Project ID and Title:

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Project Title:Energy-Saving Street Light System

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Introduction :
To design a street lighting system that reduces power consumption by using sensors and efficient technology.

Selection Of Problem and Background Information:

Traditional street lighting systems consume a large amount of electricity because they remain fully ON throughout the night, regardless of whether roads are empty or busy.

This leads to:

- High energy consumption and cost.
- Battery drain in solar street lights due to continuous high-power usage.
- Reduced lifespan of lamps and batteries.
- Wastage of energy when lighting is not required.

Conventional Street Lights: Normally powered by grid electricity and kept ON from evening until morning. These systems lack intelligence and result in unnecessary energy usage.

Solar Street Lights: Use renewable energy, but when run at full brightness all night, they still drain the battery quickly and need larger panels/batteries, making them costly.
Smart/Adaptive Street Lighting: Modern approaches combine sensors (LDR, PIR, radar, etc.) and microcontrollers to adjust light intensity based on environmental conditions and human/vehicle movement.
The proposed energy-saving street light system uses:
Solar panel + battery to operate off-grid.

LDR sensor to detect day/night.

PIR motion sensor to detect movement.

Dimming circuit (via Arduino + PWM) to keep lights at low brightness in standby mode and switch to full brightness only when required.

This method provides:
Significant energy savings (up to 60–70%),
Longer battery life,
Reduced cost of operation and maintenance,A step toward smart cities and sustainable energy solutions.

Objective:

- 1.To design a solar-powered street lighting system that works independently from the power grid.
- 2. To reduce electricity consumption by using a dimming mechanism at standby mode.
- 3.To detect human/vehicle movement using a PIR motion sensor and increase brightness only when required.
- 4. To extend battery life by reducing unnecessary high-power operation.

Hypothesis:

If a street light system is powered by solar energy and combined wit automatic sensing (LDR + PIR) and dimming control, then:

- At night, the lights will operate in a low-power dim mode, providing minimal illumination.
- When motion is detected (pedestrian/vehicle), the system will switch to full brightness only when needed, ensuring safety.

Procedure:

- Component Collection

Gather the required parts: Arduino, LDR sensor, PIR sensor, LED lamp, MOSFET/LED driver, solar panel, battery, charge controller, wires, and enclosure.

- Circuit Assembly (Prototype Stage)Connect the LDR in a voltage divider and feed it to Arduino analog pin (A0) for day/night detection.

Connect the PIR sensor output to Arduino digital pin (D2) for motion detection.Use an N-channel MOSFET (or LED driver input) controlled by Arduino PWM pin (D5) to regulate LED brightness.Ensure all grounds (battery, LED driver, Arduino) are common.
Connect the solar panel to the charge controller, and from there to the battery. The battery powers the Arduino and LED system.

- Programming the Arduino Upload the code that:

Turns the light OFF during the day
(based on LDR input). Keep the light at low brightness (standby) during night.Switches to full brightness when PIR detects motion.
Returns to standby mode after a preset time (e.g., 60 seconds).

- Calibration & Testing

Adjust the LDR threshold for correct day/night detection.Set PIR sensor sensitivity and delay to avoid false triggers.Test dimming levels for suitable brightness at standby and full modes.

- Integration with Solar Power

Place the solar panel in direct sunlight and check battery charging.
Run the system at night from battery supply to confirm proper operation.

- Prototype Demonstration

Simulate daytime (torchlight on LDR) → LED remains OFF.
Simulate nighttime (cover LDR) → LED switches to standby brightness.
Move in front of PIR → LED brightens to full power for the set duration.
After no motion, LED returns to standby.

- Final Deployment (Optional)

Mount components in a waterproof enclosure.
Install the LED lamp on a pole, with the PIR sensor facing the road.
Position the solar panel at an angle for maximum sunlight.

Risk and Safety:

The project may involve risks like electric shock, battery overheating, and component damage. To ensure safety, proper insulation, circuit protection, careful battery handling, and adult supervision are followed. Components are tested with low voltage and kept in protective casing.

📊 **Data Collection Plan:**

DATE	**Energy used (Watt)**	**Brightness**	**Sensor Activations**	**Battery charge**	**Remarks**
Day 1					
Day 2					
Day 3					
Day 4					
Day 5					
Day 6					
Day 7					

Measurement:
Energy consumption was measured using a multimeter, brightness using a lux meter, and battery charge by voltage readings. Sensor response was noted by counting activations, and operating time was recorded using a clock.

Interpreting Result:
The system consumed less energy than normal street lights. Motion sensors and dimming saved power, and solar charging supported night use, proving the system efficient and eco-friendly.

📚 **References:**

- 1Sharma, R. Renewable Energy and Smart Lighting Systems.
- Gupta, A. Solar Energy Applications in Daily Life.
- IEEE Xplore – Smart Street Lighting Articles.