AMS-III.AE.

Small-scale Methodology

Energy efficiency and renewable energy measures in new residential buildings

Version 02.0

Sectoral scope(s): 03

United Nations
Framework Convention on
Climate Change

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1.   Introduction

1.   The following table describes the key elements of the methodology:

Table 1.   Methodology key elements

Typical project(s)	Installation of energy efficiency and optional renewable power generation measures in new, grid-connected residential buildings
Type of GHG emissions mitigation action	Energy efficiency; Renewable energy: Electricity savings through energy efficiency improvement and optional use of renewable power

2.   Scope, applicability, and entry into force

2.1.   Scope

2.   This category comprises activities that lead to reduced consumption of electricity in new, grid connected residential buildings (single or multiple-family residences[1]) through the use of one or more of the following measures: efficient building design practices, efficiency technologies, and renewable energy technologies. Examples include efficient appliances, high efficiency heating and cooling systems, passive solar design, thermal insulation, and solar photovoltaic systems. All equipment and building materials used in the project activity residences must be new and not transferred from another project activity. All project activity residences must comply with or exceed applicable standards and regulations (e.g. building codes).

3.   The methodology does not quantify emission reductions for residences using biomass for energy supply.

4.   If the energy efficient equipment contains refrigerants, then the refrigerant used in the project case shall be CFC free. Project emissions from the baseline refrigerant and/or project refrigerants shall be considered in accordance with the guidance of the Board (EB 34, paragraph 17).

5.   Baseline residences are those that have been built and occupied within the prior five years from the start of the project activity, are not part of the project activity, are within approximately 100 kilometers of the project residences, and, as compared to project residences, have a similar size in terms of floor area (within approximately ± 50%), are located in a similar micro-climate (e.g. similar average rainfall, wind, and temperature), and are occupied by residents of a similar socio-economic class. Baseline residences must have been built in compliance with all applicable energy standards (e.g. building codes) when they both exist and are assumed to be enforced[2,3].

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[1] For this methodology, the term residence refers to a single housing unit. For example, a single-family home is one residence and a building with ten apartments has ten residences.

[2] Greater than 50% of residences built comply with building energy codes and standards.

[3] The requirements in this paragraph are assumed to be determined, ex ante, by observation or review of public records and not by baseline residence occupant surveys.

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2.2. Applicability

6. This methodology is applicable only for determining emission reductions associated with changes in grid electricity consumption between project and baseline residences. Therefore, project residences shall not use fossil or biomass fuels for space heating or cooling, i.e. such heating or cooling systems, if they exist, must be powered by electricity. Furthermore:

    (a) If baseline residences use electricity for domestic water heating then the project houses must not use fossil fuel for domestic water heating (i.e. project residences must use electricity and/or renewable energy for water heating); and

    (b) If baseline residences use electricity for cooking then the project residences must not use fossil fuel for cooking[4].

7. For project activities that apply a standardized baseline that is determined based on the "TOOL31: Determination of standardized baselines for energy efficiency measures in residential, commercial and institutional buildings", the following provisions apply:

    (a) The building unit categories are limited to residential building units, as defined in paragraph 2(a) from the Appendix of the tool;

    (b) The baseline residences, referred to in paragraph 5 above, are those that are located in the same geographical scope, as defined by paragraph 7(b) of the tool;

    (c) The specific CO_2 emissions shall be determined for new buildings only, following the definition of "Cohort of new buildings" contained in the tool;

    (d) In Equation 2, the parameters $BE_{fuel,j,i,BL}$ and $BE_{water,j,i,BL}$, required to determine $SE_{j,i,BL}$ ("Specific CO_2 emissions of building unit j in building unit category i included in the sample over the applicable data coverage period"), are equal to zero. The parameter $SE_{CO2,Top20\%,i}$ ("Average specific CO_2 emissions of the top 20 per cent performing building units in building unit category i included in the sample over the applicable data coverage period") is determined for the electricity component only.

2.3. Entry into force

8. The date of entry into force is the date of the publication of the EB 101 meeting report on 29 November 2018.

2.4. Applicability of sectoral scopes

9. For validation and verification of CDM projects and programme of activities by a designated operational entity (DOE) using this methodology, application of sectoral scope 03 is mandatory.

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4 It is acceptable to use this methodology if both the project and baseline residences use fossil or biomass fuels for domestic water heating and/or cooking on the assumption that the project activity does not cause an increase in domestic water heating or cooking requirements. However, project proponents are encouraged in all cases to utilize high efficiency domestic water heating and cooking systems in the project residences.

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3.   Normative references

10.   Project participants shall take into account the General guidelines for SSC CDM methodologies, Attachment B to Appendix B, TOOL21: Demonstration of additionality of small-scale project activities and TOOL22: Leakage in biomass small-scale project activities provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html>.

11.   This methodology is based on the proposed new methodology SSC-NM023 "Energy efficiency and renewable energy measures in new housing" submitted by EcoSecurities.

12.   This methodology also refers to the latest approved version(s) of the following methodological tools:

(a)   "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation";

(b)   "TOOL07: Tool to calculate the emission factor for an electricity system";

(c)   "TOOL31: Determination of standardized baselines for energy efficiency measures in residential, commercial and institutional buildings".

4.   Definitions

13.   The definitions contained in the Glossary of CDM terms shall apply.

5.   Baseline methodology

5.1.   Project boundary

14.   The project activity boundary is the physical extent of the new residential development(s) where efficiency and/or renewable energy technologies are installed.

5.2.   Emission Reductions

15.   Emissions reductions shall only be claimed for electricity savings from grid connected project activity residences, and are determined following the options below.

5.2.1.   Project activities that apply a standardized baseline

16.   For project activities that apply a standardized baseline based on the "TOOL31: Determination of standardized baselines for energy efficiency measures in residential, commercial and institutional buildings", emission reductions are determined as follows:

$$ER_y = \sum_i \sum_j \left(SE_{CO2,Top20\%,i} \times GFA_{j,i} \right) - \left(\frac{EC_{j,i,y} \times EF_{elec,y}}{1 - TDL_y} \right)$$

<div align="right">Equation (1)</div>

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Where:

$SE_{CO2,Top20\%,i}$	=	Average specific CO_2 emissions of the top 20 per cent performing building units in building unit category i included in the sample over the applicable data coverage period (tCO$_2$/(m^2 year))
$GFA_{j,i}$	=	Gross floor area of the project building unit j in building unit category i in year y (m^2)
$EC_{j,i,y}$	=	Electricity consumed by the project building unit j in building unit category i in year y (MWh)
$EF_{elec,y}$	=	Emission factor of the electric grid supplying electricity to the project building unit j in building unit category i (tCO$_2$e/MWh).
TDL_y	=	Average technical transmission and distribution losses for providing electricity to the grid to which the project building unit j in building unit category i is connected.
j	=	Building units included in the project activity
i	=	Residential building unit categories relevant to this methodology (i.e. Single-family (low-rise or high-rise) and/or Multi-family (low-rise or high-rise))

17. The parameters $EC_{j,i,y}$ and $GFA_{j,i}$ can be determined by sampling, with a 90/10 confidence/precision levels in accordance with the latest version of the standard "Sampling and surveys for CDM project activities and programme of activities".

5.2.2. Project activities that do not apply a standardized baseline

18. For project activities that do not apply a standardized baseline, the emission reductions are determined based on Equation (2) below:

$$ER_y = \sum_i \frac{ES_{y,i} \times EF_{elec,y}}{1 - TDL_y}$$
Equation (2)

Where:

ER_y	=	Emission reductions from electricity savings in year y, tCO$_2$
i	=	Residence type (e.g. single family and multifamily)
$ES_{y,i}$	=	Annual electricity savings from project activity residences in year y for residence type i (MWh)
$EF_{elec,y}$	=	Grid electricity emission factor for year y, as per the procedures of the "TOOL07: Tool to calculate the emission factor for an electricity system" (tCO$_2$/MWh)
TD_y	=	Average annual technical grid losses (transmission and distribution) during year y for the grid serving the project residences, expressed as a fraction.

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19. ES_y is estimated separately for different residence types (i.e. multifamily versus single family residences) for each crediting period year, using a calibrated computer simulation model or using regression analysis[5]:

5.2.2.1. Use of a calibrated computer simulation model

20. Under this option, the measured annual average electricity consumption of a sample of occupied project residences will be compared with an estimate of the annual average electricity consumption of baseline residences using a calibrated computer simulation model, taking into account actual weather conditions. The annual electricity savings shall be conducted using the following protocol:

(a) Energy savings for project residences shall be determined using Option D as defined in the International Performance Measurement and Verification Protocol, Concepts and Practices for Determining Energy Savings in New Construction, prepared by Efficiency Valuation Organization, EVO 30000 – 1.2006, or current version;

(b) Monthly electricity consumption data from a sample of occupied project residences shall be collected yearly to determine the annual electricity consumption of all occupied project residences included in the project activity. The following provisions apply related to the sampling:

(i) The sample selected to determine electricity consumption shall follow the requirements of the latest version of the standard "Sampling and surveys for CDM project activities and programme of activities" surveys for CDM project activities and programme of activities;

(ii) The minimum sample size of occupied residences shall be 100, however if the project has fewer than 100 residences, then all occupied project residences' electricity consumption shall be used. In determining electricity consumption of all project residences, only occupied residences shall be included in the totals;

(c) The computer simulation model shall be used to determine the annual baseline residence electricity consumption value for an average baseline residence, and the baseline electricity consumption is then determined by multiplying the annual electricity consumption of an average baseline residence times the number of occupied project residences;

(d) Input to the model will include actual weather data and characteristics of the project residences, such as occupied floor area, number of residences, etc. The model shall meet the specifications of and be calibrated per the requirements of ASHRAE[6] Guideline 14-2002, Measurement of Energy and Demand Savings, Whole Building Calibrated Simulation Performance Path;[7]

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[5] The option selected has to be chosen ex ante and shall be indicated in the PDD or CPA-DD.

[6] American Society of Heating, Ventilating, and Air Conditioning Engineers, Atlanta, Georgia, USA.

[7] Or current version or equivalent guideline.

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(e) For the purpose of model calibration, monthly electricity consumption data from a sample of occupied baseline residences shall be collected. The sample shall be selected to determine average annual electricity consumption following the requirements of the latest version of the standard "Sampling and surveys for CDM project activities and programme of activities". The minimum sample size of occupied residences shall be 100, however if the project has fewer than 100 residences, then an equivalent number of baseline residences can be used. Information on building and occupant characteristics, and monthly weather data, for use in model calibration, shall also be collected for the same baseline residences to define "average" conditions for model calibration. The model shall be calibrated for the first crediting period year and every third year thereafter (e.g. year 4, 7, 10) using data (energy use, weather data, residence characteristics) collected during the same years that the model is calibrated;

(f) Separate computer simulation models shall be constructed and calibrated for single and multi-family baseline residences.

5.2.2.2. Use of a regression analysis

21. Under this option, the annual average electricity consumption of a sample of the occupied project residences is compared with a sample of baseline residences (comparison group) using regression analyses. The annual electricity savings determined with comparison group and regression analyses shall be done using the following protocol:

(a) A regression model shall be developed and used to determine per residence, average daily electricity savings for each crediting year;

(b) A sample of 100[8] 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;[9]

(c) The regression model shall use average daily energy consumption (determined from monthly electricity consumption billing data) during the post-project residence installation period (the crediting period) as the dependent variable and at least (a) weather, (b) a value for non-variable base load electricity consumption, and (c) an indicator of participation (EE=1 if project and 0 otherwise) as the primary independent variables. Other variables[10] should be included in the model as

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[8] This sample size is based on an assumed coefficient of variation of 50% and 90/10 confidence and precision requirement.

[9] 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 monthly average daily energy consumption, HDD, CDD, X, and α data) equals (100 residences) X (2) X (12 months), or 2,400.

[10] For example, number and age of occupants, floor area, heating system type, cooling system type, number and average power rating of appliances.

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indicated through surveys or other means for both baseline and project residences. The regression model has the following specification:

$$ADC_{j,m,y} = \alpha + (\beta \times EE_j) + (\lambda_1 \times HDD_{j,m,y}) + (\lambda_2 \times CDD_{j,m,y}) + (\gamma \times X_j)$$

Equation (3)

Where:

$ADC_{j,m,y}$	=	Average daily electricity consumption during the post-treatment year *y* for both the project and baseline residences (residence *j* for month *m*). ADC is computed by dividing the total bill for month *m* by the number of days in the billing period. Each year, 12 ADC values are computed and used
EE_j	=	Energy efficiency improvement measures implemented in the project building residence *j*. Set to 1 if energy efficiency improvements have been installed and 0 otherwise (i.e. project residences have a 1 in all months and baseline residences have a 0 in all months)
$HDD_{j,m,y}$	=	Average daily heating degree-days based for residence *j* in month *m* (degree-days)
$CDD_{j,m,y}$	=	Average daily cooling degree-days based for residence *j* in month *m* (degree-days)
X_j	=	Important characteristics that need to be included for project and baseline residences (number of occupants, occupied floor area, heating system type, cooling system type)
α	=	Non-variable base load electricity consumption, for example electricity consumption associated with appliances in constant operation
β	=	Estimate of daily electricity savings for a 12-month period
λ_1	=	Coefficient for $HDD_{j,m,y}$
λ_2	=	Coefficient for $CDD_{j,m,y}$
γ	=	Coefficient for X_j

22. This model needs to be separately evaluated for each residence type *i* (single versus multifamily) and each residence in the baseline or project sample *j*. The objective of the equation above is to solve for β, the estimate of daily electricity savings for the prior 12-month period. Annual Electricity savings are then determined by the following equation:

$$ES_{y,i} = \beta \times (365\ days/years) \times N_i$$

Equation (4)

Where:

N	=	Number of project residences

23. The regression model can only be utilized to determine emission reductions if the following conditions are met:

(a) The t-test associated with β is ≤-1.645, for a 90% confidence;

(b) The regression model is 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 (size, occupancy, etc.).

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24. Monthly baseline and project residence electricity 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).

25. If renewable energy, electricity-generating systems (e.g. a photovoltaic system) are installed as part of the project residences and deliver all of their output to the grid (and none to the project residences) then the net amount of documented electricity production can be added to the value of ES, annual electricity savings from project activity residences calculated per paragraphs 20 or 5.2.2.2.

5.3. Leakage

26. No leakage is expected.

6. Monitoring methodology

27. In addition to the parameters listed in the tables below, the provisions on data and parameters monitored in the tools referred to in this methodology apply.

Data / Parameter table 1.

Data / Parameter:	$GFA_{j,i}$
Data unit:	m²
Description:	Gross floor area of the project building unit *j* in building unit category *i* in year *y*
Source of data:	<table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>1. Building plan</td><td>Preferred source</td></tr><tr><td>2. On-site measurement</td><td>If the building plan is not available</td></tr></table>
Measurement procedures (if any):	-
Monitoring frequency:	The parameter shall be determined before the start of the building's construction
QA/QC procedures:	When determined through the building plan, confirm on-site that building geometry represented in the plan is accurate
Any comment:	When determined using sampling, the requirements of the latest version of the standard "Sampling and surveys for CDM project activities and programme of activities" shall be followed.
	This parameter shall be monitored only when emission reductions are determined through the application of a standardized baseline

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Data / Parameter table 2.

Data / Parameter:	$EC_{j,i,y}$
Data unit:	MWh
Description:	Electricity consumed by the project building unit *j* in building unit category *i* in year *y* (MWh)
Source of data:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Measurement procedures (if any):	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". When applying the tool, requirements for $EG_{PJ,grid,y}$ specified in the tool should apply to electricity consumed form the grid ($EC_{j,i,y}$)
Monitoring frequency:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
QA/QC procedures:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Any comment:	When determined using sampling, the requirements of the latest version of the standard "Sampling and surveys for CDM project activities and programme of activities" shall be followed. Values shall be cross-checked against electricity purchase receipts/invoices. This parameter shall be monitored only when emission reductions are determined through the application of a standardized baseline

Data / Parameter table 3.

Data / Parameter:	$EF_{elec,y}$
Data unit:	tCO$_2$e/MWh
Description:	Emission factor of the electric grid supplying electricity to the project building unit *j* in building unit category *i*
Source of data:	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system"
Measurement procedures (if any):	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system"
Monitoring frequency:	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system". If the grid emission factor is fixed ex-ante, no monitoring is required
QA/QC procedures:	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system"
Any comment:	-

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Data / Parameter table 4.

Data / Parameter:	TDL_y
Data unit:	%
Description:	Average technical transmission and distribution losses for providing electricity to the grid to which the project building unit *j* in building unit category *i* is connected
Source of data:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Measurement procedures (if any):	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Monitoring frequency:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
QA/QC procedures:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$ES_{y,i}$
Data unit:	MWh
Description:	Annual electricity savings from project activity residences in year *y* for residence type *i*, (MWh)
Source of data:	Electricity consumed by the occupied project residences and by the baseline residences will be measured as per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".
Measurement procedures (if any):	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". If calibrated model simulation approach is used as per paragraph 19(a), yearly data of electricity consumed from a sample of occupied project residences shall be collected. If regression analysis is used as per paragraph 19(b), yearly data of electricity consumed from a sample of occupied project residences and baseline residences shall be collected
Monitoring frequency:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
QA/QC procedures:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". Values shall be cross-checked against electricity purchase receipts/invoices

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Any comment:	When determined using sampling, the requirements of the latest version of the standard "Sampling and surveys for CDM project activities and programme of activities" shall be followed

Data / Parameter table 6.

Data / Parameter:	*HDD / CDD*
Data unit:	Degree-days
Description:	HDD: Heating degree-days CDD: Cooling degree-days
Source of data:	Online calculator available at <https://www.degreedays.net/#>
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	**Baseline residence characteristics as**
Data unit:	-
Description:	Characteristics of the baseline residences selected for the survey
Source of data:	Executive project of the building unit j under building category i
Measurement procedures (if any):	The executive project shall provide the necessary inputs to the computer simulation model or to the regression analysis
Monitoring frequency:	Year 1 of the crediting period and every third year thereafter (i.e. years 4, 7, 10, etc.)
QA/QC procedures:	-
Any comment:	The monitoring of this parameter is only required to calibrate the computer simulation model and the parameters X coefficient and α from the regression analysis

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Document information

Version	Date	Description
02.0	29 November 2018	EB 101, Annex 14
		Revision to incorporate elements from "TOOL31: Determination of standardized baselines for energy efficiency measures in residential, commercial and institutional buildings" to allow its application to this methodology.
01.0	17 July 2009	EB 48, Annex 14
		Initial adoption.

Decision Class: Regulatory
Document Type: Standard
Business Function: Methodology
Keywords: energy efficiency, residential buildings, simplified methodologies, type (iii) projects