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

TYPE III- OTHER PROJECT ACTIVITIES

Project participants shall apply the general guidelines to SSC CDM methodologies, including information on additionality (attachment A to Appendix B) provided at: <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> *mutatis mutandis.*

III.AZ. Energy efficiency and/or energy supply projects in commercial buildings

Technology/Measure

1. This methodology is applicable to on-site building energy supply and whole building energy end-use (thermal and/or electrical) projects whose associated emission reductions can be determined with a whole building computerized simulation tool.

Applicability conditions

2. The methodology applies to commercial buildings[1] for both retrofit and new construction projects. Allowable projects include energy efficient building design features; energy efficient appliances, equipment and/or technologies; energy management controls; on-site renewable energy projects; on-site cogeneration; and/or fossil fuel switching – alone or in combination.

3. All technologies (e.g. equipment or appliances) used in the project activity must be new and not transferred from another project activity.

4. This methodology is not applicable to project activities that affect off-site district heating and/or cooling plants and distribution networks even if they supply energy to the subject building(s).

5. If the project activity includes fuel switching, the requirements in AMS-III.B "Switching fossil fuels" for establishing a baseline for fuel switching shall be followed.

6. The Project Design Document (PDD) shall document how the potential for double counting of emission reductions, for example due to equipment manufacturers or others claiming credit for emission reductions for project activities, are avoided.

7. Projects are limited to those activities that result in annual emissions reductions of less than or equal to 60 kt CO_2 equivalent.

Boundary

8. The project activity boundary encompasses the physical extent of the buildings sites where the emission avoidance projects are implemented.

Crediting period

9. With this methodology, Certified Emission Reductions (CERs) can only be earned for one crediting period of up to 10 years.

[1] See Appendix 1, Terms and Definitions, including examples of common types of commercial buildings in the private sector and in government.

Ex ante emission reduction calculations

10. The *ex ante* baseline scenario shall be based on the characteristics and operation of the existing building(s) (Retrofit) or the building(s) that which would have been constructed in the absence of the CDM project activity (New Construction). The sources of data used to establish the baseline building energy use shall be cited and referenced in the PDD.

(a) In the case of a retrofit of an existing building (Retrofit), the *ex ante* baseline emissions scenario is based on the energy consumed over the previous year (or past 12 months) in the subject building(s); refer to Figure 1, left pathway in "Baseline";

(b) In the case of the construction of a new building (New Construction), the *ex ante* baseline emissions scenario shall be based on a whole building computerized simulation tool model of the proposed project building(s) using one of the following two approaches with assumptions of average or typical weather,[2] building operating characteristics, building control strategies and settings, building occupancy and socio-economic conditions of building tenants (e.g. for apartment buildings): (refer to Figure 1, right pathway in "Baseline"):

(i) Where there is a legally mandated code on energy performance, the baseline emissions scenario is based on minimum energy requirements in the building code for the subject building type(s) or classification(s) in the same climate zone (e.g. in $kWh/m^2/year$); or

(ii) Where there is no legally mandated and enforced building code on energy performance, the baseline emissions scenario is based on the average energy consumption in buildings of the same or similar building type, usage or classification as the subject building(s) within the same climate zone.

11. The *ex ante* project scenario shall be based on a whole building computerized simulation tool model of the proposed project building(s) using the same typical weather, building physical and occupancy characteristics utilized for calculation of the baseline scenario, with the only changes from the baseline scenario being changes associated with the project activity.

12. The *ex ante* emissions reduction is estimated as the difference between baseline and project scenario energy use with the application of applicable emission factors. *Ex ante* emission reductions are assumed to be the same for each year of the crediting period as determined with the same weather, building operating characteristics, building control strategies and settings, and building occupancy assumed for the baseline scenario.

[2] For example, using a Typical Meteorological Year (TMY) weather file, source to be documented and included in the PDD.

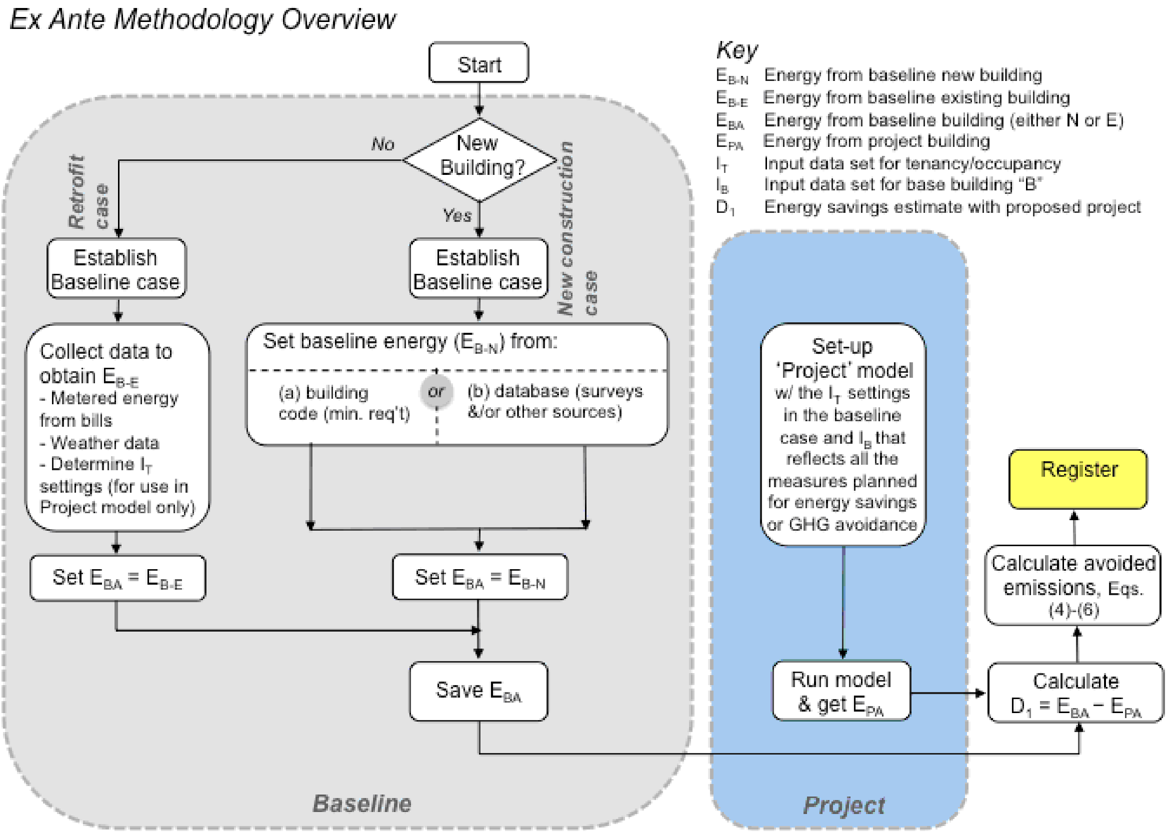

Figure 1: Flowchart of the *ex ante* methodology

Computer simulation

13. The avoided GHG emissions between the baseline and the project activity is determined using a whole building computerized simulation tool to generate energy use estimates (calibrated models) of the baseline building(s) scenario and the project building(s) scenario with emission reductions calculated based on the differences in energy use and emissions between the baseline and project scenarios (Figure 2) using weather and building occupancy experienced during the crediting period (*ex post*).

14. Only whole building computerized simulation tools that have undergone verification and general validation through the International Energy Agency's BESTEST[3,4] protocol can be used with this methodology.

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[3] The Building Energy Simulation Test (BESTEST) is a methodology for testing computer models/tools using a combination of empirical validation, analytical verification and comparative analysis techniques. Initiated by NREL in 1981, this has been developed under the auspices and coordination of the International Energy Agency (IEA).

15. Project participants must demonstrate that the building energy simulations (and related calibrations) have been performed by skilled operator(s) as demonstrated by having at least three years of relevant experience and professional education and/or training.

Baseline emissions

16. For retrofit projects, the baseline emissions scenario is based on the energy consumed over a period of a year as calculated using a calibrated model[5] of the subject baseline building(s), generated by a whole building computerized simulation tool (See Figure 2, "Baseline"). Base (B)[6] building settings for the baseline scenario should match the original building features before the retrofit. The baseline model's weather, building operating characteristics and building occupancy settings, referred to as "T"[7] settings, shall match those in the calibrated model of the project activity building(s) (See Figure 2, "Model modification").

17. For new construction projects, the baseline emissions scenario is based on the energy consumed over a period of a year as calculated, using a calibrated model, of a "reference" baseline building, generated by a whole building computerized simulation tool.

(a) The reference baseline model shall be configured as a building on the project site that matches the project's building type (see Appendix 1, definition and types of commercial buildings) and size (height or number of floors, and floor area), with a window-to-wall ratio and front façade orientation on the site the same as that can be demonstrated as typical of the project location (e.g. city). This baseline building model shall exclude all the project activity measures such that the base (B) building features for the baseline scenario will be that which would have been constructed in the absence of the project activities. This reference baseline model may be configured as identical to the calibrated building model of the subject project building(s), excluding project activity measures;

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[4] eQUEST is an example of a public domain whole-building energy simulation program that has passed BESTEST, and which can be used in this methodology. It has a graphical user-interface that runs DOE-2.2 as its simulation "engine" (from the US Department of Energy). Further information and free software downloads are available at: <http://doe2.com/DOE2/index.html>. Other tools that can be used include EnergyPlus and those that have been certified to have undergone BESTEST evaluation here: <http://apps1.eere.energy.gov/buildings/tools_directory/>.

[5] See paragraph 20 for model calibration procedures.

[6] Base "(or physical) base" (B) building physical data are not the same as baseline building. Base building generally refers to the aspects of a whole building simulation model's input data set and settings building that can be separated from individual commercial building tenant 's decisions or responsibility aspects (T), such as the building envelope features, building central services, heating, ventilation and air conditioning (HVAC) system, control systems, exterior lighting, hot water system, car parking ventilation and lighting, fans (kitchen, toilet, refuse, etc), supplementary service for tenants (e.g. chilled water, condenser water, etc), energy sources, and on-site generator(s), if any.

[7] The occupancy or tenancy related settings (T) in the whole building simulation model/tool are those associated with individual commercial building variables that are associated with weather and each tenant, such as tenant lighting, power/plug loads (including appliances and office equipment) and supplementary air conditioning units, and hours of operation/occupancy including facility manager's operational settings.

(b) The baseline model's weather, building operating characteristics and building occupancy settings, earlier referred to as "T" settings, shall match those in the calibrated model of the project activity building(s) (See Figure 2, "Model modification");

(c) Where there is a legally mandated code on energy performance, if the baseline emissions as calculated using whole building computerized simulation tool are higher than those associated with the minimum energy requirements in the building code for the subject building type(s) or classification(s) in the same climate zone (e.g. in $kWh/m^2/year$), then the simulation results shall be carried forward. But if the baseline emissions from simulation are lower than those associated with the minimum energy requirements in the building code, then the latter shall be carried forward.

18. An exception to paragraph 17's building simulation model's treatment of the occupancy or tenancy-related (T) and base-building related (B) settings is applicable where a special tenancy lease arrangement[8] is in place in, or part of, the CDM project activity. In this case, any tenancy-related settings identified above that are included in a legally binding tenancy lease arrangement will be considered to be part of the CDM project activity's base settings for the model. The baseline data in this case will then be the prevailing industry practice in the country of the project activity.[9]

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[8] A special tenancy lease arrangement includes various forms of legally binding energy efficiency-focused contracts, or "green lease" contracts (covering broader environmental impact considerations).

[9] A simple illustrative example is setting the building simulation model for the baseline (without special lease arrangement) for tenant lighting and plug-loads (e.g. computers and office equipment) based on common procurement specifications (e.g. from government or industry data sources). Note that since special tenancy lease arrangements can vary from one case to another, the actual terms planned in the CDM project activity should be clear and included as a key part of project documentation. Whole building simulation models for both baseline and project buildings should then reflect these arrangements accordingly.

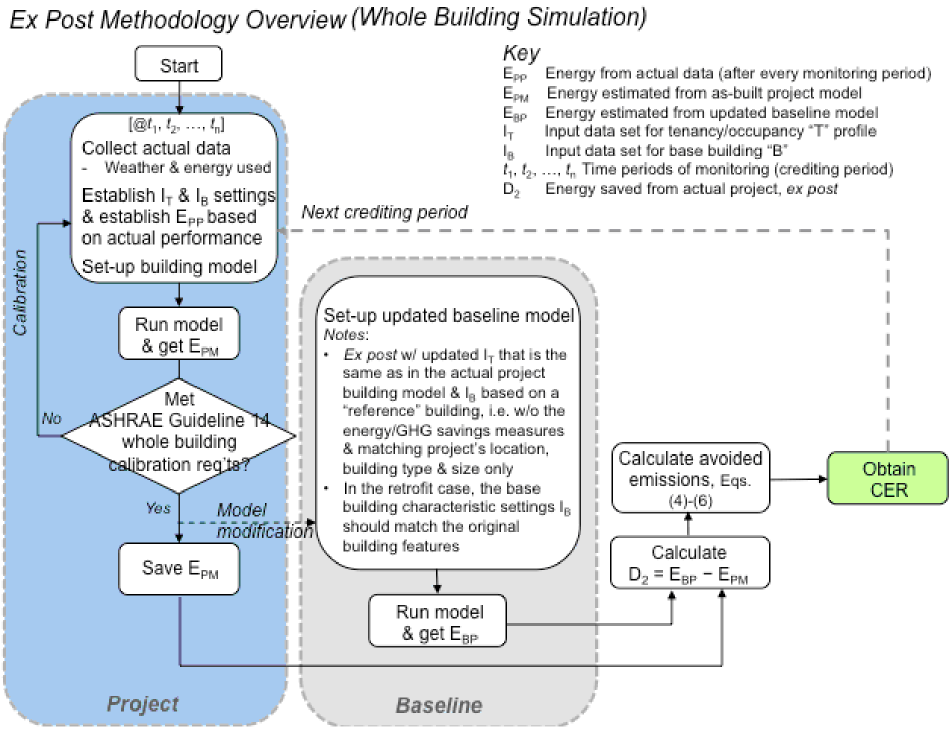

Figure 2: Flowchart of the *ex post* methodology using a whole building simulation tool

Emission reductions

19. A calibrated building model of the subject project building(s), generated by a whole building computerized simulation tool, is developed to: (a) match (via calibration) the actual energy consumption of the project building; (b) estimate baseline building energy consumption; and (c) determine the electrical and thermal energy savings between the two (refer to Figure 2), which are then multiplied by appropriate emissions factors.

20. For both retrofit and new construction projects, the calibrated building model is established at the end of the first year of project (building) operation and when one year of energy use data under expected ("full") operations are available for the project building. The model is established and calibrated using the: (i) as-built project building characteristics; (ii) weather, building operating characteristics, building control strategies and settings, and building occupancy experienced during the first full year of project building operation; and (iii) actual annual energy used in the building during the first full year of project building operation. The project building model is calibrated against actual data as shown in Figure 2 and the modelling process is conducted as described below.

Step 1. The following data are collected for the project building:

- Physical properties of the building: (i) building envelope (e.g. building geometry, location of building surfaces such as windows, building shades, relative position of the building thermal zones) and (ii) thermal properties (layer-by-layer description of the building materials with their conductivity, specific heat, and density);

- Specification of the space conditioning system, including its performance;[10]
- Control systems;
- Information about actual base building and occupancy or tenancy-related settings: (i) internal loads (occupancy or average number of people say per month; lighting and equipment power density; internal load schedules); and (ii) building operations (control temperatures, window opening and related schedules, reflecting occupant behaviour); Actual weather data and energy consumption in the first 12 months of building (full) operation.

Step 2. Model calibration[11]

- A simulation input file for the project building is developed based on input data from Step 1;
- The computer simulation results for the project building is compared to the actual energy consumption first 12 months of building (full) operation, and the whole building model is calibrated following the ”Whole Building Calibrated Simulation” path in ASHRAE Guideline 14-2002.[12]

Step 3. Computer simulation and energy savings

- After the project model calibration has been completed in Step 2, the calibrated model is representative of the project building(s);
- The calibrated model is modified to represent the baseline building(s) as described above;
- Simulations of the project building and the baseline building are completed for each project year using weather, building operating characteristics, building control strategies and settings, and building occupancy settings, referred to as “T” settings, for each year of the crediting period.

[10] For projects supplied by district heating or cooling, the overall thermal efficiency of the district system is included in the model. Although emission reductions from improvements to the district system are outside the scope of this methodology, its efficiency is necessary to derive the net emission reductions from measures applied to the buildings.

[11] Calibration is the process of adjusting the input data or parameters in a model (as opposed to changing the form of the model) to match its output with the measured data from the real-world system. During this process, assumptions about the building’s internal loads and operational characteristics are adjusted to produce a closer match between the simulated and benchmarked energy usage.

[12] American Society of Heating, Air Conditioning, and Refrigeration Engineers Guideline 14-2002 Measurement of Energy and Demand Savings, or current version.

Step 4. Documentation. The following information is reported in the PDD:

(i) Physical properties of the baseline and project buildings, including but not limited to: (i) building envelope (e.g. building geometry, location of building surfaces such as windows, building shades, relative position of the building thermal zones) and (ii) thermal properties (layer-by-layer description of the building materials with their conductivity, specific heat, and density);

(ii) Specification of the space conditioning system of the project and baseline buildings;

(iii) Specification of the control systems and control settings of the project and baseline buildings;

(iv) Information about actual baseline and project buildings' occupancy and tenancy-related settings: (i) internal loads (occupancy or average number of people say per month; lighting and equipment power density; internal load schedules), and (ii) building operations (control temperatures, window opening and related schedules, reflecting occupant behaviour);

(v) Weather files for the project location with hourly data of temperature, humidity, wind direction and speed, total and diffuse solar radiation;

(vi) Documentation of the calibration process and results; and

(vii) Any other relevant information, including special tenancy lease arrangements.

21. The avoided emissions are calculated as follows:

$$ER_y = ER_{elec,y} + ER_{th,y} \quad \textbf{(1)}$$

where:

ER_y	Emission reductions in year y, tCO_2
$ER_{elec,y}$	Emission reductions from electricity savings in year y, tCO_2
$ER_{th,y}$	Emission reductions from thermal energy savings in year y, tCO_2

The calculation of emissions reductions from electricity is as follows:

$$ER_{elec,y} = \sum_i ES_{elec,y,i} \times EF_{elec,y} \times \left(1 + TD_y\right) \quad \textbf{(2)}$$

Where:

$ER_{elec,y}$	Emission reductions from electricity savings in year y, tCO_2
i	Building counter (e.g. building 1, building 2, building 3, etc.)
y	Crediting period year

$ES_{elec,y,i}$	Difference in electricity consumption between baseline building(s) and project building(s) as indicated by calibrated computer model(s) in year *y* for building *i*, MWh
$EF_{elec,y}$	Electricity emission factor for year *y*, as per the procedures of AMS-I.D, 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. 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 0.1 shall be used for average annual technical grid losses, if no recent data are available or the data cannot be regarded as accurate and reliable. In the case that electricity is not from the grid, $TD_y = 0$

The calculation of emissions reductions from thermal energy is as follows:

$$ER_{th,y} = \sum_i \sum_j ES_{th,y,i,j} \times EF_{FF,j} \quad \textbf{(3)}$$

where:

$ER_{th,y}$	Emission reductions from thermal energy savings in year *y*, tCO_2
i	Building counter (e.g. building 1, building 2, building 3, etc.)
j	Fossil fuel type
y	Crediting period year
$ES_{th,y,i,j}$	Difference in fossil fuel consumption between baseline building(s) and project building(s) as indicated by calibrated computer model(s) in year *y* for building *i*, TJ
$EF_{FF,j}$	CO_2 emission factor of the fossil fuel that would have been used in the baseline plant, (tCO_2 / TJ), obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used

Leakage

22. No leakage is expected.

Documentation and monitoring

23. The documentation, reporting and monitoring plan shall generally conform to ISO 50001: *Energy management systems — Requirements with guidance for use*[13], and in particular, the clauses that support the purpose of this CDM methodology and that specifically relate to data documentation and management.

24. The following data and calibration documentation are needed to allow for accurate recreation of the baseline and project models by qualified modelers and shall be archived and made available to the DOE:

(a) *Ex ante* baseline building data: The actual sources of data used to establish the baseline building energy use intensity should be provided and the data analysis process documented;

(b) Software Version: Report the name and version number of the whole building simulation software used, including certification or evidence of BESTEST validation;

(c) Paragraph 20, Steps 1 and 3 input files to define the project and baseline building models, *ex ante* and *ex post*, including: (i) building physical properties; (ii) characteristics of the space conditioning system; (iii) initial load and operating assumptions; (iv) typical year weather file; (v) occupancy schedules; (vi) HVAC and lighting control settings; and (vii) lighting schedules; and

(d) Paragraph 20, Step 2 information documenting the calibration process, including: (i) initial simulation results for benchmark building; and (ii) accuracy with which the simulation results match the calibration energy data.

25. Monitoring during the crediting period shall include:

(a) Weather data, typically obtained from third-party sources (frequency: monthly);

(b) Electricity emission factor (if applicable), according to AMS-I.D (frequency: once or every time this is updated);

(c) Archiving input and output files from model simulation of electrical and thermal energy savings performed under Steps 1 and 3 (frequency: once and every time updated);

(d) Energy consumption (electrical and/or thermal, as appropriate to the project activity) of the project building(s) on at least a monthly basis, throughout the crediting period;

(e) Base building setting change(s) (see paragraph 16 footnotes; frequency: every time there is a change);

(f) Occupancy or tenancy-related setting change(s) including lighting and HVAC schedules and control settings (see paragraph 16 footnotes; frequency: annual).

[13] ISO 50001:2011(E) or current version.

Project activity under a programme of activities

26. The methodology is applicable to a programme of activities, no additional leakage estimations are necessary other than that indicated under leakage section above.

Appendix 1

TERMS AND DEFINITIONS

Climate zone	Classification of climate within a given area (zone) that is deemed to be the same for the purpose of building energy performance measurement, assessment and/or modelling (e.g. same average rainfall, wind, and temperature). Areas with a different set of climate characteristics are assigned different climate zones
Commercial building	A building that is primarily used for commercial purposes, but excluding industrial production. Private sector commercial buildings include commercial offices, shopping centers, apartments, hotels, private hospitals and private educational facilities. Government buildings include government offices, government owned health facilities (hospitals), government owned educational facilities, galleries, museums, law courts and correctional centers

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History of the document

Version	Date	Nature of revision
01	EB 66, Annex # 02 March 2012	To be considered at EB 66.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		