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

TYPE III - OTHER PROJECT ACTIVITIES

Project participants 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.

III.AC. Electricity and/or heat generation using fuel cell

Technology/measure

1. This category covers electricity and/or heat generation including cogeneration using fuel cell technology using natural gas as feedstock. The generated heat and/or electricity will be supplied to existing or new users/facilities to displace more carbon intensive fossil fuel that would have been used in the baseline.

2. This category also includes the case where electricity generated from the project activity is supplied to the grid.

3. The category is not applicable where energy produced by fuel cell is used for transportation application.

4. Electricity and/or steam/heat produced by the project activity and delivered to facility or facilities within the project boundary, will be covered by contract specifying that only the facility generating the energy can claim emission reductions from the energy displaced.

5. Natural gas is sufficiently available in the region or country, e.g., future natural gas based power capacity additions, comparable in size to the project activity, are not constrained by the use of natural gas in the project activity[1].

6. The lifetime of fuel cell in the project activity shall be available in accordance with the procedures described in General Guidance for SSC methodologies. If the project activity includes the replacement of the cell or any part of it (the molten carbonate, the electrodes, etc.) during the crediting period, there shall be no significant changes in the efficiency or capacity of the fuel cell technology used in the project activity due to the replacement.

7. The requirements concerning demonstration of the remaining lifetime of the baseline equipment shall be met as described in the General Guidance for SSC methodologies.

8. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

[1] In some situations, there could be price-inelastic supply constraints (e.g., limited resources without possibility of expansion during the crediting period) that could mean that a project activity displaces natural gas that would otherwise be used elsewhere in an economy, thus leading to possible leakage. Hence, it is important for the project proponent to document that supply limitations will not result in significant leakage as indicated here.

Project Boundary

9. The project boundary encompasses the physical, geographical site of the fuel cell based heat and/or electricity generation source and facilities where heat and/or electricity are supplied.

10. The boundary shall include pre-treatment of the natural gas (desulfurizer), pre-treatment of water (filter) and steam generation, pre-treatment and air blowing etc.

Baseline

11. The simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity times an emission coefficient for the fossil fuel displaced. IPCC default values for emission coefficients may be used.

12. Project activities producing both heat and electricity shall use one of the following baseline scenarios[2], based on the approach used in AMS-I.C.

(a) Electricity is imported from the grid and thermal energy (steam/heat) is produced using fossil fuel;

(b) Electricity is produced in an on-site captive power plant using fossil (with a possibility of export to the grid) and thermal energy (steam/heat) is produced using fossil fuel;

(c) A combination of (a) and (b)

(d) Electricity and thermal energy (steam/heat) are produced in a cogeneration unit using fossil fuel (with a possibility of export of electricity to the grid/other facilities and/or thermal energy to other facilities);

13. The calculation of baseline emission from electricity, shall be according to the following equation:

$$BE_y = EG_y * EF_{CO2,elec,base} \quad \textbf{(1)}$$

Where:

BE_y	The baseline emission from electricity displaced by the project activity during the year *y* (tCO2e/year)
EG_y	The amount of electricity supplied by the project activity during the year of *y* (MWh/year)

[2] For Greenfield projects or cases where no historical information is available, the most plausible energy supply sources shall be established in accordance with the guidance on Greenfield projects in the general guidance to SSC methodologies.

$EF_{CO2,elec,base}$	The CO_2 emission factor of the baseline fossil fuel or grid emission factor (tCO2/MWh)

14. Baseline emissions for electricity produced in captive plants shall be calculated as follows:

$$BE_{captelec,y} = (EG_{captelec,PJ,y} / \eta_{BL,captive\ plant}) * EF_{BL,FF,CO_2} \quad \textbf{(2)}$$

Where:

$BE_{captelec,y}$	The baseline emissions from electricity displaced by the project activity during the year *y*; tCO_2
$EG_{captelec,PJ,y}$	The amount of electricity produced by the project activity during the year *y*; MWh
EF_{BL,FF,CO_2}	The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data if available; otherwise, IPCC default emission factors are used; (tCO_2 /MWh)
$\eta_{BL,captive\ plant}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

15. Baseline emission for supply of electricity to and/or displacement of electricity from the grid shall be calculated as the amount of electricity produced by the project activity (MWh) multiplied by the CO_2 emission factor of that grid (tCO2/MWh). CO_2 emission factor for grid electricity shall be calculated as per the procedures described in paragraph 19 below.

16. For steam/heat produced using fossil fuels the baseline emissions are calculated as follows:

$$BE_{thermal,CO_2,y} = (EG_{thermal,y} / \eta_{BL,thermal}) * EF_{FF,CO_2} \quad \textbf{(3)}$$

Where:

$BE_{thermal,CO_2,y}$	The baseline emissions from steam/heat displaced by the project activity during the year *y*; tCO_2.
$EG_{thermal,y}$	The net quantity of steam/heat supplied by the project activity during the year *y*; TJ
EF_{FF,CO_2}	The CO_2 emission factor of the fossil fuel that would have been used in the baseline plant; tCO_2 / TJ
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

17. For the determination of the emission factor ($EF_{BL,i}$) and of the net calorific value (NCV_j) for the fossil fuel used in the baseline scenario, guidance by the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories shall be followed where appropriate. Project

participants may either conduct measurements or they may use accurate and reliable local or national data where available. In the case of coal, the data shall be based on test results for periodic samples of the coal purchased if such tests are part of the normal practice for coal purchases. Where such data is not available, IPCC default emission factors (country-specific, if available) may be used if they are deemed to reasonably represent local circumstances. All values shall be chosen in a conservative manner (i.e., lower values should be chosen within a plausible range) and the choice shall be justified and documented in the SSC-CDM-PDD. Where measurements are undertaken, project participants shall document the measurement results and the calculated average values of the emission factor or net calorific value for the baseline fuel *ex ante* in the SSC-CDM-PDD.

18. For cases 12 (a), (b) and (c), baseline emissions shall be calculated as the sum of emissions from the production of electricity and steam/heat considering most recent historical records (average of the data from a minimum of three most recent years excluding abnormal years is required).

For project activities that displace on-site captive electricity and/or displace grid electricity import and/or supply electricity to grid, the emission factor for the electricity should reflect the emissions intensity of the captive power plant and the grid of the baseline scenario. If annual electricity produced in the project activity is less than or equal to the sum of on-site captive generation and net grid import (average of most recent three years data) in the baseline scenario, the emission factor shall be calculated as the weighted average of on-site captive electricity generation and the net grid electricity import in the baseline. If annual electricity produced in the project activity is greater than the sum of on-site captive generation and net grid import (average of most recent three years data) in the baseline, lower of the two i.e., emission factor of the grid or the emission factor of the baseline captive plant shall be used for the incremental generation (i.e., the difference between the electricity generation in the project activity and the sum of captive generation and net grid import).

In the case of new users, "combined tool to identify the baseline scenario and demonstrate additionality" shall be used for the determination of the ratio in baseline scenario.

19. In the case that the project activity generates electricity to export to the grid, the lowest baseline emission factor shall be used among the following three options:

- Option 1: The build margin, calculated according to "Tool to calculate emission factor for an electricity system";
- Option 2: The combined margin, calculated according to "Tool to calculate emission factor for an electricity system", using a 50/50 OM/BM weight;
- Option 3: The emission factor of the technology (and fuel) identified as the most likely baseline scenario according to "Combined tool to identify the baseline scenario and demonstrate additionality".

20. For electricity and heat produced in a cogeneration plant, using fossil fuel (case 12 (d)), the following formula be used:

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III.AC. Electricity and/or heat generation using fuel cell (cont)

$$BE_{cogen,CO_2,y} = \lfloor (EG_{PJ,thermal,y} + EG_{PJ,electrical,y} * 3.6) / \eta_{BL,cogen} \rfloor * EF_{FF,CO_2} \qquad \textbf{(4)}$$

Where:

$BE_{cogen,CO_2,y}$	Baseline emissions from electricity and thermal energy displaced by the project activity during the year *y*; tCO_2e
$EG_{PJ,electrical,y}$	The amount of electricity supplied by the project activity during the year *y*; MWh
3.6	Conversion factor; TJ/MWh
$EG_{PJ,thermal,y}$	The net quantity of thermal energy supplied by the project activity during the year *y*; TJ
EF_{FF,CO_2}	The CO_2 emission factor of the fossil fuel that would have been used in the baseline cogeneration plant; tCO_2 / TJ. The emission factor shall be calculated using the approach described in paragraph 17 above
$\eta_{BL,cogen}$	The total efficiency (including both thermal and electrical) of the cogeneration plant using fossil fuel that would have been used in the absence of the project activity. Efficiency should be calculated as the total energy produced (electricity and steam/heat extracted) divided by thermal energy of the fuel used

21. Efficiency of the baseline scenario ($\eta_{BL,captive\ plant}$, $\eta_{BL,thermal}$ and $\eta_{BL,cogen}$) shall be determined by adopting one of the following criteria (in a preferential order):

(a) Highest annual measured operational efficiency of a unit with similar specifications, using baseline fuel;

(b) Highest of the annual operational efficiency values provided by two or more manufacturers for units with similar specifications, using the baseline fuel;

(c) Default efficiency of 100%.

In case of (a) and (b), unit with similar specification means that other electricity and/or heat generation technology has similar output for the project activity. Also the choice of efficiency can be considered according to the fuel type which is determined in baseline scenario.

Leakage

22. If the fuel cell heat & power generating equipment is transferred from another activity, leakage to be considered.

Project activity emissions

23. The project activity utilizes hydrogen derived from natural gas. In the process of producing hydrogen, CO_2 would be generated from (1) the reactions of methane from natural gas as feedstock during the steam-reforming/shift-reaction, (2) from the use of heat and/or electricity

as auxiliary fuel consumption such as start up fuel and for the operations of the auxiliary equipment. The procedure for the calculation of project emission (1) is derived from the existing methodology AMS-III.O.

$$PE_y = PE_{natual,feed} + PE_{heat} + PE_{elec} \quad \textbf{(5)}$$

Where:

PE_y	The project emission during the year *y* (tCO2/year)
$PE_{natual,feed}$	The project emission from consumption of natural gas used as feed stock during the year *y* (tCO2e/year)
PE_{heat}	The project emission from heat consumption during the year *y* (tCO2/year)
PE_{elec}	The project emission from electricity consumption during the year *y* (tCO2e/year)

24. To calculate project emission from consumption of natural gas used as feed stock, the composition of natural gas shall be reported based on the composition analysis of stand-by natural gas stock in the validation process. Also the data of composition of natural gas shall be determined *ex-post* during monthly based monitoring process. This shall be based on:

(a) Information provided by the supplier; or

(b) Compositional analysis conducted by an independent certified laboratory; or

(c) Product specification statement provided by the national gas supplier of the host-country.

25. CO_2 emissions generated in reactions of natural gas during the steam-reforming/shift-reaction are determined by calculating the CO_2 generation potential from the feedstock natural gas (R_{CO2}) which is calculated through analysis of the steam-reforming/shift reactions involving the individual molecules contained in natural gas[3]. The project emission $PE_{natual,feed}$ shall be calculated as below:

$$PE_{natual,feed} = R_{CO_2} * MW_{CO_2} * C_1 \quad \textbf{(6)}$$

Where:

R_{CO_2}	CO_2 generation potential in the consumption of natural gas as feedstock (kmol-CO_2)
MW_{CO_2}	Molecular weight of CO_2 (44 kg/kmol-CO_2)
C_1	Conversion factor kilograms to tonnes (0.001)

[3] The remaining/unconverted methane in the steam reforming process is converted to CO_2 in a catalytic oxidation process.

26. The generic steam reforming reaction is:

$$C_nH_m + nH_2O \leftrightarrow nCO + (m/2+n)H_2 \quad \textbf{(7)}$$

The generic shift reaction is:

$$nCO + nH_2O \leftrightarrow nCO_2 + nH_2 \quad \textbf{(8)}$$

The net reaction from the above reactions is the sum of the above formula (6) and (7):

$$C_nH_m + 2nH_2O \leftrightarrow nCO_2 + (m/2+2n)H_2 \quad \textbf{(9)}$$

27. Because hydrocarbon C_nH_m generates nCO_2 in the reaction of steam reforming and shifting CO_2 generation potential in the consumption of natural gas as feedstock, R_{CO_2} , shall be calculated by the composition of natural gas used in the project activity as below:

$$R_{CO_2} = \sum_i (n_i * m_i) * \sum_i [M_{natural} / (m_i * MW_i)] \quad \textbf{(10)}$$

Where:

n_i	The number of carbon atoms composed in the molecule of hydrocarbon type i
m_i	The proportion of mol of hydrocarbon type i in natural gas
$M_{natural}$	Mass of natural gas used as reaction feedstock annually (kg-natural gas)
MW_i	Molecular weight of hydrocarbon type i (kg/kmol)

28. If the project activity utilizes heat and/or electricity as auxiliary fuel (e.g imports of electricity for start up and parasitic energy consumption[4]), relevant emissions also shall be considered in the calculation of project emission. For project emission from heat consumption shall be calculated as below:

$$PE_{heat} = HC_y * EF_{CO_2,heat,proj} / \eta_{th,proj} \quad \textbf{(11)}$$

Where:

HC_y	The amount of heat consumption of the project activity during the year of y (TJ/year)
$EF_{CO_2,heat,proj}$	The CO_2 emission factor per unit of energy of the fuel used in the plant (tCO2/TJ)

[4] These include all auxiliary equipment necessary to the operation of the fuel cell, like the pre-treatment of the natural gas (desulfurizer), the pre-treatment of water and steam generation, the pre-treatment and air blowing,.

$\eta_{th,proj}$ The efficiency of the plant that supplies heat in the project activity. The average value of the efficiency of the plant in most recent three years shall be used. Efficiency shall be measured monthly throughout the crediting period, using the monitored amounts of fuel or energy source consumption and output energy, and annual averages should be used for emission calculations.

29. The electricity consumed in the hydrogen power plant would be imported from the grid or supplied from existing power plant. For project emission from electricity consumption shall be calculated as below:

$$PE_{elec} = EC_y * EF_{CO_2,elec,proj} \qquad \textbf{(12)}$$

Where:

EC_y The amount of electricity supplied to the project activity during the year of *y* (MWh/year)

$EF_{CO_2,elec,proj}$ The CO_2 emission factor of electricity supplied to the project activity (tCO2/MWh). The emission factor shall be determined by using the average of emission factors of the plant in most three years or grid emission factor

Monitoring

30. Monitoring consist of metering the electricity and steam generated by the fuel cell electricity and heat generation technology.

31. For the determination of project emission, the following parameters shall be monitored:

(a) The amount of electricity and/or heat generated in the project activity (MWh or TJ);

(b) The amount of electricity and/or heat monitored at the recipient facilities (MWh or TJ);

(c) The natural gas quantity that will be used as feed-stock in the hydrogen plant (kg-Natural gas);

(d) The amount of auxiliary fuel used in the process of heat and/or electricity generation;

(e) The composition of natural gas shall be monitored one of the three following options by monthly measurement and collection:

- Information provided by the supplier; or
- Compositional analysis conducted by an independent certified laboratory; or
- Product specification statement provided by the national gas supplier of the host-country.

Project activity under a programme of activities

32. Leakage may result from fuel extraction, processing, liquefaction, transportation, regasification and distribution of natural gas outside of the project boundary. This includes mainly fugitive CH_4 emissions and CO_2 emissions from associated fuel combustion and flaring. In accordance with ACM0009 methodology, leakage emission sources shall be considered.

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History of the document

Version	Date	Nature of revision(s)
01	EB xx, Annex # 28 May 2009	To be considered at EB xx.