UNFCCC CDM PROJECT

Visakhapatnam (India) OSRAM CFL distribution CDM Project

(Project 1754)

Monitoring Report

Project coordinator: OSRAM GmbH, OSRAM India Pvt. Ltd.

First Monitoring Interval

Monitoring period: 12/02/09 – 31/03/10

Version: 01

Date: 06/05/10

Contents

Project Description

The project was registered on 12th February 2009 under reference number 1754. Further information regarding the project can be found in the registered project design document available on the official UNFCCC website: http://cdm.unfccc.int/Projects/DB/TUEV-SUED1206629154.85/view

The project activity is a type (ii), category C project activity. It takes place in the district of Visakhapatnam, Andhra Pradesh, India. The goal of the project is to increase the efficiency of the domestic lighting use in the project area by replacing inefficient incandescent lamps (GLS) by highly efficient OSRAM Long Life Compact Fluorescent Lamps (CFL). As a result electricity is saved and therefore greenhouse gas (GHG) emissions are reduced. The project is registered under small scale methodology AMS-II.C. v. 9 "Demand-side energy efficiency programmes for specific technologies".

The following measures have been implemented in accordance with the registered project design document and the respective methodology:

1. Replacement of eligible[1] incandescent bulbs by project energy efficient lamps (CFL). (here referred as CFL Distribution) Project Lamps have been directly installed in households by distribution teams, to assure the eligibility of the replaced lamps as well as the correct installation of the new devices.

2. Collection and destruction of all replaced incandescent lamps, which took place under supervision of an independent body. (here referred as GLS Destruction)

3. Installation of meter equipment by Meter Company (appointed by Bureau of Energy Efficiency/BEE, Government of India) to determine daily operating hours of:

    a. Baseline sample group (Baseline Metering)

    b. Project sample group (Spot check Metering)

4. Functionality check of installed CFLs in sample group (Cross Check)

[1] Eligibilty criteria as defined in the registered PDD,

Implementation Status of Project

All measures as described in the registered PDD have been successfully implemented and are operational. Table 1 gives an overview of all devices installed. In Table 2 the participation statistics are shown.

CFL Distribution statistics	Absolute [-]	Share [%]
Total amount of CFL distributed	669,036	100%
15 W CFL	645,703	96.51%
20 W CFL	23,333	3.49%

Table 1: CFL Distribution Statistics

Participation Statistics	Absolute [-]	Share [%]
Households entered into Project DB	762,201	100.00%
Households participating	669,036	87.78%
Households not participating:	93,165	12.22%
Reason:		
- Not a Household (Commercial)	2640	0.35%
- Service Disconnection	1719	0.23%
- No Qualifying GLS Point	239	0.03%
- Not willing to Participate	29491	3.87%
- Not at Home	21072	2.76%
- Household Not Found	38004	4.99%

Table 2: Project Participation Statistics

Monitoring Period

The monitoring period has been chosen from **12/02/2009 up to 31/03/2010 (including both the start and end date)**. It is the first monitoring period of the project.

Monitoring Protocol and Data Assurance

The Monitoring protocol has been followed in accordance with the registered monitoring plan. The following table gives an overview of all monitored parameters.

	No.	Monitored Parameter	Value	Unit/ Format	Parameter Description	Measurement methods and procedures applied	Reference Document(s)
Monitoring Interval	1	$Date_{START,1}$	12.02.2009	date / dd/mm/yyyy	Date of the start of the credting period .	The start date for the first MI is the start date of the crediting period. The start date of the monitoring interval is set by the project coordinator directly in the CDM Project Database.	UNFCCC website; CDM Project Database - General Settings
	2	$Date_{END,1}$	31.03.2010	date / dd/mm/yyyy	Date of the end of the monitoring interval 1.	The end date of the monitoring interval is set by the project coordinator directly in the CDM Project Database.	CDM Project Database - General Settings
CFL Distribution	3	$Date_{i,k}$	Nov 2008 - Jan 2010 [1]	date / dd/mm/yyyy	Date of the replacement of GLS bulb i by CFL k [1] Value is recorded for each lamp individually and can be verified in the CDM Project Database.	Value is recorded in standardized Distribution Form (Form B) during the visit of the household. Information of Distribution Form (Form B) is entered into the CDM project database. Storage of Distribution Form (Form B)	Distribution Form (Form B) CDM Project Database - Household Details & Distribution Form
	4	p_i	60, 100	Watt / integer	p_i is the power of the GLS bulb i used before replacement (60 W or 100 W)	Value is recorded in standardized Distribution Form (Form B) during the visit of the household. Information of Distribution Form (Form B) is entered into the CDM project database. Storage of Distribution Form (Form B)	Distribution Form (Form B) CDM Project Database - Household Details & Distribution Form
	5	p_k	15, 20	Watt / integer	p_k is the power rating of the CFL k used to replace GLS bulb i (15 W or 20 W)	Value is recorded in standardized Distribution Form (Form B) during the visit of the household. Information of Distribution Form (Form B) is entered into the CDM project database. Storage of Distribution Form (Form B)	Distribution Form (Form B) CDM Project Database - Household Details & Distribution Form
	6	BN_k	t_c 828 t_c 848 t_c 858 t_c 868	- / t_c xxx	Batch number (production number) of each CFL k	Value is recorded in standardized Distribution Form (Form B) during the visit of the household. Information of Distribution Form (Form B) is entered into the CDM project database. Storage of Distribution Form (Form B)	Distribution Form (Form B) CDM Project Database - Household Details & Distribution Form

	No.	Monitored Parameter		Unit/ Format	Parameter Description	Measurement methods and procedures applied	Reference Document(s)
GLS Destruction	7	$n_{SCRAP,i}$	678.307	- / integer	Number of scrapped GLS bulbs collected from households until the end of the first monitoring interval.	Collecting of GLS during replacement of CFL using a specifically designed packaging design.Sticker used to indicate the wattage and to seal the packaging. Counting and Destruction of GLS takes places under supervision of independent body. Documentation of GLS Destruction using Booklets containing Form G: GLS Destruction (one booklet per section)	Booklets Form G: GLS Destruction
Baseline Study	8	$Date_{START,BL}$	13.11.2009	date / dd/mm/yyyy	Date of the start of the Baseline Monitoring.	The date of the start of the baseline monitoring is set by the project coordinator directly in the CDM Project Database.	CDM Project Database - General Settings
	9	$Date_{END,BL}$	10.02.2010	date / dd/mm/yyyy	Date of the end of the Baseline Monitoring.	The date of the endof the baseline monitoring is set by the project coordinator directly in the CDM Project Database.	CDM Project Database - General Settings
	10	$o_{r,d,q}$	4.640 [2]	hours / decimal	Operating hours of GLS bulb i on day d as given by valid meter r in month q during the baseline study in the baseline households. [2] Value shows the average over the full Baseline metering period after daylight correction and all statistical corrections.	Installation of Baseline GSM Meters (one per bulb) in randomly selected households. Wireless transmission of meter values via textmessages (SMS) to metering company appointed by the Bureau of Energy Efficiency (BEE), Government of India.	Form E: Baseline Study Database of Metering company
	11	$n_{r,d}$	192.9 [3]	- / integer	Number of meters r that provide a valid value for day d during the baseline study [3] Value shows average of meters providing a valid value over the full baseline metering period.	Wireless transmission of meter values via textmessages (SMS) to metering company appointed by the Bureau of Energy Efficiency (BEE), Government of India.	Database of Metering company

	No.	Monitored Parameter		Unit/ Format	Parameter Description	Measurement methods and procedures applied	Reference Document(s)
Spotcheck Study	12	$o_{m, d, 1}$	4.822 [4]	hours / decimal	Operating hours of CFL k on day d as given by valid meter m in a spotcheck household during the monitoring interval 1. [4] Value shows the average over the full metering period statistically corrected to a confidence level of 95 %.	Installation of Spot-Check GSM Meters (one per CFL) in randomly selected households (stratified random sampling). Wireless transmission of meter values via textmessages (SMS) to metering company appointed by the Bureau of Energy Efficiency (BEE), Government of India.	Form F: Spotcheck Study Database of Metering company
	13	$n_{m, d, 1}$	140.8 [5]	- / integer	Number of meters m that provide a valid value for day d during the monitoring interval 1. [5] Value shows average of meters providing a valid value over the spotcheck metering period.	Wireless transmission of meter values via textmessages (SMS) to metering company appointed by the Bureau of Energy Efficiency (BEE), Government of India.	Database of Metering company
Cross-Check	14	$Date_{c, 1}$	Feb 10 - April 10	date / dd/mm/yyyy	Date of Cross-Check in Cross-Check household c in monitoring interval 1.	Value is recorded in standardized Cross-Check Form during the visit of the Cross-Check household. Cross-Check Form is mannualy entered into the CDM project database. Storage of Cross-Check Form until verification is completed.	Cross-Check Form CDM Project Database - Household Details& Cross-Check Form
	15	$n_{sample, CC, 1}$	301	- / integer	Number of Cross-Checked CFLs during Cross-Check CC in Monitoring interval 1.	Calculated internally by the CDM project database.	Cross-Check Form CDM Project Database
	16	$n_{OK, 1}$	292	- / integer	Number of distributed CFLs to cross-check households which are functional during cross-check of monitoring interval 1.	Calculated internally by the CDM project database.	Cross-Check Form CDM Project Database

Quality Assurance and Quality Control Measures

The following measures have been implemented for quality assurance and quality control:

CFL Distribution

- CDM distribution training: all team members received a professional training, information and instruction manual was handed over (ref. document: Bilingual Training Manual English/Telugu).
- Pre-sorting of Distribution forms by section and for each distribution team
- Direct installation of CFLs in households door-to-door by distribution teams
- Easy to understand distribution form with bilingual instructions printed on backside (ref. doc.: Form B)
- Distribution process in 5 steps:
  1. Verification of correct household (service connection/SC no. and/or electricity bill) & Explanation of project idea and benefits to household
  2. Checking for eligible GLS
  3. Exchange of GLS to CFL lamp
  4. Functionality test of CFL
  5. Filling out of form: lamp type exchanged, date & signature
- Data entry screen of web application similar to Form B to ensure easy data entry
- Several input validations by the CDM database to ensure correct and complete data entry
- Frequent and random quality checks of data entry by supervisor for 3 % of all forms entered
- Full documentation of CFL installation in CDM Database (ref.: CDM Database -> Household history)

GLS Destruction

- Especially designed packaging to prevent misuse of lamps, ensure easy collection of GLS and destruction process
- Sticker indicating Wattage for easy counting and sealing of packaging
- Supervision of counting, destruction and disposal process by Pollution control officer and APEPDCL official (ref. doc.: Form G)
- Data entry of all forms into Database; reviewable in database

Baseline Study

- Stratified random sampling of baseline households using the consumer data provided by the utility. (Baseline Sequence list)
- Training of meter teams for procedure to be followed for meter installation (ref. doc. : Baseline metering manual)
- Installation of more meters than required for statistical representativeness
- Easy to understand distribution form with bilingual instructions printed on backside (ref. doc.: Form E)
- Functionality Test of meter prior to installation by meter company
- Meter Installation process in 5 steps:
  1. Verification of correct household (service connection/SC no. and/or electricity

bill) & Explanation of project idea and benefits to household
2. Checking for eligible GLS
3. Installation of Meter to GLS holder
4. Functionality test of GLS
5. Filling out of form: meter number, date & signature

- Data entry screen of web application similar to Form E to ensure easy data entry

Spot check Study

- stratified random sampling of spot check households automatically generated by the database using the consumer data provided by the utility (Spot check Sequence list)
- Training of meter teams for procedure to be followed for meter installation (ref. doc.: Spot check metering manual)
- Installation of more meters than required for statistical representativeness
- Easy to understand distribution form with bilingual instructions printed on backside (ref. doc.: Form F)
- Functionality test of meter prior to installation by meter company
- Meter & CFL Installation process in 5 steps:
  1. Verification of correct household (service connection/SC no. and/or electricity bill) & Explanation of project idea and benefits to household
  2. Checking for eligible GLS
  3. Exchange of GLS to CFL lamp & Installation of Meter
  4. Functionality test of CFL
  5. Filling out of form: lamp type exchanged, meter number installed, date & signature
- Data entry screen of web application similar to Form F to ensure easy data entry

Cross Check

- Stratified random sampling of cross check households automatically generated by the database using actually entered data from the distribution (cross check sequence list)
- Training of cross check teams for procedure to be followed for cross checks
- Functionality check of at least 200 CFLs
- Easy to understand cross check form (bilingual)
- Cross-Check process in 3 steps:
  1. Verification of correct household (service connection/SC no. and/or electricity bill) & Explanation of project idea and benefits to household
  2. Checking for eligible CFL / Functionality test of CFL
  3. Filling out of form: result of cross-check, date & signature
- Data entry screen of web application similar to Cross Check Form to ensure easy data entry

Emission Reductions achieved during the Monitoring Period

The calculation of emission reductions was conducted as shown in the following chapters. All steps of the calculation are shown in Illustration 1.

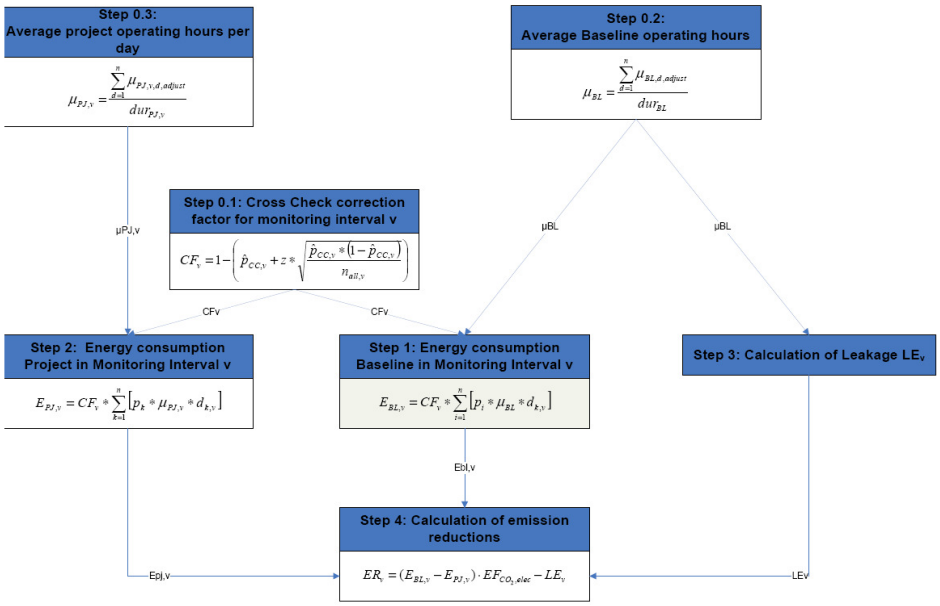

Illustration 1: Overview of calculations

Step 0.1: Calculation of the Cross Check correction factor

According to the PDD a functionality check had to be conducted for at least 200 project CFLs. The result is then statistically corrected to a confidence level of 95 % (see Illustration 2**Fehler! Verweisquelle konnte nicht gefunden werden.**).

Step 0.1: Cross Check correction factor for monitoring interval v

$$CF_v = 1 - \left(\hat{p}_{CC,v} + z * \sqrt{\frac{\hat{p}_{CC,v} * (1 - \hat{p}_{CC,v})}{n_{all,v}}} \right)$$

Illustration 2: Calculation of the Cross Check correction factor

In total 301 CFLs have been surveyed. To achieve statistically unbiased and representative results stratified random sampling was used and a strict procedure was followed during cross checks.

Table 3 gives an overview of the crosscheck results.

Cross Check Results:	Variable [-]	Absolute [-]	Share [%]
Households visited total:	-	328	100.00%
Households not participating:	-	27	8.23%
Households participating/CFLs cross checked:	$n_{sample,\ CC,\ 1}$	301	100.0%
CFL working:	$n_{OK,1}$	292	97.01%
CFL not working/not found:	$p_{CC,1}$	9	2.99%
Standard normal for confidence level of 95 %	z	1.96	-
Cross Check correction factor:	**CF_1**		**95.09%**

Table 3: Cross Check Results

Step 0.2: Calculation of Average Baseline operating hours

As per the PDD the Baseline operating hours have to be measured for a continuous period of 90 days. The measurement was conducted by the meter company which was appointed by the Bureau of Energy Efficiency (BEE), Government of India. OSRAM instructed and supervised the full metering process.

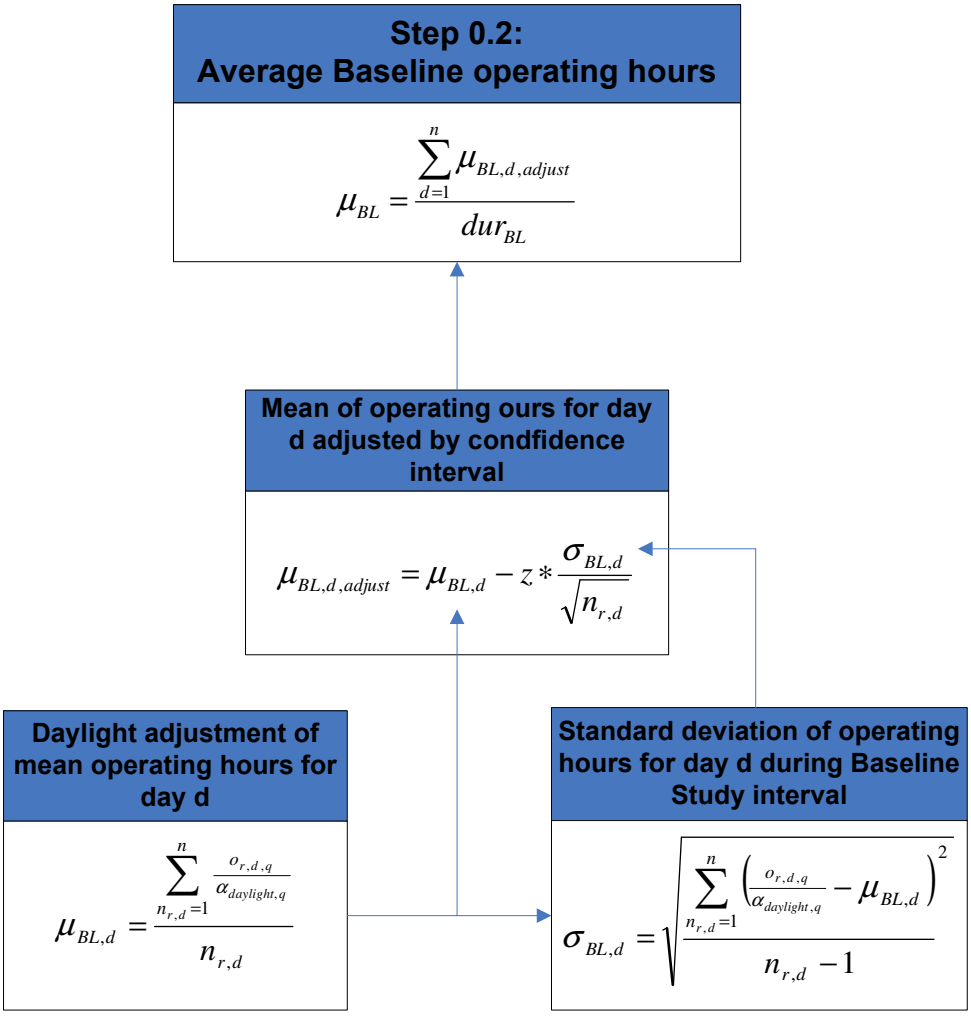

Illustration 3: Calculation of average Baseline operating hours

The baseline was metered over the required period of 90 days continuously. Based on the daily meter values delivered by the meter company, the average Baseline operating hours are calculated as shown in Illustration 3. Each meter value was corrected using the daylight adjustment factors shown in Table 4.

q	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
$\alpha_{daylight,\ q}$	0.937	0.921	0.901	0.896	0.871	1.026	1.133	1.153	1.167	1.072	0.983	0.940

Table 4: Daylight adjustment factors

The meter values were statistically corrected to a confidence level of 95 %. The final average baseline usage hours amount to μ_{BL} = 4.640 h.

Step 0.3: Calculation of the average project operating hours

The measurement of the project operating hours was conducted by the meter company, which was appointed by the Bureau of Energy Efficiency (BEE), Government of India. OSRAM instructed and supervised the full metering process.

Based on the daily meter values delivered by the meter company, the average project operating hours are calculated as shown in Illustration 4.

The meter values were statistically corrected to a confidence level of 95 %. The final average project operating hours amount to $\mu_{PJ,\ 1}$ = 4.822 h.

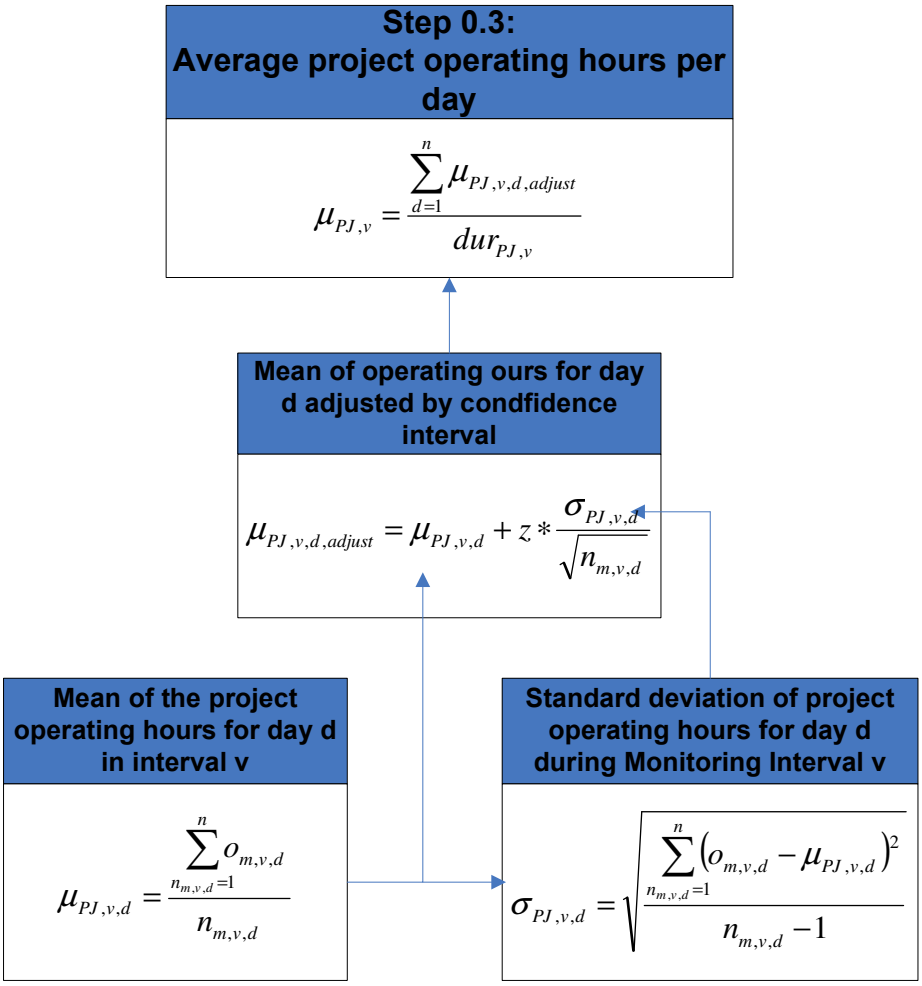

Illustration 4: Calculation of average project operating hours per day

Step 1: Calculation of the Energy consumption of the Baseline

The formulas applied for calculating the Energy consumption of the Baseline is shown in Illustration 5.

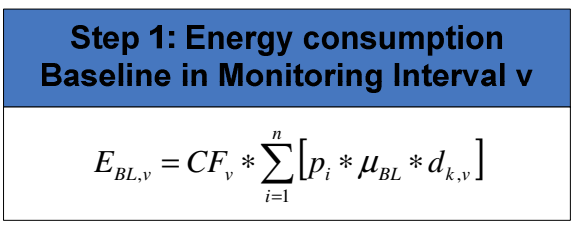

Illustration 5: Calculation of energy consumption baseline

As for each distributed CFL the date of installation/replacement of GLS is recorded in the database, the average amount of CFLs of each type (15 W or 20 W) which was correctly installed on each day of the monitoring interval can be determined.

Each 15 W CFL has replaced a 60 W GLS bulb and a 20 W CFL has replaced a 100 W GLS bulb. Applying this and the results derived from Step 0.1 (Cross Check correction

factor) and Step 0.2 (Baseline operating hours) the Energy consumption of the Baseline for Monitoring Interval 1 $E_{BL,1}$ can be calculated. The result is shown in **Table 5**.

Duration of Monitoring Interval 1	d_1	[d]	413
Average of 60 W GLS replaced over full MI		[pcs]	419,348.58
Average of 100 W GLS replaced over full MI		[pcs]	16,860.91
Cross Check Correction Factor	CF_1	[-]	0.9509
Average operating hours Baseline	μ_{BL}	[h]	4.640
Energy Consumption Baseline	$E_{BL,1}$	**[kWh]**	**48,921,383**

Table 5: Energy Consumption Baseline

The energy that would have been consumed without the project activity (Baseline) amounts to $E_{BL,1}$ = 48,921,383 kWh.

Step 2: Calculation of the Energy Consumption of the Project

The calculation of the energy consumption of the project group is analog to the calculation of the Baseline Energy consumption. Instead of the power rating of the replaced GLS the power rating of the distributed CFLs, instead of the operating hours baseline the operating hours of the spot check group are used (see Illustration 6).

Step 2: Energy consumption Project in Monitoring Interval v

$$E_{PJ,v} = CF_v * \sum_{k=1}^{n} [p_k * \mu_{PJ,v} * d_{k,v}]$$

Illustration 6: Calculation of the energy consumption of the project

The results of the calculation of the energy consumption of the project are summarized in Table 6.

Duration of Monitoring Interval 1	d_1	[d]	413
Average of 15 W CFL installed over full MI		[pcs]	419348.58
Average of 20 W CFL installed over full MI		[pcs]	16860.91
Cross Check Correction Factor	CF_1	[-]	0.9509
Average operating hours Project	$\mu_{PJ,1}$	[h]	4.822
Energy Consumption Project	$E_{PJ,1}$	**[kWh]**	**12,550,423**

Table 6 :Energy Consumption Project

The energy consumed with the project activity amounts to $E_{PJ,1}$ = 12,550,423 kWh.

Step 3: Calculation of Leakage

As the full amount of GLS replaced by CFLs was destroyed in the GLS Destruction Process, no leakage has to be considered.

Hence the leakage in the first (and all following) monitoring intervals is LE_1 = 0 $kgCO_2$.

Step 4: Calculation of emission reductions

Considering the results derived in the previous steps the Emission reductions achieved due to the project activity can be calculated as shown in Illustration 7.

Step 4: Calculation of emission reductions
$ER_v = (E_{BL,v} - E_{PJ,v}) \cdot EF_{CO_2,elec} - LE_v$

Illustration 7: Calculation of emission reductions

The results of the calculation of the emission reductions of the project are summarized in Table 7.

Energy Consumption Baseline	$E_{BL,1}$	[kWh]	48,921,383
Energy Consumption Project	$E_{PJ,1}$	[kWh]	12,550,423
Leakage	LE_1	[$kgCO_2$]	0
Grid Emission Factor	$EF_{CO2, ELEC}$	[kgCO2/kWh]	0.85
Emission Reductions	**ER_1**	**[tCO_2]**	**30,915**

Table 7: Emission reductions

From 12/02/09 – 31/03/10, the project has achieved 30,915 tCO_2 emission reductions which is lower than the estimated value, corresponding with emission reductions of 32,433 tCO_2 in the registered PDD.