Appendix

Additional information to the Proposed Methodology
"Introduction of Biomass Combined Heat and Power Plant"

It is concluded to apply the: 1) boiler efficiency of 93% for calculating the reference emissions from heat generation; and 2) emission factor of 0.533 tCO_2/MWh and grid power interruption time percentage of 2% for calculating the reference emissions from electricity generation, to achieve net emission reductions.

1. Heat generation

1.1. Background

Emission reductions from displacement of fossil fuel consumed for heat production are calculated by multiplying the amount of heat displaced by the inverse of the reference boiler efficiency and emission factor of the reference fuel. In order to secure net emission reductions, the fuel used and efficiency of industrial boilers in Ethiopia were studied.

1.2. Findings and rationales

There is no official data on the boilers used in Ethiopia. However, from the interviews with government officials and business people it can be assumed that in Ethiopia, the common source of energy for boilers used in industries is diesel. It is also noted that thermal oil boilers are commonly used.

The efficiency of modern diesel -fired thermal oil boilers can be as high as 93%[1]. For example, Bono Energia S.p.A. has supplied at least four thermal oil boilers to Ethiopia[2].

The boilers usually run below the maximum efficiency because such efficiency is only achieved under certain optimal conditions. In order to achieve net emission reductions, it is assumed that the heat provided to the heat loads by the project biomass CHP plant displaces heat produced by a diesel-fired thermal oil boiler running constantly at an efficiency of 93%. Furthermore, the reference emissions assume zero heat loss during heat transfer from the boiler to the heat loads.

2. Electricity generation

2.1 Background

Emission reductions from displacement of fossil fuel consumed for electricity generation are calculated by multiplying the amount of electricity generated by the project biomass CHP plant, by the grid power interruption time percentage and emission factor of captive gensets. In order to secure net emission reductions, the annual time of power interruption and emission factors of captive gensets in Ethiopia were studied.

[1] Website of Bono Energia S.p.A.
[2] Information provided by Bono Energia S.p.A.

2.2. Findings and rationales

2.1. Status of grid power and power interruption

The power source of the national grid of Ethiopia is almost 100% renewable. However, power interruption is very common and industries requiring continuous operation resort to captive diesel power generation.

The Enterprise Surveys conducted during 2015 and 2016 by the World Bank[3] found that the number of power interruption in a typical month was 8.2 and each interruption lasted on average 4.6 hours. This translates into an interruption duration of approximately 453 hours per year or a power interruption time percentage of 5.2%.

In addition, the raw data of the medium voltage line interruption report provided by the Ethiopian Electric Utility was analyzed. The dataset contained the duration of power interruption of all medium voltage feeders in the greater Addis Ababa area recorded at the substations. The analysis found that the average interruption duration for a feeder ranged from 176 to 365 hours per year during the past three years[4]. This translates into a power interruption time percentage of 2.0% to 4.2%.

Accordingly, it is assumed that as the minimum ratio from the survey 2% of the electricity generated by the project biomass CHP plant displaces electricity generated by a captive diesel genset using the most efficient diesel power generator in the world, and the balance displaces grid electricity, which is assumed to have an emission factor of zero.

2.2. Emission factor of diesel power generation

The emission factor of the most efficient diesel power generation is found to be close to 0.533 tCO_2/MWh in the additional information for the approved JCM methodology PW_AM001 “Displacement of Grid and Captive Genset Electricity by a Small-scale Solar PV System.” According to that additional information, the most efficient diesel power generator in the world has a generation efficiency close to 49%. In order to achieve net emission reductions, an emission factor of 0.533 tCO_2/MWh, which corresponds to a power generation efficiency of 49%, is selected as the reference emission factor of captive gensets.

3. Conclusions

From the foregoing discussions, in order to achieve net emission reductions, it is concluded to apply the: 1) boiler efficiency of 93% for calculating the reference emissions from heat generation; and 2) emission factor of 0.533 tCO_2/MWh and grid power interruption time percentage of 2% for calculating the reference emissions from electricity generation.

[3] http://www.enterprisesurveys.org

[4] Data for the period of 1 June 2013 to 31 May 2016 was analyzed. In case of missing data or doubt in the recorded data, the analysis assumed zero interruption to ensure underestimation of the interruption duration.