



Monitoring report form (Version 03.2)

Monitoring report

Title of the project activity	Improving Energy Efficiency in Railways' Residential Quarters – Western Region
Reference number of the project activity	3811
Version number of the monitoring report	Version 01
Completion date of the monitoring report	25/03/2014
Registration date of the project activity	26/11/2010
Monitoring period number and duration of this monitoring period	2 nd Monitoring period Duration: 01/01/2013 - 31/12/2013 (both days inclusive)
Project participant(s)	Ministry of Railways (Railway Board) C-Quest Capital Malaysia Limited Swedish Energy Agency
Host Party(ies)	India
Sectoral scope(s) and applied methodology(ies)	Sectoral Scope 3 : Energy demand; Applied Methodology: AMS-II.J. , Version 3.0
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	46,332 tonnes of CO ₂ equivalent
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	19,168 tonnes of CO ₂ equivalent (upto 31/12/2013)
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period up to 31 December 2012(if applicable)	Nil
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved during the period from 1 January 2013 onwards (if applicable).	19,168 tonnes of CO ₂ equivalent

SECTION A. Description of project activity**A.1. Purpose and general description of project activity**

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- a) Purpose of the project activity and the measures taken greenhouse gas emission reductions

The purpose of the project activity is to improve the energy efficiency of the lighting loads in railways' residential quarters over Indian Railway zones, Production Units and Workshops by replacing less energy efficient incandescent lamps (ICLs) with compact fluorescent lamps (CFLs).

The reduction in total power demand through the energy saving achieved has resulted a reduction of greenhouse gases (GHG) emissions that would otherwise being emitted during production of the equivalent amount of power in grid connected with mostly fossil fuel based power plants.

- b) Brief description of the installed technology and equipments

Two types of CFLs were used in the project activity. The 14W and 20W CFLs were distributed to railways' residential quarters in exchange of equal number of normal luminous flux 60W and 100W ICLs, respectively. Each household was given up to a maximum of 4 CFLs in exchange for an equal number of less energy efficient incandescent lamps (ICLs) that have been in use by the households.

These CFLs, manufactured by Philips, have the equivalent or higher lumen to the replaced ICL (620lm and 1240lm, respectively) and a rated lifetime of 10,000 hours. These are also high power factor CFLs and they can withstand wide voltage fluctuations. Below table provides the rated normal lumen output for the ICL as per IS 418:2004, as used in this project.

	ICL (baseline)	CFL (project)	ICL (baseline)	CFL (project)
Wattage (W)	60	14	100	20
Lumen output (lm)	620	760	1,240	1,240
Rated Lifetime (h)	1,000	10,000	1,000	10,000

The rated lifetime certificates, which are for 10,000 hours, of the CFL bulbs used in the project activity have been provided to the verifying DOE.

- c) Relevant dates for the project activity

Relevant dates for the project activity are as below:

Event	Date
Start date of the CFL installation	05/02/2010
End date of the CFL installation of all types of CFLs	31/05/2010
Registration of project activity at UNFCCC website	26/11/2010
Start of first monitoring survey	16/11/2010
End of first monitoring survey	27/11/2010
Start of 1 st monitoring period	26/11/2010
End of 1 st monitoring period	31/12/2012
Issuance of 1 st monitoring period	22/11/2013
Start of second monitoring survey	06/02/2014
End of second monitoring survey	21/02/2014
Start of 2 nd monitoring period	01/01/2013
End of 2 nd monitoring period	31/12/2013

- d) Total GHG emission reductions achieved in this monitoring period.

This monitoring period is from 01/01/2013 to 31/12/2013 (both days inclusive). The total GHG emission reductions achieved in this monitoring period is 19,168 tCO₂ equivalent.

A.2. Location of project activity

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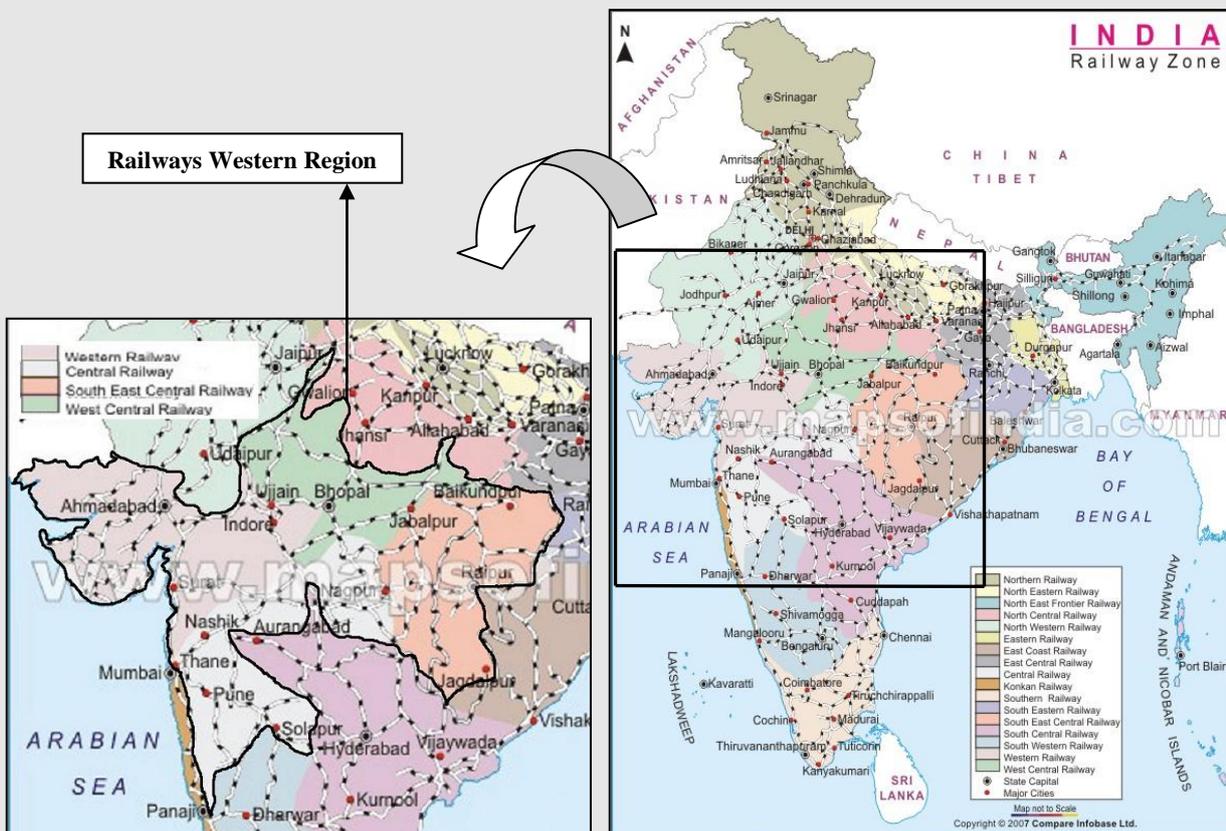
The project activity is located at the Western Region of Indian Railways which spreads across 4 States in India (Host Country). The States that fall within this project boundary include Gujarat, Maharashtra,

Madhya Pradesh and Chhattisgarh. Under the Western Region, the project area covers four zones which are Western, Central, West Central, and South East Central Zones.

The latitude and longitude information on the major cities and towns within the project boundary, where CFLs were distributed is provided in the table below.

Main Town	Latitude	Longitude
Mumbai Central	18° 55' 01"N	72° 54' 00"E
Vadodara	22° 00' 00"N	73° 16' 01"E
Ahmedabad	23° 03' 00"N	72° 40' 01"E
Rajkot	22° 18' 00"N	70° 55' 59"E
Bhavnagar	21° 46' 01"N	72° 10' 59"E
Jabalpur	23° 10' 01"N	79° 58' 59"E
Bhopal	23° 16' 01"N	77° 36' 00"E
Kota	25° 40' 12"N	75° 52' 01"E

Source: www.mapsofindia.com



Source: Indian Railways, GOI. 2009

A.3. Parties and project participant(s)

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)

India (Host)	Ministry of Railways (Railway Board)	No
The Netherlands	C-Quest Capital Malaysia Limited	No
Sweden	Swedish Energy Agency	Yes

A.4. Reference of applied methodology

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The project activity uses AMS-II.J. "Demand-side activities for efficient lighting technologies" version 3.0

A.5. Crediting period of project activity

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26/11/2010 - 25/11/2020 , 10 Years Fixed Crediting Period

Present monitoring period is from 01/01/2013 till 31/12/2013 (both days inclusive)

SECTION B. Implementation of project activity**B.1. Description of implemented registered project activity**

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The project activity involved installation of self-ballasted CFLs to replace existing ICLs used in the household. The electronic ballast integrated in the CFL is a non-removable part. The table below shows the lumen output and rated lifetime of the CFLs installed in the project activity against the replaced ICLs. The project CFLs meet or exceed the rated normal lumen output of the replaced ICL.

	ICL (baseline)	CFL (project)	ICL (baseline)	CFL (project)
Wattage (W)	60	14	100	20
Lumen output (lm)	620*	760**	1,240*	1,240**
Rated Lifetime (hours)	1,000	10,000	1,000	10,000

*Rated normal Lumen output for 60 W and 100 W of ICLs as per IS 418:2004.

** Rated normal Lumen output for 14 W and 20 W CFLs as per IS 15111:2002 (Part 2)

The project CFLs is in compliance with Indian Standard IS 15111:2002, which is the national standard for self-ballasted compact CFLs. The specifications of the project CFLs are as below:

- Self-ballasted type
- Rated lifetime of 10,000 hours
- Embossed or laser printed with project logo for clear unique identification
- BC/B22 base
- Power factor of greater than 0.85
- Lumen output of 760 lm for 14 W CFL and Lumen output of 1240 lm for 20 W CFL
- Manufactured in India by Philips Electronics India Limited

Implementation Status:

- The project activity consists of Railways Region consisting of Railways Zones/Workshops as mentioned in Section A.2 of the registered PDD. Under the Railways management at zonal level, the area is divided into several divisions. The table below shows the complete list of divisions at

Western region. The information on the division-wise number of CFLs installed is attached as well. Overall, the CFL installation activity at Western Region started on 05/02/2010 (From Ratlam division) and completed on 31/5/2010 (at Bhusawal division and Kota division).

No	Railways Region	Railways Zones/ Workshops	Division	Number of CFLs installed as per ledger record		Start date of CFL installation	Completion date of CFL installation
				14 W	20 W		
1	Western	Western	Mumbai	19883	9355	14/02/2010	30/04/2010
2			Vadodara	10648	5714	12/02/2010	30/05/2010
3			Ratlam	13329	7625	05/02/2010	28/05/2010
4			Ahmedabad	21173	9855	13/02/2010	10/05/2010
5			Rajkot	6590	2935	04/03/2010	07/05/2010
6			Bhavnagar	11726	4437	15/02/2010	30/05/2010
7			Dahod Workshop	6313	2962	25/02/2010	23/05/2010
8		Central	Bhusawal	18288	8051	06/03/2010	31/05/2010
9			Nagpur	13100	7150	10/03/2010	15/04/2010
10			Pune	2083	2177	02/03/2010	16/04/2010
11			Sholapur	6798	3665	10/03/2010	29/05/2010
12			Mumbai Central	14233	10065	24/02/2010	27/05/2010
13			Nasik Workshop	344	192	22/02/2010	12/03/2010
14		West Central	Kota	18003	8417	06/02/2010	31/05/2010
15			Bhopal	16319	6783	27/02/2010	22/05/2010
16			Jabalpur	15765	7502	20/02/2010	15/05/2010
17		South East Central	Raipur	11251	5360	04/03/2010	13/04/2010
18			Bilaspur	17074	8048	03/03/2010	15/04/2010
19			Nagpur	15282	7263	06/03/2010	06/04/2010

- The project activity was implemented and operated in accordance with the registered PDD. The operation of the CFL distribution process was organised by Indian Railways and CFLs were distributed on door to door distribution mode. No extra cost being charged on the household for the exchange of ICL with CFL. The information on the exchange of bulbs at the household was recorded using the ledger book. The ledgers have all the details including the Provident Fund Number, Quarter Number (Address), Quarter Type, Name, Station Code, Name of Railway Colony, Number and type of CFLs given (14 W and 20 W), Number and type of ICLs received (60 W and 100 W), Date of installation and Signature of participating household. For the verification of the accuracy of data collected in the ledger book, Indian Railways project coordinator will sign on the ledger book and provide their contact details.
- CFLs distributed to the household were marked with the unique logo and "not for sale". This is to prevent the resale of CFLs by household. The ownership of the CFLs installed at the household belongs to Indian Railways; therefore the possibility of household to resale of CFL given is zero.
- The ICLs collected from the households were stored in separate boxes according to the bulb's wattage and labelled clearly of their content. The ICL boxes were then transferred to the waste management company for further destruction. The ICL destruction was recorded by video or photography. Certificate of destruction was issued upon the destruction of ICLs.
- The first *ex post* monitoring survey was carried out within the first year after the installation of CFLs (from 16/11/2010 – 26/11/2010) and thereafter the second *ex post* monitoring survey has been carried out after three year of the first monitoring survey (i.e. from 06/02/2014 to 21/02/2014). The

monitoring survey was carried out by qualified market survey and consultancy company (third party). The quantity of CFLs placed in service and operating ($Q_{P,j,i}$) were determined from the survey. The value of $Q_{P,j,i}$ obtained will serve as a constant value in the whole crediting period.

6. During the monitoring period, the project activity was in normal operation. There was no events or situations occurred which may impact the applicability of the methodology.
7. The actual number of CFL distributed (i.e. 355,758) was less compared to the projected one (i.e. 625,992). CFL distribution is linked directly to the extent on the participation of consumers in the program. Despite awareness carried out, it was noted that actual participation was lower than what was anticipated during the planning stage.
8. During second monitoring survey it was found that 78.77% of 14W CFLs were operating and 67.52% of 20W CFLs were operating, resulting a 75.05% of success rate of overall CFLs.
9. Project Participant has hired Global E-waste Management Service (GEMS) for destruction of ICLs collected. The copy of the agreement is shared with the verifying DOE for verification. The various dates of ICL collection and destruction activities have been tabulated below. The certificates released by GEMS mentioning the number of ICLs collected and destroyed on various dates are also shared with the verifying DOE.

No	Railways Region	Railways Zones/Workshops	Division	Date of Collection by GEMS	Date of Destruction by GEMS
1	Western	Western	Mumbai	14/05/2011	25/05/2011
2			Vadodara		
3			Ratlam		
4			Ahmedabad		
5			Rajkot		
6			Bhavnagar		
7			Dahod Workshop		
8		Central	Bhusawal	05/07/2011 & 06/07/2011	12/07/2011 & 13/07/2011
9			Nagpur		
10			Pune		
11			Sholapur		
12			Mumbai Central		
13			Nasik Workshop		
14		West Central	Kota	11/05/2011	11/05/2011
15			Bhopal		
16			Jabalpur		
17		South East Central	Raipur	09/05/2011	27/05/2011
18			Bilaspur		
19			Nagpur		

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

>> No deviation has been applied to this monitoring period.

B.2.2. Corrections

>> No corrections have been made in this monitoring period.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

>> The monitoring plan in respect of the project activity or the applied methodologies has not undergone any permanent changes since registration.

B.2.4. Changes to project design of registered project activity

>> No project design changes have been occurred in the registered project activity.

B.2.5. Changes to start date of crediting period

>> There is no change in start date of crediting period.

B.2.6. Types of changes specific to afforestation or reforestation project activity

>> Not applicable.

SECTION C. Description of monitoring system

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1. The monitoring of number of CFLs placed in service and operating under the project activity

The objective of the second monitoring survey as prescribed in methodology AMS-II.J. ver 3.0 was to determine the number of each type of CFLs placed in service and operating under the project activity. The results of the survey decides the quantity of lamps ($Q_{PJ,i}$) applied in the Emission Reduction calculation.

Prior to the monitoring survey, the number and type of CFLs installed under the project activity is obtained from the project database. The project database is maintained in electronic form and it is constructed from the data captured in the ledger record. The ledger record is used in the CFL distribution process to capture the CFL recipient data, number and type of bulbs exchanged and date of bulb installation.

Due to the large number of CFLs installed in the project area, a sample-based monitoring survey would be the best approach to obtain a reliable estimate of the fraction of CFLs placed in service and operating. The value of $Q_{PJ,i}$ will be adjusted based on the estimate of fraction of CFLs obtained.

Sampling approach

A Simple Random Sampling approach was adopted in the second ex post monitoring survey. The monitoring survey was to identify CFLs labelled with project marking and identified CFLs were cross-checked with the project database. CFLs which are not in sockets or do not match with database will be counted as a loss. The following data was collected from the survey respondents which included profiling information (name, address, PF no. of the respondent), number and type of project CFLs found installed at the household (against the information in the database), identification on the physical status of project CFLs (whether installed and operating), reasons for failure of project CFLs, and replacement activity of defective project CFLs.

Using the Simple Random Sampling approach, the sample size to be covered within the divisions was calculated to be 250 households. The sample size was determined at a 90% level of confidence and with a 10% margin of error. The methodology requirement on sample size was 100, whereas it was confirmed that 110 samples would be covered. However as a part of the survey 250 households have been covered which leads to much more accurate results. An extra 10% of households for each division were additionally selected as a buffer for non-response sample. The same is explained in chapter 3.6 of the survey report.

The survey revealed that the fraction of CFLs for 14 W and 20 W that placed in service and operating

under the project activity was estimated at 78.77% and 67.52% respectively. From the fraction of CFLs obtained, the study concluded that there are 187,725 project CFLs of 14 W and 79,375 project CFLs of 20 W which were placed in service (installed) and correctly working within Western Region during the survey period. Data collection and face-to-face interviewing was administered adopting strict guidelines prescribed by the Methodology AMS-II.J. ver 3.0, with the information collected through face-to-face interviews using structured questionnaires.

Data collection

The data collection procedure adopted the strict guidelines prescribed in the methodology. All the data was collected through face-to-face interviews using structured questionnaires. The Chief Wage Earner (CWE) of each household was targeted for providing a response. On the occasion where the CWE was unavailable, only the resident of household which more than 12 years old can be selected as qualified respondent. Only CFLs with an original marking can be counted as installed. CFLs replaced as part of a regular maintenance or warranty program can be counted as operating, CFLs cannot be replaced as part of the survey process and counted as operating.

Quality control and quality assurance

- a) To maintain the accuracy of the data collected, CFL found in the socket was switched on to ensure that it is still operating.
- b) Precautions were taken to capture all of the relevant data points, such as the presence of Research Executives at each sampling location to ensure that data capturing was efficient, unbiased and synchronized with the database of CFLs (provided by CQC).
- c) 30% back check on the data collected from the household surveyed before the task of data entry commenced.

2. The monitoring of number of ICLs collected and destroyed

As the precautions to ensure that the real emission reduction occurred from bulb replacement activity, the methodology (paragraph 12) demands the value of $Q_{P,j,i}$ shall be equal or less than the documented number of ICLs destroyed, $Q_{BL,i}$.

ICL storage

After the completion of CFL installation stage, the collected ICLs were stored in separate boxes according to the wattage and clearly labeled of their contents. These ICL boxes were transferred to centrally designated ICL storage facilities which were organized by Indian Railways. Further arrangement was made with waste management company to collect ICLs from these centrally designated storage facilities (collection points) for the destruction of ICLs in safe manner.

Sequence of events for the ICL collection and disposal by waste management company

The activities of ICL collection and disposal were organized in accordance with the following sequence of events:

- a) Nomination of Railways Collection Point contacts and handing over of ICLs from the collection point to waste management company;
- b) Verification of quantity of ICLs by the waste management company at the Collection Point;
- c) Transportation of ICLs from Collection Points to ICL destruction site(s);
- d) Destruction of ICLs; and
- e) Recording and documentation of ICL handing over and destruction.

The detail of the events above is described on the paragraphs below.

Each centrally designated storage facility will serve as one collection point for handing over the ICLs to waste management company. Prior to the ICL collection, Indian Railways pointed Railways personnel to act as "Collection Point Contact" to liaise with the waste management company for ICL collection activity.

Upon the acceptance of ICLs by the waste management company at the collection point, the waste management company acknowledged the receipt of ICLs and issued a "Certificate of Handing/Taking Over". The "Inventory List for Certificate of Handing/Taking Over" was attached to the certificate issued.

The inventory list was to describe the origin and the number and type of ICLs handed over. The origin of ICLs was referred to the respective Railways division.

Prior to physically transporting ICLs from the Collection Point, the waste management company conducted a random inspection on the ICLs handed over (Random ICL Inspection). In relation to the Random ICL Inspection, the waste management company recorded accordingly the result of verification of ICL quantities and issued a "Certificate of Verification of Quantity".

Following the Random ICL Inspection, all ICLs collected were transported from the collection point to a disposal facility which is qualified and authorized to destroy ICLs (ICL Destruction Facility). Upon arrival at the ICL Destruction Facility, waste management ensured that there has been no change in the total number of ICLs from that recorded at the Collection Point. After the completion of ICL destruction, waste management company issued a "Certificate of Destruction".

The entire process of ICL collection and disposal has been video recorded or photography started from the collection point (where the handing over of ICLs take place) until the complete of ICL destruction at the destruction facility. The date and time of recording was included in the video recorded.

Format of data collection

The brief function of the certificates used in the data collection is provided as below.

a) **Certificate of Handing/Taking Over**

It provides the number and type of ICLs handed over from collection point to waste management company.

b) **Inventory List for Certificate of Handing/Taking Over**

It provides a list of the number and types of ICL handed over together with the source where the ICL is transferred from.

c) **Certificate of Verification of Quantity**

It provides the actual sample size of ICLs verified by the waste management company. The number and type of ICLs checked and found from the verification against the inventory record is documented accordingly.

d) **Certificate of Destruction**

It provides the number and types ICLs destroyed at the ICL destruction facility.

To obtain the total number of ICLs destroyed ($Q_{BL,i}$) under the project activity, all the copies of certificates of destruction issued was gathered and the number of ICLs destroyed as stated in the certificates was added up. The steps defined above are deemed to be appropriate to provide a clear evidence trail to justify the number of ICLs destroyed.

Quality Control and quality Assurance

Waste management company shall ensure that a representative sample (at least 5%) of ICL destruction is:

- witnessed by an authorized representative from waste management company, and
- Recorded via video recorder and/or still photography. Each video recording and/or photograph shall be date and time stamped, and shall be submitted to CQC immediately upon completion.

3. Replacement of CFLs and Monitoring of fused CFLs collected and destroyed

Fused CFLs was replaced as part of a warranty program for the project, and these replacement CFLs installed in households prior to the monitoring survey was counted as operating. There was no replacement as part of the survey process. The replaced and fused CFLs were recorded in the project database.

Fused CFLs from the Railways' residential quarters have been collected and will handle the mercury according to the Central Pollution Control Board (CPCB) Guidelines. All collected CFLs are being stored at designated locations until they are transferred to the CFL treatment facilities operated by disposal agencies for proper disposal of mercury inside of the CFLs. In absence of any existing guideline from CPCB of mercury disposal, the CFLs are kept in store only and have not been disposed yet and the same will be disposed of as per the country's guideline of CFL disposal once the guideline comes into place.

4. Operational & Management Structure:

CQC as the principal project owner & implementer is in charge of the overall planning and management of the project including monitoring along with Indian Railways, the other project participants. The management teams of both CQC and Indian Railways ensures establishment of all procedures, databases, infrastructure for smooth roll out of the CFLs distribution in exchange of right ICLs (i.e. distribution of 14W CFL for 60W ICL and 20W CFL for 100W ICL) and the destruction of ICLs surrendered by the users. CQC and Indian Railways conformed to all procedures for monitoring to ensure high integrity of data and quality of verification reports. Database software has been developed in order to manage collected information electronically as well as manually.

5. Method of recording data

CQC has developed a two-fold process to collect the required data. Firstly, the relevant data is entered into hard copy ledgers or other forms of records that collect the same information as ledgers. This information is then transmitted or entered into an electronic web-based database. These two formats are described in more detail below:

Ledgers

Firstly, when distributing the CFLs to eligible households, the Indian Railways' project coordinator is required to input data into hard copy ledgers. The ledger format developed by CQC contains the following fields:

- *Information to identify the recipient:* Railways section number, name of occupant, address of quarter, type of quarter, contact number, and provident fund (PF) number;
- *Information related to the replaced ICLs:* Number of ICLs collected by wattage (either 60W or 100W);
- *Information related to the distributed CFLs:* Number of CFLs distributed by wattage (14W CFLs to replace 60W ICLs and 20W CFLs to replace 100W ICLs);
- *Information to assist in verifying the accuracy of the data:* The Indian Railways' project coordinator distributing the CFLs and completing the ledger is required to sign the ledger and provide their contact information (section number, name, designation, division, and station code and telephone number).

Database

Once the hard copy ledgers were completed by the Indian Railways' project coordinators, these ledgers were then sent to the Divisional level staff that was responsible for entering this data into the electronic database. As per CDM requirements, the database will be kept for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data / Parameter:	$EF_{CO_2,ELEC,y}$
Unit:	tCO ₂ /MWh
Description:	Emission factor
Source of data:	"Baseline Carbon Dioxide Emission Database Version 5, November 2009 and UNFCCC "Tool to Calculate the Emission Factor for an Electricity System", Version 1.1, the Combined Margin for the Integrated Northern, Eastern, Western and North-Eastern Region is 0.84.
Value(s) applied:	0.84
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)

Additional comment:	-
Data / Parameter:	O_i
Unit:	Hours
Description:	Average daily operating hours of the ICLs replaced by CFLs
Source of data:	AMS-II.J. ver 3.0 option value
Value(s) applied:	3.5 hours per 24 hours period
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	-
Data / Parameter:	L_i
Unit:	Hours
Description:	Rated average operating hours for CFL type <i>i</i>
Source of data:	Manufacturer's life test report of CFLs
Value(s) applied:	10,000 hours
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	
Data / Parameter:	R_i
Unit:	%
Description:	% of lamps of type <i>i</i> operating at the rated lifetime
Source of data:	AMS-II.J. ver 3.0 default value
Value(s) applied:	50%
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	-
Data / Parameter:	X_i
Unit:	Hours
Description:	Number of operating hours per year for equipment type <i>l</i>
Source of data:	Calculated value
Value(s) applied:	1,277.5 hours
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	Bulb usage per year equals to 3.5 hours/day * 365 days/year = 1,277.5 hours

Data / Parameter:	NTG
Unit:	-
Description:	Net-to-gross adjustment factor
Source of data:	Default value as per AMS-II.J. ver 3.0
Value(s) applied:	0.95
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	-

D.2. Data and parameters monitored

Data / Parameter:	$Q_{BL,i}$
Unit:	Units
Description:	Number of replaced ICLs collected under the project activity
Measured/ Calculated / Default:	Measured
Source of data:	Actual record 60W and 100W ICLs collected
Value(s) of monitored parameter:	Record from project database: 60 W: 238,202 ICLs 100 W: 117,556 ICLs Record from certificates of ICL destruction: 60 W: 238,004 ICLs; 100 W: 117,431 ICLs During the ICL destruction, about 198 ICLs of 60 W and 125 ICLs of 100 W were found less in Jabalpur Division when compared with the ICL record in project database. No leakage calculation would be imposed since the $Q_{PJ,i}$ applied in the emission reduction calculation is less than the documented number of ICLs destroyed.
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	The data is recorded from start date of CFL distribution up to 31/05/2010, which is the end date of CFL distribution, fixed value thereafter
Calculation method (if applicable):	NA

QA/QC procedures:	<p>During CFL distribution activity:</p> <ul style="list-style-type: none"> • Only 60 W and 100 W of working ICLs were accepted for bulb exchange during the CFL distribution activity. • Check the marking of the wattage of ICLs before data recording in the ledger book. <p>After completion of CFL distribution activity:</p> <ul style="list-style-type: none"> • ICLs collected were stored in separate boxes according to the wattage and clearly labeled of their contents. • Destruction of ICLs was organized by qualified independent service provider (ISP) and total number of ICLs destroyed to be verified by the ISP. • All the ICLs were destroyed within 24 hours after the handing over to ISP. This has effectively limited the undesired secondary market effects and free riders activity. <p>The handing over of ICLs and destruction activities were recorded via video recorder and/or photography.</p>
Purpose of data:	To determine the value of $Q_{PJ,i}$ applied in emission reduction calculation. As per methodology, $Q_{PJ,i}$ shall be equal to or less than the documented $Q_{BL,i}$.
Additional comment:	No Comment

Data / Parameter:	$Q_{PJ,i}$
Unit:	Number
Description:	Number of CFLs distributed or installed under the project activity
Measured/ Calculated / Default:	Measured
Source of data:	First ex post monitoring survey report
Value(s) of monitored parameter:	<p>Record from project database: 14 W: 238,202 CFLs; 20 W: 117,556 CFLs</p> <p>$Q_{PJ,i}$ obtained from first ex post monitoring survey: 14 W: 238,107 CFLs; 20 W: 117,556 CFLs</p> <p>The difference on the number of CFLs shown above is due to the adjustment made based on the estimate of fraction of operating CFLs obtained in the monitoring survey.</p> <p>The CFLs replaced under warranty period but prior to the monitoring survey was considered as operational. There was no CFL replacement as part of the survey process.</p>
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	The data is recorded from start date of CFL distribution up to 31/05/2010, which is the end date of CFL distribution, fixed value thereafter and also from the ex-post monitoring survey report

Calculation method (if applicable):	The total number of CFLs recorded in the project database will be adjusted based on the estimate of fraction of operating CFLs obtained in the monitoring survey. In the first monitoring survey the percentage of 14W & 20W CFLs were found to be 99.96% and 100% respectively. Thus the minimum between ICL collected & destroyed and CFLs found in monitoring survey has to be considered. It is to be noted that the fused CFLs which were replaced under warranty period and prior to the monitoring survey were counted as operating.
QA/QC procedures:	During CFL distribution activity: <ul style="list-style-type: none"> • Training was provided to Indian Railways by CQC to ensure that the staffs aware of the relevant procedure and the format of recording used. After completion of CFL distribution activity: <ul style="list-style-type: none"> • Monitoring survey was conducted by qualified and experience ISP • Monitoring survey conducted in accordance with the requirement of methodology so that the estimate of $Q_{P,j}$ obtained is unbiased and reliable.
Purpose of data:	For emission reduction calculation.
Additional comment:	No Comment
Data / Parameter:	$P_{i, BL}$
Unit:	Watts
Description:	Weighted average of wattage of ICLs bulbs collected
Measured/ Calculated / Default:	Calculated
Source of data:	Project database
Value(s) of monitored parameter:	73.22
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	Once, as the ICLs to be replaced are of 60W & 100W and is as per the project design
Calculation method (if applicable):	60 W x fraction of 60 W ICLs destructed + 100 W x fraction of 100 W ICLs destructed
QA/QC procedures:	Number and type of ICLs collected in boxes is used to verify the numbers recorded in the ledger and database. This was also cross referred to the CFLs distributed as per project database.
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)

Additional comment:	No Comment
Data / Parameter:	$P_{i, PJ}$
Unit:	Watts
Description:	Weighted average of wattage of CFLs bulbs distributed
Measured/ Calculated / Default:	Calculated
Source of data:	Project database
Value(s) of monitored parameter:	15.98
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	Once, as the CFLs to be distributed are of 14W & 20W and is as per the project design.
Calculation method (if applicable):	14 W x fraction of 14 W CFL distributed + 20 W x fraction of 20 W CFL distributed
QA/QC procedures:	The record of CFLs purchased and delivered to Railways was used to verify the number recorded in the ledger and database. This was also cross referred to the ICLs collected.
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	No Comment
Data / Parameter:	Date of CFL distribution/issued
Unit:	Date
Description:	Date of distribution of CFLs to each recipient
Measured/ Calculated / Default:	Day, month, and year were recorded
Source of data:	Ledger and database
Value(s) of monitored parameter:	Start date of CFL distribution – 05/02/2010 End date of CFL distribution - 31/05/2010
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	The data is recorded from start date of CFL distribution up to 31/05/2010, which is the end date of CFL distribution
Calculation method (if applicable):	NA

QA/QC procedures:	The date of CFL distribution from ledger & database was cross verified from the consent deeds
Purpose of data:	Emission reduction calculation
Additional comment:	No Comment
Data / Parameter: CFL recipient information	
Unit:	-
Description:	Data of CFL recipient for each household
Measured/ Calculated / Default:	Information to be recorded in the ledger during CFL distribution shall consist of name of the recipient, address, and PF number (unique identification).
Source of data:	Ledger and database
Value(s) of monitored parameter:	-
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	The data is recorded from start date of CFL distribution up to 31/05/2010, which is the end date of CFL distribution.
Calculation method (if applicable):	-
QA/QC procedures:	The data of recipient from ledger & database was cross verified from the consent deeds
Purpose of data:	Data is to verify number of CFLs replaced and whether the recipient is from railway residential quarter or not.)
Additional comment:	No Comment
Data / Parameter: $LFR_{i,y}$	
Unit:	%
Description:	<i>Ex post</i> Lamp Failure Rate for CFL type <i>i</i> in year <i>y</i> (fraction)
Measured/ Calculated / Default:	Measured
Source of data:	To be monitored on subsequent <i>ex post</i> monitoring surveys which will take place in 3 years interval after the first <i>ex post</i> monitoring survey

Value(s) of monitored parameter:	<p><i>Ex post</i> LFR observed from the second monitoring survey is: 14 W: 21.23%; 20 W: 32.48% resulting LFR as 24.95%</p> <p>LFR applied in the ER calculation is the <i>ex-ante</i> LFR which is calculated using the formula provided in methodology¹. In year 3, LFR applied is 19.18% and For year 4, LFR applied is 25.57%.</p> <p>The <i>ex post</i> LFR observed from the monitoring survey is lower than calculated <i>ex ante</i> LFR. Therefore it is concluded that the project CFLs are operating in accordance with the <i>ex-ante</i> linear failure rate. To obtain a conservative estimate of emission reductions achieved, <i>ex-ante</i> LFR is applied in the calculation.</p>
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	<i>ex post</i> monitoring surveys conducted at least once every 3 years
Calculation method (if applicable):	Ex post $LFR_{i,y}$ is determined by dividing the number of fused CFLs determined at the ex post monitoring survey by the number of CFLs distributed by the project activity ($Q_{P,J,i}$) determined by first ex post monitoring survey. The detailed calculation is shown in the Monitoring Survey report. Copy of the same is submitted to verifying DOE.
QA/QC procedures:	To obtain a reliable estimate LFR, sampling size of the survey is determined by minimum 90% confidence interval and maximum 10% error margin. The size of sample shall be no less than 100.
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	No Comment
Data / Parameter:	TD_y
Unit:	%
Description:	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.
Measured/ Calculated / Default:	Data taken from most recent publicly available tariff order documents

¹ According to the clarification number SSC 354, in the absence of the mortality curve developed in accordance with a national or international standard, the *ex post* LFR obtained from the monitoring survey shall only be used to confirm the *ex ante* LFR or increase the *ex ante* LFR.

Source of data:	Publicly available tariff order documents, which include T&D loss values submitted by electricity distribution companies (Discom) within the project area and approved by the electricity regulatory bodies that regulate these distribution companies. These tariff order documents are available on the web, and the websites where project participant accessed these documents are listed in the CER calculation excel spreadsheet.
Value(s) of monitored parameter:	For 2013-14, T&D losses of various Discoms in Western Region are ranging from 16.61% to 36.57%. The lowest values which are 16.61% is applied in the calculation for conservative estimate.
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	Yearly
Calculation method (if applicable):	NA
QA/QC procedures:	Project participant first collected T&D loss values specific to individual electricity distribution companies within the project area, using the T&D loss values confirmed by the electricity regulatory commission in recent tariff order documents published by electricity regulatory commissions that oversee these distribution companies. Then project participants selected the lowest T&D loss value, which was 16.61% from Madhya Gujarat Vij Company Limited (MGVCL) to represent a T&D loss value for the entire project area. Compared to the average of 22.87% of T&D loss for the electricity distribution companies in Western Regions, the value selected by the project participant represents a much more conservative value.
Purpose of data:	Emission reduction calculation (Only the emission reduction formula is provided in the methodology)
Additional comment:	No Comment

D.3. Implementation of sampling plan

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Under this project sampling is required for determining the CFL failure rate (ex-post monitoring surveys for $LFR_{i,v}$). The second ex post monitoring survey integrating the " $LFR_{i,v}$ " survey was carried out during 6th to 21st February, 2014 which was just after three year of the first monitoring survey; i.e. once every three years.

Sampling Criteria adopted

- Participating residential quarters under the Western Region of Indian Railway.
- Random sample group determined using statistical tools as representing the households falling under the Western Region. Survey sample size was determined to have at-least 90% confidence interval and 10 % maximum margin of error.

The distributed CFLs in the project area surveyed as per the applied methodology AMS-II.J. for " $LFR_{i,v}$ " (lamp failure rate of type i) in the project area:

Sampling Design

The sampling is carried out as per the sampling plan described below. The monitoring surveys were carried out by third party M/s AC Nielsen. The survey procedures were established and implemented as per AMS-II.J, to ensure that the field data collection is performed properly and any potential intentional errors or unintentional errors are minimized and documented.

Using the Simple Random Sampling approach, the sample size to be covered within the divisions was calculated to be 250 households. The sample size was determined at a 90% level of confidence and with a 10% margin of error. The methodology requirement on sample size was 100, whereas it was confirmed that 110 samples would be covered. However as a part of the survey 250 households have been covered which leads to much more accurate results. An extra 10% of households for each division were additionally selected as a buffer for non-response sample. The same is explained in chapter 3.6 of the survey report.

The survey revealed that the fraction of CFLs for 14 W and 20 W that placed in service and operating under the project activity was estimated at 78.77% and 67.52% respectively. From the fraction of CFLs obtained, the study concluded that there are 187,625 project CFLs of 14 W and 79,375 project CFLs of 20 W which were placed in service (installed) and correctly working within Western Region during the survey period.

A Simple Random Sampling approach was adopted for the survey. The monitoring survey was to identify CFLs labeled with project marking and identified CFLs were cross-checked with the project database. CFLs which are not in sockets or do not match with database was counted as a loss. The following data was collected from the survey respondents which included profiling information

- Name
- Address
- PF* no. of the respondent
- Number and type of project CFLs found installed at the household (against the information in the database)
- Identification on the physical status of project CFLs (whether installed and operating)
- Reasons for failure of project CFLs, and
- Replacement activity of defective project CFLs.

* PF no: Provident Fund Number

An extra 10% of households for each division under the project area were additionally selected as a buffer for non-response sample. The same is explained in chapter 3.6 of the survey report.

Data Collection

The following activities were done before collecting the data from households as per the registered PDD and described in the Monitoring Survey report.

- Standardized data forms were developed and were used for the data collection during Survey(s).
- Accordingly, an appropriate statistically robust sample size for conducting the monitoring survey has been used.
- Detailed instructions were given to the survey agency/surveyor(s) on data collection procedures and determination of household sample size as prescribed in AMS-II.J. Ver 03.

Data Analysis

The data collected through the standard forms through the surveys was compiled and collated. Project database and survey findings were the basis of data analysis. From the Project database for all the residential quarters, the total number of CFLs distributed was taken for each wattage type 'i'. For the selected sample of households, the total number of CFLs distributed was taken for each wattage type 'i'. Survey Findings for the selected sample of households was the basis of determining the total number of CFLs installed and operating was found for each wattage type 'i'.

The $LFR_{i,v}$ value for each type of CFL type 'i' is calculated as presented in $LFR_{i,v}$ table of section D.2. The value of the $LFR_{i,v}$ considered for the calculation of the emission reductions is higher of the value obtained from the ex-post monitoring survey results.

Subsequent ex post monitoring surveys will be carried out at either 3 years or 30% of the elapsed rated life of the lamp to determine the ex post Lamp Failure Rate ($LFR_{i,y}$) and where relevant ex post average daily operating hours (O_i) for use in ex post Emission Reduction calculations over the project life time.

Confidence / Precision

The applied methodology AMS-II.J. Ver 03 requires a minimum 90% confidence interval and the 10% maximum error margin which was followed during the survey. The methodology requirement on sample size is 100, whereas it was confirmed that 110 samples would be covered. However as a part of the survey 250 households have been covered which leads to much more accurate results.

SECTION E. Calculation of emission reductions or GHG removals by sinks

The emission reductions were calculated using the formulae as below.

Net Electricity Savings (NES_y)

The net electricity saved is derived using the equation (1):

$$NES_{,y} = \sum_i Q_{PJ,i} * (1-LFR_{i,y}) * ES_i * [1 / (1 - TD_y)] * NTG \tag{1}$$

Where:

$$ES_i = (P_{i,BL} - P_{i,PJ}) * O_i * 365 / 1000 \tag{2}$$

Where:

- NES_y Net electricity saved (kWh)
- $Q_{PJ,i}$ Number of CFLs distributed or installed under the project activity (units)
- $LFR_{i,y}$ Lamp failure rate (Fraction)
- ES_i Estimated electricity savings for a CFL (kWh)
- $P_{i,BL}$ Rated power of ICLs (baseline lighting devices), based on the mix ratio of 60W and 100 W ICLs (Watts)
- $P_{i,PJ}$ Rated power of CFLs (project lighting devices), based on the mix ratio of 14W and 20 W CFLs (Watts)
- O_i 3.5 hours per day; average daily operating hours of ICLs replaced by CFLs
- TD_y 17.12%(for year 1); average annual technical grid losses
- NTG 0.95; net-to-gross adjustment factor

Lamp Failure Rate ($LFR_{i,y}$)

$$\text{If } y * X_i < L_i, \text{ then } LFR_{i,y} = y * X_i * (100 - R_i) / (100 * L_i) \tag{3}$$

$$\text{If } y * X_i > \text{ or } = L_i, \text{ then } LFR_{i,y} = 1$$

Where:

- L_i 10,000 hours; rated average life for CFLs
- R_i 50%; % of CFLs operating at the rated lifetime
- X_i Number of operating hours for CFLs (hours)
- y Counter for year

Emissions Reduction (ER_y)

Emission reduction (ER_y) is net electricity savings ($NES_{,y}$) times an emission factor ($EF_{CO2,ELEC,y}$)

$$ER_y = NES_{,y} * EF_{CO2,ELEC,y} \tag{4}$$

Where:

ER_y Emission reduction (tCO₂)
 $EF_{CO_2,ELEC_y}$ 0.84 tCO₂/MWh; emission factor

Emission reduction calculation is illustrated for the data values of Mumbai division as below:

Q_{PJi} Calculation

The Q_{PJi} value is obtained from the findings of the Q_{pj} survey as follows:

Parameter Description	60W	100 W
Number of ICLs collected and destroyed; Q _{BL,i}	238,004	117,431
Parameter Description	14W	20 W
Number of CFLs distributed or installed as per database	238,202	117,556
Percentage of CFLs found in service and operating under 1st monitoring survey (%)	99.96	100
Number of CFLs in service and operating under 1st monitoring survey; Q _{PJ,i}	238,107	117,556

Thus Q_{PJi} = 238,004 + 117,431 = 355,435

Lamp Failure Rate Calculation

The LFR value is calculated from the findings of the ex-post monitoring survey as follows:

Counter for year	3	4
Rated average life for CFLs; L _i	10000	
% of CFLs operating at the rated lifetime; R _i	50	
Number of operating hours of CFL; X _i	1,277.5	1,277.5

Now

$$1,277.5 + 1,281.0 + 1,277.5 < 10000$$

and

$$1,277.5 + 1,281.0 + 1,277.5 + 1,277.5 < 10000$$

thus

$$LFR_{i,3} = (1,277.5 + 1,281 + 1,277.5) * (100 - 50) / (100 * 10000) = 19.18\%$$

and

$$LFR_{i,4} = (1,277.5 + 1,281.0 + 1,277.5 + 1,277.5) * (100 - 50) / (100 * 10000) = 25.57\%$$

Estimated Annual Energy Savings

$$ES_i = (P_{i, BL} - P_{i, PJ}) * O_i * 365 / 1000$$

Weighted average of rated power of the baseline lighting devices (ICLs); $P_{i, BL}$	73.22
Weighted average of rated power of the project lighting devices (CFLs); $P_{i, PJ}$	15.98
Average daily operating hours of ICLs replaced by CFLs; O_i	3.5

Thus electricity savings

For first 150 days ($y=3$; 01/01/2013 to 30/05/2013)

$$ES_1 = (73.22 - 15.98) * 3.5 * 150 / 1000$$

$$= 30.05$$

For next 215 days ($y=4$; 31/05/2013 to 31/12/2013)

$$ES_2 = (73.22 - 15.98) * 3.5 * 215 / 1000$$

$$= 43.07$$

Net Energy Savings

$$NES_y = \sum_i Q_{PJ,i} * (1-LFR_{i,y}) * ES_i * [1 / (1 - TD_y)] * NTG$$

Counter for year	3	4
Number of CFLs in service and operating under 1st monitoring survey; $Q_{PJ,i}$	355,453	
Average annual technical grid losses during year y; TD_y (%)	16.61	16.61
Net-to-gross adjustment factor; NT	0.95	
LFR _i (%)	19.18	25.57

Thus net energy savings

$$NES_3 = 355,453 * (1-19.18) * 30.05 * (1/(1-16.61)) * 0.95 = 9,833.22 \text{ MWh}$$

$$NES_4 = 355,453 * (1-25.57) * 43.07 * (1/(1-16.61)) * 0.95 = 12,980.35 \text{ MWh}$$

$$NES_y = 9,833.22 + 12,980.35 = 22,813.57 \text{ MWh}$$

Emission Reductions

$$ER_y = NES_{y} * EF_{CO_2, ELEC, y}$$

$$EF_{CO_2, ELEC, y} = 0.84 \text{ tCO}_2/\text{MWh}$$

$$ER_3 = 9,833.22 * 0.84$$

$$= 8262.17 \text{ tCO}_2\text{e}$$

$$ER_4 = 12,980.57 \times 0.84$$

$$= 10,906.5 \text{ tCO}_2\text{e}$$

Thus $ER_v = 19,168 \text{ tCO}_2\text{e}$ (Rounddown value)

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

The section is left blank intentionally

E.2. Calculation of project emissions or actual net GHG removals by sinks

The section is left blank intentionally

E.3. Calculation of leakage

The section is left blank intentionally

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO ₂ e)
Total	-	-	-	19,168

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO₂e)	46,332	19,168

E.6. Remarks on difference from estimated value in registered PDD

The emission reductions achieved in the monitoring period are 59% lower than the estimation. This is due to the lesser CFL distributed as compared to the projected figure. The projected figure was 625,992 in the registered PDD and the distributed figure is 355,758 of CFLs. The difference can be attributed to the following facts:

1. CFL distribution is linked directly to the extent on the participation of consumers in the program. Despite awareness carried out, it was noted that actual participation was lower than what was anticipated during the planning stage.
2. It was also noted that the actual availability of ICLs in households was lower compared to the estimated ICL count, which in turn contributed to lower than expected CFL offtake.

3. During the distribution, it was noted that there was a consumer bias towards ICLs, given that ICLs are the more commonly used lighting device and has been in existence for long. It is pertinent to note that during the early years of its introduction, the CFL product in the Indian market was of poor quality (tended to flicker, fused easily, etc) and also there were no prevalent guidelines on lighting quality. These factors contributed to the consumer bias against the said product.
4. Further, lighting choice is driven by consumer's aesthetic preferences and ICL lampshades or other lighting devices are often unsuitable for use with CFLs.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO ₂ e)	-	19,168

Document information

Version	Date	Description
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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