JCM Proposed Methodology

"Installation of solar photovoltaic system and battery energy storage system to charge and discharge solar power through the grid"

Additional Information

1. calculating the conservative emission factor of Mongolia

Net emission reductions can be achieved by applying the following emission factors in Mongolia:

- An emission factor of **0.68 tCO_2/MWh**, which is the emission factor of the most efficient coal-fired CHP (Combined Heat and Power) plant in Mongolia, is applied in case the PV system in a proposed project activity is connected to the Mongolian national grid (supplied by the Central Energy System (CES), Western Energy System (WES), Altai-Uliastai Energy System (AUES), Eastern Energy System (EES), and/or Southern Energy Systems (SES)) including internal grid which is not connected to a captive power generator.
- An emission factor of **0.533 tCO_2/MWh**, which is the emission factor of the most efficient diesel power generator in the world, is applied in case the PV system in a proposed project activity is connected to internal grid which is connected to both the national grid (CES, WES, AUES, EES, and/or SES) and a captive power generator or in case the PV system in a proposed project activity is connected to an internal grid which is not connected to the national grid.

1.1 Current status of electricity mix in Mongolia

There are six types of fuel used for the national electricity generation: coal (lignite), wind, solar, hydro, diesel, and imported electricity[1]. Electricity generation by fuel type from 2019 to 2021 is shown in Figure 1 and Table 1. The amount of electricity from wind, solar, and hydro power plants, which are regarded as low cost/must run (LCMR) power sources, was 653.7GWh (7.5% of total and import) in 2019, 649.4 GWh (7.3% of total and import) in 2020, and 803.0 GWh (8.2% of total and import) in 2021.

[1] Development of National Methodology to Estimate Greenhouse Gas Emissions of Energy Sector of Mongolia, Energy Regulatory Commission, 2021

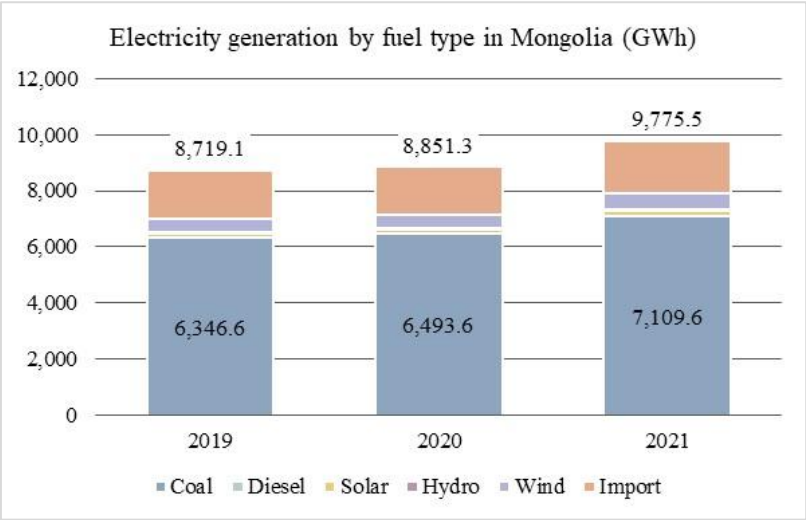

Figure 1. Electricity generation by fuel type in Mongolia from 2019 to 2021

(Source: Mongolia Energy Regulatory Commission, https://erc.gov.mn/web/mn/statistic)

Table 1. Electricity generation by fuel type in Mongolia from 2019 to 2021

Fuel type	Electricity generation (GWh)			% of total electricity generation (2021)
	2019	2020	2021	
Coal	6,346.6	6,493.6	7,109.6	89.84%
Diesel	3.0	2.7	1.1	0.01%
Solar	109.0	108.9	156.9	1.98%
Hydro	85.4	83.3	83.1	1.05%
Wind	459.3	457.2	563.0	7.12%
Total	7,003.3	7,145.7	7,913.7	100.00%
Import	1,715.8	1,705.6	1,861.8	(19.05% of "total + import")
Total + Import	8,719.1	8,851.3	9,775.5	-

(Source: Mongolia Energy Regulatory Commission, https://erc.gov.mn/web/mn/statistic)

The Mongolian national grid is composed of five interconnected electricity systems (Figure 2)[2]: CES, WES, AUES, EES, and SES. The national grid imports electricity from Russia and China (19.05% of all electricity generation in 2021). Electricity from China is also supplied to the Oyu Tolgoi area in the southern region and areas in the southern, western and eastern region. However, these areas are not connected to the Western Energy System, Eastern Energy System or Southern Energy System[3]. Therefore, these areas and their electricity imports from China are excluded from the calculation of the national grid emission factor.

[2] Current situation and future planning of the Mongolian energy sector (Ministry of Energy, 2021)

[3] Ministry of Energy, 2021

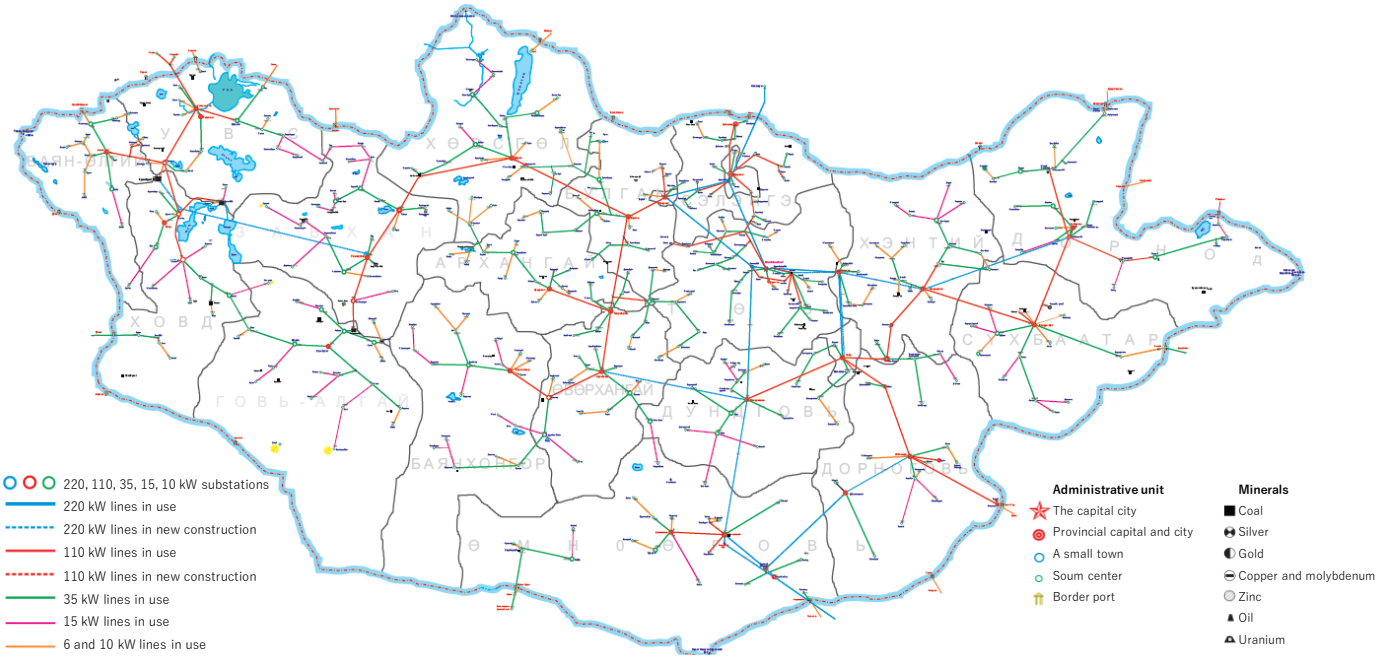

Figure 2. Map of the Mongolian electricity grid system

1.2 Calculation of coal-fired power plants emission factor

As reflected in the Table 1, 89.84% of electricity in the Mongolian grid is supplied by coal-fired CHP plants. In order to identify the conservative emission factor of the electricity system in a simple manner and to secure the net emission reductions, this methodology applies the lowest CO_2 emission factor of the coal-fired CHP plant supplying electricity to the main grid. The calculation of each coal-fired CHP plant emission factors was conducted using the specific fuel consumption of each power plant from the national authority and default values (Table 2) determined by the national authority and IPCC guidelines.

Table 2. Constants for calculation of emission factor

Item	Values	Reference[4]
CO_2 emission factor for lignite coal	90,900 $kgCO_2/TJ$	IPCC guideline for National Greenhouse Gas Inventories 2006, Chapter 2, stationary combustion
Net calorific value for lignite coal	13.4 GJ/ton	Development of National Methodology to Estimate Greenhouse Gas Emissions of Energy Sector of Mongolia, Energy Regulatory Commission, 2021

* Since the auxiliary power consumption is unknown, the plant efficiency of gross electricity generation is applied. This ensures the calculation of a conservative emission factor.

[4] IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval

The CO_2 emission factors of power generation by each coal-fired CHP plants are obtained using the following equation, applying the values indicated in Table 2.

CO_2 emission factor of power generation [tCO_2/MWh]
= Specific fuel consumption [g/kWh] * Net calorific value of fuel [TJ/Gg] * Effective CO_2 emission factor of lignite [$kgCO_2$/TJ] * 3.6 * 10^{-9}

The emission factors of each coal-fired CHP plant that supplies electricity to the Mongolian grid are calculated as listed in Table 3.

Table 3. CO_2 emission factors for electricity generation of coal-fired power plants in Mongolia

Plant name	CO_2 emission factor (tCO_2/MWh)	Publication year
CHPP-2	1.49	2021
CHPP-3	0.75	2021
CHPP-4	0.68	2021
DCHPP	1.42	2021
ECHPP	0.94	2021
EFCHPP	1.48	2021
UKhCHPP	2.00	2021
DRES	1.72	2021
DzCHPP	2.00	2021

(Source: Mongolia Energy Regulatory Commission, https://erc.gov.mn/web/mn/statistic)

As a result, the most efficient coal-fired CHP plant that supplies electricity to the grid is identified as CHP4, with a plant emission factor of 0.68 tCO_2/MWh. This value is lower than the emission factor of the CES grid (0.75 tCO_2/MWh), published by Energy Regulatory Commission in 2021. The emission factor of CES grid decreased because of the increasing electricity production from renewable sources (wind and solar) in the CES, which reached 9.1% in 2021.

1.3 Calculation of the emission factor of a diesel generator

To determine the emission factor of a diesel generator in a conservative and simple manner, the highest heat efficiency is applied.

The CO_2 emission factor of diesel power generation is calculated from the heat efficiency using the following equation:

CO_2 emission factor of power generation [tCO_2/MWh]
= CO_2 emission factor of fuel source [$kgCO_2$/TJ] *3.6*10^{-6}/ (Heat efficiency (LHV) [%]*100)

Applying the default value of the CO_2 emission factor of diesel combustion which is 72,600 $kgCO_2/TJ$ derived from "IPCC guideline 2006, Chapter 2, stationary combustion", together with the heat efficiency of 49%, the efficiency level which has not been achieved yet by the world's leading diesel generator, the CO_2 emission factor for diesel generator is calculated to be **0.533 tCO_2/MWh**.