Additional Information on the revision of the approved methodology TH_AM001 "Installation of Solar PV System"

1. Background

In the approved JCM methodology TH_AM001, reference CO_2 emission factor of grid and/or captive electricity was set based on the status about the mix of power sources and the power generation efficiency of related power sources in Thailand prior to 2016, when the initial version of the methodology was developed. Since then, the status may have changed, which means that the emission reductions may be overestimated when the calculation is based on the CO_2 emission factor determined in 2016.

Therefore, the information necessary to determine the CO_2 emission factor was collected in December 2023, and based on this, a decision was made with regard to whether the CO_2 emission factor needs to be updated in order to ensure conservativeness and net emission reductions.

2. Findings and rationales

2.1. Current status of the mix of power sources in Thailand

To this day, natural gas-fired power plants have the largest share of the power supply in Thailand. The share was around 53.6% of the total as of the most recent year. The share of coal and lignite was approximately 17.3% of the power supply. The share of petroleum was only around 0.7%. The combined margin (CM) emission factor of the grid in Thailand published in 2021 is 0.525 tCO_2eq/MWh.

2.2. Power generation efficiency and emission factor of natural gas-fired power plants

In order to identify the most efficient natural gas-fired power plants in Thailand, desk research was conducted. The power plants identified in the research are listed in Table 1. The most efficient power plant identified through this research was manufactured by GE Vernova and has been owned by EGAT (Electricity Generating Authority of Thailand), having efficiency of 64.1% (Lower Heating Value: LHV).

Table 1: Efficiency of natural gas-fired power plants in Thailand

Manufacturer	Product	Capacity	Plant efficiency (LHV)
GE Vernova[1]	9HA.02	N/A	64.1%
Mitsubishi Heavy Industry[2]	M701JAC	N/A	64%
IHI Corporation[3]	LM6000PF	60MW	>54%

Although it has not been possible to confirm that this power plant manufactured by GE Vernova is the most efficient natural gas-fired power plant in Thailand, this power plant, which has the efficiency of 64%, is more efficient than the most efficient group of natural gas-fired power plants in commercial operation in Japan, which has the efficiency of 56-62% (LHV).

In this methodology, emission reductions are calculated by using the emission factor of the grid electricity that is replaced. However, it is difficult to identify which of the natural gas-fired power plants is displaced by the project solar PV system(s), and even if it is identified, it is difficult to calculate the CO_2 emission factor of power generation by such natural gas-fired power plant(s) due to the absence of dataset. Therefore, the grid CO_2 emission factor of replaced electricity is established by assuming that the most efficient natural gas-fired power plant in Thailand is displaced in conservative manner, which will lead to ensuring net emission reductions. It is assumed that the most efficient natural gas-fired power plant in Thailand has the efficiency of 64.1% (LHV).

The CO_2 emission factor of power generation by natural gas-fired power plant can be calculated from the plant efficiency using the following equation.

CO_2 emission factor of power generation by natural gas-fired power plant [tCO_2eq/MWh]
= CO_2 emission factor of natural gas [tCO_2eq/MM standard cubic foot (scf)] / (Plant efficiency (LHV) [%] / 100) * 1,000 * 3.6 / (Net calorific value of natural gas [MJ/scf] * 10^6)

Applying the values indicated in Table 2, the CO_2 emission factor of power generation by the most efficient natural gas-fired power plant of **0.305 tCO_2eq/MWh** is derived. This value is lower than the combined margin (CM) emission factor of the grid (0.566 tCO_2eq/MWh) shown in

[1] https://www.ge.com/gas-power/products/gas-turbines/9ha
https://www.ge.com/gas-power/resources/case-studies/egat-thailand-9ha02-gas-turbine
[2] https://www.mhi.com/jp/news/220905.html
[3]
https://www.ihi.co.jp/all_news/2018/resources_energy_environment/1190429_1616.html
https://www.ihi.co.jp/powersystems/lineup/LM6000/index.html

Section 2.1. From this result, it can be concluded that by applying the emission factor of power generation by the most efficient natural gas-fired power plant for grid electricity displaced by the electricity generated by the project solar PV system(s) will ensure net emission reductions.

Table 2: Constants for calculation of CO_2 emission factor

Item	Values	Source
CO_2 emission factor of natural gas	55.39 tCO_2eq/MMscf	A study on Thailand grid emission factor 2014
Net calorific value of natural gas	1.02 MJ/scf	A study on Thailand grid emission factor 2014
Plant efficiency (LHV) of most efficient natural gas-fired power plant	64.1%*	Table 1

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

2.3. CO_2 emission factor of captive power generator

As shown in Table 3, the emission factor of the most efficient captive power generator is identified as 0.46 tCO_2eq/MWh. This value is greater than the CO_2 emission factor of power generation by the most efficient natural gas-fired power plant in Thailand, 0.305 tCO_2eq/MWh, derived in Section 2.2.

Therefore, the CO_2 emission factor of the most efficient natural gas-fired power plant will ensure net emission reductions for a project activity that displaces captive electricity by the electricity generated by the project solar PV system(s).

Table 3: CO_2 emission factor of captive electricity by fuel type

Fuel type	CO_2 emission factor	Source
Diesel oil	0.8 tCO_2eq/MWh	CDM approved small scale methodology: AMS-I.A. (Version 19.0)
Natural gas	0.46 tCO_2eq/MWh*	・ 2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas ・ CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems" (Version 03.0) for the default efficiency for off-grid power plants.

* CO_2 emission factor of power generation by natural gas-fired captive generator can be calculated

with the following equation. The lower value of default effective CO_2 emission factor for natural gas (0.0543 tCO_2eq/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.

CO2 emission factor of power generation by natural gas-fired captive generator [tCO_2eq/MWh] = 3.6 * (100 / power generation efficiency [%]) * CO_2 emission factor of natural gas [tCO_2eq/GJ]

3. Conclusion

As Table 4 shows, reference CO_2 emission factor of grid and/or captive electricity calculated based on the latest information (0.305 tCO_2eq/MWh) is lower than that determined in the initial version of the methodology. Therefore, the CO_2 emission factor is required to be updated to 0.305 tCO_2eq/MWh to ensure conservativeness and net emission reductions.

Table4: Reference CO_2 emission factor of electricity before/after update

Methodology version	Reference CO_2 emission factor of grid and/or captive electricity
TH_AM001 version 01.0/02.0	0.319 tCO_2eq/MWh
TH_AM001 version 03.0	0.305 tCO_2eq/MWh