth in energy supply have failed to meet the ever-increasing demands exerted by the multiplying population, rapid urbanization and progressing economy. The higher energy consumption will also create serious environment issues, affect our ozone layer.

The Energy Audit of street light under the scheme "AMRUT" will not only help to reduce the demand & supply gap in some extent and protect ozone layer as well as our environment. In general, Energy Audit street light will identifying the areas where scope for improvement exists. In other word to manage demand of power or demand side management (DSM).

Power consumption in Urban local body (ULB) sector is increasing steadily over the last few years. ULB must not only consider financial & resource security benefit through DSM measures, but also need to recognize impact on environment created by burning of fossil fuels. DSM measures have a key role in eliminating power shortage. There is need to address these issues on priority through integrated and comprehensive approach and by adopting latest techniques available in market.

Objective this task under scheme "AMRUT" of MoUD is to energy audit of street light and to Optimize energy consumption in street lights by using energy efficient lights and increasing reliance on renewable energy and insensitive to green building, with this objective, Energy Audit of JHASNI NAGRA NIGAM has carried out..

Based on our observations of the various areas, we have identified certain potential areas for energy conservation opportunities, which are summarized below:-

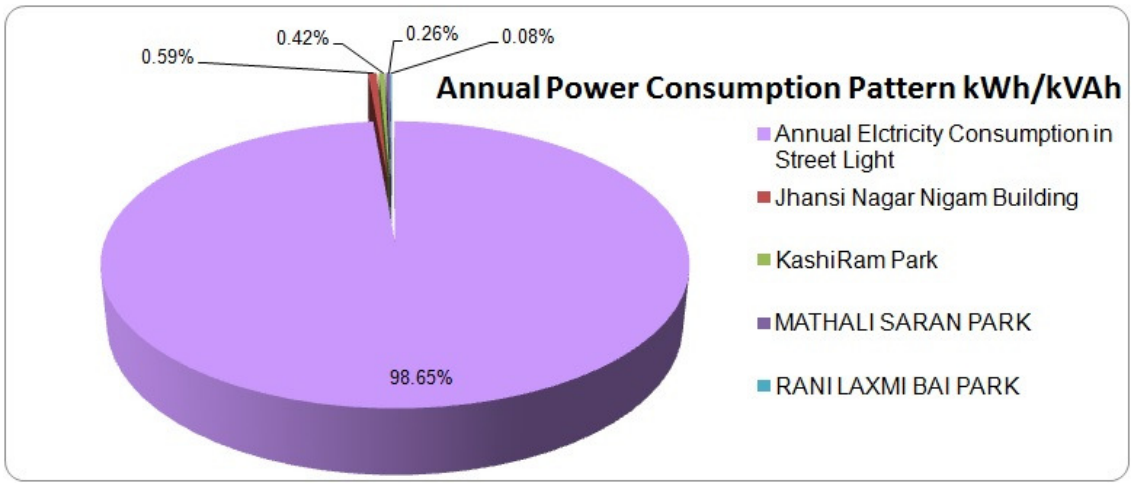
Present Scenario

Presently, Jhansi Nagar Nigam is provides amenities services in 60 wards (detail of wards provides in chapter no. 3) and total 10593 no. of 70W HPSV, 11716 no. 250 W HPSV and 93 no. 400W HPSV Luminaries are installed to maintain lamination in street/ side street & in alley (Gali). Total connected load is approx 4027 kW and average operation is 12 hr/ day.

Annual Power Consumption Pattern

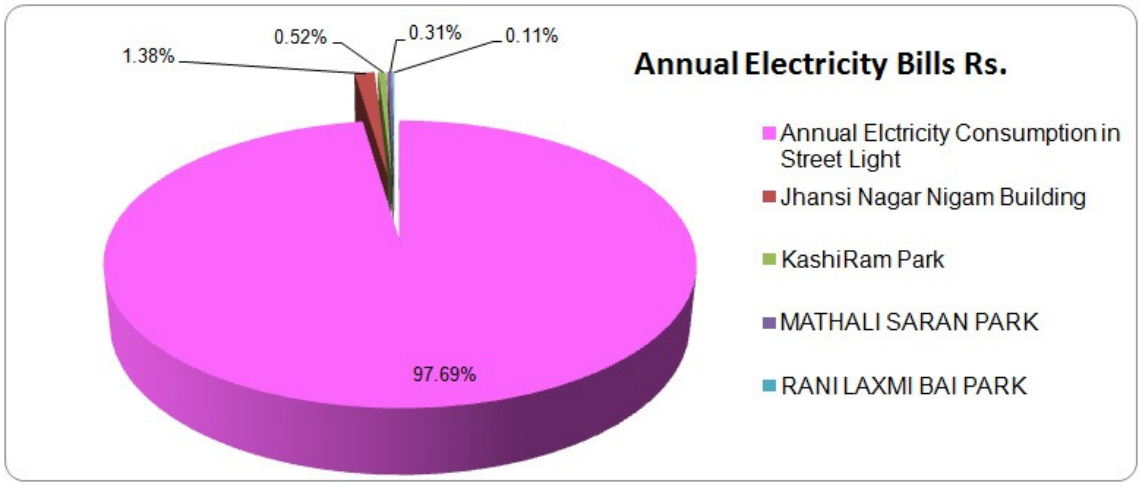
Annual power consumption in street light, parks and Jhansi Nagar Nigam is depicted as below,

Sr. no.	Name	Unit kWh/ kVAh	%	Rs.	%
1	Annual Electricity Consumption in Street Light	17638260	98.65%	173966400	97.69%
2	Jhansi Nagar Nigam Building	106337	0.59%	2450933	1.38%
3	Kashiram Park	75324	0.42%	925180	0.52%
4	Maithili SARAN PARK	46620	0.26%	545699	0.31%
5	Rani Laxmi Bai Park	13972	0.08%	198127	0.11%
	Total	17880513	100%	178086339	100%



Annual power consumption in street light is around 176.38 lakh unit, i.e. 98.65% of total power draw power DVVNL, while it is 0.65% for Jhansi Nagar Nigam.

In term of annual bills, Jhansi Nagar Nigam pay Rs. 1739.66 Lakh i.e. around 97.69% of total annual electricity bills pay to DVVNL.

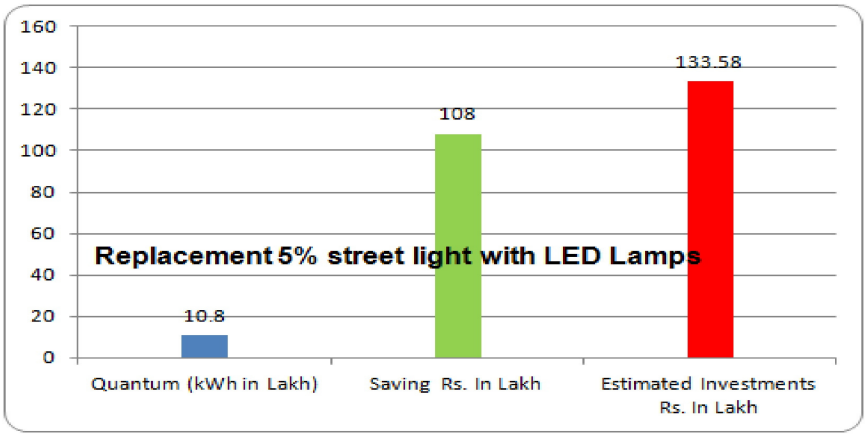


POST SCENORIO

After implementing energy audit measures, brief of energy saving described as below,

- Energy saving has estimated after replacement of conventional HPSV street with LED lights to achieve 5% annual energy saving, depicted as below,

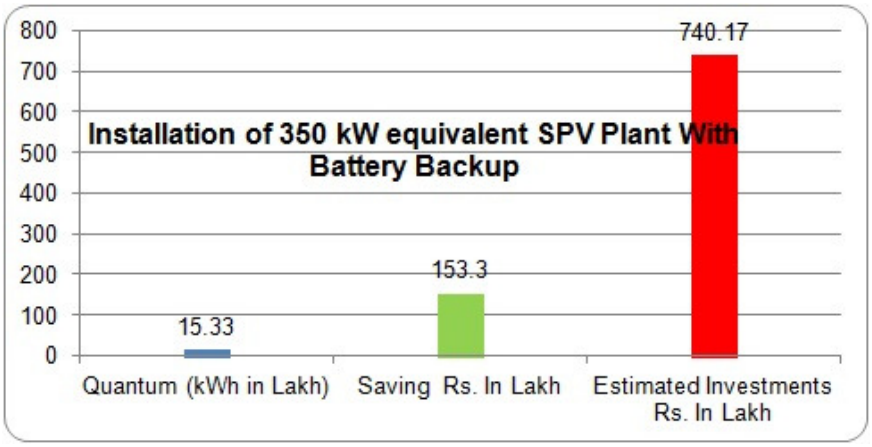
ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Replacement 5% HPSV street lights with LED Lamps	10.8	108	133.58	15



Payback period for replacement of HPSV Street light with LED lights is around 15 months and annual electrical saving will be around **6.12%**

- Energy saving after installation of Solar Photovoltaic system with one day battery back-up, to achieve 5% annual street light energy saving through grid, has estimated as below,

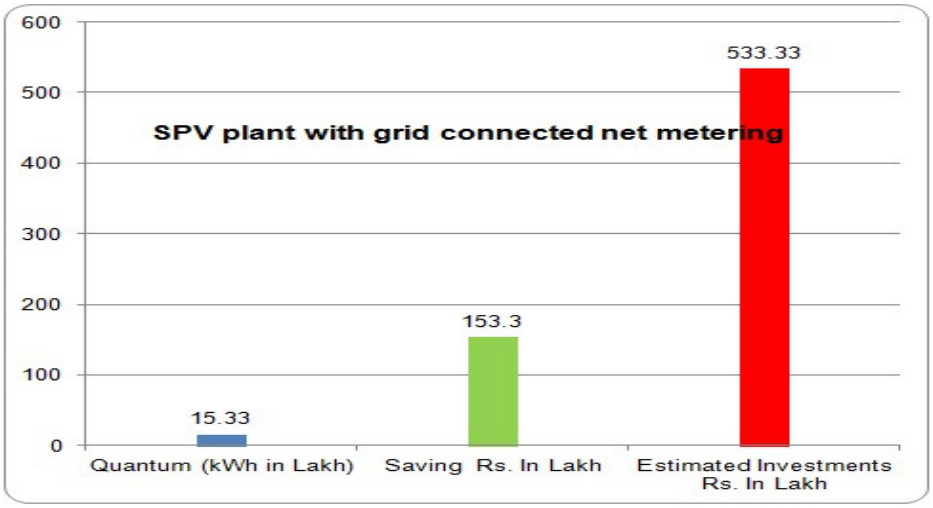
ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Installation of 350 kW Street Light equivalent SPV Plant to reduce Street light Load by 5% as per Solar city with one day battery backup	15.33	153.3	740.17	72



Annual power saving will be around 15.33 kWh i.e. 8.69% (considering forecasting for 2017-18). Investment around Rs. 740.17 Lakh will recover in 6 to 7 Years (excluding land cost and will provide by Jhansi Nagar Nigam).

- Batter cost of above SPV system is around Rs. 300.00 Lakh, thus option is to installation of Solar Photovoltaic system with Grid connected net metering system, to achieve 5% annual street light energy saving through grid, has estimated as below,

ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Installation of 350 kW Street Light equivalent SPV plant with grid connected net metering	15.33	153.3	533.33	60

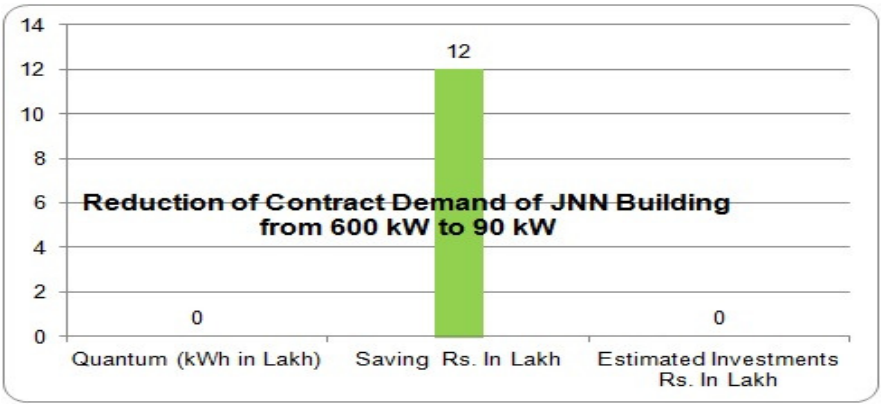


In this case, investment will be little less i.e. Rs. 533.33 Lakh and payback period will be 5 to 6 years.

Above estimation is based on subsidiary/ financial assistance provided by Central / State Government/ NABARD etc

- Cost benefits through reduction of Contract Demand (CD) of Jhansi Nagar Nigam Building from 600 kW to 90 kW

ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Reduction of Contract Demand of Jhansi Nagar Nigam Building from 600 kW to 90 kW	0	12	0	0



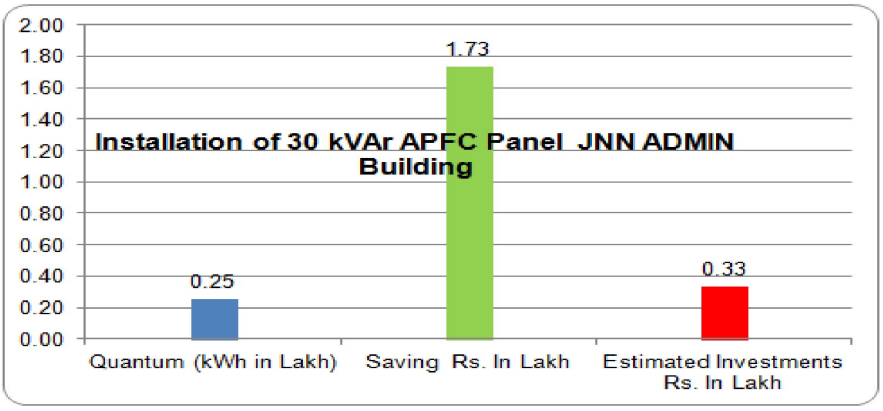
Present contract demand for Jhansi Nagar Nigam Building is 600kW, which is too high as compare to max CD recorded and thus, paying around Rs. 1.00 lakh per extra to DVVNL

Jhansi Nagar Nigam has already started rooftop SPV system UN DG Set Less back up supply..

- Installation of 30 kVAr capacitor bank in Jhansi Nagar building to maintain power factor near to unit and avoid extra payment to DVVNL[1].

ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Installation of 30 kVAr APFC Panel to improve monthly power factor above 0.95 JHANSI NAGAR NIGAM ADMIN Building	0.25	1.73	0.33	3

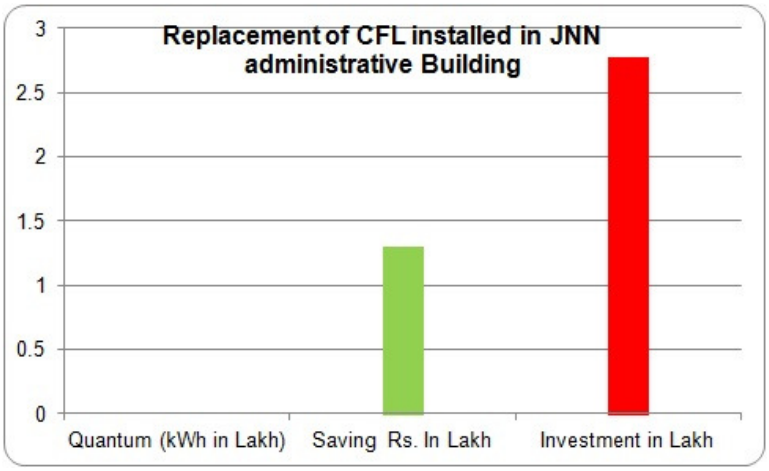
Above calculation is based on present monthly bills of Jhansi Nagar Nigam Building



[1] www.dvvnl.org

- Energy saving after replacement of all conventional & CFL fittings in Jhansi Nagar Nigam has estimated as below,

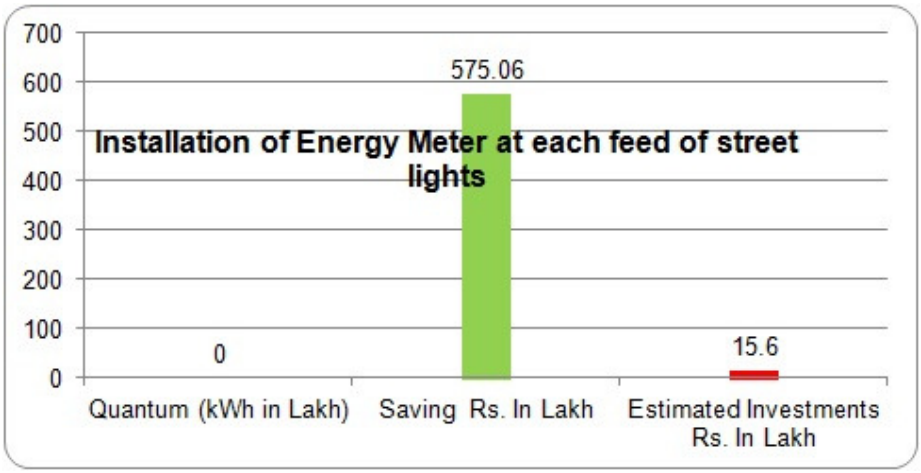
ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Replacement of CFL installed in JHANSI NAGAR NIGAM administrative Building with LED Lights	0.19	1.3	2.78	26



- Installation of energy meters in street light feeders and financial benefits has been calculated as below,

ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Installation energy meter at all street Light electricity supply feeder (Approx 140no. metered to be installed) and change un-metered tariff to meter tariff under tariff code LMV - 3	0	575.06	15.6	1

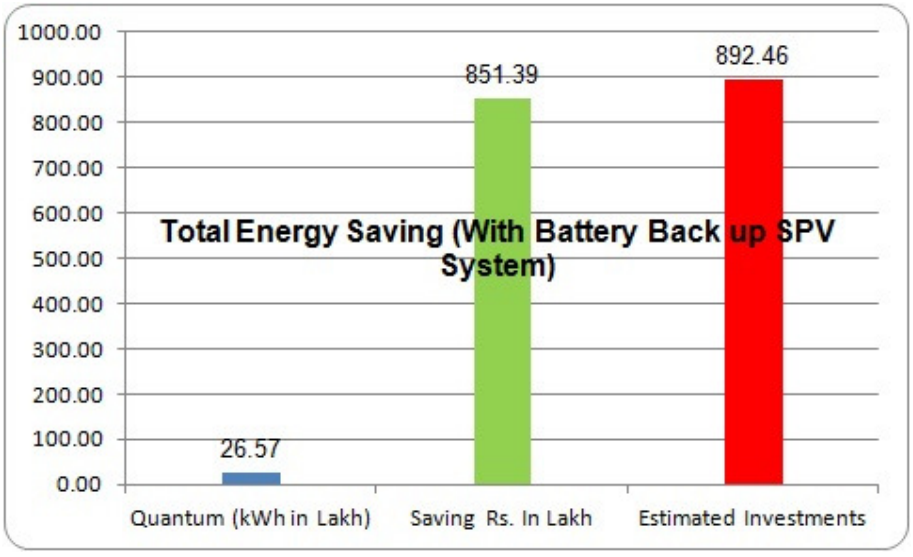
Presently, power for street lights is supplied under tariff LMV - 3 Un-metered system.

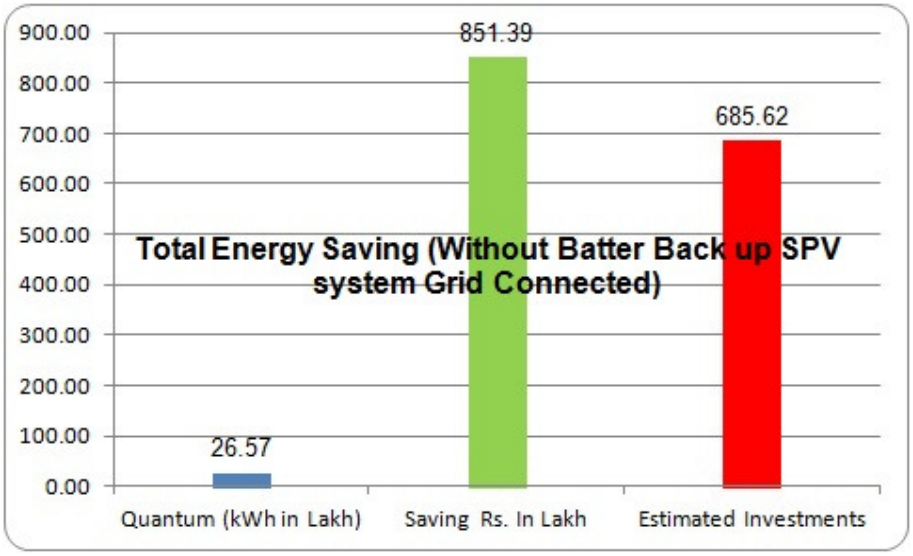


It is suggested here to change tariff plan and to install energy meter to each street light feeder for monitoring of power consumption.

Total energy saving is around 26.57 lakh unit per Annam or Rs. 851.62 Lakh per Annam with one day battery backup or without batter backup with grid connected net metering Total Investment is around Rs. 892.46 Lakh with battery one day battery backup or Rs. 685.62 Lakh without grid connected, under net metering provision.

It is suggested here to prepare DPR of each energy saving before implementation, as one energy saving may affect others.





* **Suggest to install occupancy in each office.**

Note:- Before to install above energy saving, requested to prepare DPR.

Other Energy Saving Measures

- Cleaning of Luminaries, Reflector, and lamp to be clean in periodic ways.
- Overloading should be avoided. Normally installed street light supply connect through old switch, MCB or connector and due to overloading, switch etc burn and ultimately increases maintenance & repairing cost.
- Thermostats of room ACs to be set at comfort temperature i.e. between 24^{o} C to 26^{o} C.
- Clean the window AC's filters on periodic basis,
- Install PIC technology based occupancy sensors in offices, these worked on dual technique, vibration as well as IR temperature variation.
- Installation LED dimmer'. In the night between 1.0 am to 4.0 am, traffic on road reduced and in this period luminaries lumen may be reduced. LED lamp with dimmer are now using in street facility. Initial cost of dimmer is (Rs. 5000 - 6000/- per piece for three channels) too and payback period is 3 to 4 years.

Carbon Emission

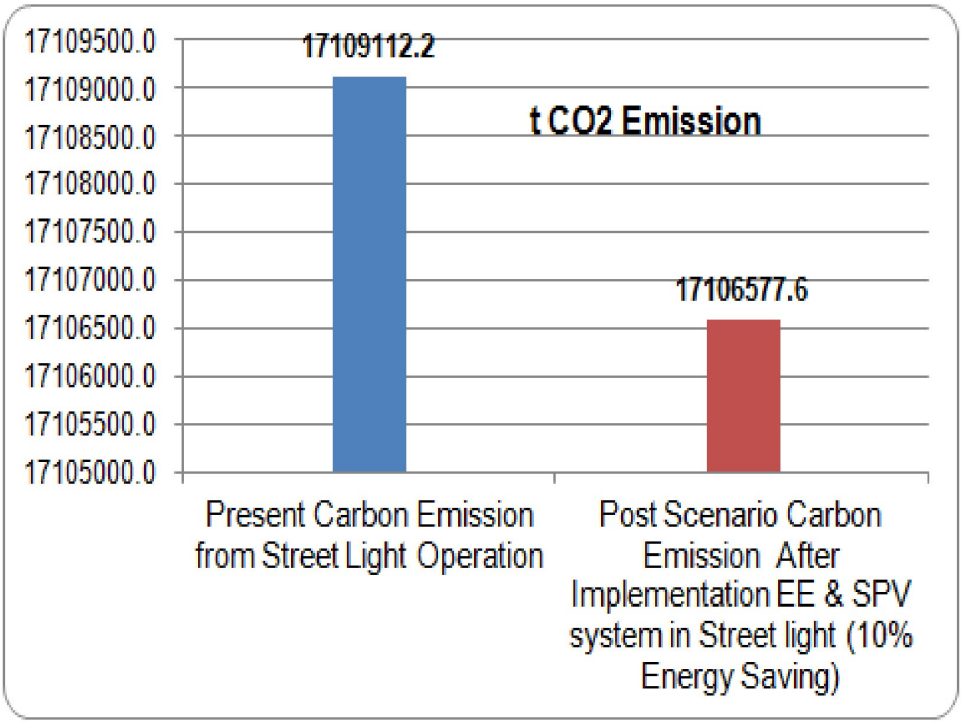
Carbon emission is the release of carbon into the atmosphere or green house gas emission; the main contributors to climate change. Since greenhouse gas emissions are often calculated as carbon dioxide equivalents, they are often referred to as “carbon emissions” [2]

[2] http://www.ecolife.com/define/carbon-emission.html

The addition of man-made greenhouse gases to the Atmosphere disturbs the earth's radiation balance. This is leading to an increase in the earth's surface temperature and to related effects on climate, sea level rise and world agriculture.

In view of above, carbon emission reduction has been estimated on implementation of above energy efficiency schemes as below,

Description	t CO2
Combine Factor t CO2/MWh (CEA data)[3]	0.97
Present Carbon Emission from Street Light Operation	17109112
Post Scenario Carbon Emission After Implementation EE & SPV system in Street light (10% Energy Saving)	17106578
Reduction in Carbon Emission after Implantation EE measure in Street Light	2535
Reduction in Carbon emission in JHANSI NAGAR NIGAM ADMN Building after Implementation EE	43
t CO2/MWh Saving Carbon Emission	2577



(Amrut reform incentive claims toolkit F.Y 2016-17)

[3] http://cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver10.pdf

CHAPTER 1.
INTRODUCTION

Municipal governance in India has existed since the year 1687, in Early nineteenth centuries almost all town of India experience some form of local self government bodies then called "municipal governance or Urban local body (ULB)". Later ULBs classified in into the four major categories.

1. Municipal Corporation (Nagar Nigam)
2. Municipalities
3. Town Area Committee (TAC)
4. Notified Area Committee (NAC)

Jhansi Nagar Nigam was established under the provisions of the Uttar Pradesh Municipal Corporations Adhiniyan of 1959, making necessary amendments from time to time. It has been categorized as Urban Local Body under the provisions of the 74th Amendment of the Constitution, where the rights duties, functions and administration have been streamlined as per the act.

India has a total installed capacity of generating **302087.84** MW, as on 31 March 2016, as per CEA, Ministry of Power. Of this, Coal based units generate 185172.88 MW, Gas based units – 2450.63 MW, Diesel – 993.53 MW, Nuclear – 5870 MW, Hydro – 42783.42 MW and Renewable energy -42849.84 MW.

The sector-wise share of installed capacity is: State owned units – 33.70%, Private units -41.05% and Central units – 25.26%.

Under the 12th Plan, the total capacity addition for power generation was 88537 MW, against this, the actual capacity added till December 2014 was 49058. 22 MW. It clearly suggests that the government has no choice but to take up the challenge of improving power distribution and consumption, as earnestly as increasing power generation capacity.

Street lighting is one the most important – and expensive – responsibilities of a city provided by municipal governance and street lights account for 10–38% (approx) of the total energy bill in cities worldwide (NYCGP 2009), while in India, street lighting consumed about 8,478 GWh of electricity in FY13, about 1.5% of total national electricity consumption . Therefore this is one domain that needs major attention if

we look at improving efficiency of power consumption with an objective of saving energy.

municipal governance have limited city budget from the supply constraints of current energy systems, it is essential to ensure that cities develop in an energy-efficient manner and contribute to national energy security. Street lighting is the one of the highest consumption of a city's share of energy. As a city grows and expands, the energy needed to meet the growth increases rapidly. Once street lighting system installed, remain in use for 15-30 years. Its poor & inadequate infrastructure incurred high maintenance costs, thus locking in energy usage for years.

Power Tariff is a state subject, increase with increase in inflation. It further increases financial burden on municipal governance and have been a matter of much debate. This need to adopt new power saving measures through DSM (demand side management) a means to reduce energy cost.

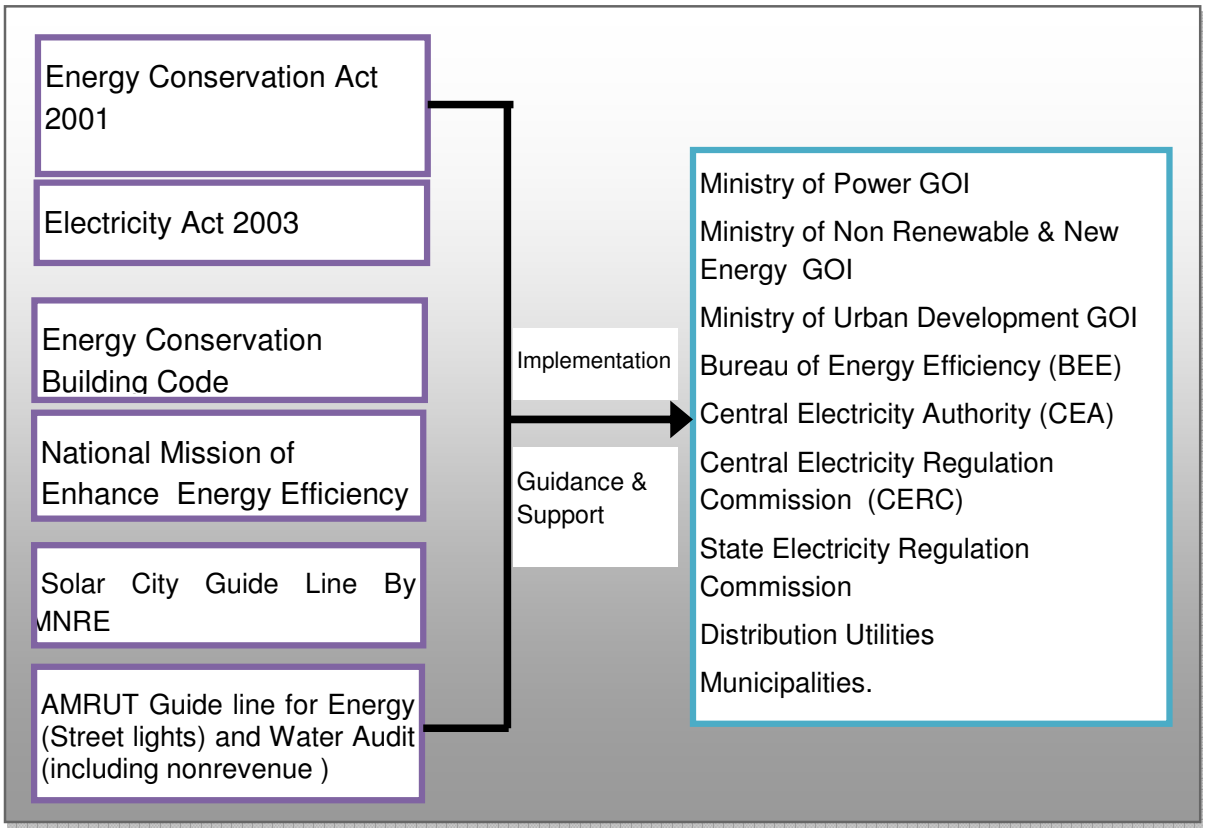
Energy efficient technologies and design can cut street lighting costs dramatically (often by 25-60%). The total opportunity of energy savings at the national level, could increase from 4,300 million kWh to about 5,000 million KWh annually. Assuming a power cost of INR 6 per KWh, this translates to an annual cost savings of INR 2,500 crores (EESL 2013), these savings can eliminate or reduce the need for new generating plants and provide the capital for alternative energy solutions for populations in remote areas. These cost savings can also enable municipalities to expand street lighting to additional areas, increasing access to lighting in low-income and other underserved areas. In addition, improvements in lighting quality and expansion in services can improve safety conditions for both vehicle traffic and pedestrians.

There are several models available across the world to overcome financial barrier for implementation of energy efficiency in street lighting projects such as PPP models (public-private partnership) based on energy savings performance contracting (ESPC) models—offered by ESCOs (energy service companies) or other energy service providers have become common tools to enhance EE measures in street lighting programs.

1.1. REGULATION AND POLICIES

Several policies and institutional initiatives have been introduced by the Government of India (GoI) as well state government in view to increase energy efficiency in

economy in the form of laws, legislation and policy frameworks. Collective effort of these interventions also applicable in street lighting or municipal segments.



1.2. ENERGY EFFICIENCY IN STREET LIGHTING

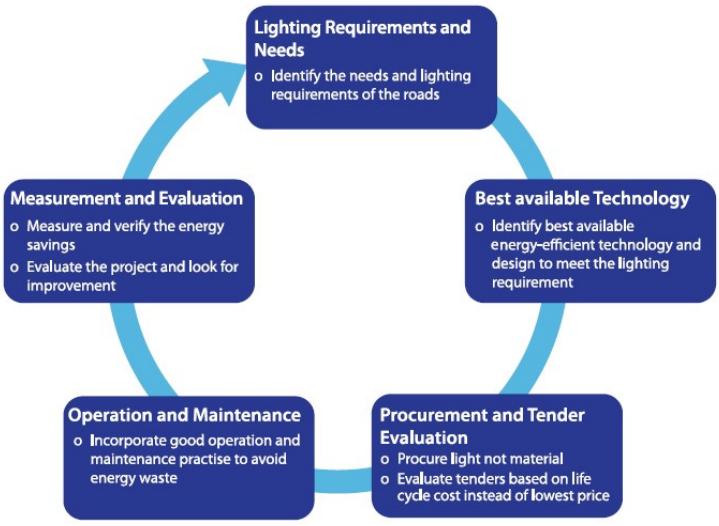
well-designed, energy-efficient street lighting system should permit users to travel at night with good visibility, in safety and comfort, while reducing energy use and costs and enhancing the appearance of the neighborhood. Conversely, poorly designed lighting systems can lead to poor visibility or light pollution, or both. Quite often, street lighting is poorly designed and inadequately maintained (e.g., there are large numbers of burned-out lamps), and uses obsolete lighting technology—thus consuming large amounts of energy and financial resources, while often failing to provide high-quality lighting.

New energy-efficient lighting technologies like LEDs (light-emitting diodes)/ Induction light are available in the market today, streetlights represent one of the most cost-effective opportunities for energy savings and for reducing municipalities' energy costs/ maintenance cost, green house gases emission as well as mercury pollution (used CFL). As street lighting loads require electricity during peak demand hours, Energy efficient street lighting job are considered attractive investment projects by electricity supply utilities also. In India. Induction lights are magnetic light without filaments conductor. Magnet function in induction light is same as filament with very long life (expected life is about 25 years). While filament expected life is about one year. These lights at initial stage and are very - very costly.

Following steps involve in street light energy efficiency projects.

Energy efficient lighting system should

- Blast Free Light Fittings or Low Loss ballasts
- Constant wattage high intensity electronic ballasts.
- Energy-efficient luminaries.
- Better monitoring and control mechanisms



1.3. BARRIES IN IMPLEMENING EE IN STREET LIGHTING

street lighting have extensive opportunities for energy savings, lack of coordination among the different government and other agencies, such projects are yet to be achieved. There are various barrier key point following to achieve objective.

- **Financial Barrier**

Limited resource of income/ poor financial condition of ULB, Lack of understanding of EE street lighting investment, Lack of faith on ULBs by financial institutions in India, Poor financial strengths of ESCOs, Lack of innovative market-based financing mechanisms for implementing EE in street light

- **Technical challenges**

Lack effective monitoring and verification systems to track energy savings & availability of inadequate infrastructure such as meters, lack of real time data, limited technical, business and risk management skills of service providers, follow up of different standard etc.

- **Capacity constraints**

ULBs has limited conceptualize capacity utilization of resources for design, implementation , lack of technical key venders in EE street light project etc.

- **Complexity in the coordination**

Lack of single coordination agency, multiple agencies including the ULBs officers work together with state and central government agencies, electricity utilities work parallel among them creates complexity etc.;

1.4. REGULATORY AND INSTITUTIONAL

Lack of stable institutional arrangements and mechanism body to encourage

investment on them for DSM & energy efficient projects and also gives low priority given to EE relative to other costs in municipal sector

In spite the above barrier, Jhansi Nagar Nigam have adopted new energy efficiency technology and installed energy efficiency light fittings at some places particularly at parks and CHAURAHA s. In fact such improvements will lead to reduction in financial expenditure in their operation & maintenance, better fiscal management, efficient use of infrastructure and enhanced service quality as largely.

1.5. AMRUT

Atal Mission for Rejuvenation and urban Transformation (AMRUT)[4] provides basic services to households and build amenities in cities which will improve the quality of life for all, especially the poor and the disadvantaged is a national priority. An estimate of the funds required over a 20 year period, at 2009-10 prices, was made by the High Powered Expert Committee (HPEC) during 2011. The Committee estimated that Rs. 39.2 lakh crore was required for creation of all urban infrastructure,

Total found allocated for AMRUT is Rs. 50,000 crore for five years from FY 2015-16 to FY 2019-20 and the Mission will be operated as a Centrally Sponsored Scheme with following four parts:

i. Project fund - 80% of the annual budgetary allocation.
ii. Incentive for Reforms - 10% of the annual budgetary allocation.
iii. State funds for Administrative & Office Expenses (A&OE) - 8% of the annual budgetary allocation
iv. MoUD funds for Administrative & Office Expenses (A&OE) - 2% of the annual budgetary allocation

1.6. COVERAGE

Five hundred cities will be taken up under AMRUT. The list of cities will be notified at an appropriate time. The category of cities that will be covered in the AMRUT is given below:

1. All Cities and Towns with a population of over one lakh with notified Municipalities, including Cantonment Boards (Civilian areas),
2. All Capital Cities/Towns of States/ UTs, not covered in 2.1(i),

[4] http://amrut.gov.in/

3. All Cities/ Towns classified as Heritage Cities by MoUD under the HRIDAY Scheme,
4. Thirteen Cities and Towns on the stem of the main rivers with a population above 75,000 and less than 1 lakh, and
5. Ten Cities from hill states, islands and tourist destinations (not more than one from each State).

Jhansi Nagar Nigam meet criteria no.1 and hence it also comes under AMRUT.

The purpose of AMRUT Mission is to improve governance through a set of Reforms. During the Mission period, 11 Reforms will be implemented**.."Optimize energy consumption in street lights by using energy efficient lights and increasing reliance on renewable energy" through "Energy Audit" comes under reform no. 10. 1 & 3 page no. 28 and also under Reforms Type, Steps and Target for AMRUT Cities FY-2015-2016 sr. no. 8. 3 page no. 49 AMRUT GUID LINE**

AMRUT 2016 - 2017

Energy Efficiency

Energy efficiency is the goal to reduce the amount of energy required to provide products and services. For example energy efficiency street light and energy efficiency building. There are two components to the project:

The first component of the project is energy efficiency investment in public facilities. This component will support energy efficiency investment in public facilities and utilities. The energy efficiency investment will reduce the energy consumption of retrofitted public and social facilities and reduce the CO_2 emission. Additionally these investment will generate substantial economic and social benefits including better environment and improved health. (ref: page no. 9 - 16) .

The second component of the project is technical assistance which will help remove the existing barriers to realization the energy efficiency potential and create an enable environment for energy efficiency in public sector (Ref: page no. 47 - 141)

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1.7. SOLAR CITIES PROGRAM

Ministry of New and Renewable Energy (MNRE) has launched a program on "Development of Solar Cities". The program assists Urban Local Governments (ULB) in:

- Preparation of a master plan for increasing energy efficiency and renewable energy supply in the city
- Setting-up institutional arrangements for the implementation of the master plan.
- Awareness generation and capacity building activities.

The aim of program is to reduction of *10%* projected demand of conventional energy at the end of five years, which can be achieved through a combination of energy efficiency measures and enhancing supply from renewable energy sources.

- **Potential sources of Data**

  - Municipal Corporation for electricity consumption in its facilities.
  - Previous Reports on energy audits of municipal services
  - surveys for understanding energy use patterns & efficiency of use

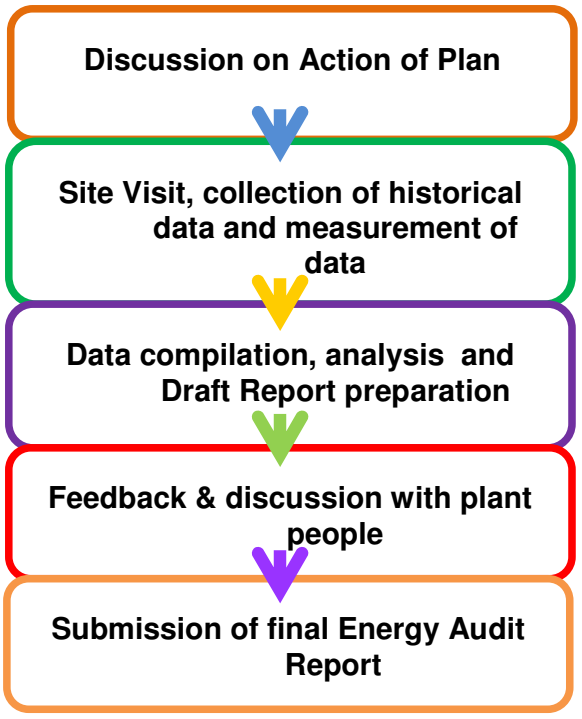
A feasibility study of potential renewable energy technologies should be done. Both, decentralized and centralized options should be considered. The goal will be that renewable energy should be able to reduce at least 5% of the projected total demand of conventional energy.

1.8. ENERGY EFFICIENCY (EE) AND DEMAND SIDE MANAGEMENT (DSM)

Renewable energy technologies provides clean energy, energy efficiency and DSM measures would help in reducing the energy demand. Energy saving potential is possible with the use of energy efficient energy lighting and their control in street light as well as in commercial building.

CHAPTER 2.
METHODOLOGY

Methodology adopted for achieving the desired objectives viz: an assessment of the current operational status and energy savings include the following:



- Discussions with the concerned officials to finalized the action of plan.
- A team of Energy Auditor & field supervisor visited the Jhansi Nagar Nigam and had discussions with the concerned officials/supervisors to collect field data/ information from various location in city with the help of supervisor/ line men etc, Type of Lighting installed, their quantities, electrical load pattern at supply point, Pole & high mass tower height, lighting "ON" & "OFF" control system, and lux levels at different type of roads equipment details with their rating etc. Field data for Jhansi Nagar Nigam Building has also collect at site with the help of technician / officers
- Above data collection from field with the help of appropriate portable instruments including continuous recording and visual observations were made to identify the energy losses in the system.
- Computation and **in-depth analysis** of the collected data, as appropriate were done to draw inferences and to evolve a suitable energy conservation street lights for reduction in energy consumption and utilization of renewable energy.

2.1. SCOPE OF WORK

AS PER AMURT GUIDLINE

- Energy audit of Street lights
- Optimize energy consumption in street lights by using energy efficient lights and increasing reliance on renewable energy.

AS PER MNRE SOLAR CITY GUIDLINE

- Recommendation for 5% energy saving through replacement of conventional steer light fittings with energy efficiency street light fittings.
- Recommendation for 5% energy reliance on renewable energy.
- Municipal corporation for Electricity Consumption in its facilities
- Energy Reports also includes following.

SOURCE OF DATA

Purchase Power

- Purchased power bill analysis for last one year with pf, kWh, kVAh, and over all power cost to company. Study of Contract demand & connected load, etc. For this, municipal corporation Jhansi has to provide monthly energy consumption/ purchased bills copy and detail of any specification of equipment installed within the office premises.
- Study of power supply on sample basis checked through measurement of major electrical parameters. System unbalance with respect to voltage, current and harmonics also to be checked.
- Measurement of Power Factor levels at various points / Load Centers and analysis of the same for further improvements, if feasible/ appropriate.
- Measurement of all major electrical parameters viz. voltage, current, power factor, power drawn, etc. on energy intensive equipments

Street Light & Office Building

- Illumination levels required vis-à-vis available shall be studied on sample basis.
- Study of the Lighting systems in respect of supply voltage, current, operating power factor and power drawn has to be carryout.
- study of BEE star rating window/ split ACs
- Optimize energy consumption in street lights by using energy efficient lights and increasing reliance on renewable energy,

2.2. INSTRUMENT USE

Following Instrument use during audit assignment

- Three phase Power Analyzer With appropriate CTs & PTs and real time data recording facilities.

- AC/ DC Clam meter with Watt and power factor measurement facilities

- Lux meter

- Distance Meter

CHAPTER 3.
BASELINE DATA

3.1. BASE LINE DATA

Jhansi is a historical city, a located in the semi-desert lands and situated in the region of Bundelkhand, between the river Pahuj and Betwa, It is an extreme south part of Uttar Pradesh.

Location

3.2. JHANSI NAGAR NIGAM BASIC DATA

Particulars		
Name	**:**	Jhansi Nagar Nigam Jhansi
Area of Jhansi Nagar Nigam Jhansi	**:**	169.5 Sq. km[5].
Area Percentage of Nagar Nigam to District	**:**	3.03%
Area of Jhansi District	**:**	5024 Sq. km.
Latitude	**:**	25.4484257 º N
Longitude		78.5684594 º E
Elevation from Sea level	**:**	285 meters (935 feet)
Solar Radiation	**:**	**6.2 to 6.4 kWh**
ation Jhansi Nagar Nigam (as per 2011 census)	**:**	505,717 No.
Sex Ratio:	**:**	905 females for every 1000 males [6]
Smart city	**:**	Selected for Smart city among 98 city in India
City rank in most populated cities in India	**:**	57th rank
Base Line Street Light Consumption per capita	**:**	00.000798 kW/ / capita

3.3. LIST OF WARDS

Total sixty ward govern under JHANSI NAGAR NIGAM and their name is as depicted as below,

Ward No.	WARD NAME	Ward No.	WARD NAME
1	HANSARI GIRD FIRST	31	LAHARGIRD SECOND
2	HANSARI GIRD SECOND	32	NANDANPURA SECOND
3	BAHAR SAIYER GATE	33	BAHAR ORCHAGATE SECOND

[5] http://jnnjhansi.com/stastistics.php

[6] http://www.census2011.co.in/census/city/134-jhansi.html

Ward No.	WARD NAME	Ward No.	WARD NAME
4	BHATTA GAON	34	NANDANPURA FIRST
5	MASIHAGANJ	35	BAHAR ORCHA GATE FIRST
6	NAINAGARH	36	ALIGOLE SECOND
7	SCHOOLPURA	37	ALIGOLE FIRST
8	TAALPURA FIRST	38	CHANIYAPURA
9	KHUSIPURA FIRST	39	NANDANPURA THIRD
10	SIMRADHA	40	TALAIYA
11	NAYI BASTI FIRST	41	DADIYAPURA FIRST
12	TAALPURA SECOND	42	CIVIL LINES SOUTH PART - 1
13	GADHIYA GAON	43	CIVIL LINES SOUTH PART - 2
14	KHUSIPURA SECOND	44	BAHAR DATIYA GATE FIRST
15	BIJAULI	45	DADIYAPURA SECOND
16	ISHAEE TOLA SECOND	46	MEWATIPURA
17	KACHIYANA PULIYA NO - 9	47	BAHAR KHANDERAO GATE
18	GUDRI	48	PREMGANJ FIRST
19	NAYI BASTI SECOND	49	PREMGANJ SECOND
20	BANGLA GHAAT	50	BAHAR DATIYA GATE SECOND
21	NAINA GHAAT SOUTH FIRST	51	CIVIL LINES (WEST PART)
22	ISHAYEE TOLA FIRST	52	CIVIL LINES (NORTH PART)
23	SIMRAHA	53	AZADGANJ
24	LAHARGIRD FIRST	54	C P MISSION COMPOUND
25	HEERAPURA	55	NANAKGANJ
26	KONCHA BANWAR	56	TORIYA NARSINGH RAO
27	BAGICHA PULIYA NO - 9	57	MUKARYANA
28	NAINAGARH SOUTH SECOND	58	DAROO BHONDELA
29	PICHAUR	59	GUNSAI PURA
30	SAGARGATE	60	LAXMANGANJ

3.4. AUDIT DATA

: A		
Brief description of assignment	:	Energy Audit of Street Light
Name & Address of Assignee	:	Nagar Ayukta, Jhansi Nagar Nigam Jhansi UP
Address of communication of Ganges Consultancy	:	Ganges Consultancy 273 / Y-1 Block Kidwai Nagar KANPUR - UP
B		
Activity	:	Street Light Facility By Jhansi Nagar Nigam Jhansi
C		
Street Light Hours per day	:	12 hr (average)
Annual Operation Days	:	365 days
Annual Street Light Operation hours	:	4380 hr
D		
No. of Ward	:	60 no.
Contact Demand CD	:	
Jhansi Nagar Nigam Part I	:	2227 kVA
Jhansi Nagar Nigam Part II	:	1800 kVA
Kashi Ram Park	:	22 kVA
Maithili Saran Park	:	28 kW
Rani Laxmi Bai Park	:	7 kW
Jhansi Nagar Nigam Administrative Building	:	600 kVA
Applied for New Connection	:	
Plastic Waste Management Eldico Colony Hansari	:	130 kVA
UNNAO Gate Cremation Point	:	100 kW
Kallan Shahi khatri	:	50kVA

CHAPTER 4.
PURCHASE POWER

4.1. POWER SUPPLY

JHANSI NAGAR NIGAM Purchase power for the operation of street lights, which are spread over a in 60 wards, Under tariff LMV - 3 DAKSHINANCHAL VIDYUT VITRAN NIGAM LIMITED (DVVNL) supply power JHANSI NAGAR NIGAM at LT level at transformer out and from them, electricity supply electricity through open conductor or underground cable both.

4.2. STREET LIGHT POWER CONSUMPTION PATTERN

DVVNL supply power under tariff LMV - 3 to JHANSI NAGAR NIGAM street light through nearby LT DTR (distribution transformer) installed for domestic supply also or from nearby domestic LT supply feeders. Supply of power is un accounted i.e. un-metered. Lamp connected to single point power supply is varies from single lamp to multiple lamps (even more than 30 no. lamps)

- **Rate schedule LMV - 3**

This schedule shall apply to public lamps including Street Light system, Road Traffic Control Signal, Lighting of Public Parks etc.

- **RATE:**

Rate gives the fixed and energy charges (including the TOD rates as applicable to the hour of operation) at which the consumer shall be billed for his consumption during the billing period applicable to the category:

Old Tariff Implemented for Year 2015-16 (from June 18, 2015.)

(a) Un-metered Supply:

Description	Gram Panchayat	Nagar Palika and Nagar Panchayat	Nagar Nigam
To be billed on the basis of total connected load calculated as the summation of individual points	Rs. 1700 per kW or part thereof per month	Rs. 2200 per kW or part thereof per month	Rs. 3000 per kW or part thereof per month

(As per UTTAR PRADESH ELECTRICITY REGULATORY COMMISSION LUCKNOW 2015-16)

New Tariff Implemented for Year 2015-16 (from Aug 1, 2015.)

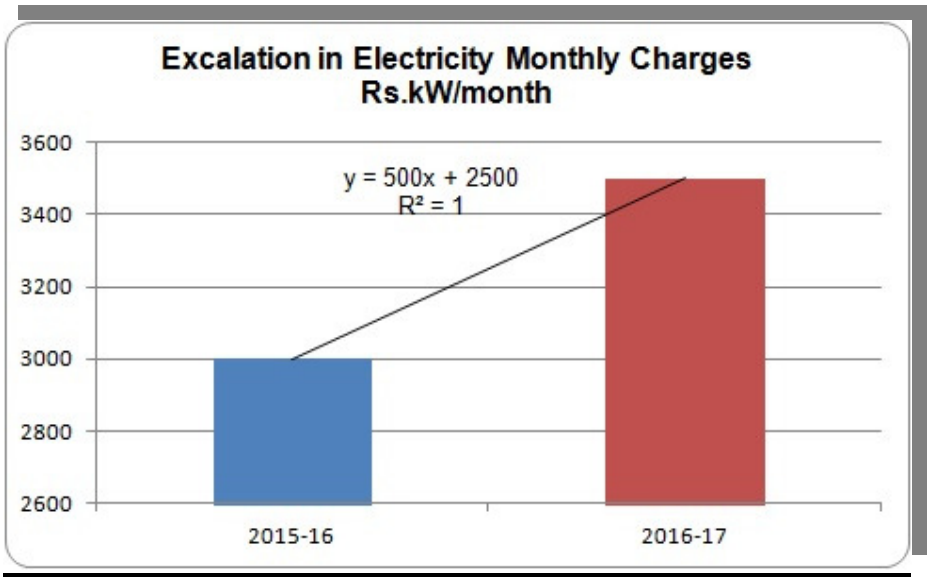
(a) Un-metered Supply:

Description	Gram Panchayat	Nagar Palika and Nagar Panchayat	Nagar Nigam
To be billed on the basis of total connected load calculated as the summation of individual points	Rs. 1700 per kW or part thereof per month	Rs. 2600 per kW or part thereof per month	Rs. 3500 per kW or part thereof per month

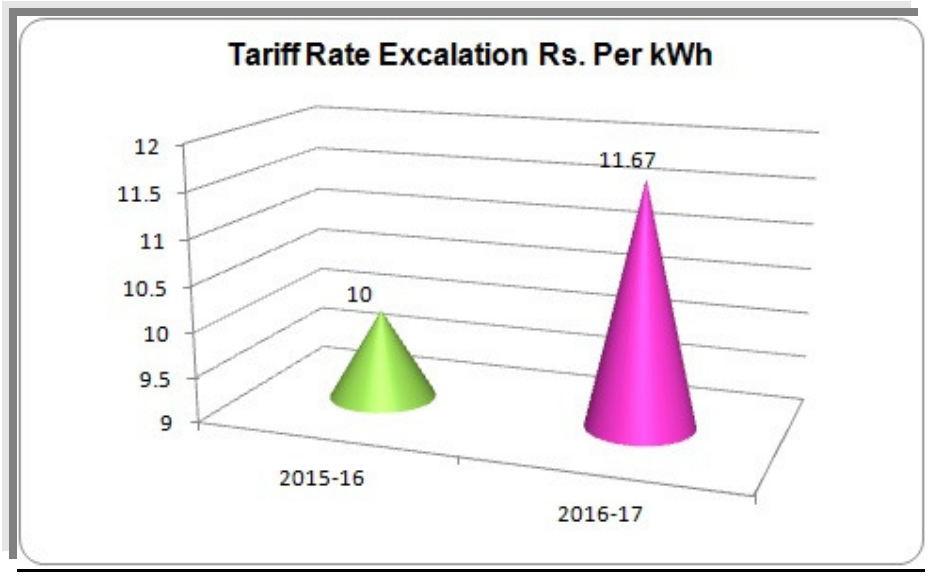
(As per UTTAR PRADESH ELECTRICITY REGULATORY COMMISSION LUCKNOW 2016-17)

Escalation in Tariff

Increase in Electricity Charges



As per notification of UP ERC 2016-17, monthly charges has been increased by 16.67% i.e. increased from Rs. 3000 per kW per month to Rs. 3500 per kW/ month.



Increase in monthly charges will increase overall electricity cost to JHANSI NAGAR NIGAM By 16.67%.

- **JHANSI NAGAR NIGAM Street Light Part 1 Purchase Power Pattern**

Billing Month	CD kWh	Fixed charges Rs. /kWh/ month	Monthly Bill Rs.	Electricity Charges Rs.	Total Electricity Charges Rs.	UPREC Charges @7.12% in Rs.	Total	Excise Duty @2%	Total Monthly Bill Rs.	Power Cost to JHANSI NAGAR NIGAM Rs. / kW/ Month Without surcharge
			a	b	c=a+b	d	e=c+d	F	G=e+f	
Aug-16	2227	3000	6681000	1336200	8017200	475687	8492887	169857	8662744	3600
Jul-16	2227	3000	6681000	1336200	8017200	475687	8492887	169857	8662744	3600
Jun-16	2227	3000	6681000	1336200	8017200	475687	8492887	169857	8662744	3600
May-16	2227	3000	6681000	1336200	8017200	475687	8492887	169857	8662744	3600
Apr-16	2227	3000	6681000	1336200	8017200	475687	8492887	169857	8662744	3600

- **JHANSI NAGAR NIGAM Street Light Part 2 Purchase Power Pattern**

Billing Month	CD kWh	Fixed charges Rs. /kWh/ month	Monthly Bill Rs.	Electricity Charges Rs.	Total Electricity Charges Rs.	UPREC Charges @7.12% in Rs.	Total	Excise Duty @2%	Total Monthly Bill Rs.	Power Cost to JHANSI NAGAR NIGAM Rs. / kW/ Month Without surcharge
			a	b	c=a+b	d	e=c+d	F	G=e+f	
Aug-16	1800	3000	5400000	1080000	6480000	292680	6772680	101590	6874270	3600
Jul-16	1800	3000	5400000	1080000	6480000	292680	6772680	101590	6874270	3600
Jun-16	1800	3000	5400000	1080000	6480000	292680	6772680	101590	6874270	3600
May-16	1800	3000	5400000	1080000	6480000	292680	6772680	101590	6874270	3600
Apr-16	1800	3000	5400000	1080000	6480000	292680	6772680	101590	6874270	3600

TOTAL STREET LIGHT SECTION LOAD = 2227 + 1800 =4027 kW

Power cost to JHANSI NAGAR NIGAM is Rs. 3600 per kW per month.

Power Cost to JHANSI NAGAR NIGAM is Rs. 10.0/ kWh

Annual Street Light Electricity Bill = 1739.66 Rs. in Lakh.(excluding surcharge as paid by Jhansi Nagar Nigam)

Annual Street Light Electricity Bill = 1864.44 Rs. in Lakh.(including surcharge)

4.3. PURCHASE POWER PATTERN OF JHANSI NAGAR NIGAM BUILDING

Power is supplied at 11kV and step down to 433 V through transformer, 200 kVA transformer is also installed to meet power demand office in case of grid supply. DG Set synchronized manually.

Applicable Tariff Code = HV-1

Sanction Contract Demand = 600 kW

Billing Month	Contract Demand kW	Recorded Max CD	Min Billable CD kVA	Electricity Rate Rs. /kWh/ month	Fixed Charges Rs	kWh	kVAh	pf	Electricity charges @Rs. 6.90/ kVAh	Total	Others Arrears	GT	Unit Cost to JHANSI NAGAR NIGAM Rs/ kWh
Jun-16	600	72.4	500	250	125000	11814.5	12978	0.91	89548	240404	422346	669970	18.52
May-16	600	91.5	500	250	125063	9154	10416	0.88	71867	222473	366638	589111	21.36
Apr-16	600	88.4	500	250	125000	6756.5	8143	0.83	56186	197045	0	197045	24.20
Mar-16	600	52.2	500	250	125000	5203.5	7490.5	0.69	51684	191272	0	191272	25.54
Feb-16	600	24.8	500	250	125000	4286	6818	0.63	47044	185322	0	185322	27.18
Jan-16	600	35.4	500	250	125000	4779	8407	0.57	58008	199380	0	199380	23.72

Billing Month	Contract Demand kW	Recorded Max CD	Min Billable CD kVA	Electricity Rate Rs. /kWh/ month	Fixed Charges Rs	kWh	kVAh	pf	Electricity charges @Rs. 6.90/ kVAh	Total	Others Arrears	GT	Unit Cost to JHANSI NAGAR NIGAM Rs/ kWh
Dec-15	600	28	500	250	125000	4256	7778	0.55	53668	193815	0	193815	24.92
Max	600	91.5	500	250	125063	11814	12978	0.91	89548	240404	422346	429566	27.18
Average	600	56.1	500	250	125000	6607	8861	0.72	61144	204244	70391	113743	23.63

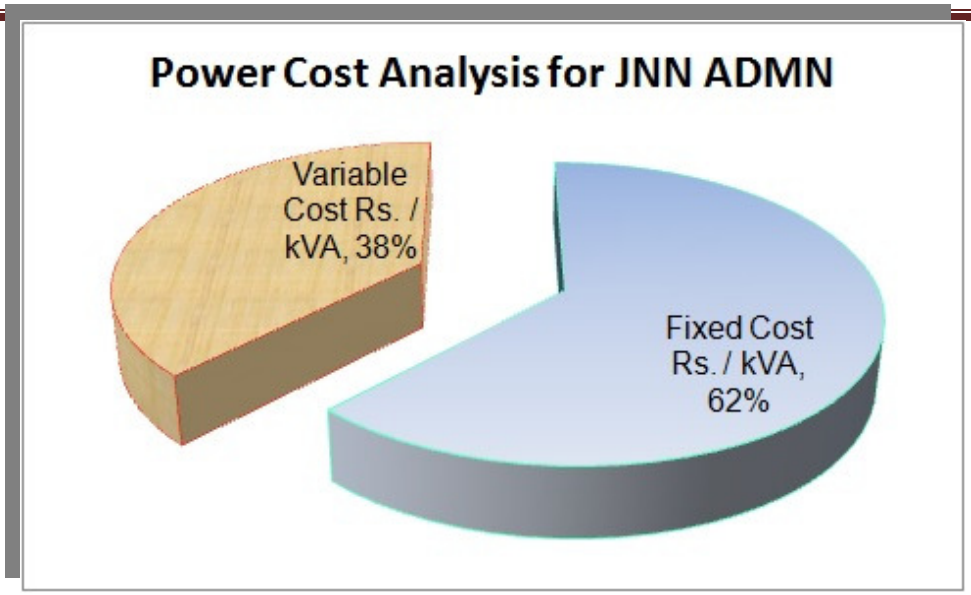
DVVNL has charged LPSC in two months of May & Jun 2016.

Average Monthly Power Cost to Jhansi Nagar Nigam =Rs. 23.63 per kVAh (including excise duty, PUERC charges)
Rate is high because of very high contract demand or in other fixed charges per unit are high.

Power Cost Analysis

Average purchase power cost for JHANSI NAGAR NIGAM ADMIN building fixed and variable is around Rs. 23.69 per kVAh. Which is thus, cost analysis has depicted as below,

Billing Month	Unit Cost to JHANSI NAGAR NIGAM Rs/ kVAh	Fixed Cost Rs. / kVA	Variable Cost Rs. / kVA
Jun-16	18.52	9.63	8.89
May-16	21.36	12.01	9.35
Apr-16	24.20	15.35	8.85
Mar-16	25.54	16.69	8.85
Feb-16	27.18	18.33	8.85
Jan-16	23.72	14.87	8.85
Dec-15	24.92	16.07	8.85
Average	23.63	14.71	8.93
%	23.63	62%	38%

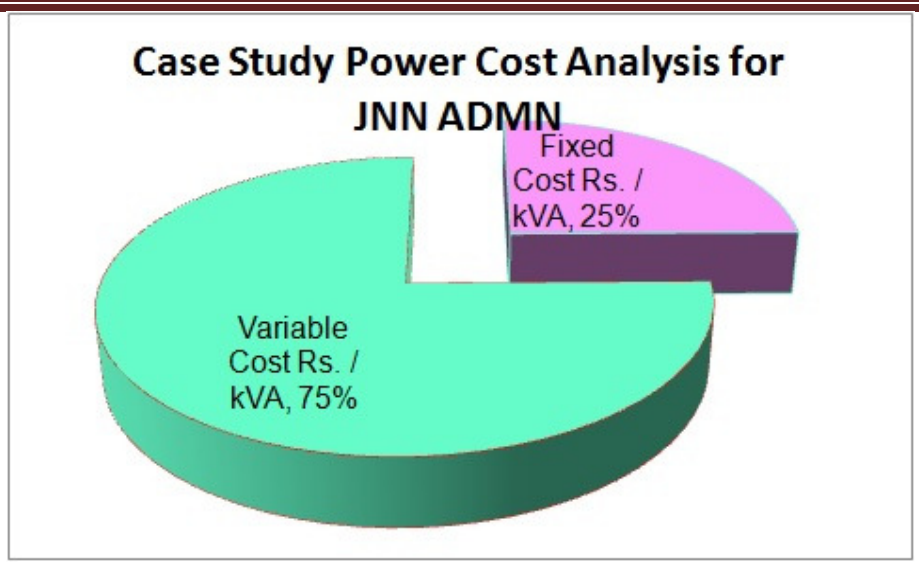


From above graph and table, it is clear that fixed & variable electricity charges are in reverse order .i.e. fixed power cost is more than the one and half times to two times the variable electricity charges.

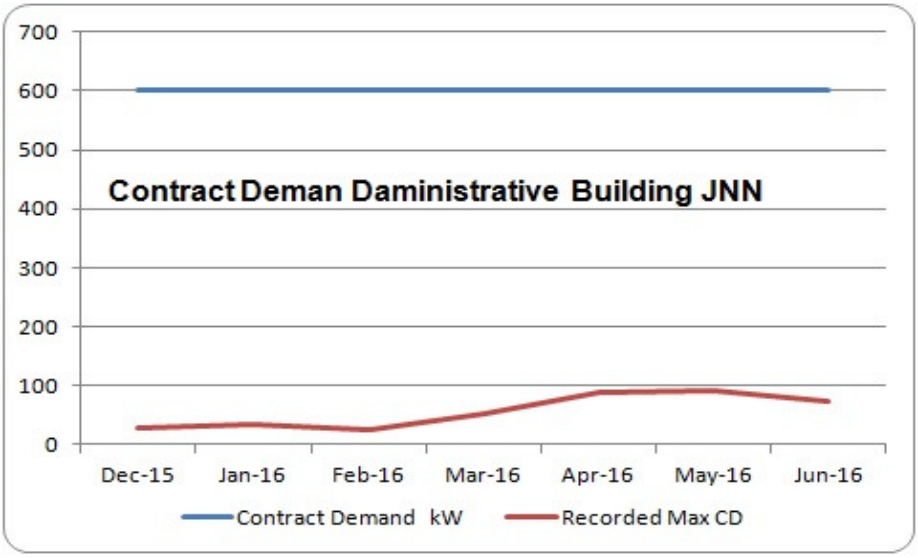
In normal case, fixed cost is between 25% to 30% of total electricity charges and 70% to 75% is variable cost.

If Contract Demand reduced to 100 kVA then fixed and variable charges will as below,

Cost	%
Fixed Cost Rs. / kVA	25%
Variable Cost Rs. / kVA	75%

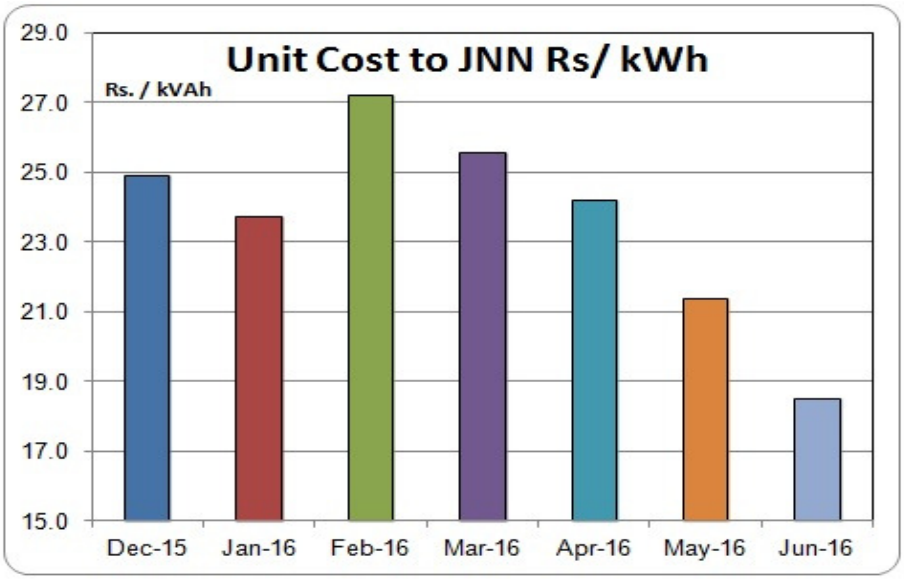


Contact Demand



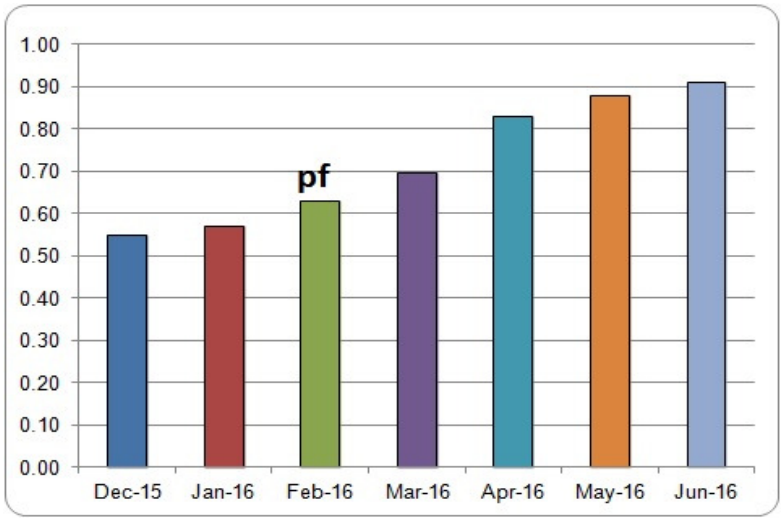
From above, sanctioned contract demand is 600 kW which is too against the max recorded CD i.e.91.5 kVA in the month of May 2016 and paid extra amount to DVVNL equivalent to 400kW as Fixed charges.

Unit Cost



High sanctioned contract demand, affect overall electricity purchase cost to JHANSI NAGAR NIGAM and average electricity purchase cost to JHANSI NAGAR NIGAM is around Rs 23..63 / kVAh. Thus, it is suggest here to take action for reduction of contact demand up to max 200 kVAh of 180 kW, detail calculation will elaborate later.

Power Factor



DVVNL has change tariff pattern and charging electricity unit in kVAh and hence, it is necessary to maintain power near to one (1.00). Average pf of last six month from (Dec 2015 to Jun-2016) is around 0.72, it means that average 28% variable electricity charges has paid extra by JHANSI NAGAR NIGAM to DVVNL. Thus, to maintain power factor near to one, it is suggest to install APFC (Automatic power factor correction) panel of 30 kVAr at primary side transformer.

- **KASHI RAM PARK**

  Kashi Ram park is maintained by JHANSI NAGAR NIGAM and There is no meter installed in this park. Electricity supply is charged on the basis contact load sanctioned.

Billing Month	CD	Min Billable CD kVA	Electricity Rate Rs. /kWh/ month	Fixed Charges Rs	kVAh	Electricity charges @Rs. 6.08/ kVAh	Excise Duty @Rs. 0.9 / kVAh	Regulation surcharge	Total	GT	Unit Cost to JHANSI NAGAR NIGAM Rs/ kWh
May-16	22	22	3000	30600	6277	38164.16	3438.2	4896	77098	77098	12.3

It is suggest to install separate electricity meter for monitoring of power supply and also verify of actual power consumption.

4.4. MAITHILI SARAM PARK

Park is maintained by Jhansi Nagar Nigam and Power is supplied by DVVNL to Maithili Saran Park under tariff LMV - 3 tariff with meter,.

Billing Month	CD	Fixed Charges Rs	Electricity charges @Rs. 6.30/ kVAh	kVAh	Excise Duty @Rs. 0.9 / kVAh	Excise Duty @Rs. 0.9 / kVAh	Regulation surcharge	Total	Unit Cost to JHANSI NAGAR NIGAM Rs/ kWh
Aug-16	28	7848	24475.5	3885	1616	1616	1383.4	45475	11.7

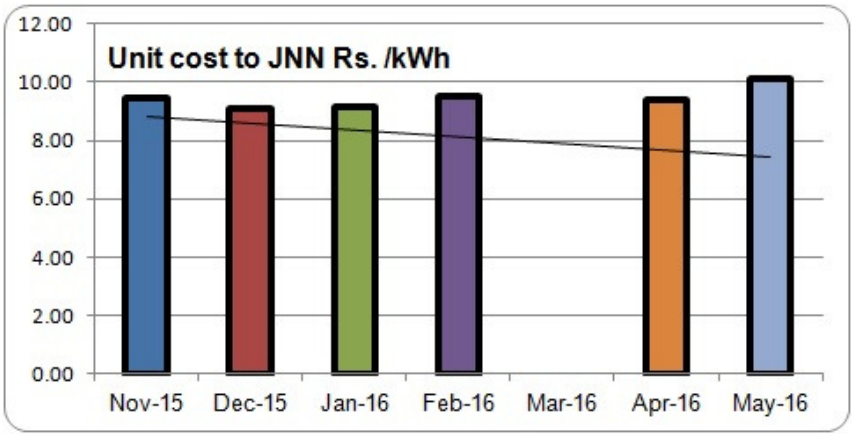
4.5. RANI LAXMI BAI PARK

It is biggest park in JHANSI CITY maintain by JHANSI NAGAR NIGAM having water sprinkles, LED 15 Watt and above lights are installed, except few HPSV of 250 Watt and CFL lights. 15 Watt LED is installed on road and walkway for illumination inside the park. Park is open for limited period in evening.

Monthly bills detail are as below,

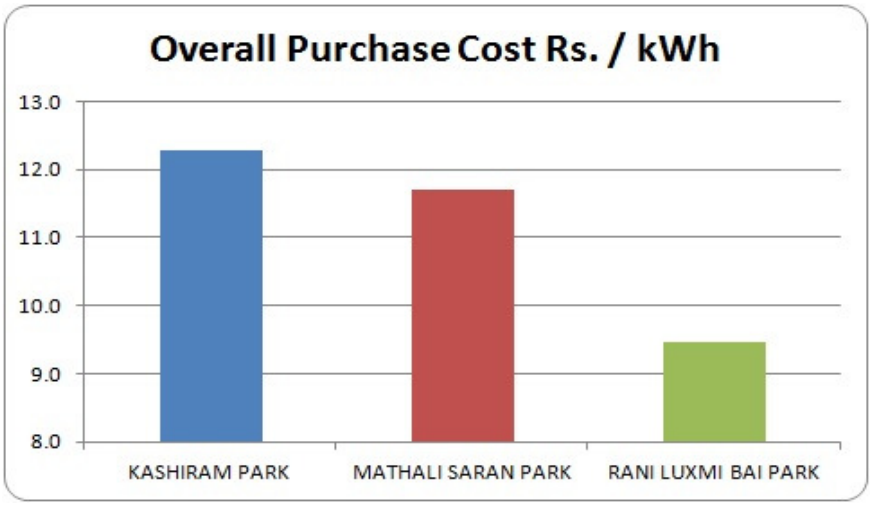
Billing Month	Fixed Charges Rs	kWh	Electricity charges @Rs. 6.6/ kVAh	Excise Duty @Rs. 0.9 / kVAh	Total	GT	Unit Cost to JHANSI NAGAR NIGAM Rs/ kWh
May-16	1244.	507	3346.2	344.28	5205	5205	10.12
Apr-16	1244.25	711	4692.6	483	276	6695	9.42
Mar-16	1244.25	0	0	0	0	1244	
Feb-16	1244.25	683	4507.8	464	265	6481	9.49
Jan-16	1244.25	845	5577	574	327	7723	9.14
Dec-15	1244.25	869	5735.4	590	337	7906	9.10
Nov-15	1244.25	892	4567.2	470	268	6550	9.46
Average							9.45

Purchase Power Cost



Rani Laxmi Bai Park is the biggest park parks of JHANSI NAGAR NIGAM and overall purchase power cost is varies from between Rs. 9.00 per kW to Rs. 10.00 per kW.

Overall Electricity Cost To JHANSI NAGAR NIGAM for Parke Lighting



Over all purchase power cost for Rani Laxmi Bai Park is found lowest in comparison to purchase power cost for Kash Ram and Maithili Saran Parks. It is because of all lights installed in Rani Luxmi Bai Park LED.

India Standard for street light and Lux Level

To ensure the citizens' safety, Bureau of Indian Standards (BIS) has established standards (IS 1944) for lighting levels for street light. BIS also provides specifications for Street Lighting Poles and recommends mounting height of luminaires and levels of illumination.

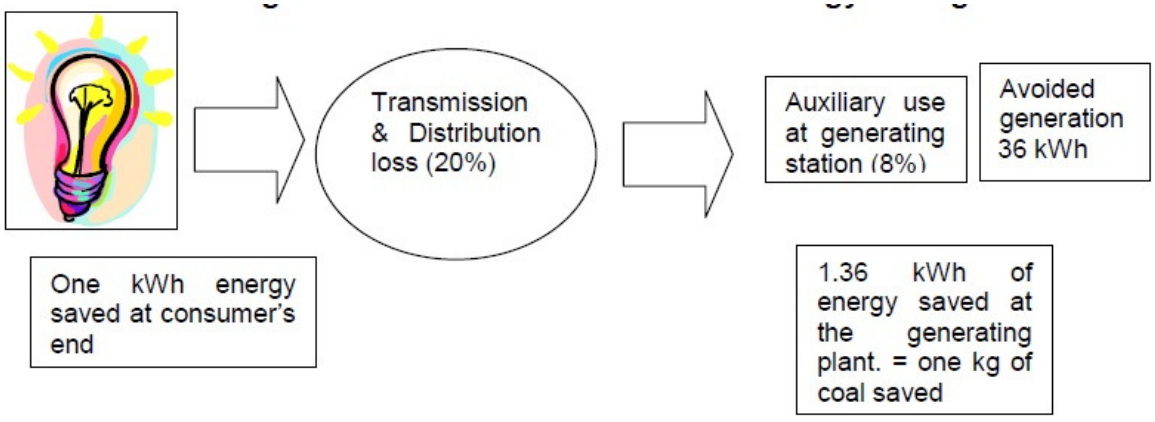
CHAPTER 5.
POWER LOAD SURVEY

.

Electricity consumption in India has increased by nearly 60 times, since independence. About 75% of India's electricity comes from burning of coal and 9% comes from burning gas/oil in power plants. Burning fossil fuels like coal or oil/gas has significantly adverse impacts on the environment and on society. The power sector contributes nearly 40% of India's carbon dioxide emissions.

One of the ways to mitigate the adverse impacts of the power sector is to conserve electricity. Energy conservation can be achieved not only by avoiding the use of electricity but also by using it more efficiently, e.g., by getting the same amount of light from a lower quantity of electricity by using more efficient lamps, supply of good quality of power and to reduce transmission losses

example, as shown in the Figure 2, one unit of electricity saved at the consumer end avoids 1.4 units of electricity generation, which implies a saving of about one kg of coal. In other words, a reduction of just 50W on the consumer side (that works out to say 6 hours a day), avoids coal usage of 110 kg per year.



5.1. STREET LIGHT ELECTRICAL CONSUMPTION SURVEY

Power Consumption (Loading Pattern) of street lights point wise has measured and

- **Elite Chock Ward No.52**

Phase	Voltage	Current	Power KW	Power Factor
R-	235	21.5	2.5	0.5
Y-	235	3	0.4	0.62s
B-	235	N/W	N/W	N/W

- **Near BSNL Office Ward No.52**

Phase	Voltage	Current	Power KW	Power Factor
R-	232	23.9	4.2	0.76
Y-	232	4.2	0.9	0.95
B-	232	N/W	N/W	N/W

- **Babu Lal Karkhana Ward No.47**

Phase	Voltage	Current	Power KW	Power Factor
R-	245	N/W	N/W	N/W
Y-	245	N/W	N/W	N/W
B-	245	N/W	N/W	N/W

- **BKD Chock Ward No.47**

Phase	Voltage	Current	Power KW	Power Factor
R-	245	1	0.2	0.91
Y-	245	1.25	0.3	0.92
B-	245	1.37	0.3	0.9

- **Comminatory Road Ward No.52 Left Side**

Phase	Voltage	Current	Power KW	Power Factor

R-	247	15.9	3.2	0.82
Y-	247	6.8	1.0	0.62
B-	247	1.8	0.3	0.72

- **Comminatory Road Ward No.52 Right Side**

Phase	Voltage	Current	Power KW	Power Factor
R-	246	10	1.4	0.56
Y-	246	8.5	1.5	0.7
B-	246	5.9	1.1	0.78

- **BKD Gwalior Road Ward No.47**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	19	4.1	0.83
Y-	260	4	0.7	0.64
B-	260	N/W	N/W	N/W

- **Misson Gate Ward No.11**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	5.8	1.3	0.83
Y-	260	1.4	0.2	0.68
B-	260	15	3.1	0.79

- **Gwalior Road Ward No.11**

Phase	Voltage	Current	Power KW	Power Factor
R-	265	12	1.8	0.57
Y-	265	22.4	4.3	0.72
B-	265	6.5	1.3	0.75

- **Swam Puram Colony Ward No.50**

Phase	Voltage	Current	Power KW	Power Factor
R-	261	3	0.4	0.50
Y-	N/W	N/W	N/W	N/W
B-	261	22	4.6	0.80

- **Gwalior Crossing**

Phase	Voltage	Current	Power KW	Power Factor
R-	246	13.5	2.5	0.750
Y-	246	2.8	0.5	0.740
B-	246	2.9	0.4	0.500

- **Kanpur Bypass Park**

Phase	Voltage	Current	Power KW	Power Factor
R-	222	0.7	0.1	0.92
Y-	222	8.5	1.9	0.99
B-	222	7.5	1.5	0.90

- **Medical Road Left Side Ward No.29**

Phase	Voltage	Current	Power KW	Power Factor
R-	240	0.58	0.1	0.50
Y-	240	20.0	3.5	0.72
B-	240	17.5	2.9	0.68

- **Medical Road Right Side Ward No.29**

Phase	Voltage	Current	Power KW	Power Factor
R-	242	10	2.1	0.87
Y-	242	13	2.8	0.89
B-	242	14	3.0	0.89

- **Maharani Laxumi Bai Medical College Ward No.29**

Phase	Voltage	Current	Power KW	Power Factor
R-	242	11	2.3	0.87
Y-	242	13	2.7	0.87
B-	242	7	1.5	0.90

- **Maharani Laxumi Bai Medical College Ward No.29**

Phase	Voltage	Current	Power KW	Power Factor
R-	242	10	1.1	0.45
Y-	242	10.7	2.1	0.83
B-	242	N/W	N/W	N/W

- **JDA Complex Medical Road Ward No.29**

Phase	Voltage	Current	Power KW	Power Factor
R-	236	3.4	0.7	0.89
Y-	236	17.5	3.7	0.90
B-	236	15.5	3.4	0.93

- **Bundelkhand University Gate No.2, Ward No.29**

Phase	Voltage	Current	Power KW	Power Factor
R-	242	38	8.1	0.88
Y-	242	5	0.9	0.75
B-	242	N/W	N/W	N/W

- **Medical Road Naza Hospital Ward No.45**

Phase	Voltage	Current	Power KW	Power Factor
R-	245	N/W	N/W	N/W
Y-	245	13.5	2.5	0.75
B-	245	22	4.3	0.79

- **Medical Road Sapan Motors Ward No.45**

Phase	Voltage	Current	Power KW	Power Factor
R-	240	N/W	N/W	N/W
Y-	240	8	1.3	0.66
B-	240	12	1.7	0.59

- **New Market Motors Stand Ward No.11**

Phase	Voltage	Current	Power KW	Power Factor
R-	238	N/W	N/W	N/W
Y-	238	7	1.1	0.66
B-	238	7.7	1.4	0.74

- **Bus Stand Police Station Ward No.11**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	253	37	7.6	0.81

- **Kunj Vatika Havant Market Ward No.14**

Phase	Voltage	Current	Power KW	Power Factor
R-	261	13.8	3.1	0.85
Y-	261	N/W	N/W	N/W
B-	261	23	5.1	0.85

- **Near Kachehari Chock Ward No.14**

Phase	Voltage	Current	Power KW	Power Factor
R-	250	17	3.9	0.92
Y-	250	11	2.3	0.84

B-	250	11.7	2.7	0.91

- **Kachehari Chock Main Ward No.14**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	242	10.4	2.3	0.91

- **Jail Chock Ward No.42**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	242	9	1.7	0.80

- **SP Office Nawabad Ward No.42, Feeder 1**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	242	5	0.8	0.68

- **SP Office Nawabad Ward No.42 , Feeder 2**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	242	18	3.0	0.70

- **Elite Chock Main**

Phase	Voltage	Current	Power KW	Power Factor
R-	238	6.8	1.1	0.68
Y-	238	4	0.9	0.98
B-	238	3.8	0.9	0.97

- **Hansari Gird First Ward No.1**

Phase	Voltage	Current	Power KW	Power Factor
R-	242	18.5	3.0	0.68
Y-	242	8.6	1.3	0.62

B-	242	N/W	N/W	N/W

- **Nagar Nigam Jhansi Main Building Low Mass Tower**

Phase	Voltage	Current	Power KW	Power Factor
R-	209	10.3	1.7	0.80
Y-	209	20.6	1.6	0.38
B-	209	0	N/W	N/W

- **Circuit House**

Phase	Voltage	Current	Power KW	Power Factor
R-	242	16	3.2	0.82
Y-	242	18	3.3	0.76
B-	242	17	2.9	0.70

- **Near Ford Show Room**

Phase	Voltage	Current	Power KW	Power Factor
R-	238	20.5	4.0	0.82
Y-	238	20.8	4.0	0.80
B-	238	N/W	N/W	N/W

- **St. Judies Hospital**

Phase	Voltage	Current	Power KW	Power Factor
R-	248	16.5	2.0	0.48
Y-	N/W	N/W	N/W	N/W
B-	N/W	N/W	N/W	N/W

- **Sipri Bajar Thana Road**

Phase	Voltage	Current	Power KW	Power Factor
R-	248	70	8.0	0.46
Y-	248	N/W	N/W	N/W
B-	248	N/W	N/W	N/W

- **Heroes Field**

Phase	Voltage	Current	Power KW	Power Factor
R-	245	23	3.9	0.70
Y-	245	26	4.6	0.72
B-	N/W	N/W	N/W	N/W

- **LD Baba Chauraha**

Phase	Voltage	Current	Power KW	Power Factor
R-	245	50	9.3	0.76
Y-	N/W	N/W	N/W	N/W
B-	N/W	N/W	N/W	N/W

- **High Mass In Front Of Church**

Phase	Voltage	Current	Power KW	Power Factor
R-	241	18	2.8	0.65
Y-	N/W	N/W	N/W	N/W
B-	N/W	N/W	N/W	N/W

- **High Mass Tower Neta Shubhash Chandra Ji Park**

Phase	Voltage	Current	Power KW	Power Factor
R-	241	48	7.5	0.65
Y-	N/W	N/W	N/W	N/W
B-	N/W	N/W	N/W	N/W

- **Jawaharlal Park Road Pole**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	9	1.6	0.67
Y-	N/W	N/W	N/W	N/W
B-	N/W	N/W	N/W	N/W

- **Jawaharlal Nehru Park**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	0.76	0.2	0.90
Y-	260	0.76	4.0	0.92
B-	260	0.76	3.0	0.52

- **Kargil Saheed Park**

Phase	Voltage	Current	Power KW	Power Factor
R-	255	16	3.3	0.81
Y-	255	30	4.0	0.76
B-	255	N/A	N/A	N/A

- **Laher Ki Devi Mandir 1**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	22	2.3	0.40
Y-	260	4.2	0.3	0.30
B-	260	N/A	N/A	N/A

- **Laher Ki Devi Mandir 2**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	10.4	1.5	0.55
Y-	260	N/A	N/A	N/A
B-	260	N/A	N/A	N/A

- **Laher Ki Devi Mandir 3**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	4.03	0.7	0.65
Y-	260	N/A	N/A	N/A
B-	260	N/A	N/A	N/A

- **Laher Ki Devi Mandir 4**

Phase	Voltage	Current	Power KW	Power Factor
R-	260	13.5	2.5	0.71
Y-	260	N/A	N/A	N/A
B-	260	N/A	N/A	N/A

- **Laher Ki Devi Mandir 5, Low Mass Tower**

Phase	Voltage	Current	Power KW	Power Factor
R-	257	2	0.5	0.96
Y-	257	N/A	N/A	N/A
B-	257	N/A	N/A	N/A

- **Divider, Awas Vikas Colony**

Phase	Voltage	Current	Power KW	Power Factor
R-	245	27	3.7	0.56
Y-	245	N/W	N/W	N/W
B-	245	14	1.9	0.55

- **Mayawati Colony Ward No. Block 7**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	17.5	2.5	0.60

- **Mayawati Colony Ward No. Block 12**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	1.3	0.2	0.50

- **Mayawati Colony Ward No. Block 18**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.2	0.3	0.61

- **Mayawati Colony Ward No. Block 14**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	1	0.1	0.60

- **Mayawati Colony Ward No. Block 17**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.2	0.3	0.52

- **Mayawati Colony Ward No. Block 21**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.1	0.3	0.66

- **Mayawati Colony Ward No. Block 121**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.3	0.3	0.60

- **Mayawati Colony Ward No. Block 100**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	6.43	0.8	0.50

- **Mayawati Colony Ward No. Block 77**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	8.87	1.3	0.61

- **Mayawati Colony Ward No. Block 06**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	1	0.1	0.60

- **Mayawati Colony Ward No. Block 83**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	5.5	0.7	0.52

- **Mayawati Colony Ward No. Block 01**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	1.4	0.2	0.66

- **Mayawati Colony Ward No. Block 86**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	4.06	0.6	0.60

- **Mayawati Colony Ward No. Block 23**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	4.8	0.6	0.50

- **Mayawati Colony Ward No. Block 44**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.3	0.3	0.61

- **Mayawati Colony Ward No. Block 61**

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	1.3	0.2	0.60

- **Sarandha Nagar Divider Ward No.2**

Phase	Voltage	Current	Power KW	Power Factor
R-	271	44	8.5	0.71
Y-	271	N/W	N/W	N/W
B-	271	30	5.4	0.66

Sarandha Nagar Divider Ward No.2,House No.22, Block -H

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	256	25.7	4.3	0.65

Sarandha Nagar Ward No.2,House No.67, Block -H

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	265	1	0.1	0.55

Sarandha Nagar Ward No.2,House No.27, Block -H

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.2	0.3	0.61

Sarandha Nagar Ward No.2,House No.7

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.1	0.3	0.66

Sarandha Nagar Ward No.2,House No.36, Block -H

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.2	0.3	0.52

Sarandha Nagar Ward No.2,House No.11, Block -H

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.3	0.3	0.60

Sarandha Nagar Ward No.2,House No.50

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	2.2	0.3	0.61

Sarandha Nagar Ward No.2,House No.19

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	6.43	0.8	0.50

Sarandha Nagar Ward No.2,House No.40

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	238	1	0.1	0.60

Bijolly Ward No.15,Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	265	16	3.0	0.70

Bijolly Ward No.15, Reliance Petrol Pump Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	265	11	1.7	0.60

Bijolly, Dr. Singh Clinic Ward No.15,Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	255	6	1.1	0.70

Bijolly Ward No.15, Reliance Petrol Pump Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	243	16	2.3	0.60

Bijolly Ward No.15, Low Mass Tower Near Shiv Maindir Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	243	15.3	2.4	0.64

Bijolly Ward No.15, Low Mass Tower Near Shamshan Ghat Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	243	10.8	1.7	0.64

Bijolly Ward No.15, Low Mass Tower Near Sanjay Nagar Road Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	255	16	2.9	0.72

Bijolly Ward No.15, Near Waste Exchange Center Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	243	22	3.3	0.61

Bijolly Ward No.15, Near Vijay Traders Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	243	9	1.3	0.61

Bijolly Ward No.15, Near Hanuman Mandir Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	255	16.8	3.1	0.72

Bijolly Ward No.15, Near Rajgarh Colony Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	244	2	0.3	0.61

Rajgarh + Vikas Nagar Colony Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	244	21.5	3.3	0.63

Rajgarh Near Bharat Petro Pump Main Road

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	240	11.3	1.7	0.63

Rajgarh Near Bharat Petro Pump Main Road, Low Mass Tower

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	240	8.6	1.4	0.69

Hazari, Near Max Hospital, Main Road

Phase	Voltage	Current	Power KW	Power Factor
R-	268	18	2.8	0.58
Y-	268	2	0.3	0.60
B-	268	27	4.6	0.63

Hazari, Near Himalya Marbel House Main Road, Low Mass Tower

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	240	4.3	0.7	0.69

Hazari, Near Kajal Electricals Main Road

Phase	Voltage	Current	Power KW	Power Factor

Single Phase supply	243	29	3.8	0.54

Hazari, Near Kajal Electricals Main Road, Ward No.2

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	250	18	3.0	0.66

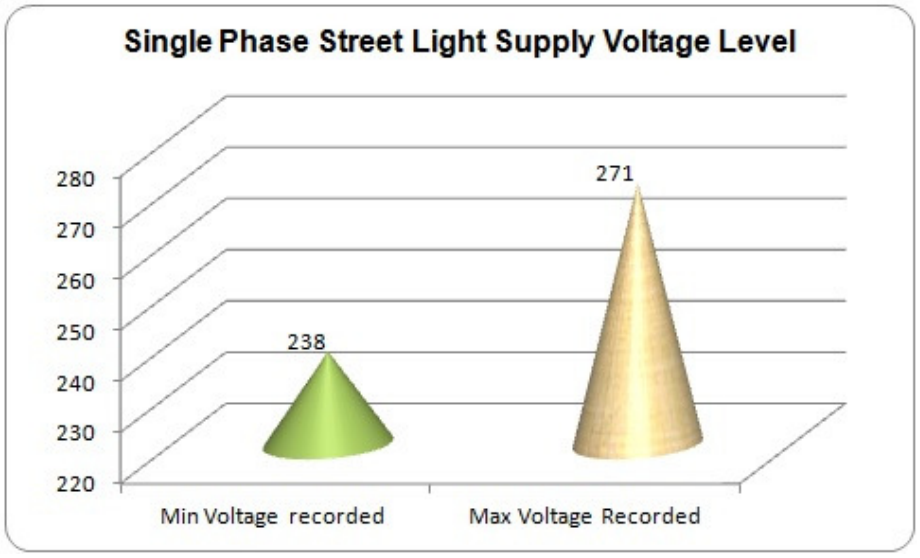
Bhatta Gaon, Main Road, Low Mass Tower

Phase	Voltage	Current	Power KW	Power Factor
Single Phase supply	240	31	5.1	0.69

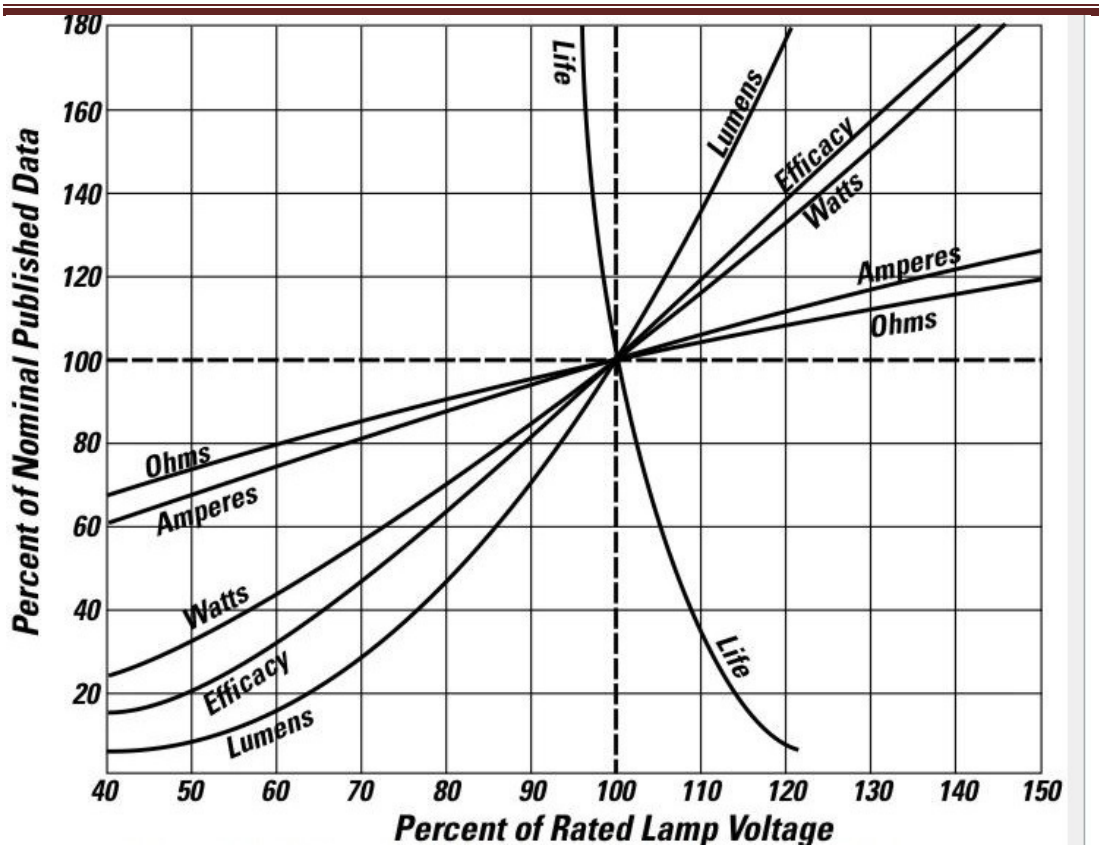
N/A = Out of order

5.2. CONCLUSION

From above on stable, supply voltage varies from 240 V to 271 V and our lamps are design to operate at max 240 V,



Max supply voltage recorded 13.8 % excess than the recommendation voltage. Various study has shown that 220V is sufficient to lit a lamp. Excess voltage increase lumen , but on other hand, it reduces life of lamp and chances of failure of lamp is higher, as may be clarify,.



So from above graph, If supply voltage is higher 10% than the design voltage, then life of will be only 40% of recommended life of lamp.

Voltage increases sharply in midnight i.e. around 1.00 hr and remain high up-to 4.00 hr to 5.00 hr in the morning and then, slowly decreases.

CHAPTER 6.
STUDY OF STREET LIGHTING

Public Street lighting system are finding it increasingly difficult to cope with an ever-increasing volume, density and speed of traffic. There is a dire need for maintenance- free and improved road lighting. Efficient road lighting means enhanced visibility and hence minimizing the risk of road accidents.

High Intensity Discharge Lamp due to its high luminous efficacy longer life and compact size is being preferred for public lighting installations. Since the surface brightness of the lamp is higher, optics of road lighting luminaires have to be specially designed not only for proper light distribution on the road surface, but also to prevent the direct glare from the luminaries.

TYPE OF LAMP TECHNOLOGIES

Various types of lamp technologies are prevalent in the market today. These technologies greatly vary in their luminous efficacy, color rendering properties, and lamp life. A brief description of types of lamp technologies currently available is provided in below table. Today, street lighting commonly uses high-intensity discharge lamps, often HPS high pressure sodium lamps.

Type of Lamp	Luminous Efficacy lm/W	Color Rendering	Lamp life in hrs.	Remarks
High Pressure Mercury Vapor (HPMV)	35-36 lm/W	Fair	10000-15000	High energy use, poor lamp life and contain Mercury
Metal Halide (MH)	70 - 130 lm/W	Excellent	8000 - 12000	High luminous efficacy, poor lamp life and contain Mercury

Type of Lamp	Luminous Efficacy lm/W	Color Rendering	Lamp life in hrs.	Remarks
High Pressure Sodium Vapor (HPSV)	50 - 150 lm/W	Fair	15000 - 24000	Energy-Efficient, poor color rendering
Low Pressure Sodium Vapor (LPSV)	100-190 lm/W	Very Poor	18000-24000	Energy-Efficient, very poor color rendering
Low Pressure Mercury Fluorescent Tubular Lamp (T12 & T8)	30-90 lm/W	Good	5000-10000	Poor lamp life, medium energy use, only available in low wattages. Contain Mercury.
EE Fluorescent Tubular Lamp (T5) Light Emitting	100-120 lm/W	Very Good	15000-20000	EE, long lamp life, only available in low
Diode (LED)	70 - 160 lm/W	Good	40000-90000	High energy savings, low O&M, long life, no Mercury, High Capital cost and evolving Technology

Currently installed street lighting in JHANSI NAGAR NIGAM is predominant HPSV technology. However, HPSV lamps are generally regarded as being inappropriate for night lighting. Because of a reflector attached behind the lamp of an HPSV, much of the luminance of the light is lost. This also produces light pollution in the surrounding area, which leads to inconvenient glare for drivers and pedestrians and this may cause roadways hazard. Although HPSV Technology is very good particularly in winter season, when roads are covered with fog & mist and it's yellow light help in traffic movement.

LED is latest and most energy efficient options available in the market for street lighting. Their brightness is much more uniform and can give up to 50% savings over Sodium Vapor lamps. But they are very expensive to buy with longer paybacks. They also produce less glare and can reduce visual fatigue for drivers and pedestrians. LEDs are also available with Solar option that can be an attractive and cost saving (but again one has to evaluate the payback period and

should be ready for the same). Typically they are rated to last for about 10 - 13 years, but as per feedback from some of our readers it needs to be protected from rust and insects to last longer

High Pressure Sodium Vapor lamp 70 W consumes power 32.4 kWh roughly in a month for 12 hours operation (including 20 W electricity consumed by ballasts & igniter). If equivalent lumen LEDs Lamps are used as replacements then a 48W (say 50W) LED panel is ideal for replacement of a 70 W HPSV.

Further EE gains can be achieved by combining LED with adaptive monitoring and control technologies. While adaptive lighting can be too demanding for some cities at this stage, there are some easy options to reduce energy demand such as installing a timing meter, to switch lamps at some point of time. For instance, Semarang switches off major parts of its street lighting after 1 am. However, it should be carefully evaluated whether this is an effective measure with respect to crosscutting issues like security on the roads

LED light did bring about a revolution in the space of the street lighting sector, where it is showing remarking improvement every generation in its efficacy, efficiency, and lumens there are key findings with respect to the different technologies' life cycle analysis (LCA).This provides insight for the policy makers to focus on the future trends to have maximum optimization from its street lighting sector.

LED lighting has the potential to save energy and improve lighting quality and performance beyond that of many conventional lighting technologies. However, in order to develop an energy use comparison for LED & HPSV lamps, it is necessary to estimate the life-cycle energy consumption of these two light technologies.

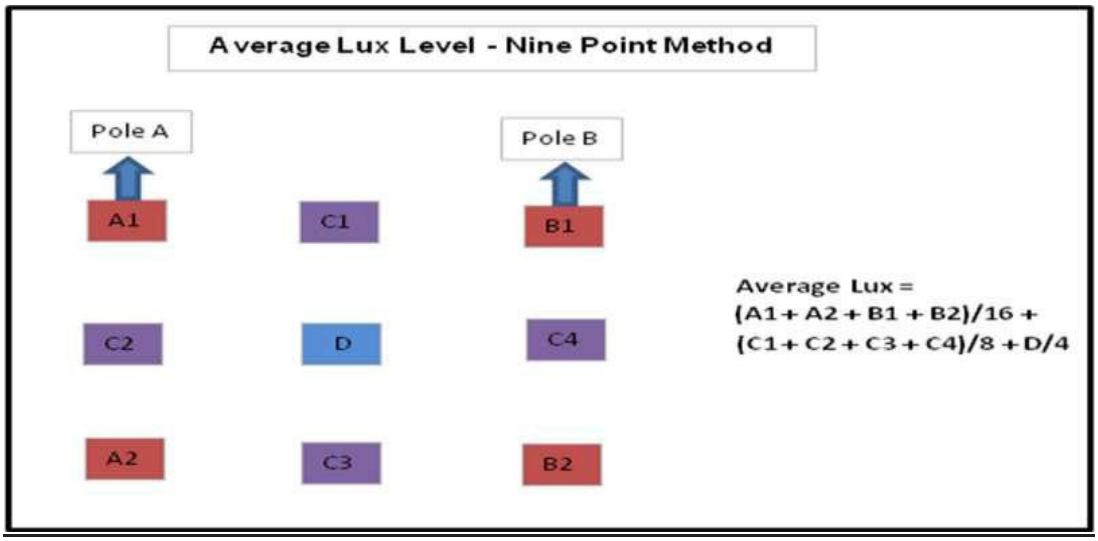
6.1. OBSERVATION ON PRESENT STREET LIGHT SENORIO

- **T**here is little uniformity for streetlight mounting in JHANSI with streetlights being mounted on lighting poles and LT domestic supply power poles etc, on smaller roads and less populated areas.
- Fixtures are not installed as per street dimension, availability of lux, requirement of lights etc.
- At some points, dark spots are observed due to irregular pole to pole distance, zebra effects, failure of fixture,

- MCB has been provided at each new installation particularly installed at road divider or approachable. road with timers. These street lights operates automatic through timers provided at supply feeders.
- In markets, colonies or in old installation e.g. NAGARA, BHATTA GAON, SIPRI BAJAR etc, street light operation controlled by manually (by nearby shop owner local peoples etc) through neutral cross connection.
- Power consumption monitoring system is missing.
- Lighting on street level is not uniform within city area with some smaller roads having very scattered lighting. The newer installations in JHANSI are more uniform in lighting than old one. Fixture spacing or distance between pole to pole varies.
- Majority of the colonies and smaller alleyways have staggered lighting, with a small percentage of them being over illuminated.
- Some of fixtures are mounted towards house instead of road side.

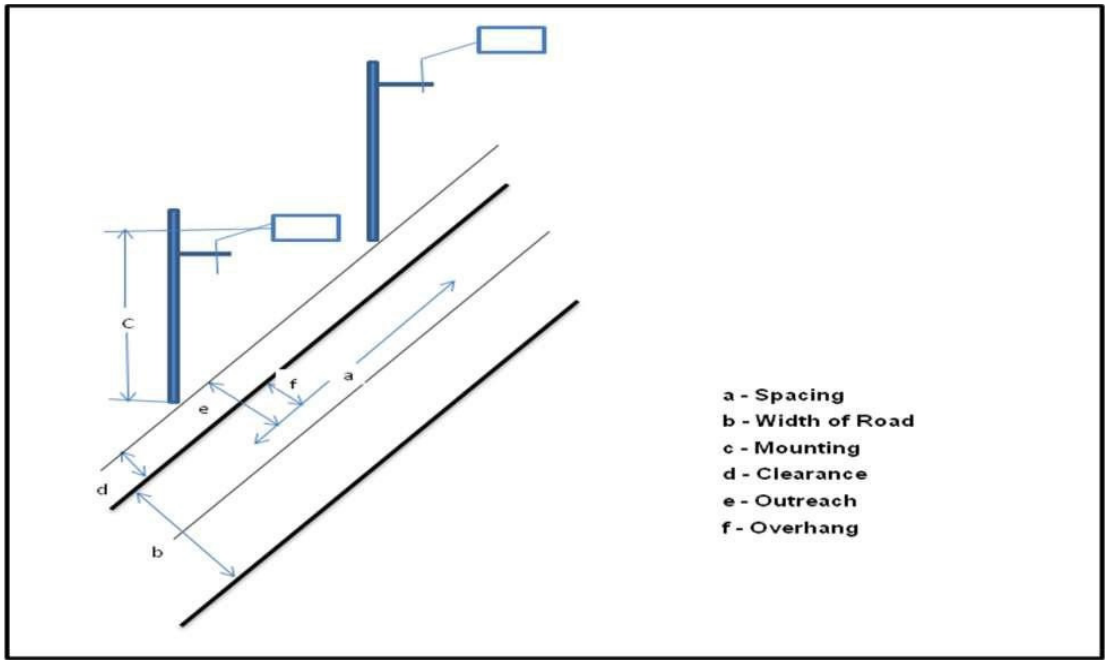
Illumination Measurement Methodology:

The 9-point method Lux measurement method is most practical and acceptable. The figure below illustrates the layout of a 9-point measuring grid of the kind sometimes used when checking new road lighting installation. Explained below in figure is the weighting procedure that should be followed when calculating average lighting level.



6.2. ILLUMINATION LEVEL

As per the nine point method any two poles of street lights were selected on sample. Illumination levels at different points between the poles as shown in the figure below were measured. The same was then averaged to give the average illumination level of the road.

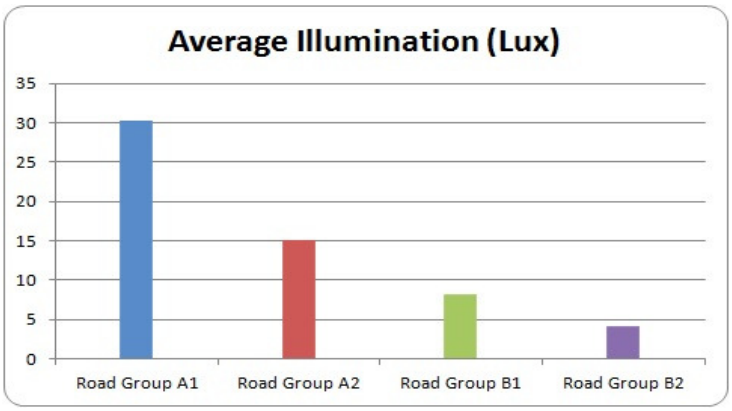


- Arrangement of luminaries along with the road mainly depends on the road width. All luminaries on one side of the road is recommended only when the width of the carriage way is equal to or less than the mounting height.
- Staggered arrangement is recommended when the width of the road is greater than the value recommended for the single side lighting but not exceeding 1.5 times the mounting height.
- Luminaries on either side of the road are advisable when the width of the road is more than 1.5 times the mounting height. Axial mounting in which the luminaries are placed along the axis of the road, is recommended for the narrow roads where the width of the road does not exceed the mountain height. This is more acceptable for tree lined roads.
- For purpose of Demo study, the streets have been categorized as below.

Categorization of Roads for Street Lighting		
Group A	Group A1	Very important routes with rapid and dense traffic where the only considerations are the safety and speed of the traffic and the comfort of the Drivers e.g. Elite to Bus Stand, Elite to B.K.D Chauraha, Elite to Sipri Bajar etc
Main Roads	Group A2	Other main roads with considerable mixed traffic like main city streets, arterial roads and thoroughfares e.g. Elite to Allahabad Bank, Punchkueya Road etc.
Group B	Group B1	Secondary roads with considerable traffic, such as principal local traffic routes, shopping streets etc. Gwalior Road from B.K.D to Railway crossing etc
Secondary Roads	Group B2	Secondary roads with light traffic E.G. Sipri Bajar, etc
Group C		Residential and unclassified roads not included in the previous groups, e.g. Nagara etc

Illumination level according to road

	Required Illumination	
Road Type	**Average Illumination (Lux)**	**Ratio Illumination (minimum/average)**
Group A1	30	0.4
Group A2	15	0.4
Group B1	8	0.3
Group B2	4	0.3



6.3. FIXTURE HEIGHT

The mounting height fixture should be greater as the road way is wider to obtain adequate transverse uniformly. The 9 to 10 meters mounted height of fixtures are suitable for heavy traffic group A1 roads and 7.5 - 9 meters fixture height is suitable for medium traffic roads. Height of less than 7.5 meters is acceptable on residential roads or roads bordered by trees. Standard luminaire spacing for different curb-to curb width of roads is given

Curb to curb Width (m)	Spacing (m)	Mounting Height (m)
18 – 28	36.5 - 45	12
12 – 23	45 – 55	9.75
11-13.5	48-60	9.75
8.5- 13.5	48-60	4.5

6.4. LUMINARIES EFFICIENCY CALCULATION FORMULA

This formula is used to decide wattage of luminaries.

- Street illumination level in Lux (E)=(Al x (cu x mf)) / (w x d)
- E = The illumination in Lux
- w = Width of the roadway
- d = Distance between luminaries

- cu = Coefficient of utilization. Which is dependent on the type of fixture, mounting height, width of roadway and the length of mast arm of outreach (Normally 0.29).
- Al = Average lumens, Al = (E x w x d) / Cu x mf
- The typical value of Al is
- 20500 lumens for 400 Watt HPSV
- 11500 lumens for 250 Watt HPSV
- 4000 lumens for 70 Watt HPSV
- The value of Al varies depending upon the type of lamp specified.
- mf : It is the maintenance factor (Normally 0.9)

Wattage of luminaries is calculated on the basis of data measured from site

Description	**1**	**2**	**3**
Luminaries HPSV Wattage	400	250	70
Chock Rating Watt	40	25	20
Total Wattage HPSV Luminaries	440	275	90
Average Lumen lm	20500	11500	4000
Luminous efficacy lm/W	47	42	44

- **Verification of Installation of 400 Watt HPSV Fixtures**

Description		Unit
400 HPSV		
Average width of road (w)	8	M
Average Distance between each Pole (D)	40	M
Required Illumination Level for Street Light (L)	15	
Luminous efficacy	46.6	lm/W
Maintenance Factor (mf)	0.29	
Coefficient of Utilization Factor (cu)	0.9	
Average Lumen of Lamp Installed	20500	Lumen

Description		Unit
400 HPSV		
Average Lumen of Lamp (Al)	18391	
Watt of Each Street Light Laminar	395	Watt
Suggested Luminaries Wattage	400	Watt

400 HPSV luminaries are installed very few numbers, particularly in side or narrow road, where installation of street light pole is difficult or for more glowing of structure.

- **Verification of Installation of 250 Watt HPSV Fixtures**

Description		Unit
250 Watt HPSV		
Average width of road (w)	12	M
Average Distance between each Pole (D)	30	M
Required Illumination Level for Street Light (L)	8	
Luminous efficacy	41.8	lm/W
Maintenance Factor (mf)	0.29	
Coefficient of Utilization Factor (cu)	0.9	
Average Lumen of Lamp Installed	11500	Lumen
Average Lumen of Lamp (Al)	11034	Lumen
Watt of Each Street Light Laminar	264	Watt
Suggested Luminaries Wattage	250	Watt

250 W HPSV are mostly installed in shopping areas, side road, single road etc

- **Verification of Installation of 70 Watt HPSV Fixtures**

Description		Unit
70 Watt HPSV		
Average width of road (w)	10	m
Average Distance between each Pole (D)	20	m
Required Illumination Level for Street Light (L)	5	lm
Luminous efficacy	44.4	lm/W
Maintenance Factor (mf)	0.29	
Coefficient of Utilization Factor (cu)	0.9	
Average Lumen of Lamp Installed	4000	Lumen
Average Lumen of Lamp (Al)	**3831**	Lumen
Watt of Each Street Light Laminar	86	Watt
Suggested Luminaries Wattage	70	Watt

70 Watt HPSV fixtures are installed, at group road A & A1, particularly at divider or widen road.

Oservation

- Max height pole used is 10 meter for group A 1 & Grough A2 road., particularly at divider or broad road.
- Full cut off lights are installed at heavy traffice road (Divider light and main rao group A1).
- In Group B1, B2 and Group C roads, mostly non cut off type lighting system are installed.
- High Mast tower lighting are installed almost all Chauraha (road crossing) and height of high mast varies with area of chauraha,. These all are installed as Full Cut type.

6.5. ILLUMINATION LEVEL AT HIGH MAST AREA

Conventional lighting systems are those using mounting heights of 50 feet or less. This description is used to differentiate between conventional mounting heights and high mast lighting, which uses mounting heights of 50 feet or more.

Installation cost comparisons between high mast and conventional lighting systems vary widely, depending on the application. High mast lighting for interchanges is frequently less expensive to install than conventional lighting, due to reduced complexity of conduit and conductor and the smaller number of fixtures and poles required. Outside the interchange, conventional lighting usually requires a smaller initial cost.

Lux has measured at different location High Mast Installed,

High Mast Location	Lamps installed	Wattage of Lamp	No. of Lamps Installed	High Mast Height m	Lux Level	Distance Where Lux measured
PUNCH KUINYA	HPSV	250	4	12	26	15.3
ASHIK CHAURAHA	HPSV	250	4	12	21	8.2
B.K.D Chauraha	LED	50	8	20	12	15.6
ALLAHABAB BANK	LED	100	6	12	42	12.9
Elite Chauraha	LED	150	16	25	14	30.5
NAGARA TIRAHA	HPSV	259	8	6	16	8.1
Khandera Gate Chauraha	HPSV	250	4	10	16	13.2

6.6. FAILURE OF LAMPS

As discussed in previous chapter (Study of Street Light), major cause for failure of lamps are high voltage supply and following table also depicted same.

Description	No.
250 Watt Lamps Replaced (From Apr to Sept 2016	2112
70 Watt Lamps Replaced (From Apr to Sept 2016	2496

CHAPTER 7.
BASE LINE ENRGY CONSUMPTION

7.1. BASE LINE ENERGY CONSUMPTION

Base Line Energy Consumption parameter is a reference data to assess the energy saving will achieved after implemented of energy saving measures in term of quantity or percentage. it is also necessary to fix the annual consumption of energy before implementation of the energy saving measures and then compare the same with the consumption when the energy savings measures have been implemented under monitoring & verification. It also provides information about the, what will be energy consumption pattern in future.

For above calculation, the data collection involved both primary & secondary data capture. This method is quite useful in the fixation of Baseline. Normal operation of street light is on average 12 hours a day (most of street light operates manually.

Annual operating hours of street light is 12x365 hr= 4380 hr.

7.2. DETAIL OF STREET LIGHT INSTALLED

Ward No.	Ward Name	70W HPSV	250 W HPSV	400 W HPSV
1	Hansari Girdh First	94	136	
2	Hansari Girdh Second	190	235	
3	Saiyar Gate Out Side	84	112	
4	Bhatta Gaon	125	201	3
5	Mashiha Gang	94	121	
6	Nainagarh	237	220	4

Ward No.	Ward Name	70W HPSV	250 W HPSV	400 W HPSV
7	School Pura	172	146	4
8	Tal Pura First	185	236	
9	Khushi Pura First	144	179	
10	Simaradha	134	91	1
11	New Basti First	211	133	2
12	Talpura Second	124	171	1
13	Gariya Gaon	175	141	
14	Khushi Pura Second	185	216	
15	Bijjoly	191	121	
16	Esai Tolla Second	81	63	4
17	Kachiyana First No.09	146	87	
18	Gudari	65	30	
19	New Basti Second	136	107	2
20	Bangala Ghat	143	214	
21	Nainagarh South First	149	219	1
22	Esaitolla First	196	316	8
23	Simaraha	92	62	1
24	Lahar Gird First	89	110	
25	Hirapura	123	140	4
26	Kochabhawar	290	115	1
27	Bagicha P. No. 09	85	83	
28	Nainagarh South Second	210	179	

Ward No.	Ward Name	70W HPSV	250 W HPSV	400 W HPSV
29	Pichore	320	316	1
30	Sagar Gate	178	216	
31	Lahar Gird Second	55	50	2
32	Nandpura Second	150	163	
33	Oraucha Gate Outside Second	107	234	
34	Nandpura First	101	177	
35	Oraucha Gate Outside First	220	188	
36	Aligoal Second	190	157	
37	Aligoal First	285	319	
38	Chhaniapura	86	150	
39	Nandpura Second	149	177	
40	Tallya	138	221	
41	Dariyapura First	166	76	1
42	Civil Lines South Part First	114	236	2
43	Civil Lines South Part Second	209	266	1
44	Outer Dattya Gate First	295	316	1
45	Daryapura Second	285	260	
46	Mawatipura	185	239	26
47	Khanderaw Gate Outside	184	244	2
48	Premganj First	121	119	5
49	Premganj Second	119	87	
50	Outer Dattya Gate Second	107	129	3

Ward No.	Ward Name	70W HPSV	250 W HPSV	400 W HPSV
51	Civil Lines West	100	201	
52	Civil Lines North	206	318	2
53	Ajad Ganj	87	122	
54	C.P. Misson Compound	153	144	
55	Nana Ganj	84	105	
56	Toria Narsingh Rao	204	127	2
57	Mukarayana	156	165	
58	Durubhondala	69	63	
59	Gusaipura	177	264	3
60	Laxmani Ganj	209	214	
61	Main Road Divider		384	
62	Street Light March To December, 2016	9359	10631	87
	Extra Fixtures added Between Apr 2016 to Sep -2016	1234	1085	6
	Total	**10859**	**13131**	**87**
	HPSV Rating Watt	70	250	400
	Chock Rating Watt	20	25	40
	Total	90	275	440
	Total power consumption Watt	953370	3221900	40920
	Total power consumption kWh	953.37	3221.9	40.92
	Total connected Load kWh	4216.19		

There is difference in sanctioned load and actual connected load. It may be due to installation of new luminaries in current years.

Power cost =10.0 Rs. /kW contract demand

Annual Street light Electricity (JHANSI NAGAR NIGAM First +Second)

CHAPTER 8.
RECOMMENDATION ENEGY EFFICIENCY LED INSTALLATION

RECOMMENDATION

- **Installation of 5% Energy Efficient LED in place of conventional luminaries**

Like others ULB, JHANSI NAGAR NIGAM has also started energy efficiency program at sample basis. as per solar city guide line, to replace 5% street light with energy efficiency lights.

But this adaptation totally depends on their technical competence (how much they know) and financial condition (how much money they have). In order to accelerate the Municipal Energy Efficiency Programs it becomes inevitable to introduce ESCOs into the picture to take the march ahead. ESCOs will fund the Municipal Energy Efficiency Program which will be repaid over the time from the stream of project benefits.

8.1. TOTAL STREET LIGHT CONNECTED LOAD

Street Light Connected Load		
JHANSI NAGAR NIGAM FIRST	2227	kW
JHANSI NAGAR NIGAM SECOND	1800	
Total	4027	
5% of total street light connected Load	201.35	kW
Say	250	kW

As per scope of work 5% of energy saving program, to replace reduce 250 kW load by installation of LED Light.

It is suggested here to replace all 87 no. 400 Watt HPSV with equivalent lumen produced by 150Watt LED light. Energy Saving has worked out as below,

400 Watt HPSV Fixture Installed	93	
Power consumed 87 no 150W LED Power	13.95	kW
Power Consumed by 87 no. 250W HPSV lamp	40.92	kW
Energy Saving After Replacement Lamps	26.97	kW

After Replacement of 93 no. 400 Watt HPSV lamp with 150 Watt LED lamp , power will save only 26.97 kW say 25 kW. Thus it is adviced to replace 250 W HPSV lamp with equivalent lumen output 150 W LED Lamp to achieve energy saving 250kW i.e 5% of total saving .

Further reduction through replacement of 250 Watt HPSV with 50 LED	225	kWh
Power Consumption in 250 W HPSV Lamp (including chock)	275	Watt
Power Consumption in 150 LED Lamp	150	Watt
Energy Saving after Replacement of 250 W HPSV with 150 LED Lamp	0.125	kW
No. of 250 W HPSV lamp to be replaced to achieve target.	1800	no.

8.2. INVESTMENT

Higher Initial investment cost of LED is main constraint to implement EE program beside it's number of merits particularly environment friendly, long life and consume less power etc. Although, price LED lamp has fallen down sharply in last year and financial burden for replacement of lamps has gradually reduced. EE program for retrofitting in ULB for street light has gradually pickup. another reason behind is availability of ESCO models, where profit sharing market developed. Quality of LED is depend on its gear installed inside LED lamp to

control supply voltage supply. There are two type gears are available. First one called constant voltage type gear and another one is constant current gears.

Energy saving has worked out for replacement conventional lamps. .

Total contact demand	4027	kW
Proposed Energy Saving as per Scope of Work (5%)	201.35	kW
Say	250	kW
Monthly Power Saving	90000	kW
Monthly CD charges	3600	Rs. / kW
Annual Power Saving	1080000	kWh
Annual Energy Saving	108	Rs. In Lakh

\

Since, there is no monitoring system installed, thus un-metering tariff is followed. Thus it is essential to reduce contact Demand by installation of energy efficient street light system and it is necessary to reduce contact demand around 250 kW and annual saving will be around Rs.108.00 Lakh (10.8 Lakh kWh) .

JHANSI NAGAR NIGAM has installed three type of lamps, 70 Watt, 250 Watt and 400 Watt HPSV lamps. 400 W HPSV Lamp generates same lumen as 150 watt LED lamp and gives maximum power saving output. Similarly lumen output of 150 LED is same as 250 Watt HPSV lamp generate.

To achieve target of 5% power consumption, it is necessary to replace first replace all 400 Watt HPSV lamp then replace 250 Watt HPSV Lamp.

Energy Saved	108.00	Rs.in Lakh
Price of 150 Watt LED Lamp with three year guarantee	15000	Rs. Per lamp
Total Investment for 400 HPSV replacement. Lamp	13.95	Rs. in Lakh
Price of 100 Watt LED With Three yea guarantee	10000	Rs. / Unit
Total Investment on Purchase of 800 no. 100W LED Lamp	90.00	Rs. in Lakh
Total Investment on Purchase of LED Lamps	103.95	Rs. In Lakh
Excise Duty @ 4%	4.16	Rs. In Lakh
CST @ 14.50%	15.07	Rs. In Lakh
Transportation Cost @5% of Basic cost	5.20	Rs. In Lakh

Erection Cost @ 5% of Basic cost	5.20	Rs. In Lakh
Total	133.58	Rs. In Lakh
Simple Payback Period	15	months

Total annual saving will around Rs. 68.17 Lakh per Annam simple payback period will be 8 Months.

After installation of LED lamp, additional benefit to the ULB will be substantial reduction in maintenance and repair cost of the light fittings because of the extended life of the fittings since the voltage level to these fittings are regulated through our energy saving equipment.

8.3. ESCO OR/ BANKABLE MODEL

For finance of this energy saving project, ESCO and bank finance both mode is available. Bank finance analysis has been done the basis of 40% Equity. and following assumption basis.

Sr. No.	Description		
1	Total	133.58	Rs. In Lakh
2	Energy Saved	108	Rs. Lakh
3	Power Saving	10.80	kWh in Lakh
4	Equity	40.00	%
5	Total Equity	53.43	Rs. In Lakh
6	Total Debt	80.15	Rs. In Lakh
7	Interest on Debt	12	%
8	Tariff Escalation	5	%
9	Repair & Maintained Cost	3	%
10	Repair & Maintained Cost Escalation	2	%

Sr. No.	Description		
11	Depreciation Rate	15	%
12	P & M Cost (for 1st year)	2	%
13	P & M Cost (after 1st year)	1	%

8.4. PROJECT COST

Project Cost	133.58
Equity	40%
No. of years for debt	5
Total Investment Required (Lakh Rs)	133.58
Total Equity (Lakh Rs)	53.43
Total Debt (Lakh Rs)	80.15

8.5. REPAIR AND MAINTENANCE COST:

In order to ensure the decided energy efficiency levels and sustaining the savings R&M cost is estimated about 5% of project capital cost. Estimates of the project R&M cost is 338.12 lakhs. During the first year of the project R&M cost is covered under the warranty by the equipment manufacturers; however the project implementer (ESCO or ULB) has to carry out R&M for post warranty period.

8.6. MONETARY SAVINGS/ BENEFIT

The primary benefit for the ULB is considerable savings on the energy front in street lighting area.

The additional benefit to the ULB will be substantial reduction in maintenance and repair cost of the light fittings because of the extended life of the fittings since

the voltage level to these fittings are regulated through our energy saving equipment.

8.7. PROJECT CASH FLOW AND SUMMARY BENEFITS

The Table below provides the list of assumptions made in financial model for IRR estimation for ESCO Mode as well as ULB Mode business models. The Financial Model is attached as below,

8.8. FINANCIAL ANALYSIS

Year	0	1	2	3	4	5	6	7	8	9	10
Capital Cost of LED Lamps (Rs. in Lakh)	133.58	-	-	-	-	-	-	-	-	-	-
Tariff, Rs/ Unit	10.00	10.50	11.03	11.58	12.16	12.76	13.40	14.07	14.77	15.51	16.29
Energy Saved (Lakh kWh/annum)	-	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80	10.80
Total Saving (Rs. Lakh)	-	113.40	119.07	125.02	131.27	137.84	144.73	151.97	159.57	167.54	175.92
Revenue (savings), in Rs.in Lakh	-	113.40	119.07	125.02	131.27	137.84	144.73	151.97	159.57	167.54	175.92
Repair & Maintenance Cost of LED Fixtures (Rs. Lakh)	-	-	4.01	4.13	4.21	4.29	4.38	4.47	4.56	4.65	4.74
PMC Cost		2.67	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34	1.34
Total Expenditure (Rs. Lakh)	-	2.67	5.34	5.46	5.55	5.63	5.72	5.80	5.89	5.98	6.08
Interest on Debt (Rs. Lakh)	-	9.62	8.42	6.01	3.61	1.20	-	-	-	-	-
Earnings Before Tax (Rs. Lakh)	-	101.11	105.31	113.55	122.12	131.01	139.01	146.16	153.67	161.56	169.84
Depreciation Cost (Rs.Lakh)	-	20.04	17.03	14.48	12.30	10.46	8.89	7.56	6.42	5.46	4.64
Taxable Earning (Rs. Lakh)	-	81.07	88.28	99.07	109.82	120.55	130.12	138.61	147.25	156.10	165.20

Year	0	1	2	3	4	5	6	7	8	9	10
Tax (Rs. Lakh)	-	27.57	30.02	33.68	37.34	40.99	44.24	47.13	50.06	53.07	56.17
Net Cash Flow (Rs. Lakh)	(133.58)	73.55	75.30	79.86	84.78	90.02	94.77	99.04	103.61	108.49	113.67
Cumulative Cash Flow (Rs lakh)	(133.58)	(60.03)	15.27	95.13	179.92	269.94	364.71	463.74	567.35	675.84	789.51

Project IRR	58.78%
Payback in Months	17

8.9. INSTALLATION OF LED DIMMER

In the night between 1.0 am to 4.0 am, traffic on road reduced and in this period luminaries lumen may be reduced. LED lamp with dimmer are now using in street facility. Initial cost of dimmer is (Rs. 5000 - 6000/- per piece for three channels) too and payback period is 3 to 4 years.

CHAPTER 9.
RECOMMENDATION - SPV SYSTEM

Solar power is remarkable source energy and has a potential to fulfill our future energy demand. Of course, there are some challenges on the way. However, with continuous Research and Development (R&D), approach towards our goal of ensuring survival of our future generations is in right way. Solar energy is Carbon Neutral energy for lighting and other purpose is not new. Pole -top solar PV module with battery based installed urban areas as well as rural areas under MNRE program is a unique example of innovative solar photovoltaic (PV) device. Similarly Rooftop solar PV, is another innovative idea to generate power by small investors and more than 1,00,000 Solar PV system has been installed battery based under MNRE Program.

A large number of urban & rural people get benefited though pole to solar module base street light, although such PV module found some inherent limitations, such as:

- Mostly low powered and not suitable for urban areas.
- Illumination level and burning hours reduce with the passage of time mainly due to short life of battery.
- Battery is stolen in many of the cases and thereafter the street light becomes non-functional
- which also results in theft of PV modules and other items subsequently.
- In most of the cases batteries are not replaced after 4–5 years, resulting non-functionality of the street-light.
- Maintenance levels of such street lights are very poor or negligible.. .

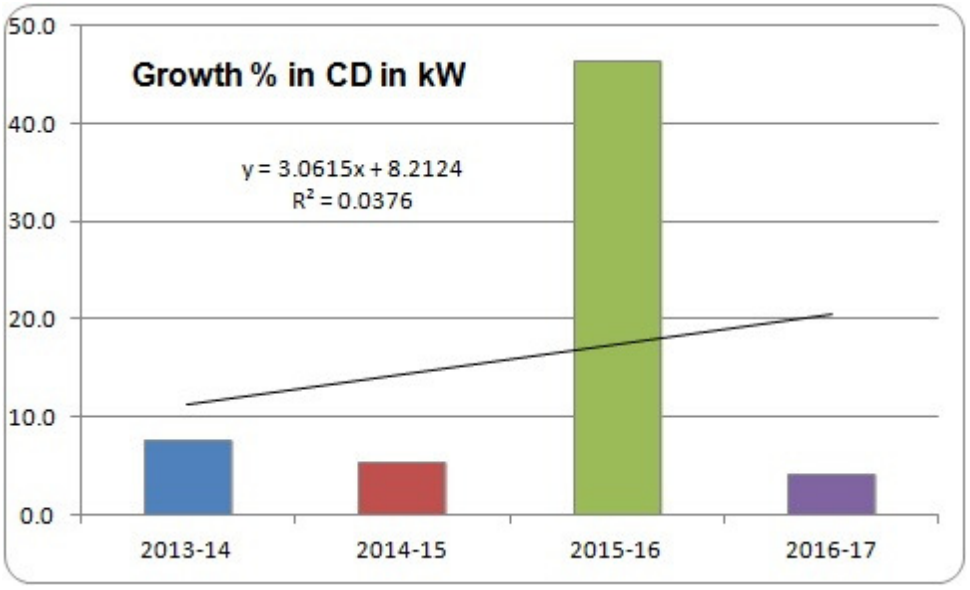
In view of above, MNRE has stated program called **"SOLAR CITY"**, under which ULB has to develop a policy towards self realization and to install high capacity SPV system with more sustainable, reliable and cheaper power supply for longer period.

As per Solar City guideline, the capacity of SPV system for street light should be decide forecast of data for next five year on the basis of growth in a sector in last five year. ,

9.1. STREET LIGHT FORCOSTING

Years	No. of consumer	Growth % in consumer	Connected Load kW	Growth % in CD	Energy consumption MU	Growth % in Energy Consumption	Energy Consumption per consumer	Energy Consumption per consumer
2012-13	1457	0	29065		104		71379.547	
2013-14	1463	0.4	31266.0	7.6	119.0	14.4	81339.7	14.0
2014-15	1468	0.3	32954.0	5.4	126.0	5.9	85831.1	5.5
2015-16	1531	4.3	48236.0	46.4	244.0	93.7	159373.0	85.7
2016-17	1604	4.8	50223.0	4.1	269.0	10.2	167705.7	5.2
Average	**1517**	**2.5**	**38348.8**	**15.9**	**172.4**	**31.1**	**113125.8**	**27.6**
2017 - 18	1554		44433.3		225.9		144344.6	
2018 - 19	1592		51483.1		296.1		184178.7	
2019 - 20	1631		59651.5		388.0		235005.7	

UP ERC 2016-17



Average growth in street light power consumption is about 27.6% and in street light contract demand is 15.9% as per data provided by UPERC. Tariff applicable for JHANSI NAGAR NIGAM street light is LMV-3 un-meter billing based on contract demand for street light. Thus considering "Growth in Contract Dement" as a rate for forecasting power demand in JHANSI NAGAR NIGAM street light

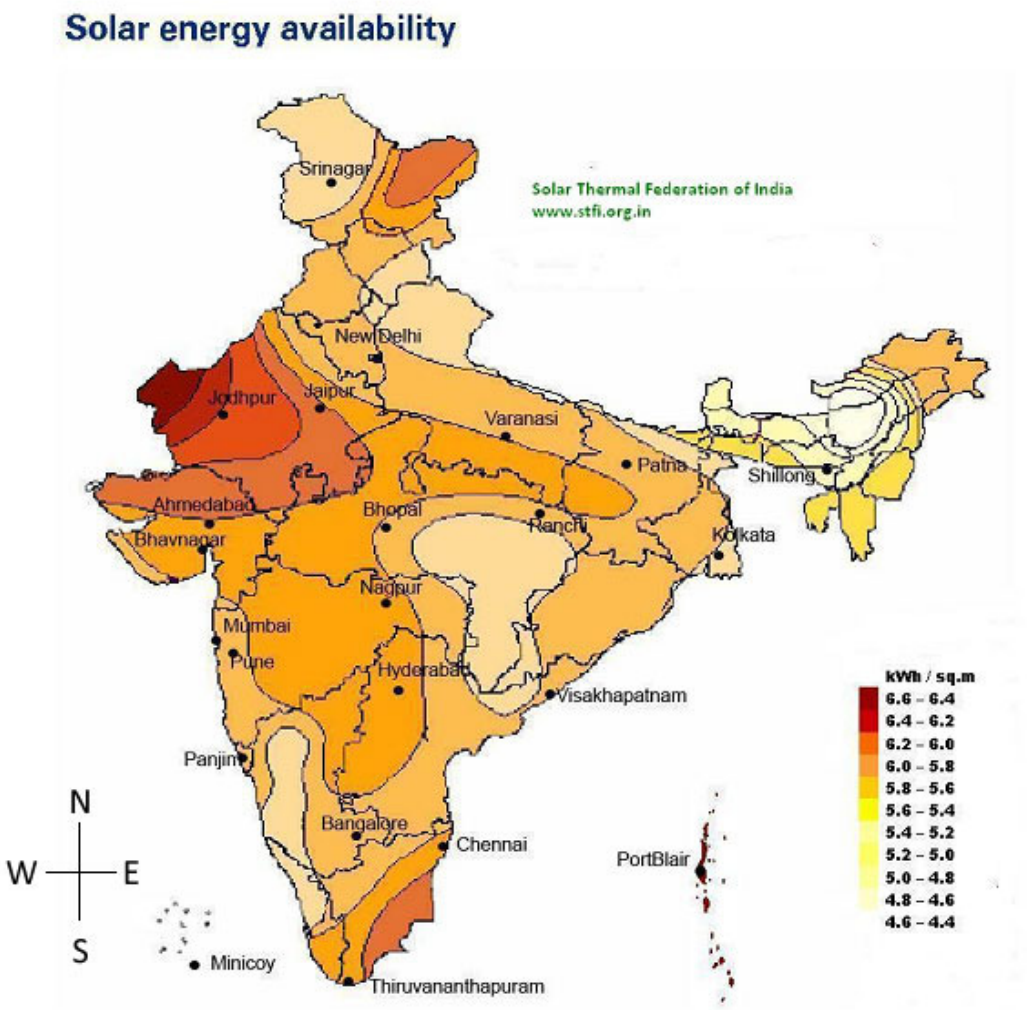
Particulars	**2016-17**	**206-17**	**2017-18**
Growth in Electricity Consumption in Street Light Electricity y in JHANSI NAGAR NIGAM kW	4027	5138	6556
5% of CD in kW			328
Capacity of SPV plant (say) to be installed kW			350

9.2. SPV SYSTEM OF 350 KW

Brief Detail of Project

SITE DETAIL

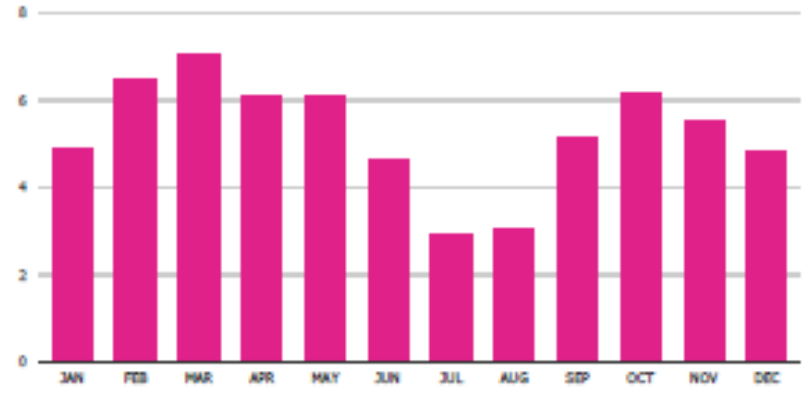
Solar maps



Solar Radiation = 6.2 to 6.8 kWh/sq meter

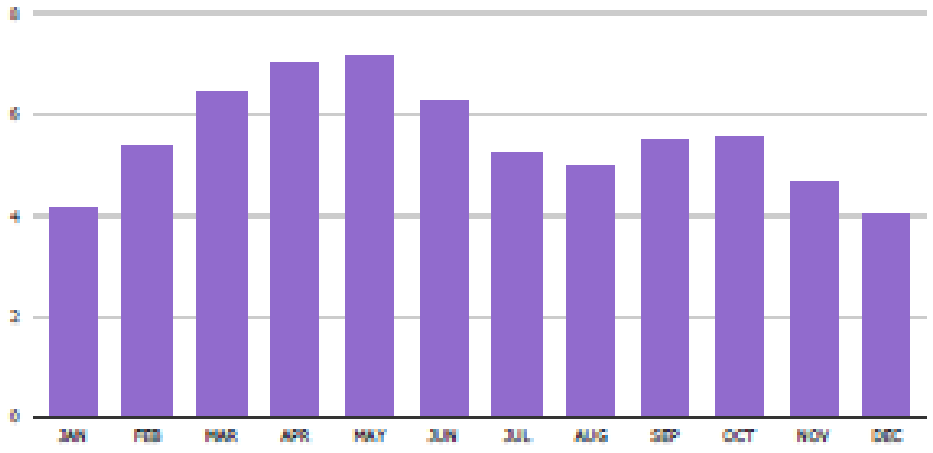
Solar Irradiance

Monthly Average	
JAN	4.89
FEB	6.49
MAR	7.04
APR	6.12
MAY	6.10
JUN	4.66
JUL	2.95
AUG	3.08
SEP	5.19
OCT	6.16
NOV	5.53
DEC	4.84



Monthly Average

JAN	4.17
FEB	5.35
MAR	6.45
APR	7.03
MAY	7.17
JUN	6.27
JUL	5.23
AUG	4.96
SEP	5.50
OCT	5.56
NOV	4.66
DEC	4.02

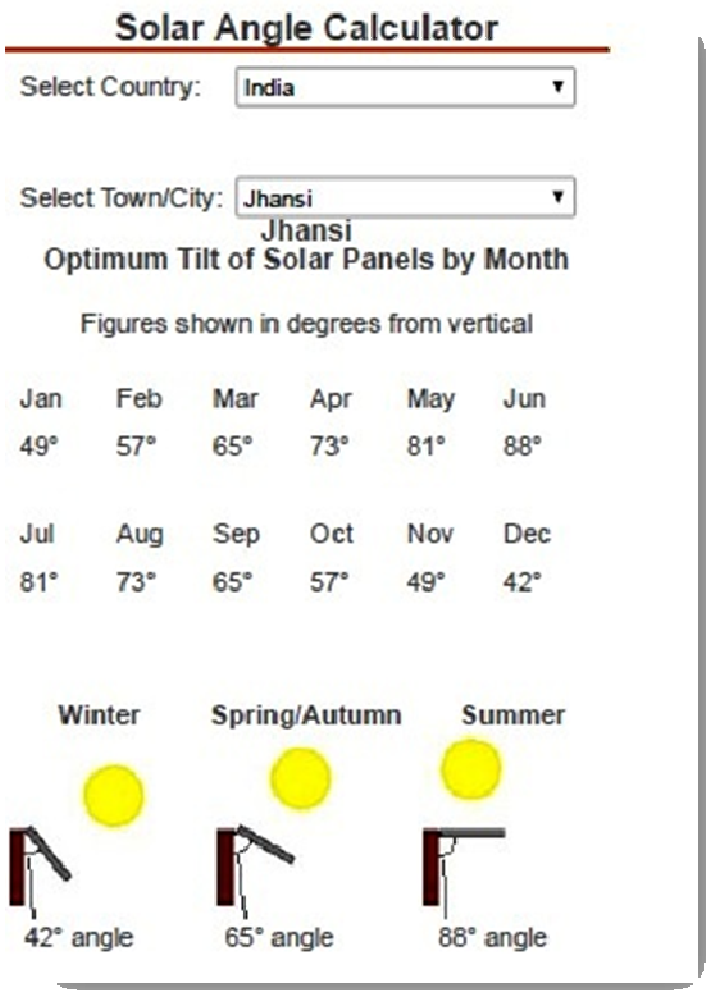


CLIMATOLOGICAL TABLE

PERIOD: 1971-2000

Month	Mean Temperature(^{O}C)		Mean Total Rainfall (mm)	Mean Number of Rainy Days	Mean Number of days with			
	Daily Minimum	Daily Maximum			HAIL	Thunder	FOG	SQUALL
Jan	7.4	23.3	9.2	0.9	0.0	0.1	0.9	0.0
Feb	10.3	26.9	9.6	1.0	0.0	0.0	0.1	0.0
Mar	15.8	33.3	7.7	0.7	0.0	0.1	0.0	0.0
Apr	21.9	39.3	2.3	0.5	0.0	0.5	0.0	0.0
May	26.3	42.3	13.9	1.3	0.0	1.0	0.0	0.0
Jun	27.3	40.5	85.0	4.9	0.0	1.3	0.0	0.0
Jul	24.6	34.0	270.4	12.3	0.0	1.0	0.0	0.0
Aug	23.7	32.2	286.2	13.1	0.0	0.9	0.0	0.0
Sep	22.8	33.3	165.3	7.0	0.0	0.2	0.0	0.0
Oct	19.1	33.9	31.8	1.6	0.0	0.1	0.0	0.0
Nov	13.2	29.6	6.3	0.5	0.0	0.0	0.2	0.0
Dec	8.5	24.5	3.6	0.5	0.0	0.1	0.8	0.0
Annual	18.4	32.9	891.3	44.2	0.0	5.3	2.1	0.0

II Angle



Notes

On the 21st December, the sun will rise 79° east of due south and set 79° west of due south. On the 21st March/21st September, the sun will rise 91° east of due south and set 91° west of due south

On the 21st June, the sun will rise 103° east of due south and set 103° west of due south. site survey to identify any potential obstructions at different times of the year.

Particulars	
Location	JHANSI UP
Latitude	25.4484257 ^{o} N
Longitude	78.5684594 ^{o} E
Area of SPV Plant	4000 Sq meter
SPV Plant Capacity	350 kW
No. of Modules	1500 (240Wp)
Inverter	3
No. of String	3
Type of module (BOSCH)	Mono Crystalline
Dimension	1660x990x2 mm
Electrical parameter	
Max Power Rating	240 Wp
Rated Current A	8.32 A
Rated Voltage V	30.26
Short circuit current	8.60 A
Open Circuit Voltage	37.40 V
Mounting Arrangement	Auto Tracking
Central Inverter	3 no.
Rated Capacity	500 kW
Input voltage	240 V DC
Output voltage	415 V AC
Frequency	50 Hz
Efficiency	98.3%
Grid Connected Detail (if Installed)	

Electrical Parameter for interconnection	415 V 3Ph3 Ph, , 50 Hz
Annual energy Generation	520000 kWh
Construction Period	15 Week
Technical Data	
Battery V	12
Connected Load	350
Hr	12
Depth of Discharge Factor	0.6
Battery in Series	20 no.
Voltage of System	240 V
Nominal Voltage of Battery	12 V
no. of battery in series	20 no.
no. of Batteries in parallel	780 no
Ah of Battery bank	
Connected Load	350 kW
Average Daily Load	4212000 Watt
Inverter Eff	90 &
System Voltage	240 V
Average Amp- hr Day	19500 Ah/day
Day of Autonomy	4
Discharge limited on Battery	50 %
Battery AH Capacity	200 Ah
Batter Output Voltage	12 V
Battery no.	780 no.
Batteries in Series	20 no.
Battery Eff.	80 %
Peak Sun Hrs/Day	4.1

Array Peak Amps	5945 A
Array Amps/ module	10
Modules in Parallel	595
Module Short Circuit	5.34 A
Modules in Series	20 no.
Module in Parallel	5 no.
Array Short Circuit Amps	33.38 A
MF	1.25
Array Short Circuit Amps	33.38 A
Controller Array Amps	44 A
Total Connect Load	350 kW
Estimated Surge Watts.	1053 kW
No. of module	4000 no.
Area	7 Acres (JHANSI NAGAR NIGAM has sufficient Open Area)

9.3. KEY COMPONENTS OF SOLAR

Solar PV MODULES:

The system will be based on high quality mono-crystalline modules mounted on fixed steel constructions. The proposed solution will generate power during daytime only and will not include any power storage. A PV Array is made up of PV modules, which are environmentally - sealed collections of PV - cells the devices that convert sunlight to electricity. Mono – crystalline solar module of 240Wp is being used in the proposed Project. The tech spec and IEC certificate of the said modules are attached.

Panel generation factor = 4.32

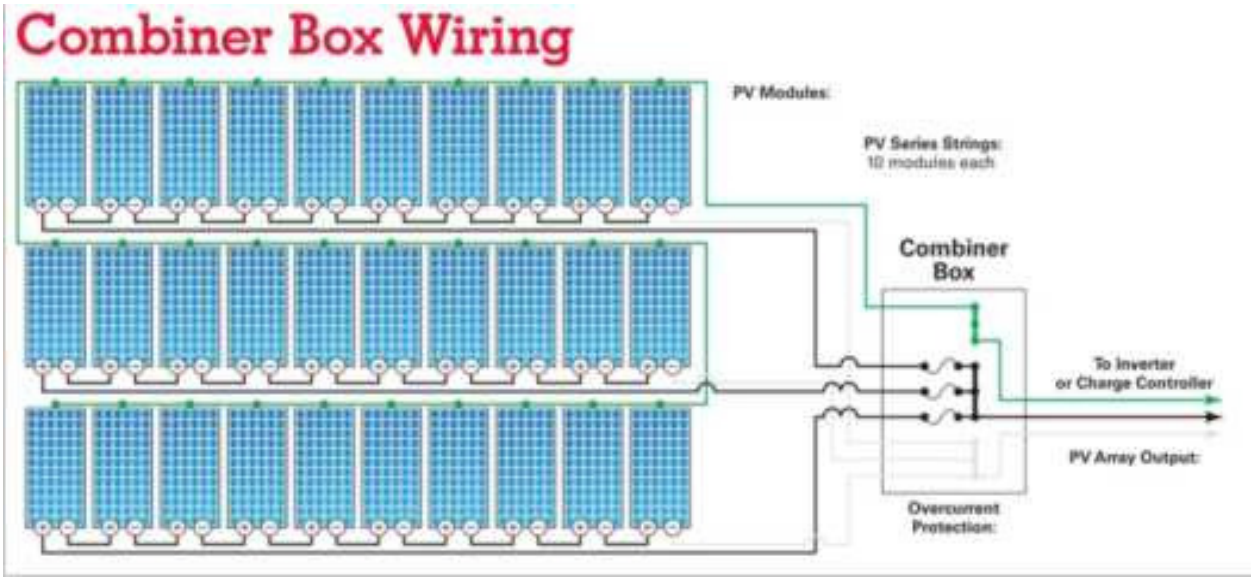
CENTRAL INVERTERS:

The grid connected inverter range is state-of-the-art equipment with robust control platform, high efficiency, high availability, low maintenance and advance features built with quality components. The product is available in range of 100kW, 500kW, 630 KW & MW solutions in three phase configurations. Optimized efficiency factor, higher availability (by proven long life components), the latest control procedure are key features. 98.3% max. efficiency, high standards features innovative ventilation system that prevents unwanted heating and dust accumulation.

Inverter size Peak Load *1.30

STRING BOXES:-

String boxes minimize the number of DC cables that enter the central inverter in medium and high power photovoltaic installations by grouping together different chains of PV panels. These string boxes are typically enclosed in IP 65 rated polycarbonate housing. Robustness: Boxes of the highest standard of quality, fully integrated cabling, with strong electrical protection and casings that resist the toughest of outdoor conditions; with an ingress protection of IP65. Flexibility: Standard boxes of 16, 24 and 32 strings with multiple options such as double output terminals of up to 240 mm^2.



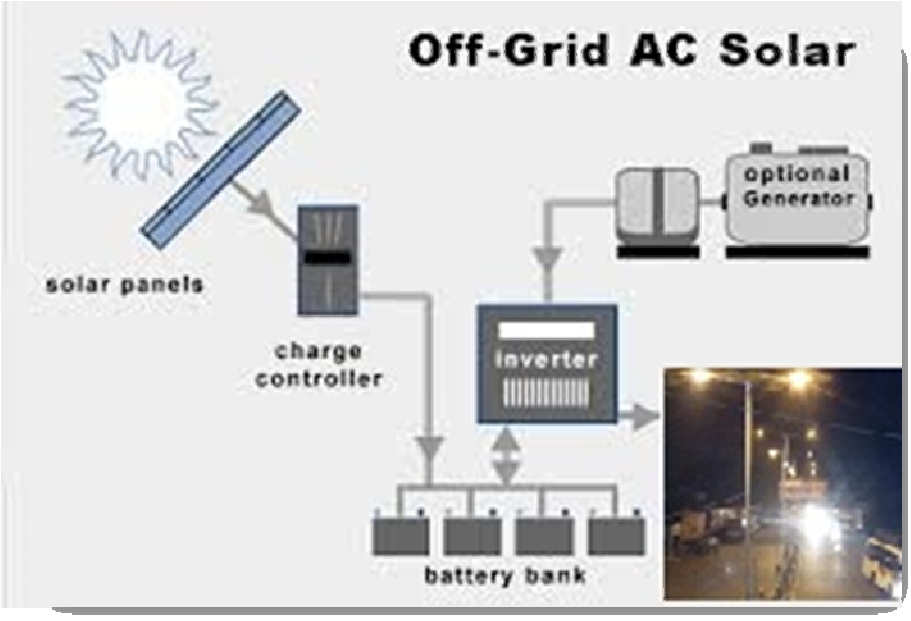
String Box: -

Module Mounting System

The module mounting structure is designed for holding suitable number of modules. The frames and leg assembles of the array structure is made of Hot Dip Galvanized materials with suitable Channel, nuts, bolts and any other section conforming to the Solar PV system to meet the design criteria. For this project, we'll use the best structure available in India, designed to provide maximum durability and longevity.

CABLES AND CONNECTORS:-

Cables will be extremely robust and resist high mechanical load and abrasion. High temperature resistance and excellent weatherproofing characteristics provide a long service life to the cables used. The connectors with high current capacity and easy mode of assembly are to be used for the connections of the power plant cables.



9.4. OPERATION & WARRANTY

The system performance can be improved as much as, by cleaning the dirt on the panels, tightening loose connections and proper maintenance in inverters.

- Full System Warranty from GAMESA 1 year
- Solar Panels (BOSCH)

10 YEARS PRODUCT WARRANTY
0 - 10 YEARS FOR 90% OF RATED POWER
10 - 25 YEARS FOR 80% OF RATED POWER

- Inverters (GAMESA ELECTRIC) 5 years
- Module Mounting structure 5 years

9.5. PROJECT IMPLEMENTATION

The project is planned to be implemented in the JHANSI NAGAR NIGAM, JHANSI.
The most essential aspect regarding the implementation of this project is to ensure that the project will completed within the schedule, spanning 15 weeks from the receipt of In-Principle approval from MNRE.

A good planning, scheduling, and monitoring program is imperative to complete the project on time and without cost overruns.

PROJECT SCHEDULE:

350 kW Ground Solar PV Grid Interactive - Project Schedule																	
Project Milestone Chart																	
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
PO with Advance																	
Submission of Detailed Project Report																	
Approval of Design Aero Space			-														

In Principle approval from MNRE																	
Procurement of BOM & Delivery at Site																	
Handover of site by Aero Space																	
Mechanical & Civil Installation																	
Electrical Installation																	
Commissioning																	
Testing, Certification & Handover																	

-

Life expectancy of components

Particulars	Life
PV module	25 years
Regulator	15 year
Inverter	10-15 years
Solar Battery	5 years
Wiring	10 years

9.6. CASE -1 SPV SYSTEM WITH ONE DAY BATTERY BACK-UP OTG

To study feasibility of SPV system, it is necessary to develop different option. In first option, chosen a SPV system with one day battery backup. Battery cost is high and quantity of battery depend up how long power back is required. For one day battery backup SPV system with OTG (off-the grid), financial analysis has estimated as below,

Since Peak Sunshine Hours per Day for India is 4.1hr/ day. So, 350 kW modules will produce 350 kW power at 100% efficiency for 4.1 hr. But street lights operates 12 hrs per days. Thus it is necessary to install SPV system of capacity, which can produce power for 12 hr street light operation at least .i.e. 350x12/4.1 kW.

Particulars		Unit
SPV Rating	350	kW

Particulars		Unit
	350000	Watt
Working hours per day	12	Hr
Average Wh per day	4200000	Wh
Day of Autonomy	1	Day
Normal Battery Voltage	12	V
Depth of Discharge	60%	
Required Battery back Capacity	29166	Ah
Voltage of system	240	V
Nominal voltage of battery	12	V
No. of Batteries in series	20	no. (Series)
Battery Rating Ah	200	Amp hour
Battery bank Rating in Ah	17500	Ah
Batteries in Parallel	146	no.
Total batteries Required	2920	No.
Battery cost	10000	Rs/ per Battery
Total Battery Cost	29200000	Rs.
	292	Rs. In Lakh
Daily Average Ah Taken from the battery	17500	Ah per day
Efficiency of Battery	80%	
Average Ah per Day to be Supplied by array	21875	Ah per Day
Peak Sunshine hours per Day	4.1	Hr/day for India
Array Peak Amp	5336	Amp
Peak Amps per Module	8.32	Amp
Module Connected in Parallel	642	No.

Particulars		Unit
Battery Bank Voltage	240	V
Max Power Rating	240	Wp
Rated Current	8.32	A
Rated Voltage	30.26	V
Short circuit current	8.6	A
Open Circuit Voltage	37.4	V
No. of Modules in Series	8	No.
Total No. of Modules	5136	No.
Total Power Generation Capacity of SPV system	**1233**	**kW**

Project cost has been estimated as below on the basis of present market unit price,

sr.	Particulars	Rate	Qty	Rs.
1	Solar panels,240W @STC	35/W	5136	43142400
2	Mounting structure	8000/kW	1200	9600000
3	Inverter	5000/kW	3	750000
4	Cables	2000/kW	1200	2400000
5	Battery, 12V/200Ah	10000	2920	29200000
6	Combiner box	6000	1200	7200000
7	Main junction box	8000	100	800000
8	Fuses & Disconnects	3000	3 Set	9000
9	Protection switches	500	100	50000
10	Energy monitoring meter	4000	1	4000
11	Remote control and monitoring system	200000	1	200000
12	Total			93355400
13	Excise Rebate	12.50%		6276625
14	Net			87078775
15	Installation Cost	5%		4353939

sr.	Particulars	Rate	Qty	Rs.
16	Miscellaneous	5%		4353939
17	Project, design and Engineering Cost	5%		4353939
18	**Total Project Cost**			100140591
19	Subsidiary 30%			26123633
20	**Net Project Cost**			**74016959**

Total project cost will be around Rs. 740.17 Lakh after avail 30% subsidiary provided by central/ state Government/ NABARD and custom & Excise duty exemption (12.50%) ON BOM under CCDC & EDEC.

SUMMARY & OTHER ASSUMPTION

To meet project cost, various option are available in market, like PPP model, ESCO Model and loan from EREADA and NABARD

Sr. No.	Description		
1	Total	740.17	Rs. In Lakh
2	Energy Saved	153.33	Rs. in Lakh
3	Power Saving	15.33	kWh in Lakh
4	Equity	20.00	%
5	Own Contribution	148.03	Rs. In Lakh
6	Battery Cost	292.00	Rs. In Lakh
7	Other equipment cost	448.17	Rs. In Lakh
8	Total Debt	592.14	Rs. In Lakh
9	Interest on Debt	12	%
10	Tariff Escalation	5	%
11	Repair & Maintenance Cost	1	%
12	Repair & Maintenance Cost Escalation	2	%
13	Depreciation Rate		
a.	Battery	20	%
b.	Other Equipment	4	%
14	P & M Cost (for 1st year)	2	%
15	P & M Cost (after 1st year)	0	%

9.7. FINANCIAL ANALYSIS

Particulars	**Years**										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital Cost of SPV Plant (Lac Rs)	740.17	-	-	-	-	-	-	-	-	-	-
Tariff, Rs/ Unit	10.00	10.50	11.03	11.58	12.16	12.76	13.40	14.07	14.77	15.51	16.29
Energy Saved (Lac kWh/annum)	-	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33
Total Saving (Lac Rs)	-	160.97	169.01	177.46	186.34	195.65	205.44	215.71	226.49	237.82	249.71
Revenue (savings), in Lac Rs.	-	160.97	169.01	177.46	186.34	195.65	205.44	215.71	226.49	237.82	249.7
Repair & Maintenance Cost of SVP system (Lac Rs)	-	-	7.40	7.48	7.63	7.78	7.93	8.09	8.25	8.42	8.59
Salary		12.00	13.44	15.05	16.86	18.88	21.15	23.69	26.53	29.71	33.28
PMC Cost		14.80	0	0	0	0	0	0	0	0	0
Total Expenditure (Lac Rs)	-	26.80	20.84	22.53	24.48	26.66	29.08	31.78	34.78	38.13	41.86

Particulars	Years										
	0	1	2	3	4	5	6	7	8	9	10
Interest on Debt (Lac Rs)	-	71.06	63.48	53.32	41.13	26.64	9.56	(10.46)	(33.78)	(60.84)	(92.11)
Earnings Before Tax (Lac Rs)	-	63.11	84.69	101.61	120.73	142.35	166.80	194.39	225.50	260.53	299.95
Depreciation Cost (Lac Rs) Other Equipment	-	17.93	17.21	16.52	15.86	15.23	14.62	14.03	13.47	12.93	12.41
Depreciation Cost (Lac Rs) Battery her Equipment		58.40	58.40	58.40	58.40	58.40					
Total Depreciation Cost		76.33	75.61	74.92	74.26	73.63	14.62	14.03	13.47	12.93	12.41
Taxable Earning (Lac Rs)	-	45.18	67.48	85.09	104.86	127.13	152.18	180.36	212.03	247.60	287.54
Tax (Lac Rs)	-	15.36	22.94	28.93	35.65	43.22	51.74	61.32	72.09	84.18	97.76
Net Cash Flow (Lac Rs)	(740.17)	47.74	61.75	72.68	85.07	99.13	115.06	133.07	153.41	176.35	202.19
Cumulative Cash Flow (Lac Rs)	(740.17)	(692.42)	(630.68)	(558.00)	(472.93)	(373.80)	(488.85)	(355.8)	(202.38)	(26.03)	176.16

Particulars	Years										
	0	1	2	3	4	5	6	7	8	9	10
Project IRR	10.06%										
Payback in Years	6	Years									

\

CONCLUSION: -

Above financial analysis is with one day battery back power supply. total battery cost is around 30% of total project and reduced the IRR to 10.06% & higher payback period (around six years).

One day battery back for street light power supply will not the serve purpose of solely solar power supply to street light, particularly in winter and rainy season. If dual power supply (SPV supply & DVNNL supply) utilized means huge financial loss.

Two Day Battery Back power

IRR for two day battery back power will be around 7.48% and payback period will be around seven and half years, if equity is 50::50 .

Thus, in view of present scenarios, grid connected financial model developed in below case study.

9.8. CASE -2 SPV SYSTEM GRID CONNECTED NET MEETERING

Grid connected SPV system will supply power generated in day times to state utility and withdraw power in night under Net metering system from state utility. It will reduced project cost and maintenance cost. power supply will be more reliable than OTG SPV system particularly in winter and rainy season.

Since, under net metering, net energy consumption will be equal to export of energy. Thus, energy charges will be almost nil, but will pay equivalent to fixed electricity charges. Thus it is necessary to install energy meter at street light feeding points. Hence, It is also recommend to install energy meter at power supply feeding covered under SPV net metering system (Approx 20 meter) Supply power to these points through 11 kV transformer. Which installed for export of solar power in day time.

Export Power Quality

Harmonic distortion is caused principally by non-linear load such as rectifiers and arc furnaces and can affect the operation of a supply system and can cause overloading of equipments such as capacitors, or even resonance with the system leading to overstressing (excessive voltage & current). Other effects are

interference with telephone circuits and broadcasting, metering errors, overheating of rotating machines due to increased iron losses (eddy current effects), overheating of delta connected winding of transformer due to excessive third harmonics or excessive exciting current.

ii. The limits for harmonics shall be as stipulated in the CEA Regulations on grid connectivity which are as follows:

a. Total Voltage harmonic Distortion= 5%

b. Individual Voltage harmonics Distortion=3%

c. Total Current harmonic Distortion=8%

Voltage Unbalance

The Voltage Unbalance at 33 kV and above shall not exceed 3.0%.

Voltage Fluctuations

(i) The permissible limit of voltage fluctuation for step changes which may occur repetitively is 1.5%.

(ii) For occasional fluctuations other than step changes the maximum permissible limits is 3%.

It is also necessary to installed, harmonics & power quality maintain equipments.

Cost of Grid connected SPV system

Sr. No.	Particulars	Unit Rate	Qty	Rs.
1	Solar panels,240W @STC	35/W	5136	43142400
2	Mounting structure	8000/kW	1200	9600000
3	Inverter (PCU)	5000/kW	3	750000
4	Cables	2000/kW	1200	2400000
5	Battery, 12V/200Ah	12000	0	0
6	Transformer of 1500 kVA 433v / 11kV)	10000	2920	150000
7	Transformer Other Accessories (CTs, PTs, OCB etc)			150000
8	Charge controller			1000000
9	Combiner box	6000	1200	7200000
10	Main junction box	8000	100	800000
11	Fuses & Disconnects	3000	3 Set	9000

Sr. No.	Particulars	Unit Rate	Qty	Rs.
12	Protection switches	500	100	50000
13	Energy monitoring meter	4000	20	80000
14	Remote control and monitoring system	200000	1	200000
15	Total			65531400
16	Excise Rebate	12.50%		2798625
17	Net			62732775
18	Installation Cost	5%		3136639
19	Miscellaneous	5%		3136639
20	Project, design and Engineering Cost	5%		3136639
21	**Total Project Cost**			72142691
22	Subsidiary 30%			18819833
23	**Net Project Cost**			**53322859**

Total Project cost is Rs. 533.23 Lakh.

Summary and assumptions are as below,

Project is design for 20.00% equity.

Sr. No.	Description		
1	Total	533.23	Rs. In Lakh
2	Energy Saved	153.3	Rs. Lakh
3	Power Saving	15.33	kWh in Lakh
4	Equity	20.00	%
5	Own Contribution	106.65	Rs. In Lakh
6	equipment cost	533.23	Rs. In Lakh
7	Total Debt	426.58	Rs. In Lakh
8	Interest on Debt	12	%
9	Tariff Escalation	5	%
10	Repair & Maintenance Cost	1	%
11	Repair & Maintenance Cost Escalation	2	%
12	Depreciation Rate	4	%
13	For Other Equipment	4%	
14	P & M Cost (for 1st year)	2	%
15	P & M Cost (after 1st year)	0	%

Sr. No.	Description		
16	Salary	12	Rs. Lakh
17	Escalation in salary	12	%
18	Fixed Monthly electricity charges per year	12.6	Rs. In Lakh
19	Escalation in Monthly Fixed Electricity Charges per Annam	5	%

Financial analysis of grid connected net metering has done as below,

No. of years for debt	12	Years
Total Investment Required Rs)	533.23	Rs. in Lakh
Total Equity (Lac Rs)	125.62	Rs. in Lakh
Total Debt (Lac Rs)	407.61	Rs. in Lakh

9.9. FINANCIAL ANALYSIS

Particulars	**Years**										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital Cost of SPV system grid connected (Rs. Lakh)	533.23	-	-	-	-	-	-	-	-	-	-
Tariff, Rs/ Unit	10	10.5	11.03	11.58	12.16	12.76	13.4	14.07	14.77	15.51	16.29
Energy Saved (Lac kWh/annum)	-	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33	15.33
Total Saving (Lac Rs)	-	160.97	169.01	177.46	186.34	195.65	205.44	215.71	226.49	237.82	249.71
Revenue (Share of ESCO in savings), in Lac Rs.	-	160.97	169.01	177.46	186.34	195.65	205.44	215.71	226.49	237.82	249.7
Repair & Maintenance Cost (Lac Rs)	-	-	5.33	5.39	5.49	5.6	5.72	5.83	5.95	6.07	6.19
Salary		12	13.44	15.05	16.86	18.88	21.15	23.69	26.53	29.71	33.28
PMC Cost		10.66	-	-	-	-	-	-	-	-	-
Fixed Electricity Charges		12.6	13.23	13.89	14.59	15.32	16.08	16.89	17.73	18.62	19.55
Total Expenditure (Lac Rs)	-	35.26	32	34.33	36.94	39.8	42.94	46.4	50.2	54.39	59.01
Interest on Debt (Lac Rs)	-	48.91	39.7	28.02	14.21	-2.01	-20.96	-42.97	-68.45	-97.82	-131.6
Earnings Before Tax (Lac Rs)	-	76.79	97.31	115.11	135.19	157.87	183.45	212.28	244.74	281.24	322.26
Depreciation Cost (Lac Rs) Other Equipment	-	21.33	20.48	19.66	18.87	18.12	17.39	16.7	16.03	15.39	14.77
Total Depreciation Cost		21.33	20.48	19.66	18.87	18.12	17.39	16.7	16.03	15.39	14.77
Taxable Earning (Lac Rs)	-	55.46	76.84	95.46	116.32	139.75	166.06	195.59	228.71	265.85	307.49
Tax (Lac Rs)	-	18.86	26.12	32.45	39.55	47.52	56.46	66.5	77.76	90.39	104.55

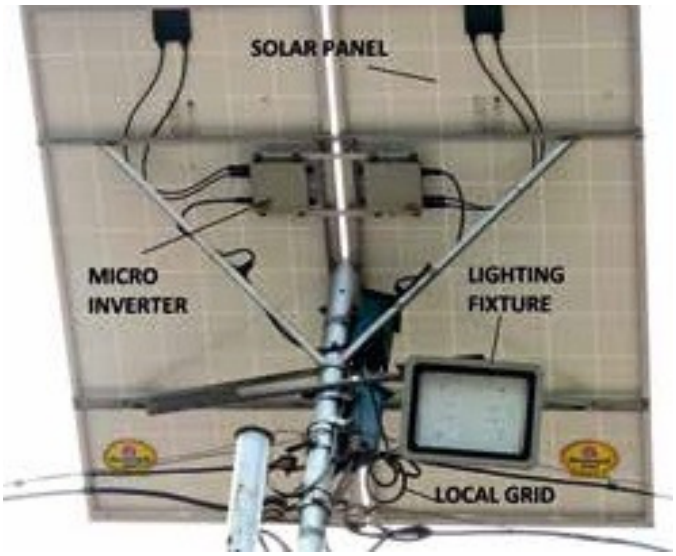
Particulars	Years										
	0	1	2	3	4	5	6	7	8	9	10
Net Cash Flow (Lac Rs)	-533.2	57.93	71.19	82.66	95.64	110.35	126.99	145.78	166.98	190.85	217.72
Cumulative Cash Flow (Lac Rs)	-533.2	-475.3	-404.1	-321.5	-225.8	-115.5	-242.5	-96.7	70.31	261.16	478.88
Project IRR	**10.00%**										
Payback in Years	**5**	Years									

Conclusion

Total project cost for grid connected SPV system would be Rs. 533.23 Lakh and payback period will be 5 years and IRR will be 10% . In this model, power supply will be more reliable in cloudy days than previous model

9.10. CASE STUDY-3. POLE MOUNTED PANEL WITH MICROINVERTOR

A new technology has developed pole mounted battery less solar street lights and provides more reliable where power through micro inventor installed inside solar panel. Export power during day time to grid and draw power in night.



Such Solar system even could be operated with solar panel up to 200-W LED, which gives light almost as good as a 400-W High Pressure sodium vapor lamp. The advantages of this new solar system is as below,

- ✓ High illumination level matching with urban needs
- ✓ Much reliable since the street light works with grid power during night time
- ✓ No batteries resulting in recurring expenses almost nil
- ✓ Totally climate responsive
- ✓ No additional infrastructural cost except solar panel and micro-inverter
- ✓ Continuous monitoring possible to ensure carbon neutrality.

Components of a Battery-less Solar PV Street Light with 200-W LED Lamps

- 2 x 150-W Solar PV panel (crystalline)
- Pole-top mounting frame of the PV modules
- 300-W grid tied micro-inverter to be installed just below the solar panel
- Carbon Neutrality Manager (CNM) for group monitoring of the system about export of solar power and import during night time to keep the street lights carbon neutral.

The CNM dims lamp if necessary in the midnight automatically in case there are continuous cloudy days. However, it ensures minimum lux level required for urban areas..

Basic Requirements to Install Grid Connected Solar Street Lights

The basic requirements for the above are as follows: (i) Availability of reliable grid and pole; and (ii) Permission to connect micro-inverter with grid under the State Electricity Regulatory Commission order.

Energy Saving Potential

There is a very high potential of solar street lights planted on flyovers, bridges, etc, in Indian cities, where power availability is more than 95 per cent and, therefore, carbon neutral street lights may be installed.

Cost of Pole Mounted Micro-invertors

The cost of generation varies from Rs.6.00–Rs.7.00/kWh depending on the site conditions. Whereas electricity generation cost from battery based solar street light works out to be Rs.20.00/kWh (mainly due to very high cost of battery). Indian cities where power supply is reliable may opt for carbon neutral solar street light at this stage. Proven technology is available.

The estimated cost for installation for one such type of solar streetlight (complete in all respects) works out to be Rs.50,000 – Rs.55,000. The program could be executed through ESCO Model or from CSR Fund of power utilities.

Limitation

This technology has some limitation as below,

- It can't be installed shaded area or limited space area, particularly in shopping area, congested or busy market area, side lane etc.
- There is no system installed to control power quality, particularly to control harmonics, voltage flicker etc. .
- Maintenance & repairing cost is high.
- Cleaning of panel surface is costly & difficult, while big size normal can easily cleaned. .

This system is suitable only for small size Solar power plant. Thus, selection of this system is left to JHANSI NAGAR NIGAM decision.

CHAPTER 10.
METERING SYSTEM FOR STREET LIGHT

In present scenario, DVNNL supply electricity for street light under un-metering system under tariff code LMV - 3 and per unit cost to JHANSI NAGAR NIGAM is around Rs. 10.0 kWh, while metered supply electricity cost to JHANSI NAGAR NIGAM is quiet low as estimated below,

10.1. TARIFF CODE

Description	Un- metered Supply	Metered Supply	
	Nagar Nigam	Nagar Nigam	
All Load	Rs. 3500 per kW or part thereof per month	Fixed Charges	Energy Charges
		Rs. 160 /kW /month	Rs. 6.25 / kWh

DVNNL Tariff LMV - 3 2016-17 tariff

Monthly Street light Bill of Jhansi Nagar Nigam 1st + 2nd = Rs. 14497200.00

Without any taxes/ duty or surcharge

Total Contract Demand =2227+1800=4027 kW

Total Contract Demand	4027	kW
Per Day street Light operation hours	12	hrs
Monthly Electricity Street Light consumption	1449720	kWh
Monthly Total electricity Bill	14497200	Rs.
Metering System		

Fixed Charges	160	Rs. /kW/ Month
Fixed Charges	644320	Rs.
Energy Charges	6.25	Rs./kWh
	9060750	Rs.
Total Monthly Bill under metering System	9705070	Rs.
Monthly Saving	4792130	Rs.
Annual Saving	575.06	Rs.
Energy Meter Cost	4000.00	Rs./energy meter
Total energy meter to be Installed	140.00	no.
Total metering cost	5.60	Rs.
Remote sensing cost	10.00	Rs.
Total investment	15.60	Rs.
Simple Payback Period	1	Month

Thus, it is suggest here to install energy meter at each street light feeder and prepare DPR of it before implantation

CHAPTER 11.
JHANSI NAGAR NIGAM ADMINISTRATIVE BUILDING

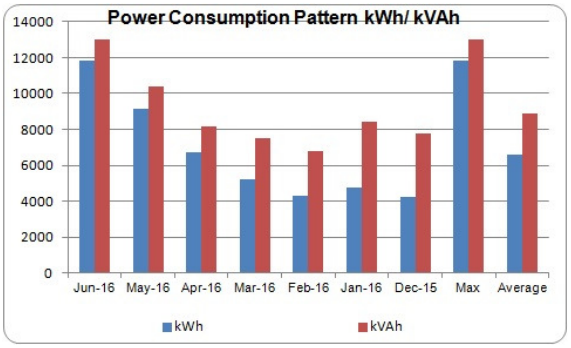
11.1. PURCHASE POWER

Purchase power from DVVNL at 11 kV V and step down to 433 V through transformer installed. Contract Demand is 600 kW, detail of monthly bills depicted as below

Billing Month	Contract Demand kW	Recorded Max CD kW	Min Billable CD kVA	Electricity Rate Rs. /kWh/ month	Fixed Charges Rs	kWh	kVAh	Electricity charges @Rs. 6.90/ kVAh	Monthly Bill Rs.*
Dec-15	600	28	500	250	125000	4256	7778	53668	193815
Jan-16	600	35.4	500	250	125000	4779	8407	58008	199380
Feb-16	600	24.8	500	250	125000	4286	6818	47044	185322
Mar-16	600	52.2	500	250	125000	5203.5	7490.5	51684	191272
Apr-16	600	88.4	500	250	125000	6756.5	8143	56187	197045
May-16	600	91.5	500	250	125063	9154	10416	71867	222473
Jun-16	600	72.4	500	250	125000	11814.5	12978	89548	240404
Max	**600**	**91.5**	**500**	**250**	**125063**	**11815**	**12978**	**89548**	240404
Average	**600**	**56.1**	**500**	**250**	**125009**	**6607**	**8861**	**61144**	204244

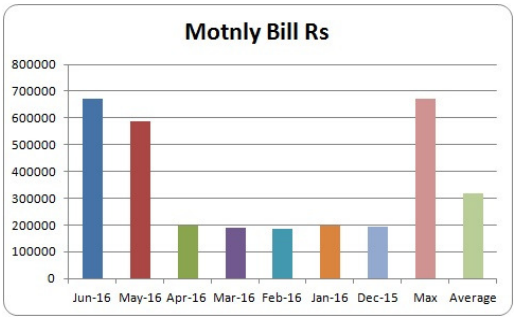
***** Excluding arrear

Power consumption in administrative building is varies from 4256kW in Dec - 2015 to 11814.5 kW in Jun 2016. While in term of kVA, it varies from 6818 kVA in Feb 2016 to 12978 kVA in Jun-2016.



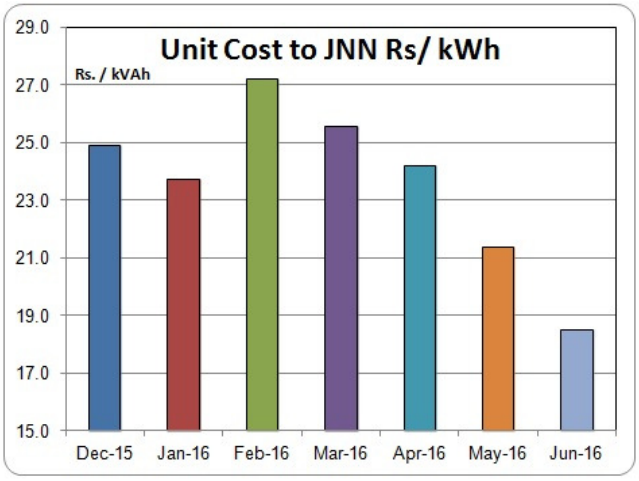
Monthly Billing Pattern

Monthly administrative building bill is varies from Rs. 185322.00 in Feb - 2016 to Rs. 240404.00 in Jun 2016. Average monthly billing is around Rupees is Two Lakh.



Unit Cost

Billing Month	Unit Cost to JHANSI NAGAR NIGAM Rs/ kVAh
Dec-15	24.92
Jan-16	23.71
Feb-16	27.18
Mar-16	25.54
Apr-16	24.20
May-16	21.36

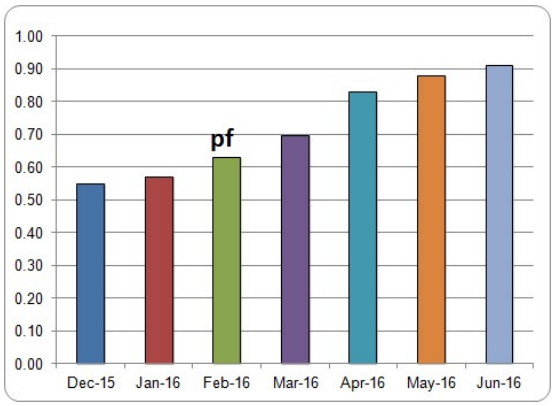


Jun-16	18.52
Max	**27.18**
Average	**23.63**

Overall power cost JHANSI NAGAR NIGAM is varies inversely proportional to monthly consumption.

Power Factor

Billing Month	Pf
Dec-15	0.55
Jan-16	0.57
Feb-16	0.63
Mar-16	0.69
Apr-16	0.83
May-16	0.88
Jun-16	0.91
Average	0.72
Max	0.91



Power Factor is directly proportional to monthly power consumption

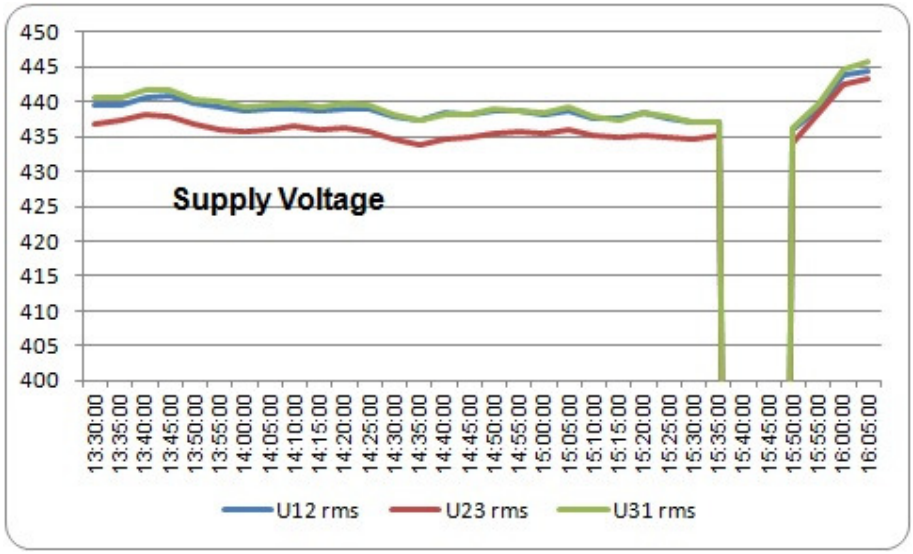
Power Quality Pattern

Supply power quality has been measured through phase power analyzer with recording facility at transformer incomer.

- **Supply Voltage and Current Pattern**

Date:	Time:	U12 rms	U23 rms	U31 rms	A1 rms	A2 rms	A3 rms
04-11-2016	13:30:00	439.6	436.9	440.7	40.5	26.3	32.9
04-11-2016	13:35:00	439.6	437.3	440.5	46.5	26.1	35
04-11-2016	13:40:00	440.7	438.1	441.8	43.7	25.7	29.5
04-11-2016	13:45:00	440.8	438	441.8	43.2	24.9	30.5
04-11-2016	13:50:00	439.8	436.9	440.4	42.2	26.1	31.8
04-11-2016	13:55:00	439.3	436	440.1	42.5	27.5	28.5
04-11-2016	14:00:00	438.7	435.7	439.3	43.4	25.9	27.7
04-11-2016	14:05:00	438.9	436	439.4	40.9	25.5	30.3
04-11-2016	14:10:00	439	436.4	439.8	42.4	25.3	27

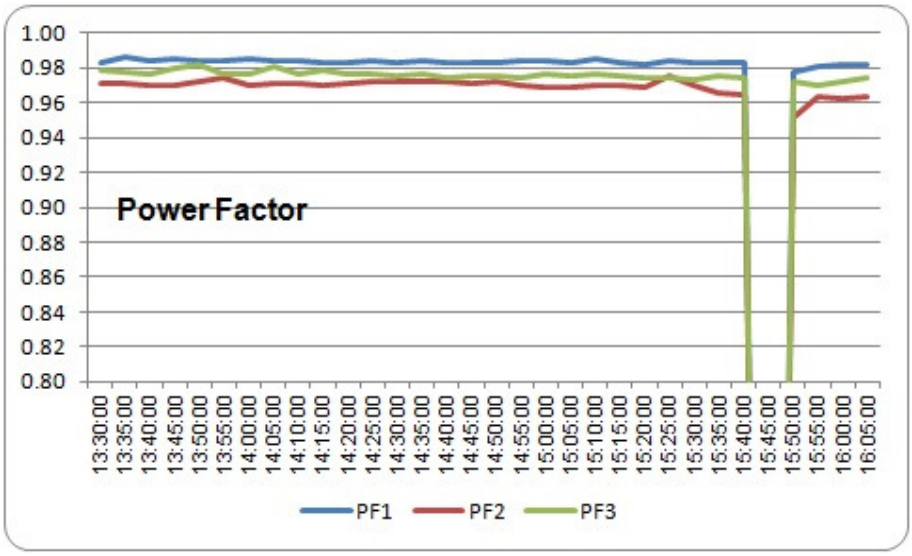
Date:	Time:	U12 rms	U23 rms	U31 rms	A1 rms	A2 rms	A3 rms
04-11-2016	14:15:00	438.7	436	439.2	42.3	26.4	31.7
04-11-2016	14:20:00	439.1	436.2	439.9	42.3	26.4	31.7
04-11-2016	14:25:00	439	435.8	439.5	41	26.1	27
04-11-2016	14:30:00	438	434.5	438.2	41.2	25.8	26.7
04-11-2016	14:35:00	437.3	433.8	437.4	41.9	25.9	26.8
04-11-2016	14:40:00	438.3	434.7	438.1	42.7	26.7	27.3
04-11-2016	14:45:00	438.2	434.8	438.2	41.3	25.9	26.7
04-11-2016	14:50:00	438.8	435.5	439	40.8	26.2	26.6
04-11-2016	14:55:00	438.6	435.6	438.7	42.9	25.7	31
04-11-2016	15:00:00	438.2	435.4	438.4	41.4	24.3	27.7
04-11-2016	15:05:00	438.7	436.1	439.2	43.3	24	26.4
04-11-2016	15:10:00	437.7	435.3	437.8	45.8	21.3	26.4
04-11-2016	15:15:00	437.5	434.8	437.4	41.6	21.5	26.5
04-11-2016	15:20:00	438.3	435.3	438.4	42.3	22.5	26.4
04-11-2016	15:25:00	437.6	434.8	437.9	42.7	25.1	25.5
04-11-2016	15:30:00	437	434.7	437.1	41.7	21.8	29.3
04-11-2016	15:35:00	437	435.1	437	41.2	20.2	27.2
04-11-2016	15:40:00	88.9	88.6	88.5	8.4	4.1	4.7
04-11-2016	15:45:00	98.7	98.1	98.5	0	0	0
04-11-2016	15:50:00	436.1	434.1	436.3	15.4	8.4	10.6
04-11-2016	15:55:00	439.1	438.3	439.8	37.9	20.3	27.7
04-11-2016	16:00:00	443.8	442.6	444.6	37.4	18.9	29
04-11-2016	16:05:00	444.3	443.3	445.7	36.5	18.8	25.5
Average		**439.8**	**437.7**	**440.4**	**37.1**	**20.9**	**25.9**



Supply voltage is on higher side and in single phase 438/1.732 = 253 V, is around 5.4% higher than recommended by lamp manufacturers and also a of cause of failure of lamps.

- **Power Factor & Unbalancing in Voltage and Current**

Date:	Time:	F	PF1	PF2	PF3	PFT	Uunb (IEEE 112)	Aunb (IEEE 112)
04-11-2016	13:30:00	50.1	0.98	0.97	0.98	0.98	0.5	21.9
04-11-2016	13:35:00	50.0	0.99	0.97	0.98	0.98	0.4	29.6
04-11-2016	13:40:00	50.0	0.98	0.97	0.98	0.98	0.5	32.6
04-11-2016	13:45:00	50.0	0.99	0.97	0.98	0.98	0.5	31.4
04-11-2016	13:50:00	50.0	0.98	0.97	0.98	0.98	0.5	26.5
04-11-2016	13:55:00	50.0	0.98	0.97	0.98	0.98	0.6	29.4
04-11-2016	14:00:00	50.1	0.99	0.97	0.98	0.98	0.5	34.2
04-11-2016	14:05:00	50.0	0.98	0.97	0.98	0.98	0.5	26.9
04-11-2016	14:10:00	50.0	0.98	0.97	0.98	0.98	0.5	34.3
04-11-2016	14:15:00	49.9	0.98	0.97	0.98	0.98	0.4	26.4
04-11-2016	14:20:00	50.0	0.98	0.97	0.98	0.98	0.5	26.4
04-11-2016	14:25:00	50.0	0.98	0.97	0.98	0.98	0.5	30.7
04-11-2016	14:30:00	50.0	0.98	0.97	0.98	0.98	0.5	31.9
04-11-2016	14:35:00	49.9	0.98	0.97	0.98	0.98	0.5	32.9
04-11-2016	14:40:00	50.0	0.98	0.97	0.97	0.98	0.5	32.5
04-11-2016	14:45:00	50.0	0.98	0.97	0.98	0.98	0.5	31.9
04-11-2016	14:50:00	50.0	0.98	0.97	0.98	0.98	0.5	30.8
04-11-2016	14:55:00	50.0	0.98	0.97	0.97	0.98	0.5	29.2
04-11-2016	15:00:00	50.0	0.98	0.97	0.98	0.98	0.4	33
04-11-2016	15:05:00	50.1	0.98	0.97	0.98	0.98	0.4	38.6
04-11-2016	15:10:00	50.0	0.99	0.97	0.98	0.98	0.4	47
04-11-2016	15:15:00	49.9	0.98	0.97	0.98	0.98	0.4	39.3
04-11-2016	15:20:00	50.0	0.98	0.97	0.97	0.98	0.5	39.1
04-11-2016	15:25:00	50.0	0.98	0.98	0.97	0.98	0.5	37.3
04-11-2016	15:30:00	49.9	0.98	0.97	0.97	0.98	0.4	34.8
04-11-2016	15:35:00	49.9	0.98	0.97	0.98	0.98	0.3	39.5
04-11-2016	15:40:00	49.9	0.98	0.97	0.97	0.98	0.3	46.5
04-11-2016	15:45:00	49.8	- - -	- - -	- - -	- - -	0.3	0
04-11-2016	15:50:00	49.8	0.98	0.95	0.97	0.97	0.3	34.3
04-11-2016	15:55:00	49.9	0.98	0.96	0.97	0.97	0.2	32.4
04-11-2016	16:00:00	50.0	0.98	0.96	0.97	0.97	0.2	33.5
04-11-2016	16:05:00	50.0	0.98	0.96	0.97	0.98	0.3	35.5
Average		**50.0**	**0.98**	**0.97**	**0.97**	**0.98**	**0.4**	**33.1**

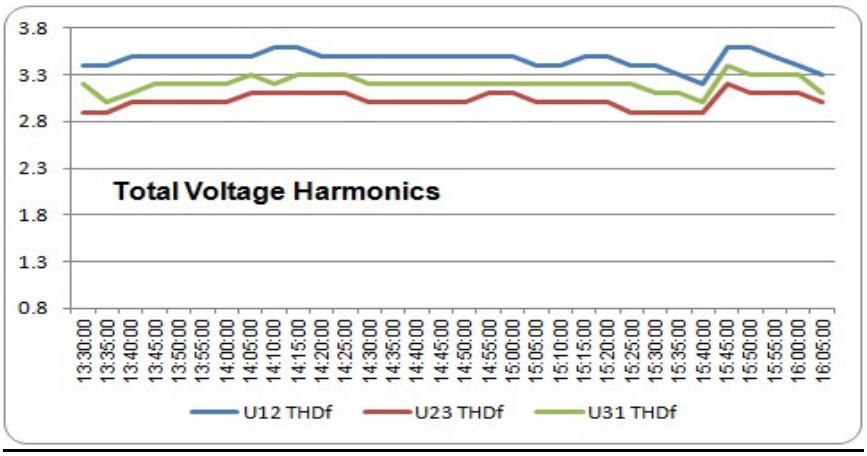


Average power factor is near to unit and found satisfactory.

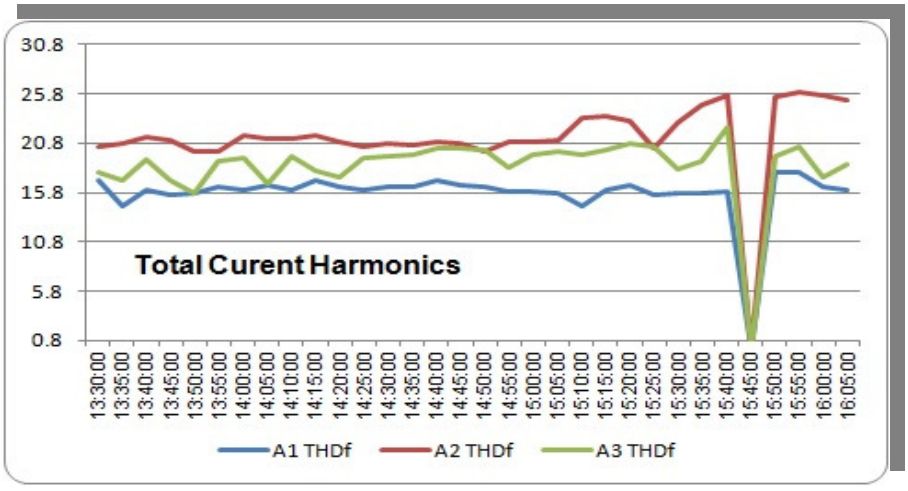
- **Voltage and Current Harmonics**

Date:	Time:	U12 THDf	U23 THDf	U31 THDf	A1 THDf	A2 THDf	A3 THDf
04-11-2016	13:30:00	3.4	2.9	3.2	17.0	20.5	17.9
04-11-2016	13:35:00	3.4	2.9	3.0	14.5	20.7	17.0
04-11-2016	13:40:00	3.5	3.0	3.1	16.0	21.4	19.2
04-11-2016	13:45:00	3.5	3.0	3.2	15.6	21.1	17.1
04-11-2016	13:50:00	3.5	3.0	3.2	15.7	19.9	15.8
04-11-2016	13:55:00	3.5	3.0	3.2	16.4	20.0	19.0
04-11-2016	14:00:00	3.5	3.0	3.2	16.1	21.5	19.3
04-11-2016	14:05:00	3.5	3.1	3.3	16.6	21.2	16.7
04-11-2016	14:10:00	3.6	3.1	3.2	16.1	21.2	19.4
04-11-2016	14:15:00	3.6	3.1	3.3	17.0	21.5	18.0
04-11-2016	14:20:00	3.5	3.1	3.3	16.3	21.0	17.3
04-11-2016	14:25:00	3.5	3.1	3.3	16.1	20.5	19.3
04-11-2016	14:30:00	3.5	3.0	3.2	16.3	20.7	19.4
04-11-2016	14:35:00	3.5	3.0	3.2	16.4	20.6	19.6
04-11-2016	14:40:00	3.5	3.0	3.2	17.1	21.0	20.2
04-11-2016	14:45:00	3.5	3.0	3.2	16.6	20.8	20.3
04-11-2016	14:50:00	3.5	3.0	3.2	16.4	19.9	20.1
04-11-2016	14:55:00	3.5	3.1	3.2	15.9	20.9	18.4
04-11-2016	15:00:00	3.5	3.1	3.2	15.9	21.0	19.7
04-11-2016	15:05:00	3.4	3.0	3.2	15.8	21.1	19.9
04-11-2016	15:10:00	3.4	3.0	3.2	14.5	23.3	19.7
04-11-2016	15:15:00	3.5	3.0	3.2	16.0	23.5	20.1

Date:	Time:	U12 THDf	U23 THDf	U31 THDf	A1 THDf	A2 THDf	A3 THDf
04-11-2016	15:20:00	3.5	3.0	3.2	16.5	23.1	20.8
04-11-2016	15:25:00	3.4	2.9	3.2	15.6	20.3	20.4
04-11-2016	15:30:00	3.4	2.9	3.1	15.7	22.9	18.1
04-11-2016	15:35:00	3.3	2.9	3.1	15.7	24.7	19.0
04-11-2016	15:40:00	3.2	2.9	3.0	15.9	25.6	22.4
04-11-2016	15:45:00	3.6	3.2	3.4	- - -	- - -	- - -
04-11-2016	15:50:00	3.6	3.1	3.3	17.8	25.5	19.4
04-11-2016	15:55:00	3.5	3.1	3.3	17.9	25.9	20.4
04-11-2016	16:00:00	3.4	3.1	3.3	16.3	25.6	17.3
04-11-2016	16:05:00	3.3	3.0	3.1	16.1	25.1	18.7
Average		**3.5**	**3.0**	**3.2**	**16.6**	**23.3**	**18.9**



Voltage is found under limit



Current harmonics is found o above the prescribed limit

- **<u>Other Electrical Parameter</u>**

Date:	Time:	Pst1	Pst2	Pst3	A1 CF	A2 CF	A3 CF	U12 CF	U23 CF	U31 CF
04-11-2016	13:30:00	- - -	- - -	- - -	1.73	1.84	1.76	1.48	1.47	1.47
04-11-2016	13:35:00	2.24	2.46	2.46	1.66	1.85	1.77	1.48	1.48	1.47
04-11-2016	13:40:00	2.24	2.46	2.46	1.70	1.86	1.82	1.48	1.48	1.47
04-11-2016	13:45:00	2.13	2.23	2.23	1.68	1.81	1.76	1.48	1.48	1.48
04-11-2016	13:50:00	1.74	1.42	1.42	1.67	1.77	1.73	1.49	1.48	1.48
04-11-2016	13:55:00	1.43	1.18	1.17	1.71	1.81	1.84	1.48	1.48	1.48
04-11-2016	14:00:00	0.27	0.34	0.3	1.70	1.85	1.86	1.48	1.48	1.48
04-11-2016	14:05:00	0.27	0.33	0.3	1.70	1.83	1.78	1.48	1.48	1.48
04-11-2016	14:10:00	0.28	0.33	0.33	1.70	1.85	1.83	1.48	1.48	1.48
04-11-2016	14:15:00	0.28	0.32	0.34	1.73	1.89	1.84	1.48	1.48	1.48
04-11-2016	14:20:00	0.32	0.3	0.38	1.71	1.84	1.81	1.48	1.48	1.48
04-11-2016	14:25:00	0.3	0.29	0.36	1.69	1.83	1.85	1.48	1.48	1.48
04-11-2016	14:30:00	0.27	0.27	0.3	1.71	1.87	1.85	1.48	1.48	1.48
04-11-2016	14:35:00	0.27	0.27	0.3	1.71	1.89	1.87	1.48	1.48	1.48
04-11-2016	14:40:00	0.27	0.27	0.3	1.74	1.89	1.89	1.48	1.48	1.48
04-11-2016	14:45:00	0.27	0.27	0.29	1.71	1.89	1.86	1.48	1.48	1.48
04-11-2016	14:50:00	0.27	0.27	0.29	1.72	1.89	1.87	1.48	1.48	1.48
04-11-2016	14:55:00	0.28	0.28	0.3	1.70	1.91	1.81	1.48	1.48	1.48
04-11-2016	15:00:00	0.35	0.36	0.37	1.70	1.87	1.85	1.48	1.48	1.48
04-11-2016	15:05:00	0.33	0.34	0.35	1.70	1.86	1.86	1.48	1.47	1.47
04-11-2016	15:10:00	0.27	0.28	0.3	1.66	1.87	1.85	1.48	1.47	1.47
04-11-2016	15:15:00	0.27	0.27	0.29	1.70	1.90	1.87	1.48	1.47	1.47
04-11-2016	15:20:00	0.27	0.26	0.28	1.72	1.94	1.89	1.48	1.47	1.47
04-11-2016	15:25:00	0.26	0.26	0.28	1.69	1.83	1.86	1.48	1.47	1.47
04-11-2016	15:30:00	0.26	0.27	0.28	1.69	1.90	1.82	1.48	1.47	1.47
04-11-2016	15:35:00	0.26	0.27	0.28	1.69	1.91	1.82	1.48	1.47	1.47

Date:	Time:	Pst1	Pst2	Pst3	A1 CF	A2 CF	A3 CF	U12 CF	U23 CF	U31 CF
04-11-2016	15:40:00	0.27	0.27	0.3	1.70	1.95	1.94	1.6	1.61	1.48
04-11-2016	15:45:00	0.27	0.27	0.3	- - -	- - -	- - -	1.5	1.5	1.46
04-11-2016	15:50:00	- - -	- - -	- - -	1.85	1.96	1.91	1.47	1.46	1.46
04-11-2016	15:55:00	42.25	42.8	39.83	1.75	1.98	1.89	1.47	1.47	1.47
04-11-2016	16:00:00	42.25	42.8	39.83	1.68	1.91	1.77	1.48	1.48	1.48
04-11-2016	16:05:00	41.34	41.65	39.32	1.67	1.88	1.83	1.48	1.48	1.48
Average		**21.3**	**21.5**	20.2	1.72	1.90	1.84	**1.48**	**1.48**	**1.47**

Conclusion

Supply Voltage is found o higher side, it should be around 415V pr even low. Power Factor and frequency are found O.K. Voltage harmonics is under limit, while current harmonics is higher side and recommend to install harmonics filter to improve power quality. Voltage flickering Pst & Voltage crest and Current crest are found within limit

Fixture installed

Sr. No.	location	STL , 28W, T5	DTL,28 W,T5	PL 11W, Double	PL 36W, Double	CFL 75 W	PL36W, Triple
Ground Floor							
1	Room no.60	1		3			
2	Jana Garna office	6					
3	Room no.58	2					
4	Lobby			6			
5	Corridor area			40			
First Floor							
6	Lift area			6			
7	Corridor area			40			
8	Room no.10		16				
9	Room no.11	4	2				
10	Room no.8	12					
11	Room no.7		20				
12	Room no.13	1	2				

Sr. No.	location	STL , 28W, T5	DTL,28 W,T5	PL 11W, Double	PL 36W, Double	CFL 75 W	PL36W, Triple
13	Room no.14		2				
14	Room no.15		2				
15	Room no.16		2				
16	Toilet			1			
17	Room no.4	5					
18	Room no.3		2				
19	Room no.2	4					
20	Room no.1			12			
21	Rani Laxmi BAI Meeting Hall						23
Second Floor							
22	It office	6					
23	Room no.35		6				
24	Room no.34			4			
25	Room no.33			4			
26	Lobby			2			
27	Toilet			2			
28	Lift area			6			
29	Room no.17						
30	Room no.18	4	1		12		
31	Computer operator			1			
32	Lobby			3			
33	Room no.23		1			1	
34	Room no.22			8			
35	Room no.20			10			
36	Room no.21	2	2				
37	Room no.25	1	7	4			
38	Room no.24	2		4			
39	Room no.29	14					
40	Room no.30	4					
41	Room no.26		2				
42	Room no.27		2				
43	Room no.28		4				
44	Room no.31		4				
45	Room no.32	1	1				
46	Corridor area			40			

Sr. No.	location	STL , 28W, T5	DTL,28 W,T5	PL 11W, Double	PL 36W, Double	CFL 75 W	PL36W, Triple
Third Floor							
47	Corridor area			40			
48	Waiting hall	4					
49	Hall	7					
50	It room		4				
51	Room no.49		4				
52	Room no.57		2				
53	Room no.56		2				
54	Room no.52		9				
55	Room no.53			4			
56	Lobby			6			
57	Room no.45	24					
58	Room no.37		5				
59	Room no.36			3			
	Total no. Of lights	**104**	**104**	**249**	**12**	**1**	**23**

11.2. LUX LEVER

Lux level measured at different location and results are as depicted below,

Ground Floor		
Sr. No.	LOCATION	Lux Level
	ROOM NO.60	105
	JANAGANANA OFFICE	130, 200
	ROOM NO.58	101
	LOBY	84

First Floor		
Sr. No.	LOCATION	Lux Level
1.	LIFT AREA	55

First Floor		
2.	ROOM NO.10	336
3.	ROOM NO.11	117
4.	ROOM NO.8	178/370
5.	ROOM NO.7	150
6.	ROOM NO.13	229
7.	ROOM NO.14	286
8.	ROOM NO.15	203
9.	ROOM NO.16	151
10.	TOILET	120
11.	ROOM NO.4	234/250
12.	ROOM NO.3	250
13.	ROOM NO.2	174
14.	ROOM NO.1	358
	RANI LAXMI BIE MEETING HALL	270 (average)

Second floor		
Sr. No.	LOCATION	Lux Level
1.	IT OFFICE	161
2.	ROOM NO.35	227
3.	ROOM NO.34	120
4.	ROOM NO.33	125
5.	LOBY	135
6.	TOILET	240
7.	LIFT AREA	45
8.	ROOM NO.17	378,368
9.	ROOM NO.18	101/186
10.	COMPUTER OPERATOR	70
11.	LOBY	15
12.	ROOM NO.23	360
13.	ROOM NO.22	146
14.	ROOM NO.20	243

Second floor		
15.	ROOM NO.21	247
16.	ROOM NO.25	255
17.	ROOM NO.24	120
18.	ROOM NO.29	135/64
19.	ROOM NO.30	159
20.	ROOM NO.26	146
21.	ROOM NO.27	325
22.	ROOM NO.28	216
23.	ROOM NO.31	303
24.	ROOM NO.32	

Third Floor		
Sr. No.	LOCATION	Lux Level
1	WAITING HALL	225
2	HALL	110
3	IT ROOM	172
4	ROOM NO.49	347
5	ROOM NO.57	223
6	ROOM NO.56	193
7	ROOM NO.52	247,155
8	ROOM NO.53	284,295
9	LOBY	28
10	ROOM NO.45	231
11	ROOM NO.37	4
12	ROOM NO.36	2

Recommended Lux Level

IES ILLUMINANCE CATEGORIES AND VALUES - FOR GENERIC INDOOR ACTIVITIES			
ACTIVITY	CATEGORY	LUX	FOOTCANDLES
Public spaces with dark surroundings	A	20-30-50	2-3-5
Simple orientation for short temporary visits	B	50-75-100	5-7.5-10
Working spaces where visual tasks are only occasionally performed	C	100-150-200	10-15-20
Performance of visual tasks of high contrast or large size	D	200-300-500	20-30-50
Performance of visual tasks of medium contrast or small size	E	500-750-1000	50-75-100
Performance of visual tasks of low contrast or very small size	F	1000-1500-2000	100-150-200
Performance of visual tasks of low contrast or very small size over a prolonged period	G	2000-3000-5000	200-300-500
Performance of very prolonged and exacting visual tasks	H	5000-7500-10000	500-750-1000
Performance of very special visual tasks of extremely low contrast	I	10000-15000-20000	1000-1500-2000

A-C for illuminances over a large area (i.e. lobby space)
D-F for localized tasks
G-I for extremely difficult visual tasks

11.3. RECOMMENDATION

- **Installation of Capacitor Bank**

Monthly Electricity billing tariff is based on apparent power (kVAh), thus it is necessary to maintain power factor near to unit or at least above 0.95

Billing Month	Recorded Power Factor pf	Recorded CD kVA	Recorded CD in KW	MF	Capacitor Bank Required kVAr
Jun-16	0.91	72.4	65.9	0.120	8
May-16	0.83	88.4	73.3	0.343	25
Apr-16	0.69	52.2	36.3	0.720	26
Mar-16	0.63	24.8	15.6	0.904	14
Feb-16	0.57	35.4	20.1	1.150	23
Jan-16	0.55	28	15.3	1.190	18
Average	0.70				
Total					26
Say					30

Average monthly power factor of last is around 0.70, it means JHANSI NAGAR NIGAM is paying around 25% extra variable tariff amount .

Billing Month	Recorded Power Factor pf	Recorded Power consumption kVAh	Power consumption after corrected pf = 0.95	Difference if kVAh
Jun-16	0.91	12978	12436	542
May-16	0.83	8143	7112	1031
Apr-16	0.69	7490.5	5477	2013
Mar-16	0.63	6818	4512	2306
Feb-16	0.57	8407	5031	3376
Jan-16	0.55	7778	4480	3298
Total			39048	12567
Average Monthly	0.70	8602	6508	2094

From above table, monthly electrical saving will be equivalent to 2094 kVAh. Annual electrical saving has been work as below,

Annual Saving in term of kVAh	25133	kVAh
Power Cost	6.90	Rs,/kVAh
Energy Saving	1.73	Rs. Lakh
Capacitor Bank Required	30	kVAr
Capacitor bank Cost @Rs. 1000/ kVAr	0.30	Rs. Lakh
Simple Payback Period	3	Months

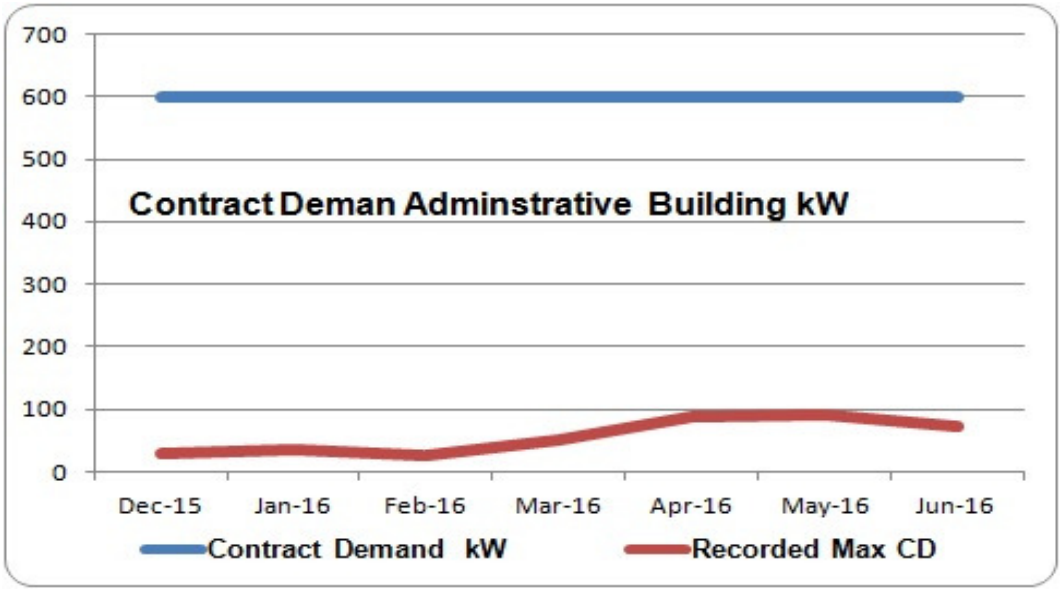
- **Reduction in Contact Demand**

Sanctioned contract demand is 600kW and JHANSI NAGAR NIGAM is paying Rs. 125000/- month as fixed charge and min billable charges is 75% of contact demand or actual recorded max contract demand, which is higher.

Max Recorded Contract Demand in last six months recorded depicted as below,

Billing Month	Contract Demand kW	Recorded Max CD kVA	Min Billable CD kVA	Electricity Rate Rs. /kWh/ month	Fixed Charges Rs

Billing Month	Contract Demand kW	Recorded Max CD kVA	Min Billable CD kVA	Electricity Rate Rs. /kWh/ month	Fixed Charges Rs
Jun-16	600	72.4	500	250	125000
May-16	600	91.5	500	250	125063
Apr-16	600	88.4	500	250	125000
Mar-16	600	52.2	500	250	125000
Feb-16	600	24.8	500	250	125000
Jan-16	600	35.4	500	250	125000
Dec-15	600	28.0	500	250	125000



From above, max recorded demand is 91.5 kVA, which is quite below sanctioned CD. and pay extra fixed charges five times of actual demand or in other word, JHANSI NAGAR NIGAM is paying around one lakh rupees extra to DVVNL.

Thus, it is adviced to reduced contract demand from 600 kW to 90 kW or 100 kVA

Proposed CD	100	kVA
	90	kW
Fixed Charges @ Rs. 250/ kVA	25000	
Present CD Charges	125000	Rs.

Diff in CD charges	100000	Rs.
	1.00	Rs. In Lakh
Annual Saving	12.00	Rs. In Lakh
Investment	nil	
Simple Payback Period	Immediate	

- **Replacement of CFL to LED Light**

It is recommend to replace all CFL installed with equivalent LED

Particulars	STL, 28W, T5	DTL, 28W,T5	PL 11W, Double	PL 36W, Double	CFL 75 W	PL36W, Triple
Total no. Of lights	104	104	249	12	1	23
Fitting Wattage Watt	28	56	22	78	80	117
Total Watt	2912	5824	5478	936	80	2691
GT Watt						17921
Equivalent LED Lamp	18	36	5	30	35	81
Total LED Wattage	1872	3744	2490	360	35	1863
GT Watt (LED)						10364
Difference in Power Watt						7557

Power Saving per hr = 7557W

Annual Saving has been workout as below,

Work day	250	day
Hr per Day	10	hr
Annual	18892.5	kWh
Power Cost (Considering After Reduction in Cd)	6.9	Rs./ kWh
Annual energy saving	1.30	Rs. In Lakh
Investment		

Cost of 18 LED Tube @Rs. 300/- per Piece	0.94	Rs. In Lakh
Cost of 5 watt LED@Rs. 200/piece	0.37	Rs. In Lakh
Cost of 15 LED @Rs. 500/ piece	0.47	Rs. In Lakh
Cost of 35 Watt LED @ Rs. 1500/ piece	0.0015	Rs. In Lakh
Total	1.78	Rs. In Lakh
Replacement cost	1.00	Rs. In Lakh
Total Investment	2.78	Rs. In Lakh
Simple Payback Period	26	Months

CHAPTER 12.
UMMERY

Energy Saving Measures as below,

ECOs	Energy Savings		Estimated Investments	Simple Payback Period
	Quantum (kWh in Lakh)	Saving Rs. In Lakh	(Rs) in Lakh	(Months)
Replacement 5% HPSV street lights with LED Lamps	10.8	108	133.58	15
Installation of 350 kW Street Light equivalent SPV Plant to reduce Street light Load by 5% as per Solar city with one day battery backup	15.33	153.3	740.17	72
Installation energy meter at all street Light electricity supply feeder (Approx 140no. metered to be installed) and change un-metered tariff to meter tariff under tariff code LMV - 3	0	575.06	15.6	1
Installation of 30 kVAr APFC Panel to improve monthly power factor above 0.95 JHANSI NAGAR NIGAM ADMIN Building	0.25	1.73	0.33	3
Reduction of Contract Demand of JHANSI NAGAR NIGAM Building from 600 kW to 90 kW	0	12	0	0
Replacement of CFL installed in JHANSI NAGAR NIGAM administrative Building with LED Lights	0.19	1.3	2.78	26
Total Energy Saving (with battery back-up SPV system)	**26.57**	**851.39**	**892.46**	**13.00**
OR, Installation of 350 kW Street Light equivalent SPV plant with grid connected net metering	15.33	153.3	533.33	60
Total Energy Saving (Without Batter Back-up) Grid Connected SPV system)	26.57	851.39	685.62	15

ACCREDTD ENERGY CERTIFICATE

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ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)

REGISTERED

BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

10/02/Accred./BEE/13/1579

July 15, 2013

Shri Aanoop Kumar Gupta
C/o Anoop Kumar Gupta
273/Y-1 Block, Kidwai Nagar,
Kanpur- 208011,
Uttar Pradesh

Sub: Application for accreditation as accredited energy auditors- reg.

Sir,

The undersigned is to refer to your application for the accreditation of Energy Auditors and the subsequent Oral interview you had before the Accreditation Advisory Committee at BEE office, New Delhi.

We are pleased to inform that the Accreditation Advisory Committee has recommended your name for the accreditation as Accredited Energy Auditor .The recommendation of Accredited Energy Advisory Committee will be put up to Management Advisory Committee of BEE for approval in its next meeting. After approval, BEE will include your name in the list of Accredited Energy Auditor, maintained by BEE on its website (www.beee-india.nic.in) and energy professional website (www.energymanagertraining.com).

Yours faithfully,

(Rajini Thomson)
Project Engineer

स्वहित एवं राष्ट्रहित में ऊर्जा बचाएँ Save Energy for Benefit of Self and Nation

चौथा तल, सेवा भवन , आर० के० पुरम , नई दिल्ली - 110 066 वेबसाईट / Web-Site : www.bee-india.nic.in
4th Floor, Sewa Bhawan, R.K. Puram, New Delhi - 110 066 टेली/Tel : 26179699 (5 Lines) फैक्स/Fax : 91 (11) 26178352

ENERGY IS LIFE
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CONSERVE IT

BUREAU OF ENERGY EFFICIENCY

Examination Registration No. : EA-6086

Accreditation Registration No.: AEA-0125

Certificate of Accreditation

This is to certify that Mr./Ms. Anoop Kumar Gupta having its trade/registered office at Kanpur has been given accreditation as accredited energy auditor. The certificate shall be effective from 26th day of November 2013

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0125 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 26th day of May 2014

Secretary,
Bureau of Energy Efficiency
New Delhi

MNRE EMPANELLED CERTIFICATE FOR BOM

भारत सरकार
नवीन और नवीकरणीय ऊर्जा मंत्रालय
Government of India
MINISTRY OF NEW AND RENEWABLE ENERGY
ब्लाक नं. 14, केन्द्रीय कार्यालय परिसर, लोदी रोड़, नई दिल्ली-110003
BLOCK NO. 14, C.G.O. COMPLEX, LODI ROAD, NEW DELHI - 110 003

Fax : 011-24361298
Telegram : RENEWABLE

सं. No. 30/42/2011-12/NSM

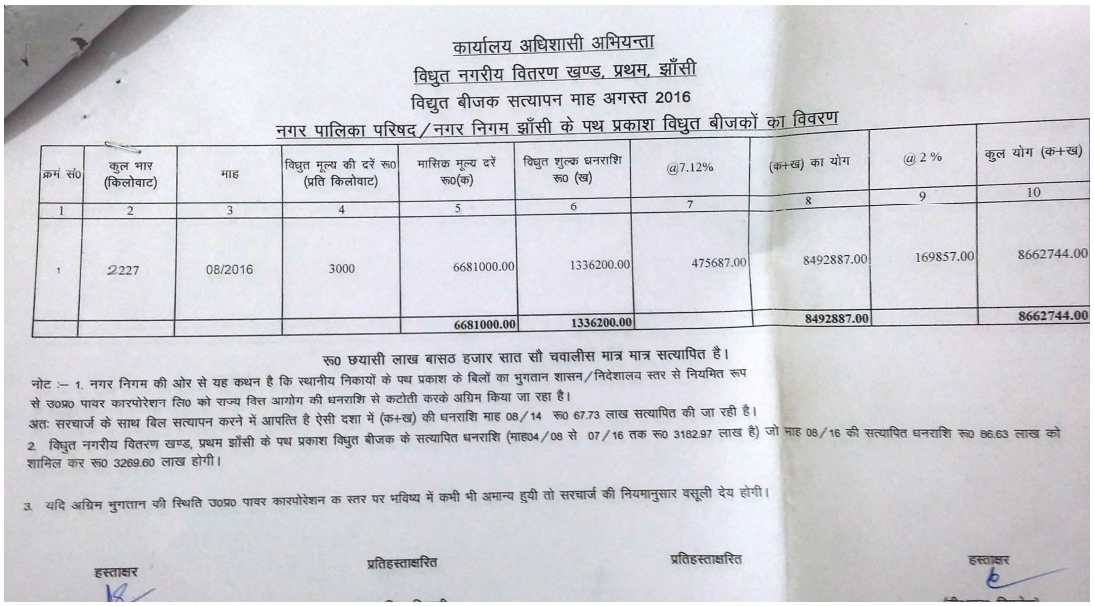
दिनांक Dated 11.04.2016

To,

Shri. Anoop Kumar Gupta
C.-58,P.N.F.C. Colony,
Naya Nagal, Ropar-140126
Punjab

It is to certify that after completion of training titled "Skill Development Programme for Chartered Engineers" held at National Institute of Solar Energy (NISE), Gurgaon, you are enrolled as Chartered Engineer for verification of Total Bill of Material (BOM) required for establishment for Solar Energy Projects for availing Concessional Customs Duties and Excise Duties Exemption Certificates towards these projects. This will be valid for a period of two years initially from this date.

Devendra Singh.
(Devendra Singh)
Under Secretary to the Government of India



कार्यालय अधिशासी अभियन्ता

विद्युत नगरीय वितरण खण्ड, प्रथम, झाँसी

विद्युत बीजक सत्यापन माह अगस्त 2016

नगर पालिका परिषद/नगर निगम झाँसी के पथ प्रकाश विद्युत बीजकों का विवरण

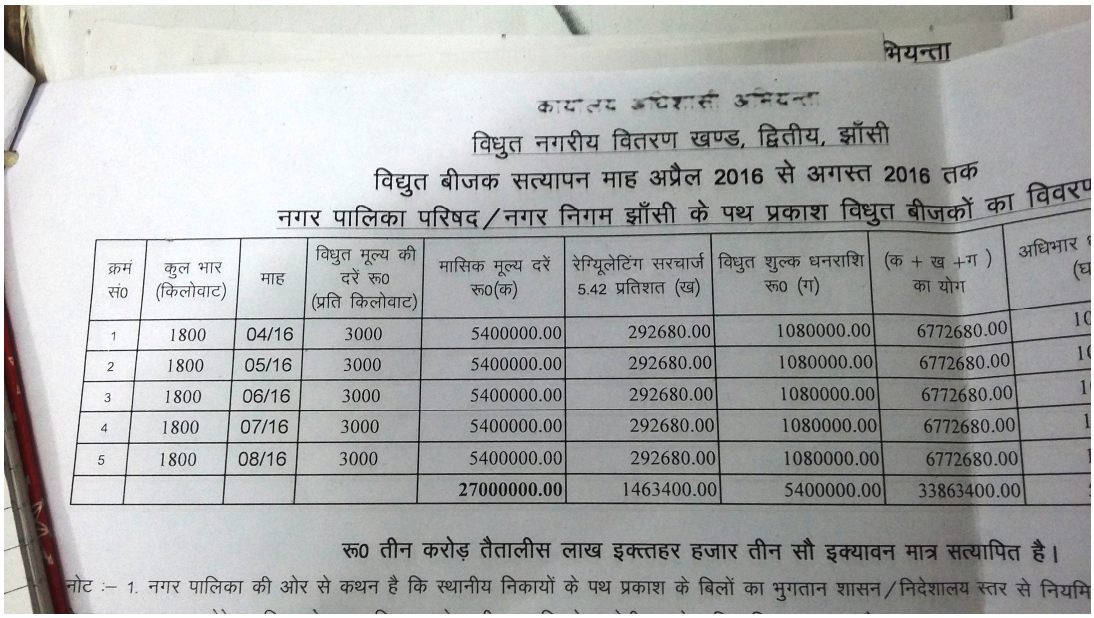
क्रम सं0	कुल भार (किलोवाट)	माह	विद्युत मूल्य की दरें रू0 (प्रति किलोवाट)	मासिक मूल्य दरें रू0(क)	विद्युत शुल्क धनराशि रू0 (ख)	@7.12%	(क+ख) का योग	@ 2 %	कुल योग (क+ख)
1	2	3	4	5	6	7	8	9	10
1	2227	08/2016	3000	6681000.00	1336200.00	475687.00	8492887.00	169857.00	8662744.00
				6681000.00	**1336200.00**		**8492887.00**		**8662744.00**

रू0 छयासी लाख बासठ हजार सात सौ चवालीस मात्र मात्र सत्यापित है।

नोट :– 1. नगर निगम की ओर से यह कथन है कि स्थानीय निकायों के पथ प्रकाश के बिलों का भुगतान शासन/निदेशालय स्तर से नियमित रूप से उ0प्र0 पावर कारपोरेशन लि0 को राज्य वित्त आयोग की धनराशि से कटोती करके अग्रिम किया जा रहा है।
अतः सरचार्ज के साथ बिल सत्यापन करने में आपत्ति है ऐसी दशा में (क+ख) की धनराशि माह 08/14 रू0 67.73 लाख सत्यापित की जा रही है।
2. विद्युत नगरीय वितरण खण्ड, प्रथम झाँसी के पथ प्रकाश विद्युत बीजक के सत्यापित धनराशि (माह04/08 से 07/16 तक रू0 3182.97 लाख है) जो माह 08/16 की सत्यापित धनराशि रू0 86.63 लाख को शामिल कर रू0 3269.60 लाख होगी।

3. यदि अग्रिम भुगतान की स्थिति उ0प्र0 पावर कारपोरेशन क स्तर पर भविष्य में कभी भी अमान्य हुयी तो सरचार्ज की नियमानुसार वसूली देय होगी।

हस्ताक्षर — प्रतिहस्ताक्षरित — प्रतिहस्ताक्षरित — हस्ताक्षर



भियन्ता

कार्यालय अधिशासी अभियन्ता

विद्युत नगरीय वितरण खण्ड, द्वितीय, झाँसी

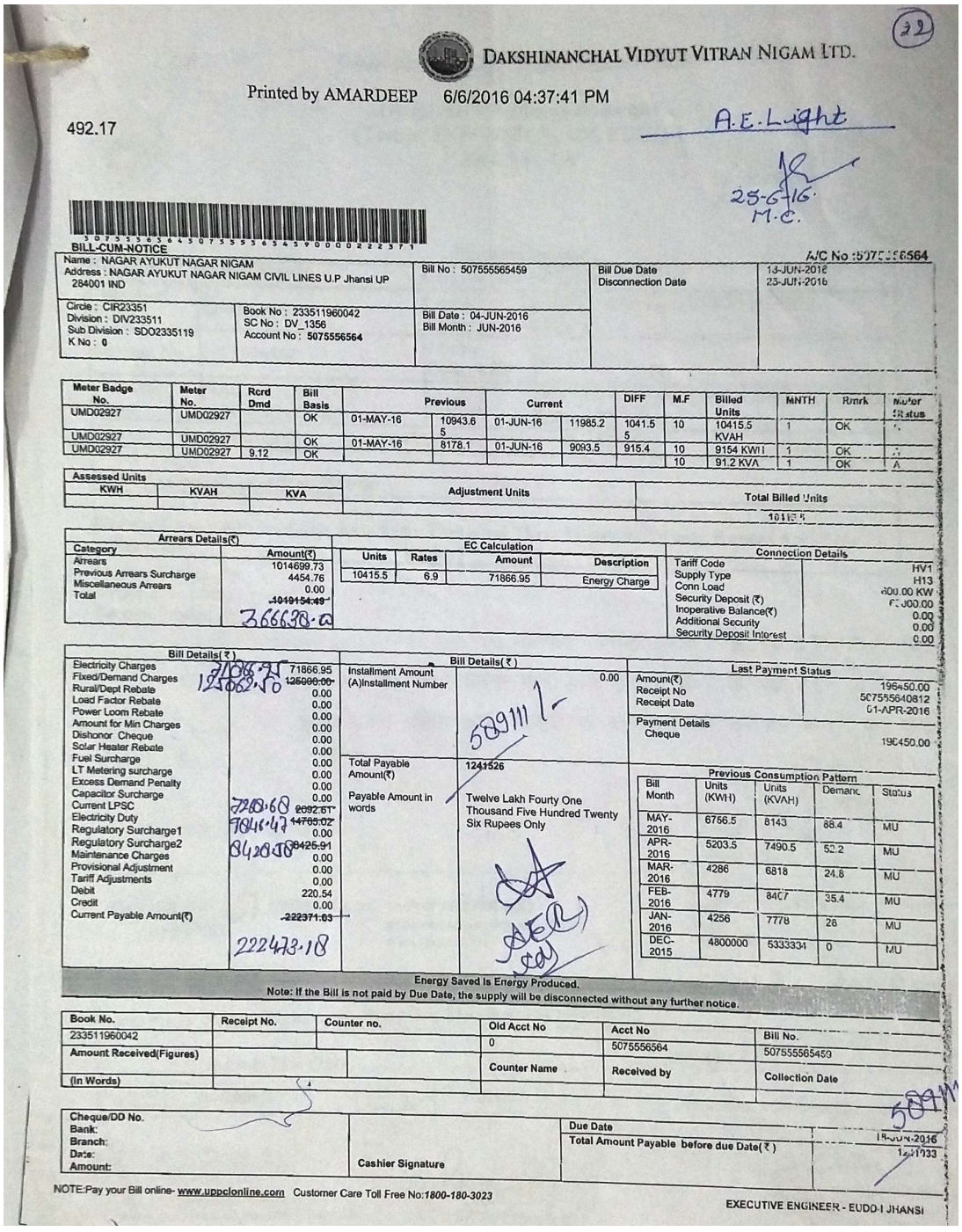
विद्युत बीजक सत्यापन माह अप्रैल 2016 से अगस्त 2016 तक

नगर पालिका परिषद/नगर निगम झाँसी के पथ प्रकाश विद्युत बीजकों का विवरण

क्रम सं0	कुल भार (किलोवाट)	माह	विद्युत मूल्य की दरें रू0 (प्रति किलोवाट)	मासिक मूल्य दरें रू0(क)	रेग्यूलेटिंग सरचार्ज 5.42 प्रतिशत (ख)	विद्युत शुल्क धनराशि रू0 (ग)	(क + ख +ग) का योग	अधिभार
1	1800	04/16	3000	5400000.00	292680.00	1080000.00	6772680.00	1
2	1800	05/16	3000	5400000.00	292680.00	1080000.00	6772680.00	1
3	1800	06/16	3000	5400000.00	292680.00	1080000.00	6772680.00	1
4	1800	07/16	3000	5400000.00	292680.00	1080000.00	6772680.00	1
5	1800	08/16	3000	5400000.00	292680.00	1080000.00	6772680.00	1
				27000000.00	1463400.00	5400000.00	33863400.00	

रू0 तीन करोड़ तैतालीस लाख इक्त्तहर हजार तीन सौ इक्यावन मात्र सत्यापित है।

नोट :– 1. नगर पालिका की ओर से कथन है कि स्थानीय निकायों के पथ प्रकाश के बिलों का भुगतान शासन/निदेशालय स्तर से नियमि



DAKSHINANCHAL VIDYUT VITRAN NIGAM LTD.

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492.17

A.E. Light

25-6-16 M.C.

BILL-CUM-NOTICE

A/C No :5075556564

Name : NAGAR AYUKUT NAGAR NIGAM
Address : NAGAR AYUKUT NAGAR NIGAM CIVIL LINES U.P Jhansi UP 284001 IND

Bill No : 507555565459
Bill Due Date 13-JUN-2016
Disconnection Date 23-JUN-2016

Circle : CIR23351
Division : DIV233511
Sub Division : SDO2335119
K No : 0

Book No : 233511960042
SC No : DV_1356
Account No : 5075556564

Bill Date : 04-JUN-2016
Bill Month : JUN-2016

Meter Badge No.	Meter No.	Rcrd Dmd	Bill Basis	Previous		Current		DIFF	M.F	Billed Units	MNTH	Rmrk	Meter Status
UMD02927	UMD02927		OK	01-MAY-16	10943.65	01-JUN-16	11985.2	1041.55	10	10415.5 KVAH	1	OK	A
UMD02927	UMD02927		OK	01-MAY-16	8178.1	01-JUN-16	9093.5	915.4	10	9154 KWH	1	OK	A
UMD02927	UMD02927	9.12	OK						10	91.2 KVA	1	OK	A

Assessed Units			Adjustment Units	Total Billed Units
KWH	KVAH	KVA		
				10415.5

Arrears Details(₹)	
Category	Amount(₹)
Arrears	1014699.73
Previous Arrears Surcharge	4454.76
Miscellaneous Arrears	0.00
Total	~~1019154.49~~ 366638.0

EC Calculation			
Units	Rates	Amount	Description
10415.5	6.9	71866.95	Energy Charge

Connection Details	
Tariff Code	HV1
Supply Type	H13
Conn Load	600.00 KW
Security Deposit (₹)	60000.00
Inoperative Balance(₹)	0.00
Additional Security	0.00
Security Deposit Interest	0.00

Bill Details(₹)	
Electricity Charges	71866.95
Fixed/Demand Charges	~~125000.00~~
Rural/Dept Rebate	0.00
Load Factor Rebate	0.00
Power Loom Rebate	0.00
Amount for Min Charges	0.00
Dishonor Cheque	0.00
Solar Heater Rebate	0.00
Fuel Surcharge	0.00
LT Metering surcharge	0.00
Excess Demand Penalty	0.00
Capacitor Surcharge	0.00
Current LPSC	~~2092.61~~
Electricity Duty	~~14765.02~~
Regulatory Surcharge1	0.00
Regulatory Surcharge2	~~8425.91~~
Maintenance Charges	0.00
Provisional Adjustment	0.00
Tariff Adjustments	0.00
Debit	220.54
Credit	0.00
Current Payable Amount(₹)	~~222371.03~~ 222473.18

Bill Details(₹)	
Installment Amount (A)Installment Number	0.00
Total Payable Amount(₹)	1241526
Payable Amount in words	Twelve Lakh Fourty One Thousand Five Hundred Twenty Six Rupees Only

Last Payment Status	
Amount(₹)	196450.00
Receipt No	5075556408l2
Receipt Date	01-APR-2016
Payment Details Cheque	196450.00

Previous Consumption Pattern				
Bill Month	Units (KWH)	Units (KVAH)	Demand	Status
MAY-2016	6756.5	8143	88.4	MU
APR-2016	5203.5	7490.5	52.2	MU
MAR-2016	4286	6818	24.8	MU
FEB-2016	4779	8407	35.4	MU
JAN-2016	4256	7778	26	MU
DEC-2015	4800000	5333334	0	MU

Energy Saved Is Energy Produced.
Note: If the Bill is not paid by Due Date, the supply will be disconnected without any further notice.

Book No.	Receipt No.	Counter no.	Old Acct No	Acct No	Bill No.
233511960042			0	5075556564	507555565459
Amount Received(Figures)			Counter Name	Received by	Collection Date
(In Words)					

Cheque/DD No.		Due Date	18-JUN-2016
Bank:		Total Amount Payable before due Date(₹)	1241933
Branch:			
Date:	Cashier Signature		
Amount:			

NOTE:Pay your Bill online- www.upcclonline.com Customer Care Toll Free No:1800-180-3023

EXECUTIVE ENGINEER - EUDD-I JHANSI