CSG STANDARD

RENEWABLE ENERGY METHODOLOGY CSG STANDARD VERSION 1.1

1. DEFINITIONS

Emission factor: the quantity of GHG (greenhouse gas) emissions generated by a unit of fuel consumed, electricity produced, etc.

Consumer: a unit connected to the electrical grid which consumes electricity.

Power plant: an energy conversion facility at a single site which generates electrical power by using a primary energy source.

Annual average capacity factor: one-year constant power capacity of a given power plant. It is smaller than its rated capacity because the annual capacity factor takes into account the starts and stops, power changes, etc.

Fossil energy source: natural energy source either without regeneration mechanisms, or with very slow ones on the human scale.

Home Power Plant (HPP): a power supply unit that is connected to a low voltage grid; its rated capacity does not exceed the amount of available power at the connection point, or it does not exceed 50kW.

Small Power Plant (SPP): a power plant with a capacity smaller than 50 MW.

Cogeneration: energy production which simultaneously generates two types of energies, e.g. electricity and heat.

Gas engine: a power generation unit which produces electricity or heat by burning natural biogas or other fuel gas in using an Otto engine

Renewable energy source: energy sources that are *not* fossil fuels, or nuclear-based energy sources: solar, wind, geothermal energy, wave and tidal energy, hydro-power, biomass energy or energy generated directly or indirectly from biomass, landfill and sewer gas, and biogas.

Producer: a facility that produces electricity.

Electricity system: a system built for electricity transit which connects producers with consumers.

2. RENEWABLE ENERGY-BASED, GRID-ATTACHABLE ELECTRICITY PRODUCTION

The methodology is applicable to renewable energy-based power plants, small power plants, and home-based power (e.g. domestic roof-based solar panels) connected to the electrical power grid.

The methodology can be used for the following project types:

- building a new power plant (at a location where there was no grid-attachable electricity production unit before the realization of the project);
- expanding a power plant or power stations, or increasing performance; and
- the reconstruction of an existing power plant.

If the power plant to be built uses both renewable and non-renewable energy sources for producing electricity (e.g. solar panels, or wind generators along with gas engines), only the renewable energy produced should form the basis of GHG reductions calculations.
In case of cogeneration (combined heat and electricity), the methodology is not applicable.

2.1. PHYSICAL BOUNDARIES

The project contains the renewable energy-based power plant and all other power plants connected to the same electrical grid as the renewable energy-based power plant. The electrical system can be a smaller local system (e.g. the internal electrical grid of a factory site) with electrical energy producers and consumers connected to it. It can also be a large system; for example, the whole electrical power system of a country (e.g. the Hungarian national electricity system). If the renewable power plant is connected to the national public grid (e.g. in Hungary the ELMÜ-ÉMÁSZ, EDF DÉMÁSZ or E.ON networks), then the whole electricity system of the country should form the basis of calculating the emission factor.

2.2. CALCULATION OF BASELINE EMISSIONS

Baseline emissions can be calculated by multiplying the electrical power generated by the project activity (expressed in in kWh) and the emission factor of the electrical grid. The calculation is made as below in Equation 1.

$$BE = EG \cdot EF_{CO_2}$$

Equation 1

where:

- BE: baseline emission (tCO_2/year);
- EG: energy produced by a renewable energy-based power plant (kWh/year);
- EF_{CO_2}: network emission factor (tCO_2/kWh).

2.3. DETERMINING THE EMISSION FACTOR

The electrical power produced from renewable energy sources will reduce fossil power plant production (as these power plants are the ones that are adjusted to load demands on the electrical power grid). This is because the electricity generated from renewable energy sources does not affect:

- production of nuclear power plants because these power plants are always operated at the maximum capacity allowed by technical facilities, therefore, they are never adjusted to load demands on an electrical power grid; or
- small power plant production (as most of these are subject to mandatory takeover), thus they do not participate in the system's load distribution.

Electricity import mix does not have to be covered when calculating the emission factor due to the lack of exact data source.When calculating the emission factor, it is important to use the most up-to-date data available from the current year or, if it is not available, from the previous year. Data older than two year cannot be used for the calculation. The calculation of the emission factor is based on Equation 2 (below).

$$EF_{CO_2} = \frac{0,9 \cdot \sum_{i=1}^{m} \left[FC_{i;m} \cdot NCV_i \cdot EF_i \right]}{\sum_{i=1}^{m} EG_m}$$

Equation 2

where:

- EF_{CO_2}: network emission factor (tCO_2/kWh);
- $FC_{i;m}$: the quantity of the "i" type of fuel used by "m" power plant for the given year (m^3 or kg);
- NCV_i: calorific value of the "i" type fuel (J/m^3 or J/kg);
- EF_i emission factor of the "i" type fuel (tCO_2/J);
- EG_m: electrical power fed into the grid by "m" power plant (kW);
- the 0.9 multiplier is required because the whole fuel consumption, and thus part of its carbon emissions is turned into the production of heat produced in power plants. The emissions associated with the production of this heat is around 10 per cent, according to the most recent data (2011).

If the emission factors of the power plants are known, then Equation 3 is applicable instead of Equation 2.

$$EF_{CO_2} = \frac{\sum_{i=1}^{m} \left[EG_m \cdot EF_{PP;m} \right]}{\sum_{i=1}^{m} EG_m}$$

Equation 3

where:

- EF_{CO_2}: network emission factor (tCO_2/kWh);
- EG_m: electrical power fed into the grid by "m" power plant (kWh);
- $EF_{PP;m}$: the emission factor of "m" power plant (tCO_2/kWh).

If the average emission factors of the fuel used in power plants and the yearly average capacity of power plants are known, Equation 4 can also be used for making the calculation.

$$EF_{CO_2} = \frac{0,9 \cdot EF_{m;i} \cdot 3,6}{\eta_m}$$

Equation 4

where:

- EF_{CO_2}: network emission factor (tCO_2/kWh);
- $EF_{m;1}$: the average emission factor of the "i" fuel consumed by "m" power plant (tCO_2/GJ);
- η_m: yearly average capacity of "m" power plant.

3. MONITORING

All monitoring data has to be archived electronically, and retained for at least three years. Only calibrated measuring instruments can be used for monitoring. Some of the parameters have to be monitored continuously, and necessary calculations have to be made at least on a yearly basis. The calculations have to be documented electronically, and attached to the project plan documentation. All input data used for calculating the emission factor have to be recorded, including:

- for every power plant connected to the grid:
  - specific information needed to identify power plants;
  - the date of installation;
  - performance of the power plant;
  - the type and calorific value of fuel used in the power plant;
  - the quantity of electrical power fed into the electrical power grid by the specific power plant;
  - the amount of fuel used (if available);

- the CO_2 emission factors used;
- the calorific value of fuels; and
- the annual capacity factor of power plants.

4. PROJECT EMISSIONS

Usually, there is no fossil fuel consumed in the case of electricity production by renewable energy-based small power plants so the emission value of such projects is zero. If fossil fuel is also used along with renewable energy sources in a specific project, then the project's emissions can be calculated using Equation 5 (below).

$$PE = \sum_{i=1}^{n} FC_i \cdot NCV_i \cdot EF_i$$

Equation 5

where:

- PE: CO$_2$ emissions due to the fossil fuel consumed (tCO_2/year);
- FC_i: the annual quantity of "i" type of fuel consumed (kg/year or m^3/year);
- NCV_i: the average calorific value of "i" type fuel (J/kg or J/m^3);
- EF_i: the emission factor of "i" type fuel (tCO_2/J);
- n: the number of fuel types consumed.

5. ANNUAL EMISSION REDUCTION

After calculating the correlations outlined above, the emission reductions of a specific project can be calculated using Equation 6 (below).

$$ER = BE - PE$$

Equation 6

where ER: annual emission reduction (tCO_2/year).