**Joint Crediting Mechanism Approved Methodology ID_AM014**

**"Installation of Tribrid Systems to mobile communication's Base Transceiver Stations"**

## A. Title of the methodology

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| Installation of Tribrid Systems to mobile communication's Base Transceiver Stations Ver 01.0 |

## B. Terms and definitions

| Terms | Definitions |
|---|---|
| Base Transceiver Station (BTS) | A facility equipped with antenna and other communication equipment for sending and receiving radio signals to mobile devices and converting them to digital signals. A typical BTS in Indonesia comprises of a transceiver, rectifier, diesel generator, and a lead-acid battery as a standby power supply to prevent momentary and/or temporary power failure. |
| Tribrid System | Tribrid System is a combined system of solar PV, batteries, and electric power control system. Tribrid System controls charge-discharge of battery, and improves the operational efficiency of diesel generators with its electric power control system. As a result, it reduces consumption of grid electricity and/or captive electricity. |

## C. Summary of the methodology

| Items | Summary |
|---|---|
| *GHG emission reduction measures* | By installation of Tribrid system(s) to mobile communication's Base Transceiver Stations, the project achieves energy saving through displacement of grid and/or captive electricity by solar power, and optimization of the efficiency of diesel generator reducing its total operation time. |
| *Calculation of reference emissions* | Reference emissions are calculated on the basis of monitored electricity consumption at the project BTS. The reference grid electricity and/or diesel consumption are calculated based on |

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| | hours for which electricity is available from grid, and efficiency of diesel generator. Then, emissions from grid electricity and/or diesel consumption are calculated multiplying by $CO_2$ emission factor of grid electricity and/or diesel. |
| *Calculation of project emissions* | Project emissions are calculated on the basis of monitored grid electricity consumption and/or diesel consumption at the project BTS after implementation of the project, and $CO_2$ emission factor of grid electricity and/or diesel. |
| *Monitoring parameters* | -The amount of grid electricity consumed at *BTSi*<br>-The quantity of diesel consumed at *BTSi*<br>-The amount of electricity generated by the project diesel generator at *BTSi*<br>-The amount of electricity generated by the project solar PV systems at *BTSi*<br>-Hours for which electricity is available from grid at *BTSi*<br>-Hours of operation of *BTSi* |

## D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

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| Criterion 1 | The project installs Tribrid system(s) to new and/or existing BTS. |
| Criterion 2 | The project BTS is located at the telecom tower sites equipped with diesel generator. |
| Criterion 3 | The PV modules have obtained a certification of design qualifications (IEC 61215, IEC 61646, or IEC62108), and safety qualification (IEC 61730-1, and IEC 61730-2) at the time of validation based on the latest version of international or national standard. |
| Criterion 4 | The battery installed by the project is Li-ion battery. |
| Criterion 5 | In the case of replacing existing Lead-Acid battery with the project Li-ion battery, lead contained in existing Lead-Acid battery is not released to the environment. |

## E. Emission Sources and GHG types

| Reference emissions |
|---|

| Emission sources | GHG types |
|---|---|
| Emissions from grid electricity and/or captive electricity | $CO_2$ |
| Project emissions | |
| Emission sources | GHG types |
| Emissions from grid electricity and/or captive electricity | $CO_2$ |

## F. Establishment and calculation of reference emissions

### F.1. Establishment of reference emissions

Reference emissions are calculated on the basis of monitored electricity consumption at the project BTS. The reference grid electricity and/or diesel consumption that are calculated based on hours for which electricity is available from grid, and efficiency of diesel generator. Then, emissions from grid electricity and/or diesel consumption are calculated multiplying by $CO_2$ emission factor of grid electricity and/or diesel.

Reference emissions are calculated using design efficiency of new diesel generator to be installed at the project BTS when it's installed to the project BTS. If new diesel generator is not installed by the project, the design value of efficiency of the diesel generator operated at the project BTS at the time of validation is applied for the calculation of reference emissions. If more than one diesel generators are equipped at the project BTS, the most efficient value among the design efficiency of the equipped diesel generators is adopted for the calculation of the reference emissions.

**Ensuring net emission reductions**

Net emission reductions are ensured by adopting a design efficiency of the project diesel generator. If a new diesel generator replaces the existing one, the design efficiency of the new diesel generator is applied. It is also ensured by calculating fuel consumption by diesel generator based on the assumption that diesel generator operates steadily with design efficiency in reference scenario although actual fuel consumption is used for the project scenario.

### F.2. Calculation of reference emissions

$$RE_p = \sum_i \left( EC_{i,p} \times \frac{\tau_{i,p}}{T_{i,p}} \times EF_{grid} + \varphi_i \times (T_{i,p} - \tau_{i,p}) \times \rho_{diesel} \times 10^{-6} \times NCV_{diesel} \times EF_{diesel} \times 10^{-3} \right)$$

and

$$EC_{i,p} = EC_{i,grid,p} + EC_{i,diesel,p} + EC_{i,solar,p}$$

Where

| | | |
|---|---|---|
| $RE_p$ | = | Reference emissions during the period *p* ($tCO_2/p$) |
| $EC_{i,p}$ | = | Total electricity consumption at *BTSi* during the period *p* (MWh/p) |
| $EC_{i,grid,p}$ | = | The amount of grid electricity consumed at *BTSi* during the period *p* (MWh/p) |
| $EC_{i,diesel,p}$ | = | The amount of electricity generated by the project diesel generator at *BTSi* during the period *p* (MWh/p) |
| $EC_{i,solar,p}$ | = | The amount of electricity generated by the project solar PV system at *BTSi* during the period *p* (MWh/p) |
| $\tau_{i,p}$ | = | Hours for which electricity is available from grid at *BTSi* during the period *p* (h/p) |
| $T_{i,p}$ | = | Total hours of operation of *BTSi* during the period *p* (h/p) |
| $EF_{grid}$ | = | Grid $CO_2$ emission factor ($tCO_2/MWh$) |
| $\varphi_i$ | = | Design efficiency of diesel generator operated at the project BTS at the time of validation at 25% load to be installed at *BTSi* (L/h) |
| $\rho_{diesel}$ | = | Weighted average density of diesel (kg/L) |
| $NCV_{diesel}$ | = | Net calorific value of diesel (TJ/Gg) |
| $EF_{diesel}$ | = | Diesel $CO_2$ emission factor ($kgCO_2/TJ$) |

## G. Calculation of project emissions

$$PE_p = \sum_i \left( EC_{\mathrm{i,grid},p} \times EF_{grid} + FC_{i,diesel,p} \times \rho_{diesel} \times 10^{-6} \times NCV_{diesel} \times EF_{diesel} \times 10^{-3} \right)$$

Where

| | | |
|---|---|---|
| $PE_p$ | = | Project emissions during the period *p* ($tCO_2/p$) |
| $EC_{i,grid,p}$ | = | The amount of grid electricity consumed at *BTSi* during the period *p* (MWh/p) |
| $EF_{grid}$ | = | Grid $CO_2$ emission factor ($tCO_2/MWh$) |
| $FC_{i,diesel,p}$ | = | The quantity of diesel consumed at *BTSi* during the period *p* (L/p) |
| $\rho_{diesel}$ | = | Weighted average density of diesel (kg/L) |
| $NCV_{diesel}$ | = | Net calorific value of diesel (TJ/Gg) |
| $EF_{diesel}$ | = | Diesel $CO_2$ emission factor ($kgCO_2/TJ$) |

## H. Calculation of emissions reductions

$ER_p = RE_p - PE_p$

Where

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|---|---|---|
| $ER_p$ | = | Emission reductions during the period $p$ ($tCO_2/p$) |
| $RE_p$ | = | Reference emissions during the period $p$ ($tCO_2/p$) |
| $PE_p$ | = | Project emissions during the period $p$ ($tCO_2/p$) |

## I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

| Parameter | Description of data | Source |
|---|---|---|
| $\varphi_t$ | Design efficiency of diesel generator operated at the project BTS at the time of validation at 25% load to be installed at *BTSi* (L/h)<br>If new diesel generator is not installed by the project, the design value of the diesel generator operated at BTS at the time of validation is applied for the calculation of reference emissions. The design efficiency of the diesel generator at 25% value is applied.<br><br>As a load factor of diesel generator at BTS site, 25% load which is set for mini-grid with 24 hour services in CDM approved small scale methodology AMS-I.F. is adopted. According to the AMS-I.F., mini-grid is defined as small-scale power system with a total capacity not exceeding 15MW. For diesel generator operation at BTS connected to unreliable grid with available electricity less than 24 hours, adopting efficiency of diesel generator (L/h) | Specification of generator.<br>Manufacturer's data.<br>If more than one diesel generators are equipped at the project BTS, the most efficient value among the design efficiency of the equipped diesel generators is adopted for the calculation of the reference emissions. |

| | | |
|---|---|---|
| | at 25% load to ensure conservativeness. | |
| $EF_{grid}$ | Grid $CO_2$ emission factor ($tCO_2/MWh$) | The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Emission Factors of Electricity Interconnection Systems", National Committee on Clean Development Mechanism Indonesian DNA for CDM unless otherwise instructed by the Joint Committee. |
| $\rho_{diesel}$ | Weighted average density of diesel (kg/L) | a) Values provided by the fuel supplier in invoices, or<br>b) Regional or national default value. |
| $NCV_{diesel}$ | Net calorific value of diesel (TJ/Gg) | IPCC default values provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. |
| $EF_{diesel}$ | Diesel $CO_2$ emission factor ($kgCO_2/TJ$) | IPCC default values provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied. |

History of the document

| Version | Date | Contents revised |
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| 01.0 | 04 December 2017 | JC7, Annex 4<br>Initial approval. |
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