

Street Lighting PPPs: Improving Energy Efficiency and Public Safety in India's Cities

Evening sales at Rashmita Khattoi's food truck increased after LED street lights were installed across Bhubaneswar. © Samarendra Dash/IFC

Street lighting PPPs help residents have access to better services, improve business and public safety, and increase energy efficiency by up to 70%.

The International Finance Corporation (IFC) has been involved in India's street lighting sector for nearly a decade, designing replicable public-private partnerships that help municipal governments address the core challenges they've faced in reducing their energy consumption and improving public safety. IFC worked with state and municipal governments, national agencies, and the World Bank to develop a scalable, bankable solution that has created a new market for private investment in India's public street lighting sector. The PPP model has also become a best practice in India. Some of the risk mitigation measures created by IFC in the first street lighting project have become industry standard.

This note is part of the PPP Insights series developed by the IFC PPP Transaction Advisory Department for infrastructure specialists, governments, and PPP practitioners. PPP Insights provides sector analysis and case studies looking at infrastructure needs and challenges in developing countries and how PPP structuring techniques are being used to help deliver improved outcomes.

Street Lighting & Energy Consumption in India: The Development Challenge

Municipal street lights account for up to 60% of a city's electricity bill depending on the size of a city, the services it offers, and the efficiency of its public lighting.¹ Despite the substantial electricity used for public street lighting, in most emerging markets these systems are marred by inadequate infrastructure, such as non-standardized poles, lamp selection not aligned to road class, substantial variation in voltage leading to higher consumption, non-functional meters, and ad hoc operation and maintenance practices resulting in safety hazards.

Significant improvements in lighting technologies have made **60-70% reduction in energy consumption** possible at affordable rates and at a lower operation and maintenance cost.

Many cities around the world are implementing public lighting programs for two main reasons – economic growth (by increasing the amount of time that people can spend after dark) and community safety (reduction in crime by ~20% and traffic accidents by ~35%). Given the accelerating pace of urbanization around the world, making public street lighting more energy efficient is critical for reducing energy consumption globally, as well as for making streets and roads safer for residents, and reducing the budget burden for overstretched municipal governments.

In India, per capita consumption of electricity is less than one third the world average.³ Yet each year, India's municipal street lights use over 8,000 GWh of energy.

Street lighting accounts for nearly 1.5% of India's entire power consumption, **costing Indian cities upward of \$500 million per year.**⁴

This is largely due to outdated and poorly maintained street lighting infrastructure and a lack of much needed equipment to monitor and control burning hours.

Earlier attempts by the municipalities to partner with Energy Service Companies (ESCOs)⁵ to upgrade their street lighting infrastructure failed to meet public sector needs. This was largely due to a lack of data on street lighting infrastructure and its current condition and energy consumption. Previous efforts were also affected by a poor understanding of monitoring and verification of services and the protocols critical for assessing service delivery levels, as well as insufficient credit worthiness of the cities, lack of payment security mechanisms, and failure to link public-sector payments to the performance of the private partners.

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Project Context: India's Odisha State is home to 42 million people, with 33% of people living below the poverty line.

The state capital, Bhubaneswar, had many residential areas lit with dim, patchy lighting or none at all. The city's street lighting fell far below national standards, causing road hazards and safety concerns for residents, leading to recurring complaints from the public.

The city had outdated and poorly maintained infrastructure and lacked needed equipment to monitor the street lighting system and control burning hours—over 75 percent of the street lights lacked meters. This led to high energy consumption and costs.

The Bhubaneswar Municipal Corporation (BMC) considered entering into a performance-based contract with the private sector, where an Energy Services Company (ESCO) would upgrade the street lighting infrastructure and improve its management. However, the lack of engagement from Indian banks as financiers and industry domination by established ESCOs that did not provide comprehensive energy management services, posed significant challenges for the city.

BMC requested IFC to help design a PPP model based around a robust performance-oriented transaction structure, and to assist the city in running a competitive tender to identify the right partner. IFC signed a mandate with BMC in 2011 and closed India's first city-wide ESCO PPP in October 2013 when local Indian consortium led by Shah Investments won the tender to renovate the city's street light infrastructure.

Innovations

- Incorporating best practices for monitoring and verification of service delivery levels into the transaction structure.
- Designing an escrow mechanism to address the issue of municipal creditworthiness, along with a letter of comfort from the State Government in an event of non-payment by BMC.
- Designing a Shared Savings model so the ESCO pays for street lighting upgrades and operations, earning revenue from energy savings realized by BMC.
- Developing detailed performance indicators to monitor performance and linking the ESCO's revenue directly to the amount of energy it saved the city.

Results

- Shah Investments has invested USD \$4.8 million to retrofit 20,000 street lights and has been achieving more than 80% energy savings since commissioning.
- Established a centralized control & monitoring system with remote operations, dimming, and monitoring capabilities for the city.
- Savings of about USD \$100,000 a year for Bhubaneswar on its energy bill.
- Greenhouse gas emission reduced by an estimated 10,500 metric tons annually.
- Residents of Bhubaneswar have better road visibility, safer streets, and increased local trade with markets able to remain open later.

Project Context: Jaipur, the capital city of the state of Rajasthan, is a popular tourist destination owing to its vibrant history and culture. The city enjoys a large network of streets, historical buildings, community spaces, and markets.

The Jaipur Municipal Corporation (JMC) operates and maintains over 100,000 public street lights, but the system was facing problems due to old, energy-intensive technology and a lack of capacity to operate such a large network, with only one in three city lights functioning. At the same time, JMC was incurring significant electricity costs from the public lights network.

Based on the results of IFC's work in Bhubaneswar, JMC asked IFC to assist it in designing a PPP that would address its street lighting crisis and bring energy consumption and costs down. IFC proposed a transaction structure based on a 10-year Energy Performance Contract (EPC). The structure included retrofitting public street lights with new energy efficient lamps, installing, operating, and maintaining a fully computerized centralized control and monitoring system, and establishing a 24/7 public grievance system dedicated to public lights within the JMC office.

The PPP agreement was structured to balance risks, make the project viable and sustainable, protect the rights of all parties, and provide measurable investment and performance objectives aligned to the city's goals.

Innovations

- ESCOs determined which technology to use to deliver the most energy efficient street lighting system, with revenues earned from JMC based on the energy savings achieved.
- The state Government of Rajasthan was also party to the contract, guaranteeing payments to the ESCO to address bidder concerns about the creditworthiness of the city (JMC).

These features gave confidence to investors, securing strong competition for the contract. After a transparent and competitive bidding process, a consortium led by SMC Infrastructures Private Ltd., a large Indian infrastructure company, comprising Samudra Electronic System Private Limited, a leading LED lights manufacturer and Winwalk System Inc., an ESCO, was selected and awarded the project.

Results

- The winning bid committed to achieve over 77% in energy savings of which over 30% would be shared with the city (JMC).
- The ESCO has achieved more than 80% energy savings since commissioning.
- This resulted in an annual fiscal savings of \$1 million per year for the city.
- Improved streetlight services for over 1,650,000 people.
- Estimated reduction in greenhouse gas emissions of over 36,000 metric tons per year.

Shared Savings Model vs. Notional Savings Model

Shared Savings Model

The Shared Savings Model is a performance-based model where the private sector is responsible for implementing the project at its expense and is responsible for operations and maintenance (O&M) throughout the term of the contract.

The private partner has the flexibility to adopt any energy conservation measures it deems appropriate to achieve minimum specified levels of energy savings (as determined by the energy bills raised by the utility) and then shares in these savings as its primary source of revenue.

The operator also earns fees based on meeting specified O&M performance indicators set out in the contract pertaining to lighting levels, glowing hours of lamps, and response time to consumer complaints, among others.

Notional Savings Model

Under the Notional Savings Model, the combination of energy conservation measures (in terms of the type and wattage of lamps, dimming technology, auto-switching, controllers, etc.) is fixed (notional savings) and prescribed by the municipality to provide the highest quantum of energy savings and implemented by the private operator.

The technical specifications and service level arrangements are determined through field-level technical demonstrations and prescribed in the tender documents. The private operator is responsible for implementing the projects and operating and maintaining the street lighting system adherence to key performance indicators (KPIs) set out in the contract in exchange for a subsidy on capital costs and an annuity fee for O&M services that meet KPIs.

Key structuring differences between Shared Savings and Notional Savings models

Description	Shared Savings	Notional Savings
Technology / Interventions	Selected by ESCO	Prescribed by municipality
Performance risk	Passed on to the ESCO	Retained by municipality
Energy savings	Based on bid (minimum threshold provided by municipality)	Notional, not measured
Bid variable	Guaranteed energy savings	Annuity payable by municipality, not linked to actual savings
Savings share with government	Can be structured in project design	Not applicable as actual savings accrue to the municipality
Energy Baseline	Robust baseline required	Not required
Monitoring & Verification (M&V)	Detailed M&V protocol prescribed by bid documents	Minimal M&V required as long as technology interventions are as prescribed
Metering	Required to establish baseline and for M&V	Not required, though preferable for long-term sector development

Project Context: The street lighting in many cities in the State of Odisha was poor or non-existent, especially in residential areas, causing hazards and safety concerns for residents.

Moreover, the old lighting system was very inefficient, resulting in high energy costs for cities. IFC worked with the state's Housing and Urban Development Department (HUDD) to structure a PPP to install new greenfield lights across four major cities (Berhampur, Cuttack, Sambalpur, and Rourkela) and to expand the street lighting network to unserved areas in Bhubaneswar not covered in the original PPP in 2013.

After successfully implementing the innovative **Shared Savings model** in Bhubaneswar and replicating it in Jaipur, the scaling-up of street lighting PPPs with this multi-city project required a different approach. IFC structured the project using a Notional Savings model. This shift was due to many factors not encountered in the first projects. This included the inclusion of a greenfield component and substantial improvements needed in the street lighting infrastructure, which are difficult to be modeled under a shared savings contract.

The notional savings approach also allowed for addressing other constraints unique to the project, such as (i) lack of firm estimates for the extent of greenfield and rehabilitation works required; (ii) lack of capacity and inclination of the municipalities to undertake asset marking and baselining of the existing street lighting system; and (iii) lower energy costs being paid by some municipalities due to old inventory data and average billing, which could affect energy saving data and result in no actual cost savings for some municipalities even after energy consumption was reduced.

Innovations

- A joint venture of state-owned power companies, Energy Efficiency Services Limited (EESL), invested a 26% equity stake in the special purpose vehicle (SPV) for the project and guaranteed payment of annuities to the ESCO.
- EESL enabled its operations to scale up, spread its capital across a larger number of projects, and undertake more projects by using its resources to mobilize greater private investment in the sector.

Results

- Improved streetlight services for over 400,000 people.
- Reduction in greenhouse gas emissions of over 12,500 metric tons per year.
- First international company to enter the street lighting sector in India, with a consortium of Novalume A/S (Denmark) and Neev Energy (India) winning the tender.

4

THE CITY OF BENGALURU 2019

Project Context: In Bengaluru, often referred to as the India's Silicon Valley, fiscal constraints had led to a lack of investment in the city's 485,000 outdated and inefficient streetlights.

Poor operation and maintenance resulted in high energy consumption, poor lighting, and non-functional meters in India's major technology hub. The poor state of street lights in Bengaluru cost the city \$34.5 million in electricity charges per year and sparked safety concerns for its residents.

The Bruhat Bengaluru Mahanagar Palika (BBMP) municipal government worked with IFC to structure a PPP using the **Shared Savings model** to find a private partner to implement energy conservation measures (ECMs) that would:

- Increase energy savings by replacing conventional lights with LEDs;
- Improve services through automation by establishing a control-center, real-time monitoring and predictive repair, complaint management through a centralized call center, and adequate field crews to minimize down-time;
- Improve infrastructure through greenfield systems for new sites, correction of single drop points, reconductoring/underground cabling, and outreach arm replacement; and
- Integrate smart-city technologies with the street lighting infrastructure by installing 198 environment sensors across the wards of the city, and developing a communication network that could (a) individually control LED lamps, and (b) enable the municipal government to procure and install up to 50,000 internet protocol (IP) cameras.

Innovations

The street lighting network in Bengaluru was designed to harness data-driven intelligence, that will help build the foundation for smart city applications, including:

- Installation of sensors to capture environmental data.
- Individual control of each LED.
- Developing a communication network to support installation of over 50,000 IP cameras.

Results

With over 485,000 streetlights, Bengaluru is possibly the world's largest street lighting project designed under a performance based Shared Savings model. The project, upon commissioning, is expected to result in:

- 85.5% reduction in Bengaluru's energy used for powering streetlights – the highest savings guaranteed to date of any project in India, making the project one of the largest municipal energy savings street lighting projects in the world.
- Improved streetlight services, enhanced commercial activity, and increased safety for over 3.5 million residents.
- Reduction of greenhouse gas emissions by 86,000 metric tons per year.
- \$100 million in private investment mobilized.

Lessons from India's Experience in Street Lighting PPPs

India's experience in reducing municipal energy consumption and delivering savings and safer streets through well-structured PPPs has lessons for cities in other emerging economies around the world.

Data

For any street lighting PPP project, data is essential to ensure the project can be properly structured and can deliver on municipal objectives. For the projects in India where municipalities lacked this essential data, extensive due diligence exercises were undertaken to address data constraints – physical infrastructure (number of street lights, types of fixtures, quality of lighting infrastructure) and consumption data (connected load, energy consumption). Typical due diligence activities included (a) survey of streetlights and (b) determination of existing lighting levels / non-functioning lights / metering.

This data is essential for determining the most appropriate model to use when structuring any street lighting PPP.

One Size Does Not Fit All

It is critical that the PPP model chosen for a project matches the street lighting context in a municipality. For example, the performance-based Shared Savings Model is most suitable for cities with good quality street lighting infrastructure and proper metering. This is because the Shared Savings Model allows these cities to undertake energy efficiency projects based on the actual energy savings the private operator can provide, thereby

translating into measurably lower municipal cash outlay for energy use, as well as improved metering and billing systems. On the other hand, the Notional Savings Model is more suitable for cities that lack proper metering of street lights, where the quality of infrastructure is poor and requires substantial rehabilitation or replacement works, or where there is an inadequate number of street lights requiring greenfield installations. The model allows municipalities in this situation to undertake energy efficiency projects without expending the time and resources required for determining the energy baseline, resolving infrastructure deficiencies, and installing meters on a city-wide basis (pre-requisites to the performance based shared savings model).

Robust Monitoring & Verification Protocols

The transaction structures introduced robust frameworks for joint surveys to determine baseline consumption data and detailed protocols for monitoring and verification of service delivery, which ensures both partners are working from the same data and towards agreed targets.

Payment Security

Poor credit worthiness of the municipalities and lack of payment security are significant risks to sustainability of the projects and limits the ability of the private partner to raise debt, thereby necessitating the need for robust payment security mechanism. The transaction structures should address credit risk perception of private investors by structuring escrow mechanisms and government guarantees. This approach—implementing projects under notional savings model and performance-based shared savings model—enables cities with

limited financial resources to tap into the technical know-how of the private sector. Based on lessons from these street lighting PPPs across different cities in India, the issues that municipalities should consider while identifying the optimal implementation framework include:

- Status of the current street lighting infrastructure, including the rehabilitation costs of (underground cables, overhead conductors, meters etc.) that may be required;
- Electricity charges being paid by the municipality (determined as a factor of connected load and electricity tariff) to assess if the energy savings will also translate into cash savings;
- Capacity and intent of the Government to undertake project development activities and subsequent monitoring and supervision;
- Technical and financial capacity of the ESCOs in the region; and
- Cost benefit analysis of the project.

The Shared Savings model can be more beneficial to a municipality since it transfers greater risk to the ESCO and requires less upfront public investment in upgrading infrastructure.

Results from India's Street Lighting PPPs

The public street lighting projects in Jaipur and Bhubaneswar have resulted in energy savings of over 80%. Other benefits include standardized lux levels across the cities, minimum 98% of lights operational at any time, reduced time to address customer complaints, and detailed data management.

The Bengaluru project, with over 485,000 streetlights, is possibly the world's largest street lighting project under a performance based shared savings model and the private sector has guaranteed 85.5% reduction in the city's current energy consumption, which is unprecedented.

Once the Bengaluru project is fully operational, the four municipal initiatives combined will save the municipalities an estimated **₹30 million annually and reduce greenhouse gas emissions by over 133,000 metric tons per year.**

Through these PPPs, residents also have access to services, such as 24x7 helpline, while remote dimming and remote fault detection results in rapid fault rectification to ensure continuously well-lit streets, making streets safer for motorists and pedestrians.

Better lighting can also result in increased business, with customers feeling safer venturing out at night and traders able to stay open later. This is especially important for women, many of whom sell food or products from their street-carts or work in jobs that require them to return home after nightfall.

The impact of these projects is being felt far beyond the cities in these case studies. IFC's clients have made the transaction documents freely available for other cities to use. IFC's model is being replicated at a scale by municipalities across India, benefiting cities and the environment through reduced energy consumption and safer roads and streets.

This case study was authored by Neeraj Gupta, Principal Investment Officer, and Sumeet Shukla, Investment Officer, at IFC, a member of the World Bank Group: ifc.org/ppp

- 1 Energy Savings Potential for Street Lighting in India, Ernest Orlando Lawrence, Berkley Laboratory, International Energy Analysis Department, February 2014, pg. 4
- 2 <https://blogs.worldbank.org/energy/led-street-lighting-unburdening-our-cities>
- 3 Per capita electricity consumption in India is 1,010 kilowatt hours (kWh), against a world average of 3,200 kWh, <https://www.dfat.gov.au/geo/india/ies/chapter-7.html>
- 4 India: Energy-Efficient Street Lighting—Implementation and Financing Solutions, World Bank Group, June 2015, pg. 14
- 5 Energy Service Companies (ESCOs) are companies in India that offer energy services, usually in the design, retrofitting, and implementation of energy efficiency projects