Additional Information on Proposed Methodology

"Waste heat recovery and utilization by installing Heat exchanger to existing waste heat recovery boiler of gas co-generation system"

The way of thinking about BaU (in case that existing activity would be continue in the absence of the project) emissions, reference emissions and net emission reductions in this methodology are as follows;

By implementing the project, the amount of fossil gas fuel consumed by duct burner of heat recovery steam generator (HRSG) is reduced because that the temperature of feed water into HRSG is increased by heat recovered by project heat exchanger.
While the amount of waste heat from exhaust gas of gas turbine into HRSG is expected to be same as the one without in the absence of the project (BaU status).

$$QH_{gt,in,BaU} = QH_{gt,in,PJ} \ (= QH_{gt,in})$$

$$QH_{db,in,BaU} > QH_{db,in,PJ}$$

$$QH_{db,in,BaU} / QH_{gt,in,BaU} > QH_{db,in,PJ} / QH_{gt,in,PJ}$$

As for reference status in this methodology, it is assumed as the following 2 equations to secure net emission reductions;

$$QH_{db,in,RE} + QH_{gt,in,RE} = QH_{db,in,PJ} + QH_{gt,in,PJ} < (QH_{db,in,BaU} + QH_{gt,in,BaU})$$

the ratio of $QH_{db,in,RE}$ to $QH_{gt,in,RE}$ is set to be same as the one in BaU to secure conservativeness in reference.

$$QH_{db,in,BaU} / QH_{gt,in,BaU} = QH_{db,in,RE} / QH_{gt,in,RE} > QH_{db,in,PJ} / QH_{gt,in,PJ}$$

So, the following 2 magnitude relationships are shown.

$$QH_{db,in,BaU} > QH_{db,in,RE} > QH_{db,in,PJ}$$

$$QH_{gt,in,BaU} = QH_{gt,in,PJ} \ (= QH_{gt,in}) > QH_{gt,in,RE}$$

Where;

$QH_{db,in,BaU}$: Amount of heating energy inputted into feed water through combustion of fossil gas fuel by duct burner in the absence of the project (BaU status) [GJ]

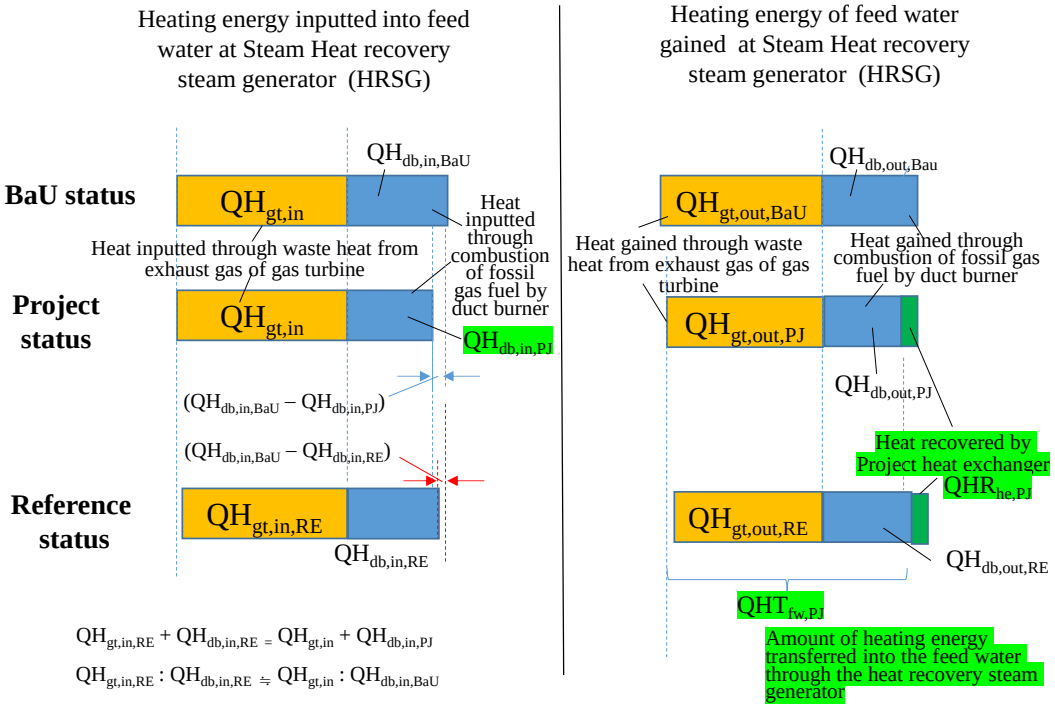
$QH_{db,in,PJ}$: Amount of heating energy inputted into feed water through combustion of fossil gas fuel by duct burner in the project [GJ]

$QH_{db,in,RE}$: Amount of heating energy inputted into feed water through combustion of fossil gas fuel by duct burner in reference [GJ]

$QH_{gt,in,BaU}$: Amount of heating energy inputted into feed water through waste heat from exhaust gas of gas turbine in the absence of the project (BaU status) [GJ]

$QH_{gt,in,PJ}$: Amount of heating energy inputted into feed water through waste heat from exhaust gas of gas turbine in the project [GJ]

$QH_{gt,in,RE}$: Amount of heating energy inputted into feed water through f waste heat from exhaust gas of gas turbine in reference [GJ]



Note) Only 2 parameters in green highlight can be known by measured data and calculation after the project starts

Only $QH_{db,in,PJ}$, $QHR_{he,PJ}$ and $QHT_{fw,PJ}$ can be estimated in the project.
Therefore, use these three to conservatively calculate reference emissions.
BaU (in the absence of the project) emissions is shown as follows;

$$BE = (QH_{db,in,BaU} - QH_{db,in,PJ}) \times EF_{gas,fuel}$$

Utilization situation of waste heat by exhaust gas of gas turbine within Steam Heat recovery steam generator (HRSG) nearly unchanged in the presence or absence of project. In both supply the side for heating energy inputted into feed water (the left side in above figure) and the side for heating energy of feed water gained (the right side in above figure), the sharing rate of the amount of heating energy through waste heat from exhaust gas of gas turbine in total amount of heating energies in project is rarely different from the one in BaU.
So, It can be inferred that the ratio of the amount of heating energy of gas fuel saved by project ($QH_{db,in,BaU} - QH_{db,in,PJ}$) to the amount of heating energy of gas fuel consumed in BaU ($QH_{db,in,BaU}$) is rarely different from the ratio of the amount of heat energy recovered by Project heat exchanger ($QHR_{he,PJ}$) to the amount of heating energy gained through combustion of fossil gas fuel by duct burner in BaU ($QH_{db,out,BaU}$).

$$(QH_{db,in,BaU} - QH_{db,in,PJ}) / QH_{db,in,BaU} \fallingdotseq QHR_{he,PJ} / QH_{db,out,BaU}$$

Furthermore, It can be inferred that the ratio of the amount of heating energy of gas fuel saved by project ($QH_{db,in,BaU} - QH_{db,in,PJ}$) to the amount of heating energy of gas fuel consumed in Project ($QH_{db,in,PJ}$) is rarely different from the ratio of the amount of heat energy recovered by Project heat exchanger ($QHR_{he,PJ}$) to the amount of heating energy gained through combustion of fossil gas fuel by duct burner in Project ($QH_{db,out,PJ}$).

$$(QH_{db,in,BaU} - QH_{db,in,PJ}) / QH_{db,in,PJ} \fallingdotseq QHR_{he,PJ} / QH_{db,out,PJ}$$

So, $(QH_{db,in,BaU} - QH_{db,in,PJ})$ is shown as follows;
$(QH_{db,in,BaU} - QH_{db,in,PJ}) \fallingdotseq QH_{db,in,PJ} \times QHR_{he,PJ} / QH_{db,out,PJ}$

So, BE is shown as follows:

Therefore, BaU emissions can be shown as the hollowing equation.

$$BE \fallingdotseq QH_{db,in,PJ} \times (QHR_{he,PJ}/QH_{db,out,PJ}) \times EF_{gas,fuel}$$

Above equation means that heating energy saved by the project is almost only the one from fossil gas fuel consumed by duct burner.
Next, the following equation means that the total amount of heating energy saved by the project

is distributed into the one from fossil gas fuel consumed by duct burner and the one of waste heat from exhaust gas of gas turbine by a certain ratio. So, the amount of saving fossil gas fuel consumed by duct burner is conservatively identified.

(If the value of $QH_{gt,out,PJ}$(parameters in blue highlight) is added to the section of denominator, the value of the following section will be lower than the value of the above-described section)

$$> QH_{db,in,PJ} \times \{QHR_{he,PJ}/(QH_{gt,out,PJ} + QH_{db,out,PJ})\} \times EF_{gas,fuel}$$
$$= QH_{db,in,PJ} \times (QHR_{he,PJ}/QHT_{fw,PJ}) \times EF_{gas,fuel}$$
$$= RE$$

Where;

BE	:	Emissions in the absence of the project [tCO_2]
RE	:	Reference emissions [tCO_2]
$QH_{db,in,BaU}$	:	Amount of heating energy inputted into feed water through combustion of fossil gas fuel by duct burner in the absence of the project (BaU status) [GJ]
$QH_{db,in,PJ}$	:	Amount of heating energy inputted into feed water through combustion of fossil gas fuel by duct burner in the project [GJ]
$QHR_{he,PJ,i,p}$	:	Amount of heating energy recovered by project heat exchanger [GJ]
$QH_{db,out,PJ}$		Amount of heating energy of feed water gained through combustion of fossil gas fuel by duct burner in the project [GJ]
$QH_{gt,out,PJ}$	:	Amount of heating energy of feed water gained through recovery of waste heat by exhaust gas of gas turbine in the project [GJ]
$EF_{gas,fuel}$	:	CO_2 emission factor for the fossil gas fuel consumed by duct burner
$QHT_{fw,PJ}$	:	Amount of heating energy transferred into the feed water through the heat recovery steam generator with project heat exchanger [GJ]

Therefore, as above mentioned, the amount of fossil gas fuel saved by the project is calculated lower than the one in actual status and reference emissions are ensured net emission reductions.