Case Studies on Street Lighting Energy Efficiency CDM Projects

SIDS DOCK Support Programme: Caribbean Energy Efficiency Lighting Project (CEELP) Training

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UNFCCC CDM case studies

i. **Street Lighting Energy Efficiency Projects implemented by AEL in India**

ii. **Thailand energy efficiency improvement for street lightings**

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i. **Street Lighting Energy Efficiency Projects implemented by AEL in India**

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The CDM project reduces the energy required for the street lighting network in 9 Municipal Corporations (MCs) in India, in the states of: Maharashtra, Rajasthan and Madhya Pradesh. Under this project **121,365** fittings were installed.

Fluorescent **T12** and mercury/ sodium vapor lamps and fixtures	→	Individual or multiple fluorescent **T5** fittings with electronic ballast

Why T5?

The selection of T5 lamps by Asian Electronics Ltd (AEL) for use in its energy saving streetlights is due to the following advantages of T5 fluorescent lamps:

1. The T5 lamp is called the energy saving lamp as it can only be **driven by electronic ballast** thus making it a highly efficient lighting system

2. It uses advanced filaments thereby making it possible to use high technology electronic ballasts which help in **warm starting** the lamp, helping in ensuring **longer lamp life**

3. The T5 lamp is one of **highest efficacy lamps** with nearly 104 lumens per watt as compared to about 70 lumens per watt for T12 lamps

4. The diameter of the lamp is only 16 mm and uses **less glass and aluminium** thus helping in the reduction of glass wastage. Due to its smaller size the luminaries required to house the lamps are significantly smaller helping in overall reduction in weight and material used, thereby reducing transportation and disposal costs, thus indirectly reducing transportation emissions

5. It uses **less mercury** than the bigger T12/T8 lamps, thus reducing environmental risk. Thus, T5 is one of the most environment friendly fluorescent lamp.

Street Lighting Energy Efficiency Projects implemented by AEL in India

Baseline Fittings		Project Fittings		Power Saving (W)
Type	**Rating (W)**	**Type**	**Rating (W)**	
FTL T12 40W - 1.2m	50	FTL T5 28W - 1.2m	28	22
FTL T12 40W - 1.2m	50	FTL T5 24W - 1.2m	24	26
HPSVL 70	82	FTL T5 2x14W - 0.6m	28	54
MVL125	145	FTL T5 2x14W - 0.6m	28	117
MVL125	145	FTL T5 2x24W - 0.6m	48	97
HPSVL/MVL 150	175	FTL T5 2x24W - 0.6m	48	127
HPSVL/MVL 150	175	FTL T5 (2x14+2x24W) - 0.6m	76	99
HPSVL/MVL 250	285	FTL T5 4x24W - 0.6m	96	189
HPSVL/MVL 250	285	FTL T5 4x14W - 0.6m	56	229
HPSVL/MVL 150	175	FTL T5 4x24W - 0.6m	96	79

FTL = Fluorescent Tubular Lamp, HPSVL = High Pressure Sodium Vapor Lamp, MVL = Mercury Vapor Lamp

Business Model

- ✓ The CDM project was designed by Asian Electronics Ltd (AEL)
- ✓ Performance based contacts projects (EPC) under ESCO business model
- ✓ EPCs between the municipality and an energy efficiency service provider
- ✓ In the EPC, goods and services associated with the project are paid for with the energy-cost savings accrued from it, allowing the municipality to implement improvements without incurring any upfront costs

Barriers

- ✓ Energy efficient lighting is not a priority as the needed investment competes with more urgent social needs such as water supply, city cleaning, school, healthcare, etc
- ✓ Public procurement procedures that favor lowest cost equipment as opposed to efficient and expensive equipment
- ✓ Difficulty to mobilize financial resources
- ✓ Lack of awareness about ESCO model
- ✓ Contracting issues

The **baseline energy** is calculated based on power of each piece of equipment to be replaced and operating hours

$$E_{BL,y} = \sum_i (n_i * p_i * o_i)/(1 - l_y)$$

$E_{BL,y}$	Energy consumption in the baseline in year y (MWh)
$\sum_i$	Sum over the group of "i" devices replaced
n_i	Number of devices of the group of *"i"* devices replaced, for which the project energy efficient equipment is operating during the year
p_i	Power of the devices of the group of "i" baseline devices
o_i	Average annual operating hours of the devices of the group of "i" baseline devices
l_y	Average annual technical grid losses (transmission and distribution) during year y for the grid serving the locations where the devices are installed, expressed as a fraction

The **baseline emissions**

$$BE_y = E_{BL,y} * EF_{CO2ELEC,y}$$

Grid Emission Factor

0.84 tCO_2/MWh

The **project emissions**

$$E_{Pj,y} = \sum_i (n_i * p_i * o_i)/(1 - l_y)$$

$$PE_y = E_{Pj,y} * EF_{CO2ELEC,y}$$

Emission Reduction

$$ER_y = (BE_y - PE_y) - LE_y$$

Cities	Total number of fixtures (all types)	Baseline Energy (MWh)	Baseline Emissions (tCO_2e)	Project Energy (MWh)	Project Emissions (tCO_2e)	Energy Savings (MWh)	Emission Reduction (tCO_2e)
		EBL,y	BEy	Epy	PEy	EBLy -Epy	BEy-PEy
Latur	10,797	6,108	5,130	2,370	1,991	3,738	3,139
Akola	13,003	5,323	4,471	2,195	1,844	3,128	2,627
Pune	13,970	13,967	11,732	5,293	4,446	8,674	7,285
Ajmer MC	24,505	9,156	7,690	3,640	3,058	5,516	4,632
Bikaner	10,868	5,227	4,391	2,266	1,719	3,180	2,671
Alwar MC	9,526	3,849	3,232	1,318	1,107	2,531	2,124
Alwar UIT	7,645	3,916	3,289	1,390	1,168	2,526	2,121
Indore	26,340	24,478	20,561	9,466	7,951	15,012	12,609
Ajmer UIT	4,711	1,919	1,611	721	606	1,198	1,005
TOTAL	**121,365**	**73,942**	**62,107**	**28,440**	**23,890**	**45,502**	**38,217**

Data and parameters to be monitored

1. Number of energy saving fittings installed in the project for group “i” of devices
2. Rated power of the project streetlight fittings (W)
3. Average annual operating hours of the fixtures for project energy and baseline energy consumption calculation in each city
4. Annual checks of a sample of non-metered systems to ensure that they are still operating (*Percentage of lamps that are still operating – Survey)*

Operating hours are on the basis of the change in streetlights turning ON time and OFF time depending on the sunrise and sunset times of the city through the year.

A sample of switching points is continuously metered for the run-time in each city. The sample size is determined for a +10% precision with a 90% confidence level. The data recorded will be downloaded annually (ESCO Agreement and CDM)

Data are reviewed by AEL and MCs. Reports signed by both parties.

Data storage on paper and electronic for 2 years after the end of the crediting period

CDM Revenues

Regarding CDM revenues, AEL financed the up-front expenses then deduct from the annual revenues the expenses and its CDM management costs and pays a negotiated portion of the CDM revenues to each municipality

Street Lighting Energy Efficiency Projects implemented by AEL in India

Baseline sodium vapor lights

Project T5 lights

UNFCCC CDM case studies

i. Street Lighting Energy Efficiency Projects implemented by AEL in India

ii. **Thailand energy efficiency improvement for street lightings**

The PoA aims to improve the energy efficiency of street lights within the Provincial Electricity Authority (PEA) service area by replacing approximately **445,783** fittings.

The PEA has designed this programme to respond to the need of reducing energy consumption in street lighting while providing the same or better service.

250 W High Pressure Sodium (**HPS**) units → 110 W Light Emitting Diode (**LED**)

The installation of LED is expected to substantially reduce the electricity consumption charges paid by PEA to power lighting on street and roads

- ✓ As per the current operating scenario of street lighting on roads and highways, the existing lamps are owned and managed by the Department of Highways (DOH), Department of Rural Road (DORR), Ministry of Transport and Department of Local Administration (DOLA), Ministry of Interior
- ✓ The electricity for the lighting system is provided by PEA free of charge
- ✓ PEA has the obligation to pay its electricity supplier, Electricity Generating Authority of Thailand (EGAT)
- ✓ PEA is the investor for this programme
- ✓ PEA will also implement this programme

Thailand standard for illumination - Department of Highway Lighting

Roadway Type	Average Minimum Illumination (lux)		
	Central - Urban Area	Sub - Urban Areas	Rural Areas
Motorway	21.5	15.0	10.75
Intersection	21.5	21.5	15.0
Main Road	21.5	13.0	9.7
Secondary Road	13.0	9.7	6.5
Local Road	9.7	6.5	2.1

Main features of LED technology to be used

Description	Value
Lifetime (L70) @Ta 35 deg.C	≥ 50,000 hour
System Efficacy (Lumen/W)	≥ 90 Lumen/W
Input Voltage	230 V +/- 10% and 50 Hz
Max power per bulb	≤ 110 watt
Lumen Maintenance at 6,000 hour as at temperature Case (Ts) 85°C and at the max current of LED	≥ 90%
Driver Power factor @ max load	≥ 0.95
Driver Efficiency @ max load	≥ 85%
Driver Total Harmonic Distortion (%)	≤ 15%
Safety standard	IEC 60598 or equivalent
Type of control	Photocell
Warranty (LED supply contract terms)	8 years

Alternative scenarios

	Alternative 1 - LED replacement (w/o CDM)	Alternative 2 - Step dimming	Alternative 3 - Dimming with electronic ballast	Alternative 4 – Business-as-usual	Sources of data
Number of lamps	60	60	60	60	PEA actual counting for the CPA
Savings Potential	65%	25%	28%	n/a	PEA FSR (p.100)
Number of operating hours	4,331	4,331	4,331	4,331	TH Sunrise-Sunset 2011.pdf
Project life (years)	10	10	10	10	PEA FSR (p.97)
Investment Cost (THB)	1,179,000	180,000	174,000	n/a	PEA FSR (p.98) and Financial Analysis
Electricity Tariff (THB/kWh)	2.4696	2.4696	2.4696	2.4696	PEA FSR (p.149)
Value of energy saved (THB)	131,559	50,538	56,602	n/a	Calculated

1 US Dollar equals 33.08 Thai Baht (THB)

$$ER_y = NES_y * EF_{CO2,ELEC,y}$$

Grid Emission Factor

0.4491 tCO2/MWh

The maximum wattage rating of an LED fitting is 110 W. The wattage of the HPS fixtures (lamp + ballast) is around 295 W. Energy savings **185 W**

Replacing **60** fittings

Estimated annual emission reduction is **23 tCO_2e**

CPA 1

Replacing **3,000** fittings

Estimated annual emission reduction is **1,143 tCO_2e**

CPAs 2, 3, 4, 5

Data and parameters to be monitored

1. Quantity of project (P) luminaries of type i distributed and installed under the project activity
2. Annual operating hours for the project luminaries in year y
3. Rated power of the project luminaries of the group of i lighting devices (W)
4. Outage factor during crediting period
5. Annual failure rate of luminaries

Promoting clean technologies and opportunities under the carbon market

Stakeholder engagement

Government level – ministries of environment and energy

Private – developers, investors/entrepreneurs

International level – donors, technology providers

CDM support

To project participants in the CDM cycle

To CDM process, providing inputs to improve the CDM

Exploring synergies between the CDM and other mitigation actions

To link buyers-sellers of carbon credits

Renewable energy and energy efficiency

Determining sectoral baselines for countries and grid emission factors

Support the development of CDM proposal at programme level, PoA (programme of activities)

Capacity building: designing and delivering trainings, promoting success stories, sharing information, and answering technical queries

Thank you

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