IMPLEMENTATION OF ENERGY EFFICIENCY MEASURES IN PUBLIC STREET LIGHTING SYSTEM WITH PRIVATE SECTOR PARTICIPATION

IFC | International Finance Corporation
WORLD BANK GROUP

July 11, 2018

IFC | International Finance Corporation
WORLD BANK GROUP

CONTENTS

- Key issues in street lighting sector in India
- Objective
- Possible implementation frameworks
- Benefits to City
- IFC assistance

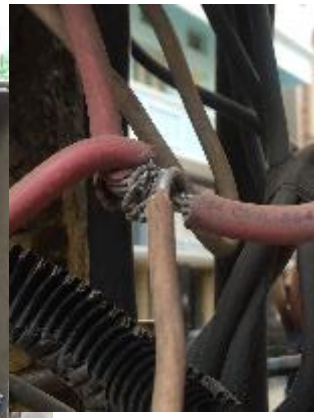
STREET LIGHTING

- Public street lighting system by making the streets safer for the people and enabling an increase in commercial activities and thereby income, impacts the life of every citizen.
- Provision of street lighting services is an obligatory function of the cities in India
- Current energy consumption levels are extremely high and can be reduced by 60 to 70% through the use of energy efficient technologies and control systems.
- Owing to constraint of funds, cities have concentrated on public services and infrastructure such as water, roads as compared to energy efficiency project.

KEY ISSUES IN STREET LIGHTING SECTOR IN INDIA

KEY ISSUES IN THE STREET LIGHTING SECTOR IN INDIA

Nature	Issues
Technical Aspects	Lamp selection not aligned to road class
	Infrastructure inadequacy in the form of non-standardized poles / large proportion of utility poles which are not designed for street lighting
	Lower efficacy of fixtures in comparison to the rated capacity
	Substantial variation in voltage leading to higher energy consumption
	Poor quality of infrastructure and maintenance • Safety hazards - Fixtures not earthed / Open joints • Poor condition of outreach arms
Procedural & Commercial Aspects	Billing on un-metered basis (meters absent / non functional)
	Procurement through inadequate specifications results in supply of equipment with lower efficacy
	Maintenance gaps leading to delays in replacement and loss of efficacy and inadequate lighting in several areas



IFC International Finance Corporation WORLD BANK GROUP

ANALYSIS OF SERVICE LEVEL

Percentage of non glowing lamps	LUX level survey of representative sample	Voltage variation survey of representative sample
• Percentage of non glowing lamps to total switching point lamps • Load attributed to non glowing lamps	• LUX level survey of different road categories as per BIS classification • Comparison of LUX level data with BIS recommendations	• Recording of voltage over a period of time at regular interval • Adjustment of estimated energy consumption for average voltage

ANALYSIS OF NON-GLOWING LAMPS

Zones with non glowing lamps

Zone	Lamps connected to S/P	Total Non Glowing Lamps	%age
1	1148	785	68%
2	744	464	62%
3	449	258	57%
4	1135	641	56%
5	862	443	51%
6	196	92	47%
7	906	409	45%
8	247	111	45%
9	329	147	45%
10	830	366	44%
11	710	307	43%
12	1013	430	42%
13	1161	492	42%
14	802	333	42%
15	635	261	41%
16	229	94	41%
Total	70,652	21,871	31%

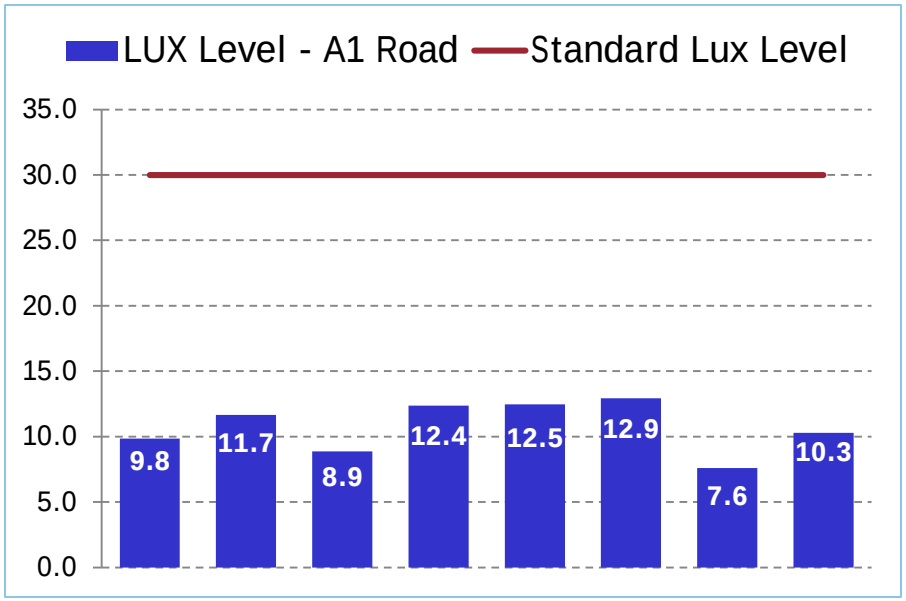
Connected Load of non glowing lamps

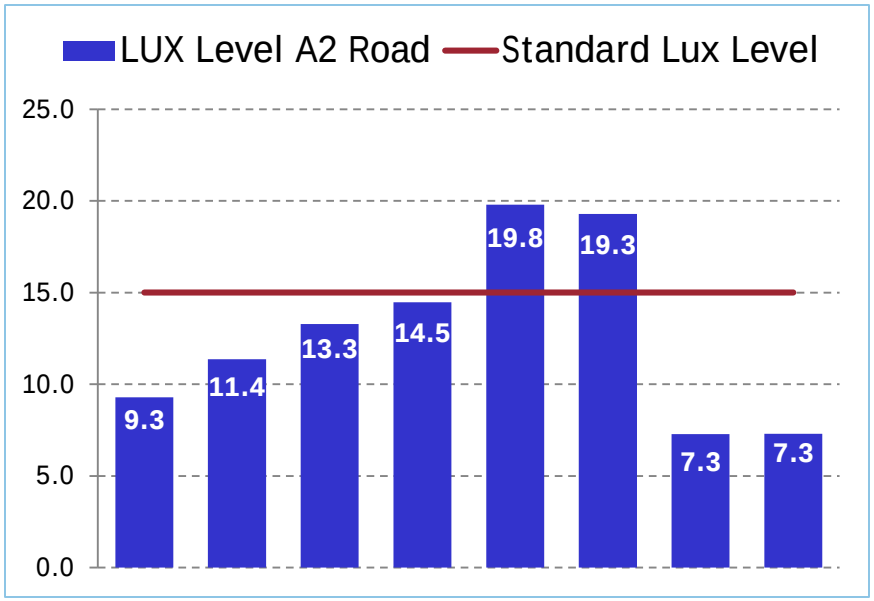
Load assessment	
Non glowing SV lamps (nos)	12,338
Wattage with choke loss (W)	230
Non glowing FTL lamps (nos)	9,533
Wattage with choke loss (W)	50
Non glowing load (kW)	3,314.39
Connected Load (kW)	13,545.36
% load non glowing	24%

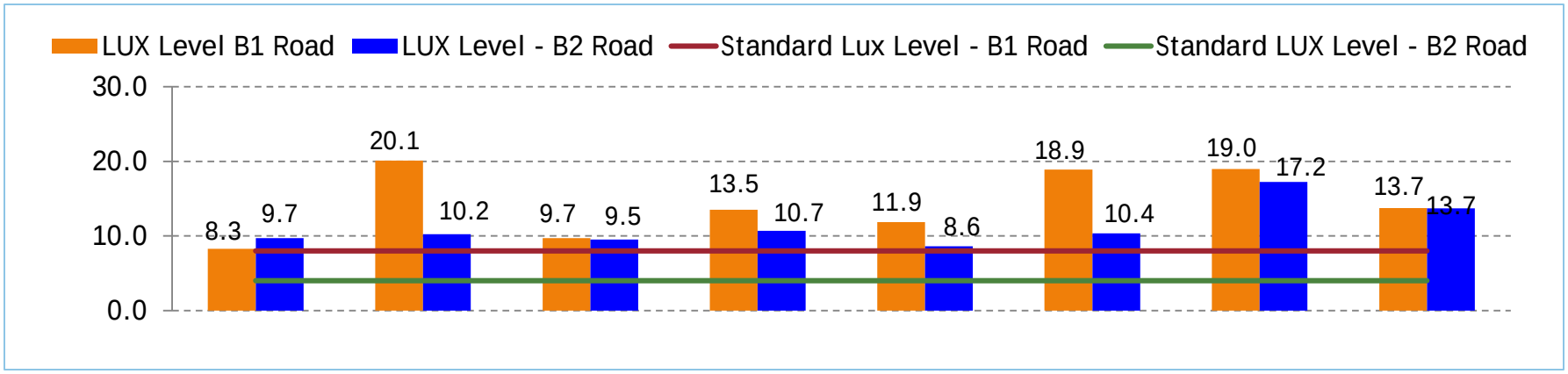
- 31% of lamps are non glowing and load attributed to non glowing lamps is 24% of gross load for switch point lamps
- Ward-wise Performance ranges from 7% non glowing to 68% non glowing

LUX LEVELS

- Lux levels not maintained as per the Applicable Laws



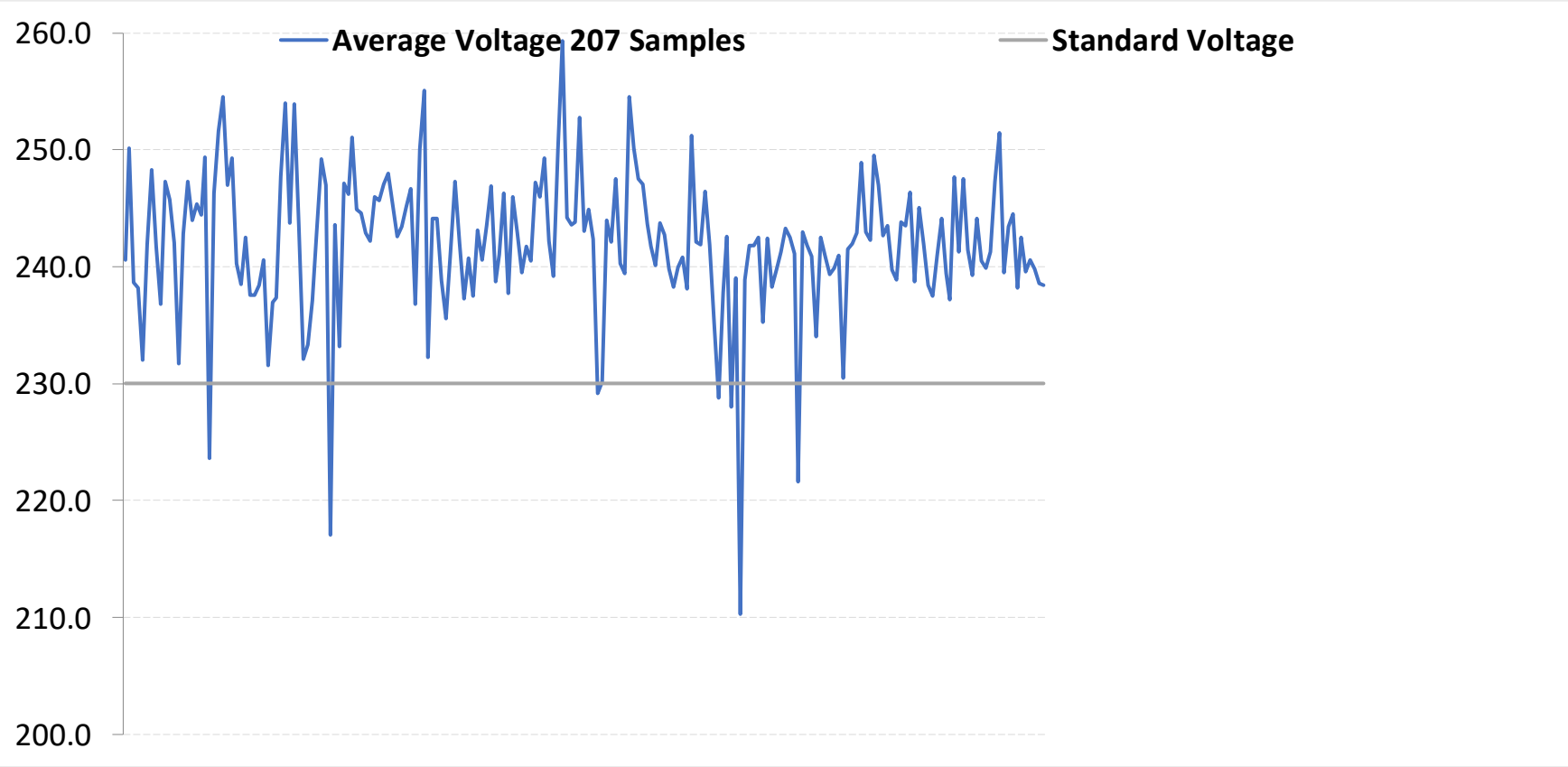




IFC International Finance Corporation WORLD BANK GROUP

VOLTAGE FLUCTUATIONS

- Significant voltage fluctuations leading to faster burn out of LEDs



PROJECT OBJECTIVE

THRUST ON ENERGY EFFICIENCY MEASURES

Government of India and the cities keen to implement energy efficiency measures

Objectives

Reduction in Energy Consumption	Improvement in Service Level	Mobilization of Private Sector
• Reduction in energy consumption by implementation of Energy Conservation Measures (ECM) • Maintain environment friendly street lighting system	• Improvement of illumination level • Reduction in number of non glowing lamps • Systematic recording of inventory, billing and maintenance data • Improvement in operation and maintenance practice – single point accountability	• Utilization of private sector expertise • Deployment of latest technological knowhow – would enable training of municipal employees as well.

Intent - Technologically and Financially sustainable project with replication potential

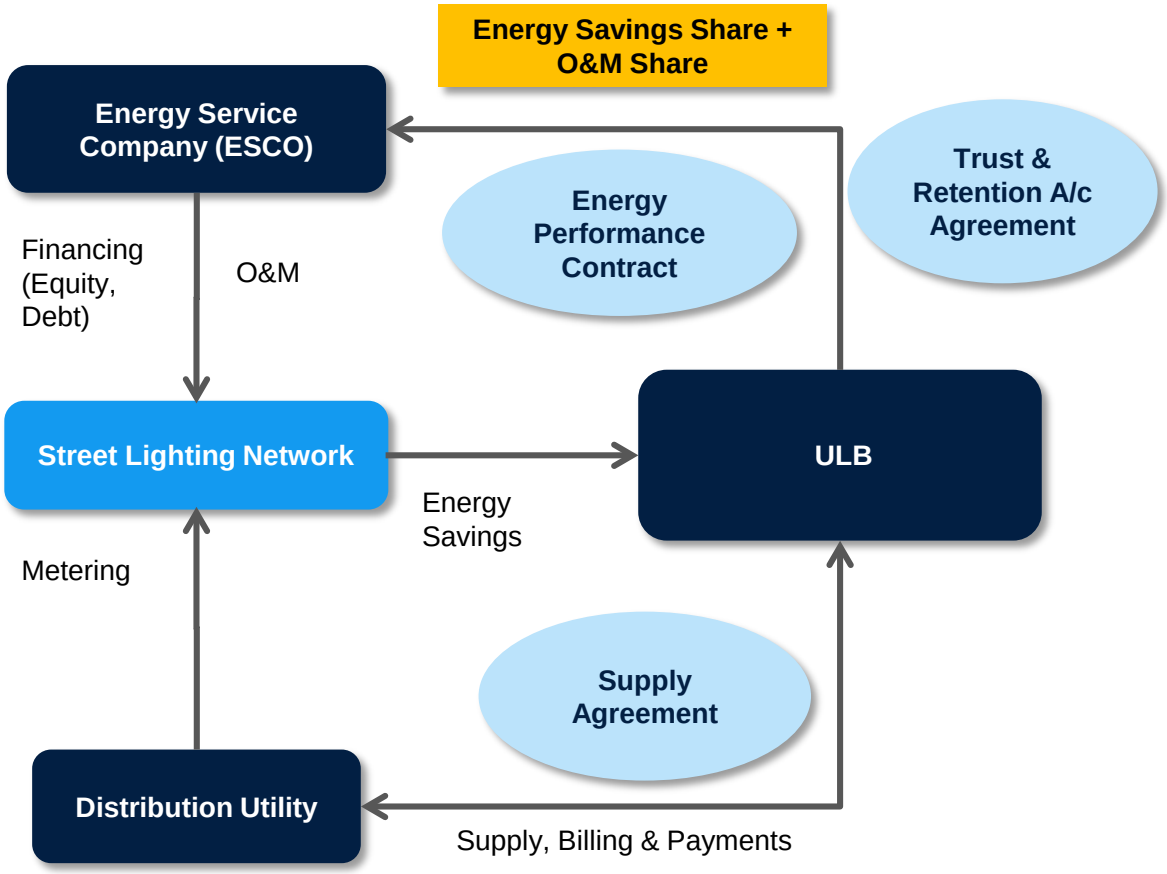
IMPLEMENTATION FRAMEWORKS

PROJECT IMPLEMENTATION MODELS

Two models for implementation of energy efficiency measures in the street lighting system:

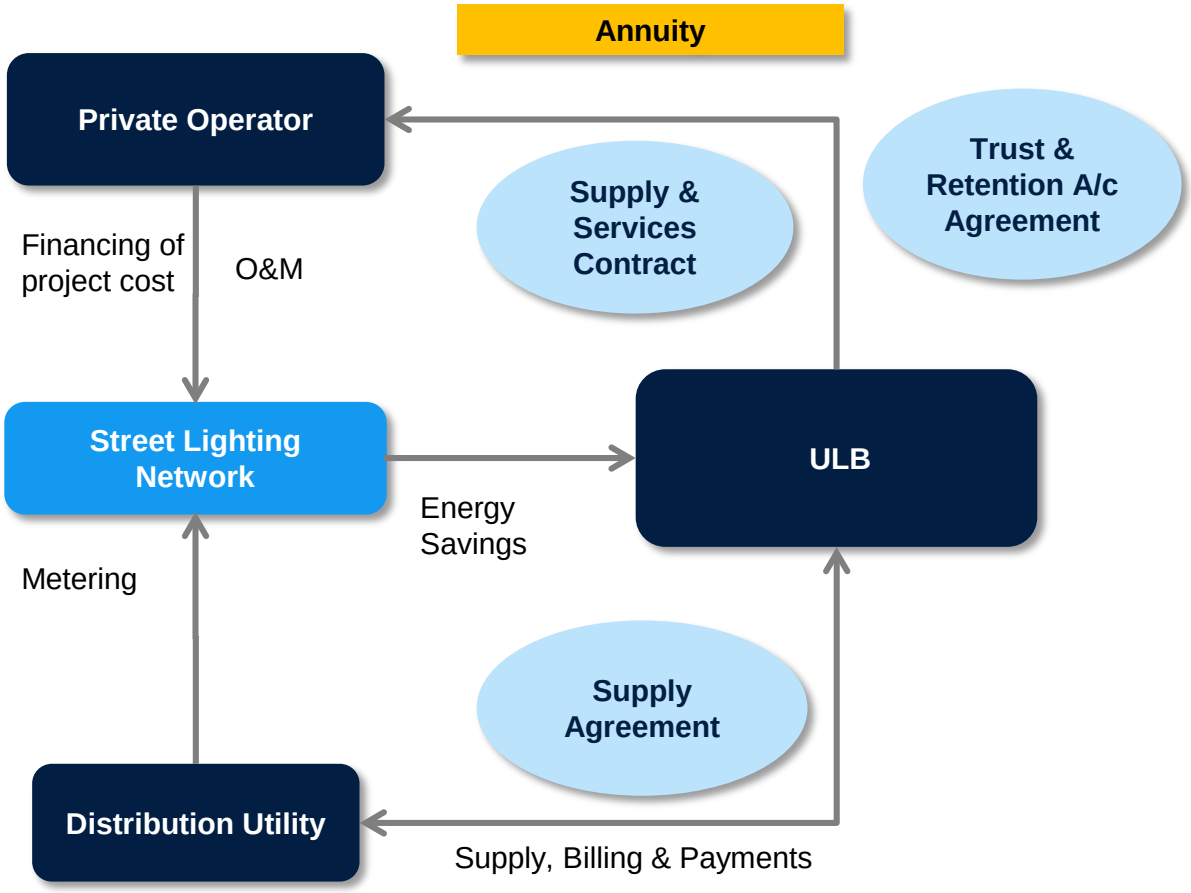
- Shared savings or ESCO model
- Notional Savings or Annuity model

ESCO MODEL / SHARED SAVINGS



- Investments and O&M of the project to be undertaken by the ESCO.
- ULB shares the savings realized from the project with the ESCO as per the provisions of the contract.
- Metering and billing by the utility to assess the amount of actual energy saved in the project post implementation.

ANNUITY MODEL / NOTIONAL SAVINGS



- Investments and O&M of the project to be undertaken by the private operator
- ULB pays a fixed amount periodically

QUESTIONS

- Transaction structure for each of the 2 implementation models
  - What should be the obligations of ESCO and City?
  - What should be the bid parameter for identifying the ESCO?
  - What payments would the city need to make?
  - What should be the duration of the contract?
  - How can the city measure the performance of the ESCO?
- Identify key project risks and discuss the mitigation measure
- Project Development Cycle
  - What assessments are required to develop the project

PROJECT STRUCTURE – SHARED SAVINGS MODEL

Parameter	Details
Project Coverage	ESCO - Implementation of energy conservation measures (ECMs), rehabilitation of infrastructure and O&M of public street lights City – Handover the street lights, reimburse rehabilitation costs, ensure co-operation of electricity utility
ECMs	ESCO to decide ECMs subject to meeting specified outputs (performance indicators) and design specifications set out in the Energy Performance Contract
Project Duration	• Implementation period depending upon the number of lights • Operations and maintenance period post project implementation – typically varies from 7 to 10 years
Bid Parameter	Guaranteed Energy Savings (%) with sharing of savings between the city and ESCO pre-defined / open (in which case bidders required to quote this as well)
Payments by city to ESCO	• Energy Savings fee • O&M Annuity – Annually per street light fixture • Reimbursable charges – on actuals towards replacement of meters, conductors etc.
Payment by city to Utility	• Electricity bills (post savings achieved)
Liquidated Damages payable by ESCO	Payable when • Savings are lower than the Guaranteed Energy Savings • Service delivery levels are not in line with the standards set out in the Contract

PROJECT STRUCTURE – NOTIONAL SAVINGS MODEL

Parameter	Details
Project Coverage	ESCO - Implementation of energy conservation measures (ECMs), rehabilitation of infrastructure and O&M of public street lights City – Handover the street lights, reimburse rehabilitation costs~~, ensure co-operation of electricity utility~~
ECMs	The City details the ECMs that need to be implemented by the ESCO
Project Duration	• Implementation period depending upon the number of lights • Operations and maintenance period post project implementation – typically varies from 7 to 10 years
Bid Parameter	Annuity required, which is a function of the estimated cost
Payments by city to ESCO	• Annuity • Reimbursable charges – on actuals towards replacement of meters, conductors etc.
Payment by city to Utility	• Electricity bills, which do not change as the street lights are not
Liquidated Damages payable by ESCO	Payable when • Service delivery levels are not in line with the standards set out in the Contract

KEY DIFFERENCES IN MODELS

Aspect	Shared Savings	Notional savings
Technology / Interventions	Selected by bidder	Prescribed by ULB
Energy savings	Based on bid (minimum threshold provided by ULB)	Prescribed by ULB by way of design (but not measured)
Bid variable	Guaranteed energy savings	Annuity payable by ULB
Savings share with government	Can be structured in project design	Not applicable as actual savings accrue to the ULB
Energy Baseline	Robust baseline required	Not required (sample surveys to demonstrate savings)
M&V	Detailed M&V protocol prescribed in bid documents	Minimal M&V required provided technology interventions are as prescribed
Metering	Required to establish baseline and for M&V	Not required, though is in the interest of the ULB and preferable for long term sector development

DESIRED OUTCOMES

Area	Responsibility Assigned
Achieve Desired Outcomes	• Retrofitting and O&M of street light points • Achieving agreed / quoted Energy Savings (%) / Implement the project as per specifications prescribed by City • Maintaining lighting quality standards as per criteria set out by the Cities • Meeting timelines specified in contract for replacements/ repair of non-functional points
Implement Project	• Capital investments required for implementation of project • O&M including replacement requirements during tenure of project • Installation of feeder panels with remote measurement & switching capability
Provide Citizen Service	• Setting up of call center for citizens to record complaints
Reporting/ Monitoring & Verification	• Remote Switching • Measurement of daily/billing period consumption • Setting up of call center for citizens to report complaints • Remote Identification and daily reporting of fused/ non-functional fittings/ fixtures as well as citizen complaint resolution status

PERFORMANCE STANDARDS AND ASSOCIATED LIQUIDATED DAMAGES

Key Performance Indicators	Monitoring Frequency
Adherence to Guaranteed Energy Savings	Monthly
Adherence to LUX levels	Semi annual
Adherence to uptime	Annual
Timely consumer grievance redressal	Daily

Road Type wise LUX Level requirement

Classification or Lighting Installation	LUX Levels on Road Surface as per Standards	LUX Level requirement of BBMP on Road Surface
Group A1	30	30
Group A2	15	15
Group B1	8	15
Group B2	4	12
Group C	4	12

Non Compliance of Lux Standards

- In case of non compliance, ESCO, at its cost, would be required to replace such LEDs within 7 days
- Penalty payable in proportion to non – compliant fixtures

[(number of non-compliant street lighting fixtures identified)
_____
number of street lighting fixtures surveyed)]

x (6 month Value of Guaranteed Energy Savings + 6 month O&M Fee)

IFC International Finance Corporation WORLD BANK GROUP

MONITORING PARAMETERS & LIQUIDATED DAMAGES (1/2)

Delay Liquidated Damages

- Liquidated Damages of an amount equal to INR 1 lakh for each week of delay, subject to a maximum delay of 120 days from specific phase SCOD

Saving is lower than Guaranteed Saving

Event	LD
Achieved savings >= 90% and less than 100% of GES	25% X (Guaranteed Energy Savings – Achieved Energy Savings for the month) X Tariff for the corresponding month
Achieved savings are between 90% and 80% of GES	50% X (Guaranteed Energy Savings – Achieved Energy Savings for the month) X Tariff for the corresponding month
Achieved savings below 80%	100% X (Guaranteed Energy Savings – Achieved Energy Savings for the month) X Tariff for the corresponding month
In case achieved saving is less than threshold level (50%) for 3 months in a year - would be construed as ESCO Event of Default	

MONITORING PARAMETERS & LIQUIDATED DAMAGES (2/2)

Failure to cure complain within 48 hours

- All faults to be cured within 48 hours after the failure is reported to BBMP.
- Failure of the same shall result in a penalty of twenty-five Indian Rupees (Rs. 25 only) per street lighting fixture per day.

Penalty for loss of functional lamp hours

- Penalty payable if non-functional lamp hours exceed 2% with the % determined at the end of each year in accordance with the following formula:

  % non-functional lamp hours for a switching point = non functional lamp hours/(total on hours x Nos of fixtures)

- Penalty for non-compliance of minimum up-time

  (% slippage) × (annual Value of Guaranteed Energy Savings + Annual O&M Fee)

KEY RISKS AND MITIGATION MEASURES

KEY STRUCTURING RISKS

Key Risks	Borne By		Mitigation
	City	Developer	
Time Overrun risk		✓	• Penalty payable in an event of delay beyond scheduled completion date • Event of Default if the project not implemented beyond a stipulated grace period • Payments to the ESCO to accrue only post project commercial operations
Cost overrun risk		✓	• In case of shared savings model, optimal project cost to result in maximization of ESCO's returns • In notional savings model, the annuity payouts are fixed upfront
Performance Risk		✓	• Periodic review of adherence to KPIs • Penalty payable in case of non adherence • ESCO to pay the utility bill exceeding the amount based on guaranteed energy savings
Repair & Maintenance		✓	ESCO, at its cost, responsible to replace / rectify any issues during the contract period.
Reduction in energy bills	✓		• City to coordinate with Utility to have the meters installed • City not benefitted if the actual payments were lesser than notional payments
Payment risk	✓		• City to deposit 3 months equivalent of payment to ESCO in an escrow account • Specific funding source for such escrow account identified upfront

ACTIVITY MAP - POST PROJECT AWARD

Implementation & Commissioning Phase

1

City: To select and appoint Independent Engineer (IE)

2

ESCO & City /IE: Joint Survey for detailed Asset Mapping

3

IE: validation of Joint Survey Report & equipment installation plan

4

City: Approval of JS report & to inform Electricity Utility about meters requiring re-calibration / installation of new meters

5

ESCO : Installation of feeder panels and supply wires at switching points

6

City : Request Electricity Utility to install their meter in feeder panel commissioned by ESCO

7

IE:

To connect data logger on feeder panels for Baseline preparation.

IE to validate metered consumption of Electricity Utility meters

8

ESCO : to implement the ECM as per provisions of Contract

9

IE: to validate implementation of project as per contractual provisions and recommend to BBMP issue of ECM commissioning certificate

O&M Phase

10

ESCO /City / Electricity Utility : Joint Meter Reading to be done for switching points

11

ESCO /City / Electricity Utility : Revision in Baseline for regularized lights/new lights

12

ESCO : O&M beyond BESCOM meter including feeder panels, cables, luminaires

Adhere to KPIs, which would be verified by IE

PROJECT DEVELOPMENT CYCLE

IFC'S CREDENTIALS IN STREET LIGHTING PROJECTS

IFC has structured projects under both ESCO and Annuity models

Bhubaneswar Street Lighting project

Client - Bhubaneswar Municipal Corporation

Coverage ~20,000 Street Lights

Shared Savings (ESCO Model)

Bid parameter – Committed savings (80.02% energy savings with 10% savings share to ULB)

Project operational

Jaipur Street Lighting Project

Client - Jaipur Municipal Corporation

Coverage ~70,000 Street Lights

Shared Savings (ESCO Model)

Bid parameter – Committed savings (77.13% energy savings with 30.06% savings share to ULB)

Project operational

Programmatic street lighting project across 5 cities in Odisha

Client - DMA

Coverage ~40,000 Street Lights

Notional Savings (Annuity Model)

Bid parameter - Life cycle cost less monetarized energy savings due to more efficient luminaires

Implementation underway

Bengaluru Street Lighting project

Client - BBMP

Coverage ~485,000 Street Lights

Shared Savings (ESCO Model)

Bid parameter – Committed savings

Bidding underway

PROJECT DEVELOPMENT ACTIVITIES

Project development activities to be undertaken include:

Technical Due Diligence

- Pilot survey of street lights to assess
  - Existing condition of the street lighting infrastructure
  - Establish performance level (glowing percentage, LUX, voltage variation, etc.) of existing system
- Analysis of data from City / Electricity Utility to assess energy consumption
- Comparison of notional bill and bills paid by City
- Estimation of indicative baseline energy consumption based on data shared by City
- Comparing current lux levels with that prescribed under Applicable Laws
- Assessment of project scope
- Assessment of project viability
  - Estimation of project cost
  - Estimation of O&M expenses

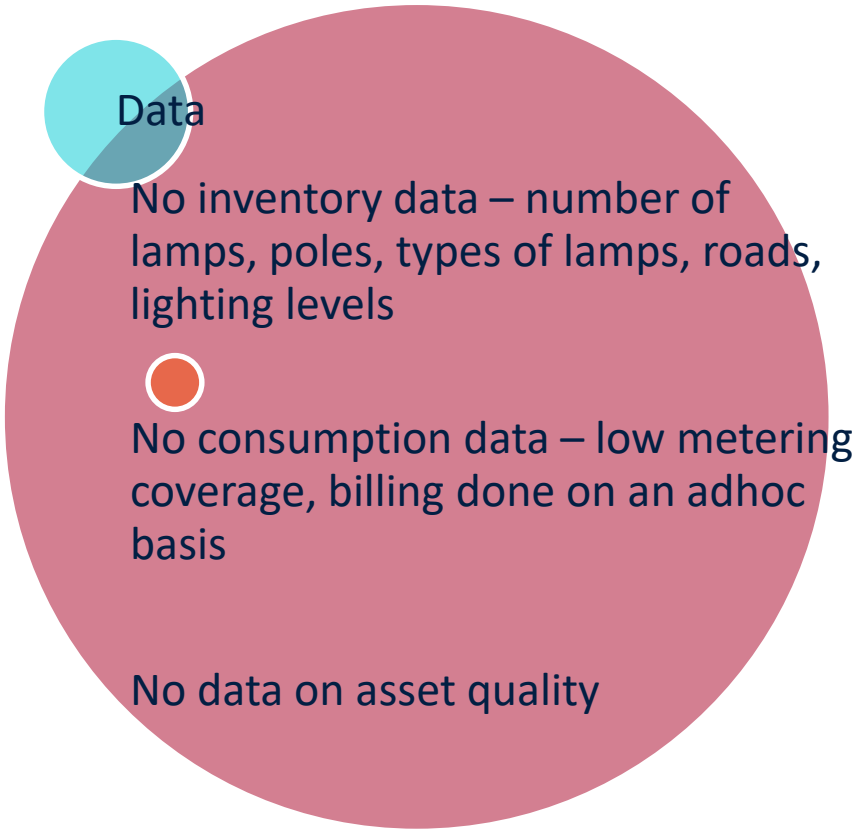
Legal Due Diligence

- Review of roles and jurisdiction of stakeholders
- Review the applicable laws

Project structuring

- Identification of key risks and mitigation measures

CHALLENGES FACED



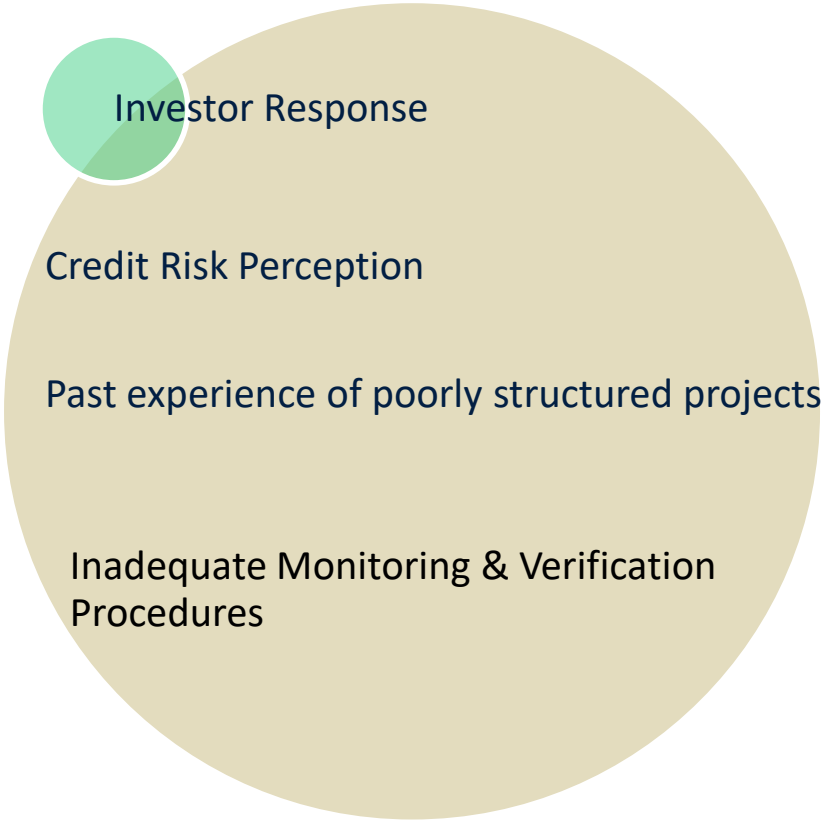
What was done

- Detailed survey over 3 months
- Identified inventory levels
- Existing lighting levels determination
- Existing level of non-functioning lights
- Existing metering level – only 15%

A comprehensive survey was conducted to estimate the baseline energy consumption in the absence of metered baseline

IFC International Finance Corporation WORLD BANK GROUP

CHALLENGES FACED



What was done

- Unique Escrow A/C mechanism for payment security
- Payments to be tapped from property tax receipts
- Inclusion of a separate “O&M” revenue source
- Detailed and fair M&V procedures

IFC International Finance Corporation WORLD BANK GROUP

BENEFITS TO CITY

PROJECT IMPACT - BHUBANESWAR

Feature	Before	After
Power consumption (kWh/day)	43,414	7,236 (down by 83%)
Non-working lamps	> 30%	< 2%
Operation & management	Manual at each location	Central, remote control
Inventory	Only at aggregate level	Each pole/lamp recorded
Measurement of power consumed	Only at aggregate level	Meters on each pole/lamp
Lux (illumination) levels	No record	Standards enforced
Complaint recording	No formal mechanism	Cell with toll-free no.
Complaint handling time	Days	< 48 hours
Accountability for non-performance	None	Penalties to the contractor
Net fiscal gain to BMC (10 years)	Nil	> $1 million

Other benefits

- CCTV cameras on poles & wi-fi routers in fixtures can be installed with minimum marginal costs
- Remote detection and identification of faults and electricity theft
- Well-lit city enhancing night commercial activity & safety of citizens particularly women & children
- Capacity strengthening for BMC in project conceptualization, execution, operation & maintenance
- The state-of-the-art central control system with LED lamps and meters without any capex by BMC
- Energy saved from the street lighting is equivalent to build a 1,150MW power plant

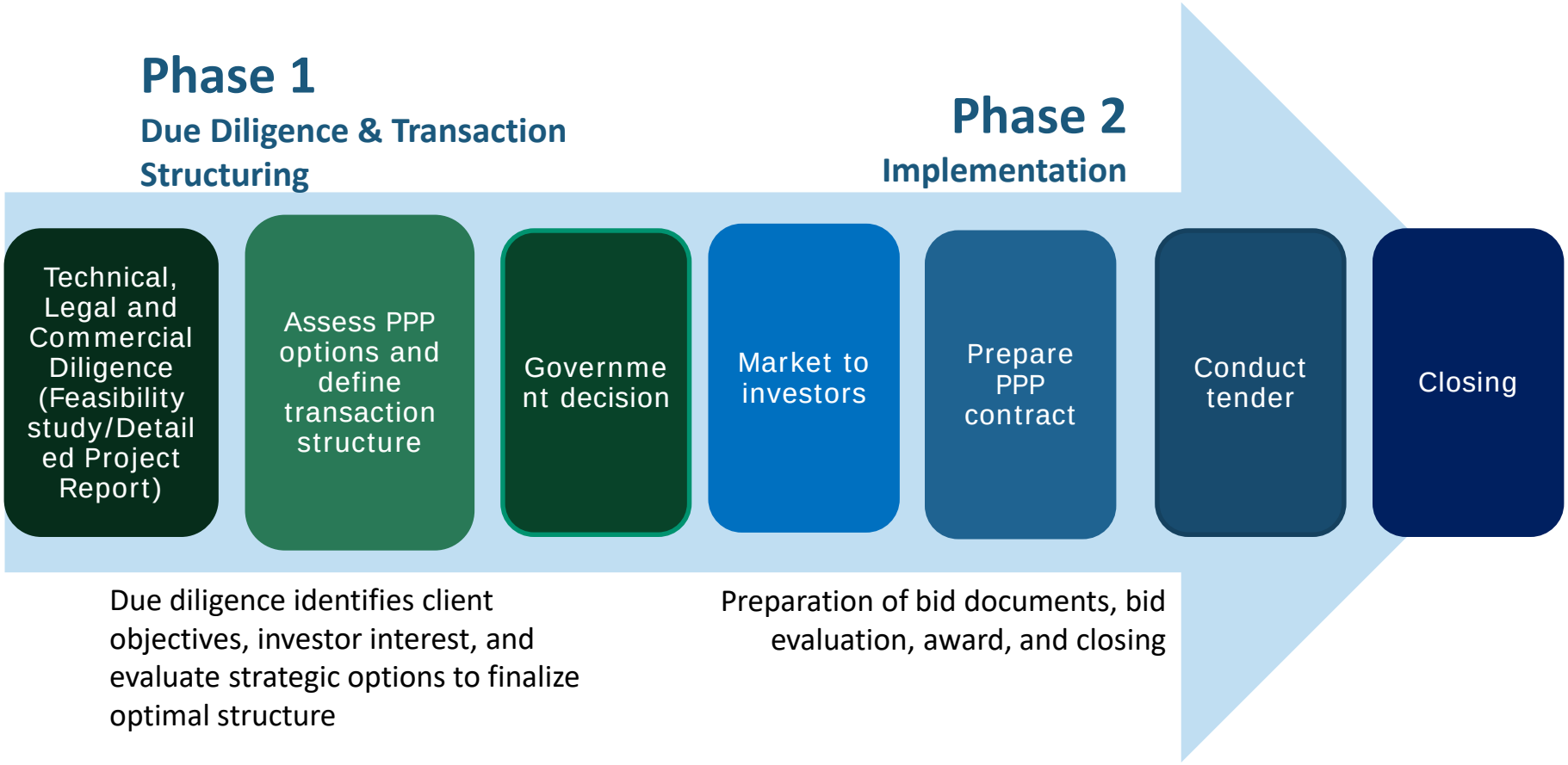
IFC International Finance Corporation WORLD BANK GROUP

EXPECTED PROJECT IMPACT - BENGALURU

Feature	Current Scenario	Post project implementation
Annual Power consumption (kWh)	515 million (for all the street lights, if connected)	75 million (down by 85.5%) 440 million units of energy available for alternate consumption which is equivalent to power generated by a 80 MW power project with 60% PLF.
Operation & management	Manual at each location	Central, remote control and each LED can be individually controlled
Measurement of power consumed	Primarily at aggregate level and on average load	Meters on each pole
Non-working lamps	Estimated at 20-25%	< 2%
Lux (illumination) levels	No formal records maintained	To be maintained across road categories as per requirements set by Bureau of Indian Standards
Complaint recording	No formal mechanism	Toll-free number with daily reporting requirements
Complaint handling time	Days	< 48 hours
Accountability for non-performance	None	Penalties payable by the ESCO
Fiscal benefit to the City	None	US$ 215 million over the term of contract US$ 130 million in NPV terms

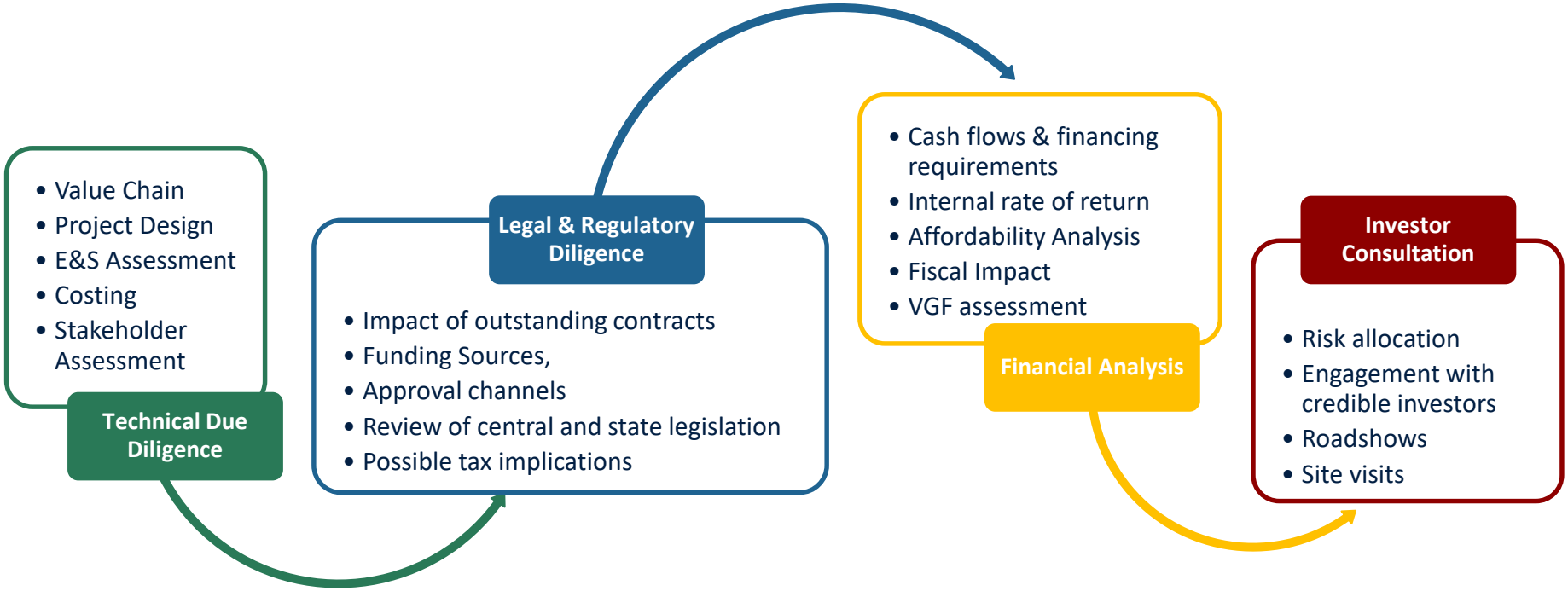
IFC ASSISTANCE

IFC'S APPROACH TO PPP PROJECTS



PHASE I: DUE-DILIGENCE & TRANSACTION STRUCTURING

Detailed Project Report + Transaction Structure Report (TSR)

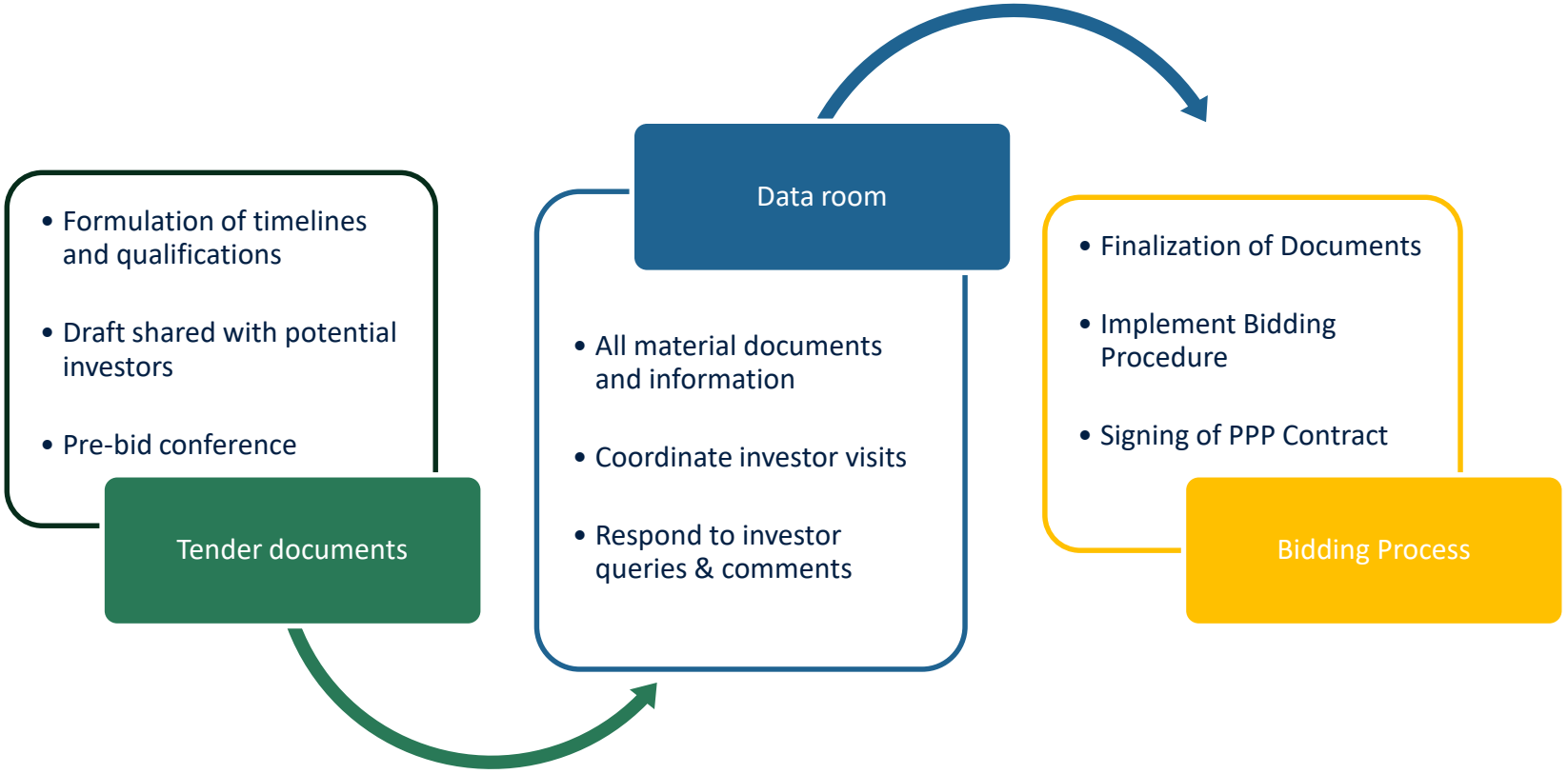


Condition Assessment based on sample survey

- Voltage; Lux Levels; Burning Hours
- Status of existing infrastructure
- Gap analysis

PHASE II: IMPLEMENTATION

Phase II commenced after approval of the TSR by the Client



Thank you

IFC International Finance Corporation WORLD BANK GROUP