Indicative simplified baseline and monitoring methodologies
for selected small-scale CDM project activity categories

TYPE II - ENERGY EFFICIENCY IMPROVEMENT PROJECTS

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html.

II.E. Energy efficiency and fuel switching measures for buildings

Technology/measure

1. This category comprises any energy efficiency and fuel switching measure implemented at a single building, such as a commercial, institutional or residential building, or group of similar buildings, such as a school, district ~~or~~ university and similar residential houses. This category covers project activities aimed primarily at energy efficiency; a project activity that involves primarily fuel switching falls into category III.B or I.A-I.D.[1] Examples include technical energy efficiency measures (such as efficient appliances, better insulation and optimal arrangement of equipment) and fuel switching measures (such as switching from oil to gas, or coal to biomass). The technologies may replace existing equipment or be installed in new facilities. The aggregate energy savings of a single project may not exceed the equivalent of 60 GWh per year.

2. If any similar registered CDM project activities exist in the same region as the proposed project activity then it must be ensured that the proposed project activity is not saving the non-renewable biomass accounted for by the already registered project activities.

Applicability

3. This category is applicable to project activities where it is possible to directly measure and record the energy use within the project boundary (e.g. electricity, ~~and/or~~ fossil fuel and non renewable biomass consumption).

4. This category is applicable to project activities, where both single fuel and/or multiple fuels are being consumed in the baseline and in the project case.

5. This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency and fuel switching) by the project activity can be clearly distinguished from changes in energy use due to other variables not influenced by the project activity (signal to noise ratio).

6. In case of residential buildings, only households are eligible that fit into one or several clusters (defined by e.g. geographical area or type of intervention)

[1] Thus, fuel-switching measures that are part of a package of energy efficiency measures at a single location may be part of a project activity included in this project category.

Boundary

7. The project boundary is the physical, geographical site of the building(s).

~~Baseline~~Emission reductions

8. The energy baseline consists of the energy use of the existing equipment that is replaced in the case of retrofit measures and of the facility that would otherwise be built in the case of a new facility.

9. In case of retrofitting existing residential buildings the baseline & project fuel use shall be assessed by using one of the following two methods

(a) Annual *ex post* assessment of the baseline adjusting the fuel consumption measured before the internvention for changes in weather, fuel costs and fuel mix.

(b) Annual *ex post* comparison of measured annual average energy consumption (by fuel type) of a sample of the occupied project residences with a sample of baseline residences (by fuel type) using regression analyses.

10. In case of new buildings, the baseline & project fuel use shall be assessed by using the following method;

Annual *ex post* comparison of measured annual average energy consumption (by fuel type) of a sample of the occupied project residences with a sample of baseline residences (by fuel type) using regression analyses.

11. In case of method a) for retrofitting buildings the fuel savings shall be assessed as follows:

$\Delta Cj = Cjb – Cjp$

Where: ΔCj : saving of fuel j, *Cjb*: consumption of fuel j in the baseline, *Cjp:* consumption of fuel j in the project *year*

$Cjb = Cj\_preproject * HDDadjust\_j * CDDadjust\_j * FuelPRICEadjust\_j * FUELMIXadjust\_j * OCCadjust\_j *$

Where:

Cj_ preproject	Amount of annual fuel measured by a representative sample of project buildings in the pre-project period (the fuel consumption has to be measured during at least 7 days and can then be extrapolated to one year using heating and cooling degree days (HDD and CDD)
HDDadjust_j	Adjustement factor for heating degree days (HDD) = $HDDj,y$ / $HDD,j,preproject$
	Where $HDDj,y$: heating degree days in project year y, $HDD,j,preproject$: heating degree days in the pre-project baseline study
CDDadjust_j	Adjustement factor for cooling degree days (CDD) = $CDDj,y$ / $CDD,j,preproject$

	Where *CDDj,y :* cooling degree days in project year y, *CDD,j,preproject :* cooling degree days in the pre-project baseline study
	CDDadjust_j can be set to 0 if no cooling is used in the project boundary
FuelPRICEadjust_j	Adjustement factor for price changes of purchased fuels[2] = *1 + Ω* (price,j,y – price,j,preproject)/ price,j,preproject*
	Where *price,j,y :* price of fuel j in project year y, *price,j,preproject :* price of fuel j in the year of the pre-project baseline study; *Ω* : Price elasticity for demand of fuel j; use country specific values or the following default factors for price elasticities:
	Ω Lower value -0.2[3]
	Ω Default value -0.3[3]
	Ω Upper value -0.4[3]
FUELMIXadjust_j	Adjustement factor for fuel mix changes = *Fuelshare,j,y / Fuelshare,j,preproject* (both in % of total Net Calorific Value). This adjustment factor has only to be used if there is a significant change in fuel mix between pre-project and project sample of project residences.
OCCadjust_j :	Adjustement factor for occupancy = *Occupancy,y / Occupancy,preproject*
	With *Occupancy,y :* average building occupancy in project year y, *Occupancy,preproject :* average building occupancy in pre-project baseline study

For estimating the fuel consumption of the project household in the situation before the project, the following variables are to be estimated by a baseline survey (representative sample of buildings);

Cj_ preproject	Fuel consumption (for all fuel types j)
price,j,preproject	Regional fuel prices (for all fuel types j)
HDD/CDD,j,preproject	Regional Heating and Cooling Degree Days (assessed with local temperature data, from public sources, and a heating threshold, either coming from public sources or measured with the sample)
Occupancy,preproject	Occupancy of building (% of heating/cooling period occupied)

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[2] Collected fuel such as wood is not adjusted.

[3] These conservative factors are derived from price elasticities in the residential sector as cited in IPCC AR4 WG 3 (2007). Mitigation of Climate Change. Chapter 6: Residential and commercial buildings. p.426. A brief literature review (Pesaran, M.H., Smith, R., Akiyama, T., 1998: Energy demand in Asian economies. Oxford University Press, Oxford; Ibrahim, B. I., Hurst, C. 1990: Estimating energy and oil demand functions. A study of thirteen developing countries", Energy Economics 12, 93-102. De Vito, G., Andresen, K., Hunt, L.C., 2006: An empirical analysis of energy demand in Namibia. Energy Policy 34, 3447-3463) confirm the IPCC findings.

12. In case of method b) for retrofitting buildings and the method for new buildings, fuel savings determined with comparison group and regression analyses shall be done using the following protocol:

- A regression model shall be developed and used to determine per residence, average daily fuel savings for each crediting year;
- A sample of 100[4] project residences should be included in the regression analysis. The number of baseline residences (comparison group) should also be 100. If the project has fewer than 100 residences, then all project residences and an equal sample of baseline residences shall be used[5];
- The regression model shall use average daily energy consumption (determined from yearly fuel consumption data) during the post-project residence installation period (the crediting period) as the dependent variable and at least (a) weather and (b) an indicator of participation (EE=1 if project and 0 otherwise) as the primary independent variables. Other variables[6] should be included in the model as indicated through surveys or other means for both baseline and project residences. The regression model has the following specification:

$$AYC_{j\,k\,y} = \alpha + \beta * EE_{jk} + \delta * HDD + \lambda * CDD + \gamma * X_{j,k,y}$$

This model needs to be separately evaluated for each cluster type *i* (e.g insulation, insulation and efficient appliance/heater), each fuel type j and each residence in the baseline or project sample *k*. The objective of Equation 2 is to solve for β, the estimate of fuel savings for the prior 12 month period. Annual Fuel savings (for fuel type j) are then determined by the following equation:

$$ES_{y,,j} = \beta_{ij} \times N_i$$

Where:

$AYC_{k,y}$	Average yearly fuel consumption during the post-treatment year *y* for both the project and baseline residences (residence *k*). ADC is computed by extrapolating the fuel consumption measured during at least 7 days to 1 year using the local Heating Degree Days.
EEk	Set to 1 if energy efficiency improvements have been installed and 0 otherwise (i.e., project residences have a 1 in all yearss and baseline residences have a 0 in all years)
$HDD_{k,y}$	Average daily heating degree days based for residence *k* in year y
$CDD_{k,y}$	Average daily cooling degree days based for residence *k* in year y
X_k	Important characteristics that need to be included for project and baseline residences (e.g. number of occupants, fuel prices, heating system type, cooling system type)
β	Estimate of fuel savings (for fuel type j) for a 12 month period
N	Number of project residences

[4] This sample size is based on an assumed coefficient of variation of 50% and 90/10 confidence and precision requirement.
[5] For example, if the baseline residence and project residence sample sizes are each 100, then the number of required annual observations for baseline and project residences (data sets with average yearly energy consumption, HDD, CDD, X, and α data) equals (100 residences) X (2) X (12 months), or 2,400.
[6] For example, number and age of occupants, fuel mix, fuel price, occupancy

- To be utilized to determine emission reductions the t-test associated with β has to be ≤-1.645, for a 90% confidence.

- To be utilized to determine emission reductions the regression model must be documented with a complete report indicating at least who completed the regression analyses, key assumptions, the regression results, the survey instrument(s), final sample results, and comparison between baseline and project homes with respect to key variables (intervention type, occupancy, etc.)

Yearly baseline and project residence fuel consumption and weather data, current for each crediting period year, must be used for the regression analyses. However, new survey data for updating X coefficient(s) and α are not required for each crediting year. Such data only needs to be collected, and used to update the value for α and the X coefficient(s), for the first crediting period year and every third year thereafter (e.g., year 4, 7, 10).

13. Each energy form in the emission baseline is multiplied by an emission coefficient. For the electricity displaced, the emission coefficient is calculated in accordance with provisions under category I.D. For fossil fuels, the IPCC default values for emission coefficients may be used.

14. In case of Non Renewable Biomass (NRB) fuel in the project baseline, then the same method for calculating the emission reductions by saving NRB shall be used as set out in AMS II.G.

Leakage

15. If the energy efficiency technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage is to be considered.

16. In case of efficient stoves being used for both space heating and cooking, leakage effects are to be considered.

17. Leakage relating to the non-renewable woody biomass shall be assessed from *ex post* surveys of users and areas from where woody biomass is sourced (using 90/30 precision for selection of samples). The following potential sources of leakage shall be considered:

(a) Use/diversion of non-renewable woody biomass saved under the project activity by non-project households/users who previously used renewable energy sources. If this leakage assessment quantifies an increase in the use of non-renewable woody biomass used by the non-project households/users attributable to the project activity then B_y is adjusted to account for the quantified leakage.

(b) Use of non-renewable biomass saved under the project activity to justify the baseline of other CDM project activities can also be potential source of leakage. If this leakage assessment quantifies a portion of non-renewable biomass saved under the project activity that is used as the baseline of other CDM project activity then By is adjusted to account for the quantified leakage.

(c) Increase in the use of non-renewable biomass outside the project boundary to create nonrenewable biomass baselines can also be potential source of leakage. If this leakage assessment quantifies an increase in use of non-renewable biomass outside the project boundary then By is adjusted to account for the quantified leakage.

Monitoring

18. In the case of retrofit measures, monitoring shall consist of:

(a) Documenting the specifications of the equipment replaced, using a representative sample (the same sample as in the baseline survey shall be used to allow for paired sampling);

(b) In case of option (a) for retrofit residential building measures:

(i) Assessing the amount of fuel used by the project buildings (in the 1st, 4th and 7th year; by measuring the fuel use during at least 7 days and extrapolating the fuel use to one year using the Heating / Cooling Degree Days) as well as their occupancy rate (yearly), both using a representative sample;

(ii) Calculating the regional Heating and Cooling Degree Days using public meteorological data (yearly or for each heating / cooling period);

(iii) Assessing regional fuel costs and, if needed due to changes in the project residences' fuel mix, the regional fuel mix[7], by conducting a survey or using publicly available data (in the 1st, 4th and 7th year).

(c) If regression analysis is used, survey data of baseline and project residence characteristics as determined necessary for regression analyses, collected in years indicated in paragraph 11

(d) Calculating the energy savings due to the measures installed.

19. In the case of a new facility, monitoring shall consist of:

(a) Metering the energy use of the building(s);

(b) If regression analysis is used, survey data of baseline and project residence characteristics as determined necessary for regression analyses, collected in years indicated in paragraph 11

(c) Calculating the energy savings of the new building(s).

20. In order to assess the leakages related to the use of non-renewable biomass specified above monitoring shall include data on the amount of biomass saved under the project activity that is used by non-project households/users (who previously used renewable energy sources). Other data on non-renewable biomass use required for leakage assessment shall also be collected.

Representative sampling methods

17. Sample size shall be chosen for a 90/10 precision (90% confidence interval and 10% margin of error) for parameter values used to determine emission reductions and project proponents shall make

[7] The fuel mix changes may also be adjusted by using the fuel mix in the project residence sample. However, to be conservative in this case, only increased shares of low carbon and decreased share of high carbon fuels have to be considered for adjustment.

all reasonable efforts to achieve this specified level of confidence/precision; in cases where survey results indicate that 90/10 precision is not achieved the lower bound of a 90% confidence interval of the parameter value may be chosen as an alternative to repeating the survey efforts to achieve 90/10 precision.

18. To lower variation in case of option (a) for retrofit residential building measures: Paired sampling shall be used, meaning the same project residences shall be sampled in the pre-project and monitoring period.

Project activity under a programme of activities

The following conditions apply for use of this methodology in a project activity under a programme of activities:

8. In case the project activity involves fossil fuel switching measures leakage resulting from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary shall be considered. The guidance provided in the leakage section of ACM009 as in annex 1 of this document shall be followed in this regard.

In case the project activity involves the replacement of equipment, and the leakage effect of the use of the replaced equipment in another activity is neglected because the replaced equipment is scrapped, an independent monitoring of scrapping of replaced equipment needs to be implemented. The monitoring should include a check if the number of project activity equipment distributed by the project and the number of scrapped equipment correspond with each other. For this purpose scrapped equipment should be stored until such correspondence has been checked. The scrapping of replaced equipment should be documented and independently verified.

Annex 1

(GUIDANCE ON LEAKAGE BELOW CONCERNS PROJECT ACTIVITY UNDER A PROGRAMME OF ACTIVITIES)

Leakage

21. Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH_4 emissions and CO_2 emissions from associated fuel combustion and flaring. In this methodology, the following leakage emission sources shall be considered:[8]

- Fugitive CH_4 emissions associated with fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity.
- In the case LNG is used in the project plant: CO_2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system.

Thus, leakage emissions are calculated as follows:

$$LE_y = LE_{CH4,y} + LE_{LNG,CO2,y} \quad (1)$$

Where:

LE_y	Leakage emissions during the year y in t CO_2e
$LE_{CH4,y}$	Leakage emissions due to fugitive upstream CH_4 emissions in the year y in t CO_2e
$LE_{LNG,CO2,y}$	Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in t CO_2e

Note that to the extent that upstream emissions occur in Annex I countries that have ratified the Kyoto Protocol, from 1 January 2008 onwards, these emissions should be excluded, if technically possible, in the leakage calculations.

Fugitive methane emissions

For the purpose of determining fugitive methane emissions associated with the production – and in case of natural gas, the transportation and distribution of the fuels – project participants should multiply the quantity of natural gas consumed in all element processes *i* with a methane emission factor for these upstream emissions ($EF_{NG,upstream,CH4}$), and subtract for all fuel types *k* which would be used in the absence of the project activity the fuel quantities multiplied with respective methane emission factors ($EF_{k,upstream,CH4}$), as follows:

[8] The Meth Panel is undertaking further work on the estimation of leakage emission sources in case of fuel switch project activities. This approach may be revised based on outcome of this work.

$$LE_{CH4,y} = \left[FF_{project,y} \cdot NCV_{NG,y} \cdot EF_{NG,upstream,CH4} - \sum_{k} FF_{baseline,k,y} \cdot NCV_{k} \cdot EF_{k,upstream,CH4} \right] \cdot GWP_{CH4} \quad (2)$$

with

$$FF_{project,y} = \sum_{i} FF_{project,i,y} \quad \text{and} \quad (3)$$

$$FF_{baseline,k,y} = \sum_{i} FF_{baseline,i,k,y} \quad (4)$$

Where:

$L_{CH4,y}$	Leakage emissions due to upstream fugitive CH_4 emissions in the year y in t CO_2e
$FF_{project,y}$	Quantity of natural gas combusted in all element processes during the year *y* in m³
$FF_{project,i,y}$	Quantity of natural gas combusted in the element process *i* during the year *y* in m³
$NCV_{NG,y}$	Average net calorific value of the natural gas combusted during the year *y* in MWh/m³
$EF_{NG,upstream,CH4}$	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas in t CH_4 per MWh fuel supplied to final consumers
$FF_{baseline,k,y}$	Quantity of fuel type *k* (a coal or petroleum fuel type) that would be combusted in the absence of the project activity in all element processes during the year *y* in a volume or mass unit
$FF_{baseline,i,k,y}$	Quantity of fuel type *k* (a coal or petroleum fuel type) that would be combusted in the absence of the project activity in the element process *i* during the year *y* in a volume or mass unit
NCV_k	Average net calorific value of the fuel type *k* (a coal or petroleum fuel type) that would be combusted in the absence of the project activity during the year *y* in MWh per volume or mass unit
$EF_{k,upstream,CH4}$	Emission factor for upstream fugitive methane emissions from production of the fuel type k (a coal or petroleum fuel type) in t CH_4 per MWh fuel produced
GWP_{CH4}	Global warming potential of methane valid for the relevant commitment period

Where reliable and accurate national data on fugitive CH_4 emissions associated with the production, and in case of natural gas, the transportation and distribution of the fuels is available, project participants should use this data to determine average emission factors by dividing the total quantity of CH_4 emissions by the quantity of fuel produced or supplied respectively.[9] Where such data is not available, project participants may use the default values provided in Table 2 below. In this case, the natural gas emission factor for the location of the project should be used, except in cases where it can be shown that the relevant system element (gas production and/or

[9] GHG inventory data reported to the UNFCCC as part of national communications can be used where country-specific approaches (and not IPCC Tier 1 default values) have been used to estimate emissions.

processing/transmission/distribution) is predominantly of recent vintage and built and operated to international standards, in which case the US/Canada values may be used.

Note that the emission factor for fugitive upstream emissions for natural gas ($EF_{NG,upstream,CH4}$) should include fugitive emissions from production, processing, transport and distribution of natural gas, as indicated in the Table 2 below. Note further that in case of coal the emission factor is provided based on a mass unit and needs to be converted in an energy unit, taking into account the net calorific value of the coal.

Table 2: Default emission factors for fugitive CH_4 upstream emissions

Activity	Unit	Default emission factor	Reference for the underlying emission factor range in Volume 3 of the *1996 Revised IPCC Guidelines*
Coal			
Underground mining	t CH4 / kt coal	13.4	Equations 1 and 4, p. 1.105 and 1.110
Surface mining	t CH4 / kt coal	0.8	Equations 2 and 4, p.1.108 and 1.110
Oil			
Production	t CH4 / PJ	2.5	Tables 1-60 to 1-64, p. 1.129 - 1.131
Transport, refining and storage	t CH4 / PJ	1.6	Tables 1-60 to 1-64, p. 1.129 - 1.131
Total	t CH4 / PJ	4.1	
Natural gas			
USA and Canada			
Production	t CH4 / PJ	72	Table 1-60, p. 1.129
Processing, transport and distribution	t CH4 / PJ	88	Table 1-60, p. 1.129
Total	t CH4 / PJ	160	
Eastern Europe and former USSR			
Production	t CH4 / PJ	393	Table 1-61, p. 1.129
Processing, transport and distribution	t CH4 / PJ	528	Table 1-61, p. 1.129
Total	t CH4 / PJ	921	
Western Europe			
Production	t CH4 / PJ	21	Table 1-62, p. 1.130
Processing, transport and distribution	t CH4 / PJ	85	Table 1-62, p. 1.130
Total	t CH4 / PJ	105	
Other oil exporting countries / Rest of world			
Production	t CH4 / PJ	68	Table 1-63 and 1-64, p. 1.130 and 1.131
Processing, transport and distribution	t CH4 / PJ	228	Table 1-63 and 1-64, p. 1.130 and 1.131
Total	t CH4 / PJ	296	

Note: The emission factors in this table have been derived from IPCC default Tier 1 emission factors provided in Volume 3 of the 1996 Revised IPCC Guidelines, by calculating the average of the provided default emission factor range.

CO_2 emissions from LNG

Where applicable, CO_2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($LE_{LNG,CO2,y}$) should be estimated by multiplying the quantity of natural gas combusted in the project with an appropriate emission factor, as follows:

$$LE_{LNG,CO2,y} = FF_{project,y} \cdot EF_{CO2,upstream,LNG} \quad (5)$$

Where:

$LE_{LNG,CO2,y}$	Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in t CO_2e
$FF_{project,y}$	Quantity of natural gas combusted in all element processes during the year *y* in m^3
$EF_{CO2,upstream,LNG}$	Emission factor for upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system

Where reliable and accurate data on upstream CO_2 emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system is available, project participants should use this data to determine an average emission factor. Where such data is not available, project participants may assume a default value of 6 t CO_2/TJ as a rough approximation.[10]

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[10] This value has been derived on data published for North American LNG systems. "Barclay, M. and N. Denton, 2005. Selecting offshore LNG process. http://www.fwc.com/publications/tech_papers/files/LNJ091105p34-36.pdf (10th April 2006)".