ENERGY EFFICIENCY SERVICES LIMITED APPROACH: TECHNICAL AND BUSINESS PROCESS

A. Introduction and Scope

1. The Demand-Side Energy Efficiency Investment Project will finance high priority areas in the Energy Efficiency Services Limited's (EESL) business plan which include: (i) municipal street lighting; (ii) efficient household appliances—lighting and ceiling fans; and efficient agricultural pump sets.

2. The implementation of these projects has already commenced and the specific projects under ADB finance will be dependent on the status of implementation agreements at the time of loan approval and fund availability. However, indicative states for each priority area have been identified.

B. EESL Approach: Technical

1. Municipal Street Lighting

3. **Project Rationale**. According to the 18th Electric Power Survey of the Central Electricity Authority, the estimated energy consumption in the public lighting sector in India was 8,478 million kilowatt hour (kWh) and is expected to grow at a compounded annual growth rate (CAGR) of 7% over the next two planning periods (2016–2017 and 2021–2022). Based on these projections, the lighting consumption in 2015–2016 is estimated at 10,508 million kWh with a total connected load of 3,400 megawatt (MW). Currently, several technologies are being used in public lighting, including high intensity discharge (HID) lamps, linear fluorescents, compact fluorescent lamps (CFLs), tungsten halogen, and incandescent lamps (ICLs). Currently, the most common luminaire technology in major roads are the HIDs – high pressure sodium vapor (HPSV), metal halide and mercury vapor. The adoption of light emission diode (LED) luminaire technology has the potential to save around 50% of the current consumption with an additional saving potential of 15% to 20% through switching controls, dimming and voltage optimization.

4. **Establishment of Baselines**. As of September 2015, EESL has successfully implemented 18 street lighting projects and a monitoring and verification (M&V) study was conducted through an external consulting firm to determine the energy and greenhouse gas (GHG) emission impacts. The M&V studies conducted in five sites have confirmed the initial estimates of demand and energy savings; and the estimates of GHG reduction. EESL has adopted a "deemed savings" approach where the results of a pilot project (usually on circuit or zone) were used as the basis for savings estimation of the guaranteed savings for the project. The savings from the pilot project was jointly verified by the client and EESL.

5. **Technical Considerations**. The basic approach is to prepare an inventory of the existing luminaires in the project site, including the luminaires that are not in operation at the time of survey. The design will include the LED option (wattages can vary from 210 watts to 30 watts) for each existing luminaire and the savings are estimated based on standard operating hours (assumed to be 11 hours per day). If the existing pole configuration does not meet the existing National Lighting Code (NLC) and Indian standards, EESL will provide recommendations for suitable modification of the pole configuration and the onus is on the client to undertake the modifications at their own cost. The project will improve the illumination levels but not necessarily the uniformity unless the pole configuration is compliant to the existing standards.

6. **Implementation Approach**. The procurement of equipment (LED luminaires and accessories) will be undertaken by EESL through international competitive bidding. The tender evaluation committee will include other government agencies including an official from the host state. The installation will be carried out by an implementing partner selected by EESL through a competitive bidding process; and will include the retrofit of all light points including the non-functional fixtures; and covers the up-gradation of wiring and other fixtures from the pole junction box to the LED luminaire.

7. **Post Installation Services**. EESL will be responsible for the maintenance of the LED luminaires during the contract period. The equipment warranty will cover manufacturing defects. EESL will ensure that the performance of the luminaires, during the contract period will be in compliance with lumen maintenance -80 and lumen maintenance -70 standards of the Bureau of Indian Standards (BIS). EESL will maintain an insurance cover for natural calamities (including fire) but excluding theft and pilferage.

8. **Business Approach.** EESL will provide a minimum guarantee of savings of 50% based on the results of the pilot project. Annuity of EESL will be based on reduction of energy and maintenance costs based on the pilot project and calculated using a debt equity ratio of 80:20, return on equity at 12% (post tax) and interest on debt on actuals for project management and maintenance at 3.0% and 2.5% respectively. The EESL investment will be paid through savings over 7 years.

2. Efficient Household Appliances

a. Domestic Efficient Lighting Program

9. **Project Rationale**. The overall energy efficiency potential in the residential sector is estimated to be around 20%, with lighting and high efficiency appliances (fans, refrigerators) offering the largest potential. The transition from ICLs and CFLs to LEDs is currently underway through several pilot programs undertaken by EESL. Through increase in demand, the cost of LEDs for general lighting has seen a significant drop over the last few years thus making them more affordable to the average household. The Electric Lamp and Component Manufacturers of India (ELCOMA) estimated that more than 758 million ICLs were sold in India in 2012. Hence, there is significant energy saving potential through the market transformation from ICLs to LEDs with around 85% saving in electricity consumption.

10. **Establishment of Baselines**. As of September 2015, EESL has successfully implemented five Domestic Efficient Lighting Program (DELP) projects and eight more projects are being implemented. An M&V study to determine the energy and GHG emission impacts of the five completed projects was conducted through an external consulting firm. The M&V studies conducted in five sites has confirmed the initial estimates of demand and energy savings; and the estimates of GHG reduction. EESL has adopted a “deemed savings” approach where the results of completed projects are used as the basis for savings estimation of the guaranteed savings for the project.

11. **Technical Considerations**. The LEDs will conform to the minimum technical specifications stipulated by the BIS. Testing of production sample will be undertaken through an accredited laboratory in India. The LEDs will come with a 3-year warranty for technical defects and EESL has established service centers for replacement of defective lamps. Procurement of LEDs will be undertaken by EESL under international competitive bidding.

12. **Implementation Approach**. EESL has adopted various implementation approaches. The initial approach was to distribute the LED door-to-door or at EESL collection points in exchange for ICLs with the distribution company (DISCOM) agreeing to pay EESL based on the number of LEDs distributed, calculated energy saving per LED, and purchase price agreed by the regulator. More recent approaches have included eligible consumers purchasing LEDs outright at a price agreed by the regulator or opting for On Bill Financing (OBF) where after an initial deposit the balance is recovered by the DISCOM through electricity bills over a specified period (8 months to 12 months). In the latter case, there is no exchange of ICLs and the onus is on the consumer to replace their existing ICLs with LEDs.

13. **Program Sustainability**. The sustainability of this type of technology transformation program needs to be market-driven. EESL is stimulating the market by its ability to bulk procure LEDs at a significantly low cost (around INR75) compared to the current market price between INR250 to INR300. However, when the project is completed in a particular state the consumers do not have the facility to purchase good quality LEDs at an affordable price and may be compelled to consider other cheaper options (ICLs or CFLs). One option to consider is the inclusion of lighting retailers in the EESL project by offering them LEDs at the project cost and agreeing with them on a fixed market price which include a specified retailer margin. When the EESL project is completed, the consumers could purchase from the retailers at a price significantly lower than the current market price. Eventually, the unit costs of LEDs will be more affordable.

14. **Business Approach.** The initial approach was for EESL to recover its investment from the DISCOM as an annuity over a period of 3 to10 years by monetizing the energy savings that accrue as a result of the replacement of ICLs with LEDs with the approval of the State Electricity Regulatory Commission. This model was adopted in the projects in Andhra Pradesh and Puducherry. The proposed approach for new projects involves an agreement for collection of OBF payments for the registered consumers and reimbursing EESL on a monthly basis.

b. Domestic Efficient Fan Program

15. **Project Rationale**. The Bureau of Energy Efficiency (BEE) has also initiated the Super-Efficient Equipment Program (SEEP) under the Market Transformation for Energy Efficiency (MTEE) component of the National Mission for Enhanced Energy Efficiency (NMEEE). SEEP is an incentive based program for manufacturers, to design high efficiency electrical appliances with the inclusion of best technology available globally. The rationale for financial incentives for energy efficiency is based on factors such as increased demand for energy, energy resource constraints, international commitments to reduce emissions, direct savings in terms of cost of conserved energy, indirect social benefits' and others. Ceiling fans are widely used in Indian households and almost all electrified household have at least one fan. According to recent estimates, around 350 million ceiling fans are currently in use with annual sales of around 32 million with an annual growth rate of 6%.

16. **Establishment of Baselines**. It is estimated that the ceiling fan efficiency could be increased by around 50% than the current units, under SEEP. In a case study in Narsapur (Andhra Pradesh) involving 20,000 efficient fans, the estimated savings was 25 watts per fan with a daily savings of 0.35 kilowatt hour (kWh).

17. **Technical Considerations**. The technical specifications will be as per BEE 5-star ceiling fans and will be procured through competitive bidding.

18. **Implementation Approach**. EESL will provide a maximum of two fans per domestic consumer, 10 fans per commercial consumer, and unlimited number of fans to industrial consumers. There are two payment options available to domestic consumers: full up-front payment; or OBF. Only consumers with no arrears in the last three consecutive billing cycles are eligible for the OBF option. The commercial and industrial consumers can only purchase upfront.

19. **Business Approach.** EESL will provide a list of domestic consumers, including campaigning agency numbers, who have availed for the OBF option to the DISCOM. The agreed installments will be included in the electricity bills and the amount collected will be reimbursed by the DISCOM to EESL. The DISCOM will provide an irrevocable and revolving Letter of Credit in favor of EESL.

c. Efficient Tube Lights Program

20. The program details are currently unavailable. It is assumed that it would involve the replacement of existing T8 fluorescent tube lights (2 foot and 4 foot) with equivalent LED tube lights. It is estimated that energy savings in the region of 55% could be achieved through this program and would be applicable to all consumer sectors.

3. Agriculture Water Pumping

21. **Project Rationale**. Electricity is the primary source of energy consumption in Indian agriculture pumping sector. This sector is the third highest consumer of electrical energy with a total consumption of 92.33 billion kWh in 2007–2008.[1] This accounts for 20% of the overall national electricity consumption. Managing agricultural load has been a key challenge to all electric utilities in India. Horsepower-based flat rate tariffs that are paid irrespective of the electricity use perceive zero marginal cost for electricity use and hence, disregard efficiency in consumption. This is reflected in purchase preference for cheap but inefficient pumps. A study by the National Productivity Council estimates a total saving potential of 27.79 billion kWh in Indian agricultural pumping sector**.** Apart from the energy savings, the benefits derived from reduction in subsidies are also significant. Subsidised tariffs for agriculture consumers are supported partly by budget subsidies from respective state governments. In 2007–2008, this was estimated to be INR141.6 billion (Government of India, 2008). EESL has undertaken several pilot projects (Hubli, Mysuru, and Andhra Pradesh) in replacing exisiting pump sets with high efficiency (BEE 5-star rating) pump sets and the verified energy savings has been in the range 33% to 37%.

22. **Establishment of Baselines**. Baselines are established through the implementation of a pilot project in the selected state. Detailed information of the existing pump specifications, status of meter installation, underground water level in different seasons, power supply patterns, etc., will be collected. The energy savings are calculated by measuring the input power of the existing pump and the input power of the new pump. Based on the power supply availability and the cropping patterns, estimates are made of the average daily hours of operation and the number of days per year. Based on the projects undertaken by EESL to date, the estimates are 6 hours per day and 300 days per year. The pilot project will also include the measurement of the pump efficiency. Incremental efficiency due to pump replacement is calculated by measuring the change in input power keeping the output water flow constant.

23. **Technical Considerations**. BEE 5-star standard rating pump sets with smart control panel. It is assumed that most of the existing pump sets are over-sized and key parameters such

[1] National Productivity Council. 2009. *State-wide Electrical Consumption and Conservation Potential in India*.

as the average bore well depth will be considered in determining the equivalent rating of the new pump sets.

24. **Implementation Approach**. The high efficiency pump sets will be distributed free-of-charge to the registered farmers in exchange for their old pump sets. Distribution will be done at Taluka Village level with the involvement of local expertise and distribution agency. The old pumps are disposed using empaneled agencies and provided a destruction certificate.

25. **Post Installation Services**. EESL will establish a Call Center to coordinate repair and maintenance over a 5-year period.

26. **Business Approach.** Payment security mechanism (bank guarantee, state government guarantee, escrow arrangements) will be finalized prior to implementation. EESL project costs (procurement, distribution, services, repair and maintenance, and awareness) will be reimbursed by the state government through agreed annuity payments over the contract period (10 years). The assumptions for EESL's annuity calculation include a debt equity ratio of 70:30, debt interest rate of 10.5%, debt tenure of 10 years, and equity return of 18%.

C. EESL Approach: Business Process

27. The tables below summarize the generalized Steps for Domestic Lighting, Municipal Lighting, and Agricultural Pump Efficiency Projects undertaken by EESL as ESCO activities. These include the main participants in each step in brackets.

Table 1: DSM Based Efficient Lighting Program

MOU	• MoU signed between EESL distribution utility
Sample Survey	• Define boundaries for program and supply list of eligible consumers. (Distribution utility) • Conduct sample survey to set baseline of prevalence of incandescent bulbs and average usage (EESL and EE consultant support)
Technology Selection	• Finalize LED specifications, including wattage and technical specifications. (EESL and EE consultant support) • Estimate annual energy savings per LED and target coverage under the program.[a] (EESL, EE consulting support, and distribution utility)
Demand Side Management Petition to State Regulator	• The State Electricity Regulatory Commission is requested to approve purchase of the calculated energy savings by the distribution utility from EESL at a tariff that allows cost recovery and investment return by EESL over the project life. (Distribution utility with EESL)
Contractual Agreement	• Contract between EESL and distribution utility with regulator-approved repayment terms drafted and signed. (EESL and distribution utility) • Contract between EESL and distribution utility for the collection of instalment payments from consumers and transfer terms drafted and signed.
Payment Security	• Payment security mechanism finalized, such as bank guarantee, state government guarantee, trust and retention account, or escrow account. (EESL and distribution utility)
Implementation	• EESL procures LEDs through competitive process with requirements for technology specifications and replacement guarantees. (EESL) • LEDs are distributed door-to-door and/or at collection point.(EESL and distribution agency) • LEDs fitted with a unique number and/or marked to avoid resale; replacement guarantee covers project life. (technology provider and EESL) • Consumers informed of ways to maximize efficiency gains. (EESL and media agency)

Monitoring and Verification	• Database developed and maintained containing records of each participating consumer, the LEDs purchased, the Wattage, and the date of purchase. (EESL) • Database verified by an independent M&V agency. (M&V agency) • Survey conducted on random sample to ensure proper operation of LEDs. (M&V agency) • Remote monitoring devices installed on a small sample basis to verify continued operation and savings. (EESL)

EE = energy efficiency, EESL = Energy Efficiency Services Limited, LED = light emitting diode, MOU = Memorandum of Understanding, M&V = monitoring and verification.

[a] Energy savings and annuities are calculated as follows using the technology specifications and sample survey information: Annual energy savings per LED in kWh/year: [(WIncandescent Light-WLED)/(1000 W/kW)*(Hours used per day)*(Operating days/year)]/(1-% losses); Annual payments to EESL: # LEDs distributed*Calculated Energy Savings per LED * Purchase price agreed by Regulator.

Table 2: Municipal DSM Street Lighting Program

MOU	• MoU signed between EESL and municipality
DPR Developed or Validated	• Detailed energy audit of existing street lighting system and joint verification. (EESL, EE consulting support, and municipality)
Technology Selection and Demonstration	• Finalize LED specifications, including required lighting need and compatibility with existing system features. (EESL, EE consultant support, and municipality) • Install selected technology and measure consumption of the new LED fixtures and consumption of the old features. (EESL, EE consulting support, and municipality) • Energy savings is estimated as the measured difference in consumption between the existing and new, LED fixtures from the demonstration. Total energy savings from the program are calculated by scaling the measured per-light savings to the number of lights to be replaced. (EESL, EE consulting support, and municipality) • Determine annuity payment based on cost recovery (equipment and O&M) for EESL, returns on equity and debt servicing costs, savings to the municipality from reduced energy bills and reduced maintenance, and a project management fee.[a] (EESL and municipality)
Contractual Agreement	• Contract between EESL and municipality drafted and agreed that covers the service and equipment specifications and the payment schedule. (EESL and municipality)
Payment Security	• Payment security mechanism finalized, such as bank guarantee, state government guarantee, and escrow arrangements. (EESL and municipality)
Implementation	• EESL procures LEDs through competitive process with requirements for technology specifications and replacement guarantees. (EESL) • Equipment supplied and installed. (EESL, equipment provider, and municipality) • Warranty and O&M coverage. (EESL and equipment provider)
Monitoring and Verification	• Completion certificates issued to municipality. (EESL) EESL installs centralized monitoring and control equipment to optimize operation. (EESL) • EESL supplies 1% of total light quantity to municipality to allow rapid replacement in the event of defects or other issues. (EESL)

DPR = detailed project report, EE = energy efficiency, EESL = Energy Efficiency Services Limited, LED = light emitting diode, O&M = operation and maintenance, MOU = Memorandum of Understanding.

[a] The annuity payment is structured so that there is a net saving to the municipality from electricity savings and O&M charges after payment to EESL is made.

Table 3: Agricultural DSM Program

MOU	• MoU signed between EESL and State Government.
DPR Developed	• General survey of all pump sets to be covered under the program and detailed energy audits of 25% of the pumps carried out to create an agreed baseline of current electricity usage. (EESL, EE consulting support, and distribution utility)
Technology Selection and Demonstration	• Pump models with Bureau of Energy Efficiency star ratings selected to as potential replacements based on power supply parameters and pumping needs. (EESL, EE consultant support) • Demonstration of more efficient pumps (~10) and confirm appropriateness to meet needs. (EESL, EE consulting support) • Energy consumption measured from demonstration of pumps selected for distribution under the program. (EESL, EE consulting support) • Power savings from the program calculated by subtracting consumption from efficient pumps from baseline estimates and scaled to the number of pumps to be distributed under the program and estimated hours of operation.[a] (EESL, EE consultant support, and distribution utility) • Annuity payment calculated based on program costs and energy previously delivered to farmers that can be sold to other customers, according to calculated energy savings. (EESL, EE consultant support, and distribution utility)
Contractual Agreement	• Contract between EESL, State Government and distribution utility drafted and agreed that covers the service and equipment specifications and the payment schedule. (EESL, State Government and distribution utility)
Payment Security	• Payment security mechanism finalized, such as bank guarantee, state government guarantee, and escrow arrangements. (EESL and distribution utility)
Implementation	• EESL procures pumps through a competitive process as per technology specifications and performance guarantees. (EESL) • Pumps distributed to farmers. (EESL and equipment provider) • Warranty and O&M coverage. (EESL and equipment provider)
Monitoring and Verification	• Power consumption in kW is measured before and after each pump set replacement. (EESL, EE consultant support) • EESL may install remote monitoring and optimization equipment. (EESL)

EE = energy efficiency, EESL = Energy Efficiency Services Limited, kW = kilowatt, MOU = Memorandum of Understanding.

[a] The annual savings is calculated at each distribution transformer where meters provide information on hours of power supplied. These are then summed to cover all pump replacements. The savings at distribution transformer x are calculated as follows: Energy savings x [kWh/year] = Average power consumption baseline [kW] – Average power consumption efficient pumps [kW] * hours operation/year.