Existing knowledge from CDM/JI on baseline and emission reduction calculation.
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Introduction

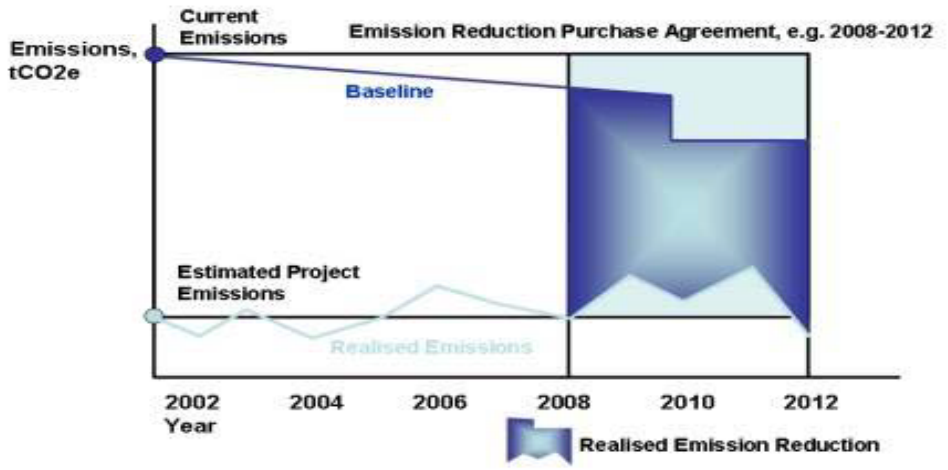
This paper gives a short overview of the CDM/JI methodologies and summaries the main topics from three relevant CDM projects (one to be added). These project description hold default values and formulas to calculate energy use and energy savings.

CDM and JI are two of the three Kyoto mechanisms under the UNFCCC. The CDM/JI mechanism is project based mechanism and each specific CDM/JI project has its specific technologies that suppose to reduce emission by, for instance, energy efficiency, renewable energy technologies or other cleaner technologies. To ensure the realized emission reduction to be certified by the CDM EB/JISC (Track II), the project participants must make sure the project has to be approved by both host and investor countries, the project activity has to be validated, registered, monitored, verified and finally certified. Another important issue for the CDM/JI project activates is additionally.

The CDM/JI calculation of the baseline studies and monitoring methodologies is focus on the GHG emission and emission reduction, and the IEA DSM energy efficiency measures focus on energy saving calculation (ESC). However, the emission reduction and energy saving are interrelated. Three selected CDM methodologies which more relevant with the IEA DSM preliminary list of techniques, will be discussed.

How does emission reduction be calculated?

As it is illustrated by the diagram, simplified GHG emission reduction calculation: the emission reduction = baseline emission – estimated project emission.



CMD tools and approved methodologies

The CDM Executive Board provided information on methodology tools and approved methodologies. These are available at: http://cdm.unfccc.int/methodologies

There is a general guidance that holds among others information on baselines and monitoring (see document general guidance).

Basis on the different types of CDM project activities, there are 4 categories of methodologies or approved methodologies, they are:

- CDM project activities (AM),
- Afforestation and Reforestation CDM project activities (AR-AM)
- Small scale CDM project activities (AMS).
- Small scale A/R CDM project activities (AR-AMS)

All methodologies are linked with the 13 sector scopes:

1. Energy industries (renewable - / non-renewable sources);
2. Energy distribution;
3. Energy demand;
4. Manufacturing industries;
5. Chemical industries;
6. Construction
7. Transport
8. Mining/mineral production
9. Metal production
10. Fugitive emissions from fuels (solid, oil and gas)
11. Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride
12. Solvent use
13. Waste handling and disposal

The CDM methodology in the Energy Demand sector (sector 3) which are more relevant with the technology list from the IEA DSM and are currently available, are six Approved Methodologies (AM) and seven Small scale Methodologies (AMS)

AM0017: Steam system efficiency improvements by replacing steam traps and returning condensate

AM0018: Steam optimisation systems

AM0020: Water pumping efficiency improvement

AM0046: Distribution efficient light bulbs to households

AM0060: Power saving through replacement energy efficient chillers

AM0068: Improvement energy efficiency by modifying ferroalloy production facility

AMS-II C: Demand side energy efficiency activities for specific technologies

AMS-II E: Energy efficiency and fuel switching measures for building

AMS-II F: Energy efficiency and fuel switching for agriculture facilities and activities

AMS-II G: Energy efficiency measures in thermal applications of non-renewable biomass

AMS-II J: Demand side activities for efficient lighting technologies

AMS-III AE: Energy efficiency and Renewable energy measures in new residential buildings

AMS-III X: Energy efficiency and HFC134a Recovery in residential refrigerators

In the CDM sector scope, manufacturing industries, chemical industries and metal production are more energy efficiency related technologies. Therefore, the CDM methodologies in those sectors, both for large scale (AM), small scale (AMS) and consolidated methodologies (ACM) can be relevant for IEA DSM.

How are the baseline and the estimated project emission reduction calculated?

CDM approved methodologies gives guideline on the scope, applicability, baseline setting, emission reduction calculation and monitoring measures. As mentioned before, CDM and JI are project based mechanism and it is direct related with the technologies hired in the project activities. Before to use any specific methodology in any specific CDM activates, the applicability of the methodology has to be well motivated in the Project Design Document (PDD)

The three selected methodologies [1] hereunder will be illustrated:

I. AMS-II.C Demand side energy efficiency activities for specific technologies
II. AMS-II. J Demand side activities for efficient lighting technologies
III. AM0046 Distribution of efficient light bulbs to household

I. AMS-II.C Demand side energy efficiency activities for specific technologies

Technology/Measure

This methodology is applicable for **energy efficient equipment/appliances**, e.g. lamps, ballasts, refrigerators, motors, fans, air conditioners, pumping systems at any sites. These technologies may replace existing equipment or be installed a new sites. The aggregate energy saving by a single project may not exceed the equivalent of 60GWh/year for electrical end use energy efficiency technologies. For fossil fuel end use energy efficient technologies, the limited is 180 GWh th/year in fuel input.

Boundary

The project boundary is the physical geographical location of each measure installed.

Baseline project emission

[1] Simplified illustration, more details please find from http:///www.unfccc.int

- If the energy displace is fossil fuel based, the energy baseline is the existing level of fuel consumption of the amount of fuel that would be used by the technology that would have been implemented otherwise.
- If the energy displaced is electricity, the emission baseline is determined using by carbon emission factor for the electricity displaced

$BEy = E_{BL},y * EF_{co2, elec, y} + Q_{ref. BL} * GWP_{ref.BL}$

BEy: Baseline emission in year y;
E_{BL},y: Energy consumption in the baseline in year y (kWh)
$EF_{co2, elec, y}$: Emission factor in year y (t CO_2/kWh), it associated with grid electricity consumption.
$Q_{ref. BL}$: Average annual quantity if refrigerant used in the baseline to replace the refrigerant that has leaked (tons/year);
$GWP_{ref.BL}$: Global warming potential of the baseline refrigerant (t CO2e/t refrigerant)

Project emission
If project emission consists of electricity a/o fossil fuel used in the project equipment:
PEy = Epj, y * EF co_2,y
PEy: Project Emission in year y;
Epj, y: Energy consumption in project activity in year y. This should be determined *ex post* based on monitoring value;
EF co_2,y : Emission Factor for electricity or thermal baseline energy, and it associated with grid electricity consumption; For fossil fuel displaced reliable local or national data for the emission factor shall be used; IPCC default values should be sued only when country or project specific data are not available or difficult to obtain;

If emissions from physical leakage of refrigerants are accounted for:
$PE_{ref,y} = (Q_{ref pj,y}) * GWP_{ref, pj}$

$PE_{ref,y}$: Project emissions from physical leakage of refrigerant from the project equipment in year y (t CO_2/y);
$(Q_{ref pj,y})$: Average annual quantity of refrigerant used in year y to replace refrigerant that has been leaked in year y (t/year), 2006 IPCCC guidelines for National Greenhouse Gas Inventories may be used;
$GWP_{ref, pj}$: Global warming potential that is used in the project equipment (t CO2e/t refrigerant)

Leakage
If the energy efficiency technology is equipment transferred from another activity, leakage is to be considered.

Monitoring
The emission reduction achieved by the project shall be determined as the difference between the baseline emission and the project emission and leakage.

ERy = (BEy-PEy) –LEy

ERy: Emission reduction in year y (tCO_2e);

LEy: Leakage emission in year y (tCO_2e).

Project activity under the programme activities

The CMP decided that a local/regional/national policy or standard cannot be considered as a CDM project activity, but that project activities under a programme of activities can be registered as a single CDM project activity provided that approved baseline and monitoring methodologies are used that, inter alia, define the appropriate boundary, avoid double counting and account for leakage, ensuring that the net anthropogenic removals by sinks and emission reductions are real, measurable and verifiable, and additional to any that would occur in the absence of the project activity.

The approved methodology can be applied in programme activities, but certain conditions have to be applied. The details please find from AMS-II.C, http://www.unfccc.int

II AMS-II J Demand side activities for efficient lighting technologies
(to be added)
Technology/Measure
This category comprises activities that lead to efficient use of electricity through the adoption of self-ballasted compact fluorescent lamps (CFLs) to replace incandescent lamps (ICLs) in residential applications. Eligible self-ballasted CFLs have ballasts integrated to the lamp as a non-removable part. The CFLs adopted to replace existing equipment must be new equipment not transferred from another activity.

The total lumen output of the CFL should be equal to or more than that of the ICL being replaced; lumen output of ICL & CFL shall be determined in accordance with relevant national or international standard/s. In the case of ICL, values in the table below may be used as an alternate option; If a lamp wattage is not in this table, linearly interpreted value shall be used to determine the minimum light output requirements e.g., 492.5 Lumens for a 45 W lamp.

Baseline Technology Incandescent Lamp (Watt)	Minimum Light Output (Lumen)
25	230
40	415
50	570
60	715
75	940
90	1,227
100	1,350
150	2,180
200	3,090

High quality lamps that have been independently tested must be used. To ensure this a relevant national or international testing standard shall be followed to determine the rated lifetime of the lighting equipment; the project design document shall cite the standard2 used to determine the rated lifetime of efficient lamps distributed under the project activity.
The project design document shall explain the proposed method of distribution of efficient lighting equipment and how the following activities will be conducted and documented; baseline incandescent lamps returned (e.g., exchanged for project CFLs), stored and destroyed4. The Project design document shall also explain how the proposed procedures eliminate double counting of Emission Reductions, for

example due to CFL manufacturers, wholesale providers or others possibly claiming credit for Emission Reductions for the project CFLs.
The project activity shall be designed to limit undesired secondary market effects (e.g., leakage) and free riders by ensuring that replaced lamps are exchanged and destroyed.

Boundary
The project boundary is the physical geographical location of each measure installed.

Project emission
Ex ante calculations are done as per the following steps:
(i) Estimate the nameplate/rated power (Watts) of the baseline incandescent lamps to be replaced;
(ii) Default value for daily hours of operation of baseline incandescent lamps is 3.5 hours per 24 hrs period. Use the default value or the measured value determined from the representative sample;
(iii) Calculate the gross electricity savings from an individual lamp by comparing the nameplate/rated power rating of the CFL with that of the baseline incandescent lamp and multiplying by annual hours of operation;
(iv) Calculate the net electricity saving (NES) by correcting the gross electricity savings for leakage, net-to-gross adjustment (NTG) factor and transmission & distribution losses.

The electricity saved by the project activity in year y is calculated as follows:

$$NES_y = \sum_{i=1}^{n} Q_{PJ,i} \times (1 - LFR_{i,y}) \times ES_i \times \frac{1}{(1 - TD_y)} \times NTG$$

Where:

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

Where:
NESy Net electricity saved in year *y* (kWh)
QPJ,i Number (quantity) of pieces of equipment of type *i* distributed or installed under the project activity (units). In total for all "i", this value shall be equal to or less than the documented number of all baseline incandescent lamps destroyed. Once all of the project CFLs are distributed or installed, *QPJ,i* is a constant value independent from *y*
i Counter for equipment type
n Number of types of equipment
ESi Estimated annual electricity savings for equipment of type i, for the relevant technology (kWh)
LFRi,y Lamp Failure Rate for equipment type i in year y (fraction)
TDy 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. This value shall not include non-technical losses such as commercial losses (e.g., theft/pilferage). The average annual technical grid losses shall be determined using recent, accurate and reliable data available for the host country. This value can be determined from recent data published either by a national utility or an official governmental body. Reliability of the data used (e.g., appropriateness, accuracy/uncertainty, especially exclusion of non technical grid losses) shall be established and documented by the project participant. A default value of 10% shall be used for

average annual technical grid losses, if no recent data are available or the data cannot be regarded accurate and reliable
NTG Net-to-gross adjustment factor, a default value of 0.95 to be used unless a more appropriate value based on a lighting use survey from the same region and not older than 2 years is available
Pi, BL Rated power of the baseline lighting devices of the group of "i" lighting devices (Watts)
Pi, PJ Rated power of the project lighting devices of the group of "i" lighting devices (Watts)
Oi Average daily operating hours of the lighting devices replaced by the group of "i" lighting devices, use 3.5 hours per 24 hrs period or the measured value determined from the representative sample; 'daily operating hours' other than 3.5 hrs/day, corrected for seasonal variation of lighting hours if any, may be used only if it is based on continuous measurement of usage hours of baseline lamps for a minimum of 90 days at representative sample households (sampling determined by minimum 90% confidence interval and 10% maximum error margin). For the latter option i.e., to use the measured value, the measurements shall be repeated at the representative sample7 households at the time of ex post monitoring as indicated in paragraph 14 and the most recent measured value is used for daily operating hours. In no case, however, a value greater than 5 hours per 24 hrs period shall be used under this methodology

Emissions reduction is net electricity savings (*NES*) times an Emission Factor (*EF*) calculated in accordance with provisions under AMS-I.D.
$ER_y = NES_y \times EF_{CO2ELEC,y}$,
Where:
$EF_{CO2,ELEC,y}$ Emission Factor in year *y* calculated in accordance with the provisions in AMSI.D (tCO2/MWh)
ER_y Emission Reductions in year *y* (tCO2e)

Ex post monitoring and adjustment of net electricity savings:
(i) First ex post monitoring survey, carried out within the first year after installation of all efficient lighting equipment will provide a value for the number of lamps placed in service and operating under the project activity. The results of this survey are used to determine the quantity of lamps (QPJ,i) in the Emission Reduction calculation; The survey will consist of identifying CFLs, marked per paragraph 6, that are installed and operating. Only CFLs with an original marking can be counted as installed. While 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.
(ii) Subsequent ex post monitoring surveys are carried out at the following intervals to determine the ex post Lamp Failure Rate (LFRi,y) and where relevant ex post average daily operating hours (Oi) for use in ex post Emission Reduction calculations until such time as CERs are being requested, (choose either of the following two options that define the minimum requirement for the frequency of the survey):
1. Once every 3 years;
2. Once for every 30% of the elapsed rated lifetime of the lamp.

On the basis of ex post monitoring surveys, the net electricity savings are adjusted considering the actual lamp failure data. If the ex post failure rates (LFRi,y) are higher or lower than the ex ante estimate, subsequent Emission Reduction claims shall be based on linear failure rate curve reconstructed for the remaining period of the crediting period9. However, under no circumstances can a estimate of LFRi,y value be lower than that indicated in the mortality

curve10 of the CFL determined as per the independent tests referenced in paragraph 5 of this methodology.

Monitoring

Monitoring includes (i) recording of lamp distribution data, and (ii) ex post monitoring surveys as defined in paragraph 14:

(i) During project activity implementation, the following data are to be recorded:

- Number of pieces of equipment distributed under the project activity, identified by the type of equipment and the date of supply;
- The number and power of the replaced devices;
- Data to unambiguously identify the recipient of the equipment distributed under the project activity;

(ii) The Emission Reductions are calculated ex ante and adjusted ex post following the monitoring surveys, as described under paragraphs above.

Generic instructions for conducting the surveys

The following survey principles shall be followed:

- The sampling size is determined by minimum 90% confidence interval and the 10% maximum error margin; the size of the sample shall be no less than 100;
- Sampling must be statistically robust and relevant i.e., the survey has a random distribution and is representative of target population (size, location);
- The method to select respondents for interviews is random;
- The survey is conducted by site visits;
- Only persons over age 12 are interviewed;
- The project document must contain the design details of the survey.
- A generic questionnaire is included in Annex 1. This questionnaire should be used adapting it to local circumstances as necessary.

The approved methodology can be applied in programme activities, but certain conditions have to be applied. The details please find from AMS-II.J http://www.unfccc.int

III. AM0046 Distribution of efficient light bulbs to household

(to be added)