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Automated Peripheral Street Lighting Solar Power Density

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RESEARCH AREA: Renewable Energy, Illumination Engineering and Science

RESEARCH STATEMENT:

The research paper enlightens the use of solar-powered LED streetlights for energy-efficient lighting in futuristic Viksit Bharat, analyzing power time, fixtures, over-voltage current, and ambient lighting network architecture. This paper modelled a new innovative concept of street road enacted with the MATLAB, HOMER ENERGY, and DIALUX software to simulate and model luminaries of automated LED streetlights in an Indian city, focusing on automatic intensity, Color Rendering Index (CRI) and Color, Color Temperature (CCT) surveillance and density simulation for nightfall and dusk use.

The exploration article is examined and compared.

RESEARCH OUTLINE

Road networks facilitate trade, transport, social integration, and economic development in India. They offer easy accessibility, flexibility, door-to-door service, and reliability, leading to an 11- fold increase in road length [1-4].

India's road network grew 59% from 2013 to 2023, shifting passenger and freight movement towards roads. As per database acquisition and data wrangled.

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NOVELTY & APPLICATIONS

Road lighting criteria, influenced by user speed, traffic volume, and navigation difficulty, ranges from strict to relaxed. The artificial extending and durability of proposed ME-Class Street lighting enhances security, quality of life, and safety for drivers, riders, and pedestrians.

The paper presents a Design Optimization method for energy-efficient lighting installations, utilizing DILUX lighting simulation, MPPT algorithm, and MATLAB simulation for optimal solutions.

Type	Distance (in Km)
National Highways/Expressways	79,116 km
State Highways	1,55,716 km
Other Roads	44,55,010 km

Table 1.2 Percentage of different Lanes

Type	Distance (in Km)
Single Lane/ Intermediate Lane	19,330 km (24%)
Double Lane	40,658 km (52%)
Four Lane/ Six Lane/ Eight Lane	19,128 km (24%)

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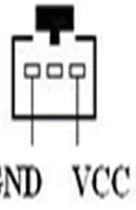
Table 1.3. Different Luminaires And Their Percentage

Description	Units (Numbers)	Proportion (%)
High Mast Lamps	20	0.56
Halogen Lamps	180	5.05
Mercury Vapour Lamps	252	7.0
Sodium Vapour Lamps	477	13.40
T8/T5 Florescent Lamps	2381	66.86
Others (MH) Lamps	251	7.05
Total	3,561	100.00

ME Class LED Fixture with Pole Mounting (Methodology)

Power Supply	DC 24V	Tolerance: +-0.1V
Max Power Consumption	3.84W	LED consumption only
Operating Condition	Ambient Temperature	0 - 40 C
Quantity of LEDs	Humidity (Region based)	20 - 80%RH
	Cooling Method	Natural Air Cooling
Connector Pin	Connection Type	

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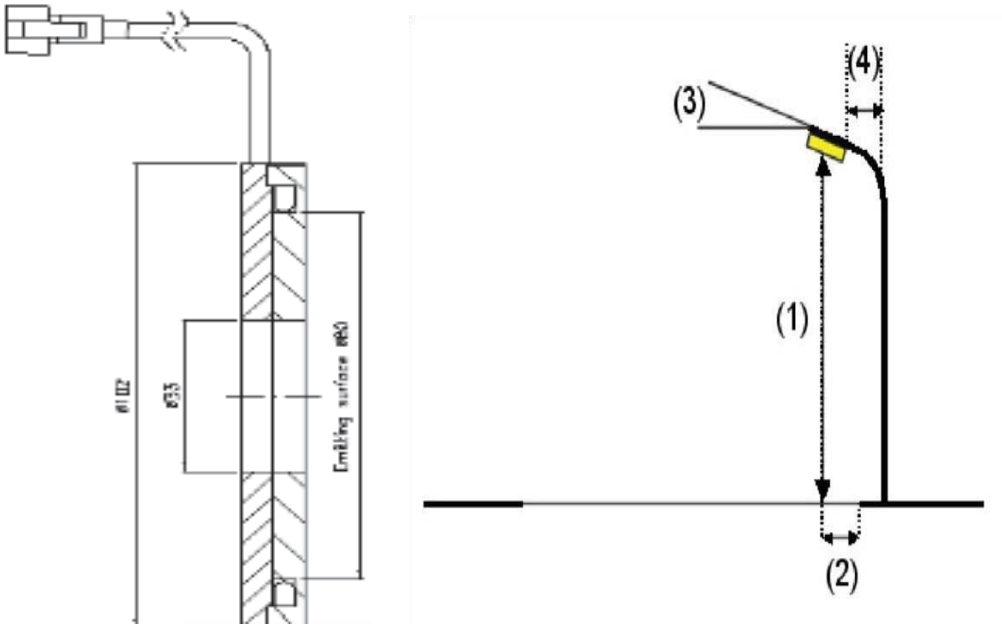

Simulation Visuals of Street Before Simulation with Luminaire

	Lav [cd/m²]	U0	Ul	TI [%]	SR
Calculated values:	0.46	0.06	0.08	0	0.98
Required values according to class:	≥ 0.75	≥ 0.40	≥ 0.60	≤ 15	≥ 0.50
Fulfilled/ Not Fulfilled	N	N	N	Y	Y

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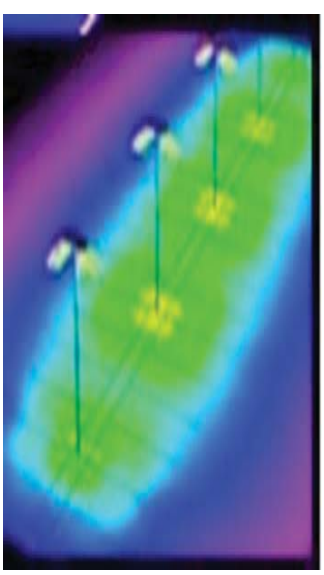
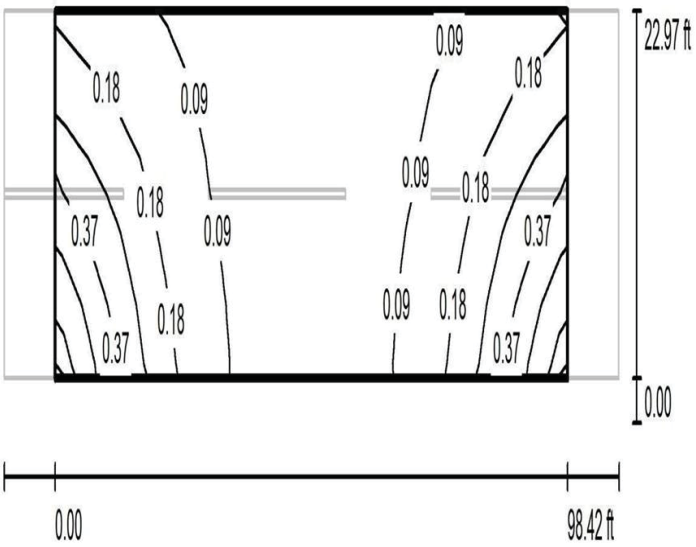
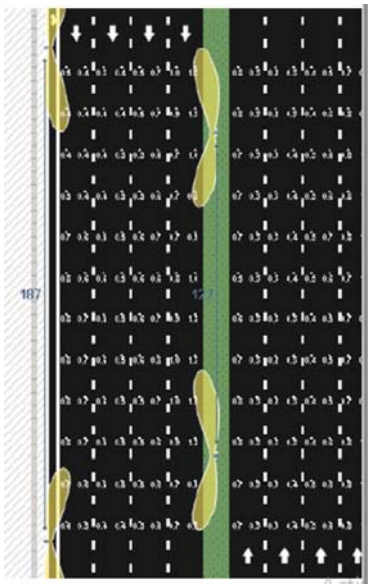
Photometric Computation: Isoline Illumination Rendering Results of LED Streetlight for Streets







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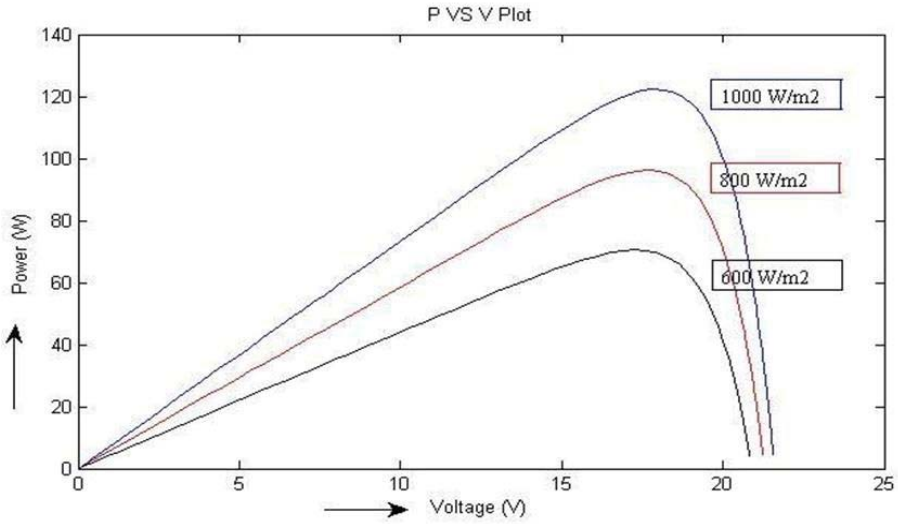
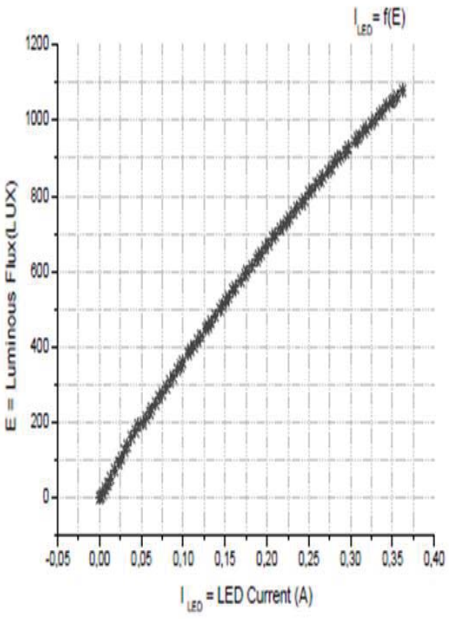
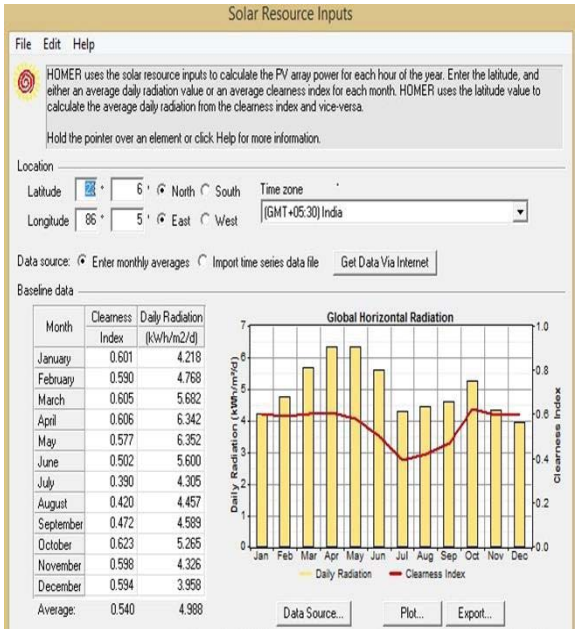
MPPT Voltage Range of Solar Street Light

Power vs Voltage curve for different irradiance



Luminous flux of tested LED as function of current intensity





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Conclusion

The real-life case of Indian city study demonstrates a custom design method that significantly reduces roadway lighting energy costs and CO2 emissions without requiring high-cost technologies. This method can be applied to large optimization problems like city-scale retrofits and can save on all road types and lighting classes. The method doesn't require additional equipment and is competitive with traditional design paradigms due to falling LED prices.

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