JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form

Form for submitting the proposed methodology

Host Country	The republic of Indonesia
Name of the methodology proponents submitting this form	Otsuka Pharmaceutical Factory, Inc.
Sectoral scope(s) to which the Proposed Methodology applies	3. Energy demand
Title of the proposed methodology, and version number	Energy saving by introducing waste hot water recovery system to autoclave in infusion manufacturing process line Ver. 01.0
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☐Additional information
Date of completion	11/12/2020

History of the proposed methodology

Version	Date	Contents revised
1.0	11/12/2020	First edition

A. Title of the methodology

Energy saving by introducing waste hot water recovery system to autoclave in infusion manufacturing process line Ver. 01.0

B. Terms and definitions

Terms	Definitions
Infusion manufacturing process line (IMP line)	A process line for sterilizing medical infusion fluid packs with hot water consisting of autoclave, water storage tank, pump, heat exchanger, which meets the standards for manufacturing control and quality control required in GMP guideline (Good Manufacturing Practice Guide for Active Pharmaceutical Ingredients).
Waste hot water recovery system	A system in which waste hot water drained from an autoclave is recovered and recycled in an IMP line
Recovery pump	A pump for waste hot water recovery system, which sends recovered waste hot water to a storage tank

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Installation of waste hot water recovery system to an IMP line reduces the amount of steam supplied by a boiler for heating water. It leads to reduction of fuel consumed by the boiler for generating steam, which consequently leads to GHG emission reductions.
Calculation of reference emissions	Reference emissions are calculated with the quantity of steam supplied to the heat exchanger, the ratio of heat quantity required under the project condition and the reference condition, the ratio of temperature difference under the project condition and the reference condition, fuel consumption by the boiler, net calorific value of fuel consumed by the boiler, total quantity of steam generated by the boiler supplying steam to the

	heat exchanger in the project IMP line, and GHG emission factor of fuel consumed by the boiler.
Calculation of project emissions	Project emissions are GHG emissions from using a recovery pump for hot water recovery system in the project IMP line, calculated with electricity consumption by the recovery pump and GHG emission factor for consumed electricity.
Monitoring parameters	● Total number of batch processes implemented in the project IMP line ● Total number of the drainage from the project autoclave ● Total quantity of steam supplied to the heat exchanger ● Total quantity of steam generated by the boiler supplying steam to the heat exchanger in the project IMP line ● Fuel consumption by the boiler supplying steam to the heat exchanger in the project IMP line ● Electricity consumption of the recovery pump for the project waste hot water recovery system

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	Waste hot water recovery system is newly installed to an autoclave(s) in an infusion manufacturing process line (IMP line).

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Fuel consumption by reference boiler	CO_2
Project emissions	
Emission sources	GHG types
Electricity consumption by recovery pump to recover waste hot water	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated based on: the quantity of steam supplied to the heat exchanger; the ratio of heat quantity required under the project condition and the reference condition; the ratio of temperature difference under the project condition and the reference condition; fuel consumption by the boiler; net calorific value of fuel consumed by the boiler; total quantity of steam generated by the boiler supplying steam to the heat exchanger in the project IMP line; CO_2 emission factor for fuel consumed by boiler to supply steam to the heat exchanger in the project IMP line.

In the water cycle of the reference system, pure water is produced and drained in each batch process. On the other hand, in the water cycle of the project system, pure water is produced at the first batch process, then recovered and reused for multiple batch processes. Therefore, the electricity consumption for producing pure water is reduced in the project system compared to the reference system. Net emission reductions are ensured by excluding the emission reductions by the reduction of the electricity consumption for producing pure water.

F.2. Calculation of reference emissions

$$RE_p = \sum_i \left\{ QS_{PJ,i,p} \times \frac{HQW_{PJ,recovery,i,p}}{HQW_{PJ,total,i,p}} \times \left(\frac{\Delta T_{RE}}{\Delta T_{PJ,i}} - 1 \right) \right\} \times \frac{\sum_k \left(FC_{PJ,k,p} \times NCV_{fuel,k} \times EF_{fuel,PJ,k} \right)}{\sum_k QS_{PJ,k,p}}$$

$$HQW_{PJ,totali,p} = HQW_{PJ,recovery,i,p} + HQW_{PJ,drain,i,p}$$

$$HQW_{PJ,recovery,i,p} = WI_{PJ,i} \times \left(N_{PJ,i,p} - D_{PJ,i,p} \right) \times SG_{PJ} \times SH_{PJ} \times \Delta T_{PJ,i} \div 10^6$$

$$HQW_{PJ,drain,i,p} = WI_{PJ,i} \times D_{PJ,i,p} \times SG_{PJ} \times SH_{PJ} \times \Delta T_{RE} \div 10^6$$

Where:

RE_p	Reference emissions during the period *p* [tCO2/p]
$FC_{PJ,k,p}$	Fuel consumption by the boiler *k* during the period *p* [mass or

	volume/p]
$NCV_{fuel,k}$	Net calorific value of fuel consumed by the boiler *k* [GJ/mass or volume]
$QS_{PJ,i,p}$	Total quantity of steam supplied to the heat exchanger in the project IMP line *i* during the period *p* [t/p]
$QS_{PJ,k,p}$	Total quantity of steam generated by the boiler *k* during the period *p* [t/p]
$HQW_{PJ,total,i,p}$	Total heat quantity required for heating water to the temperature specified in GMP guideline, in the project IMP line *i* during the period *p* [GJ/p]
$HQW_{PJ,recovery,i,p}$	Heat quantity required for heating recovered hot water to the temperature specified in GMP guideline, in the project IMP line *i* during the period *p* [GJ/p]
$HQW_{PJ,drain,i,p}$	Heat quantity required for heating pure water in the first batch after drainage to the temperature specified in GMP guideline, in the project IMP line *i* during the period *p* [GJ/p]
$\Delta T_{PJ,i}$	Temperature difference between the temperature specified in GMP guideline and the temperature of recovered hot water flowing into the heat exchanger in the project IMP line *i* [degree Celsius]
ΔT_{RE}	Temperature difference between the temperature specified in GMP guideline and the temperature of pure water flowing into the heat exchanger in the first batch after drainage [degree Celsius]
$WI_{PJ,i}$	Water quantity per a batch process consumed in the project IMP line *i* [L/time]
$N_{PJ,i,p}$	Total number of batch processes implemented in the project IMP line *i* during the period *p* [times/p]
$D_{PJ,i,p}$	Total number of hot water drainage from the project IMP line *i* during the period *p* [times/p]
SG_{PJ}	Specific gravity of pure water [kg/L]
SH_{PJ}	Specific heat of water under the project condition [kJ/kg/degree Celsius]
$EF_{fuel,PJ,k}$	CO_2 emission factor for fuel consumed by the boiler *k* [tCO_2/GJ]
i	Identification number of the project IMP line
k	Identification number of the boiler supplying steam to the heat exchanger in the project IMP line

G. Calculation of project emissions

$$\boldsymbol{PE_p = \sum_i \sum_j EC_{PJ,i,j,p} \times EF_{elec}}$$

Where:

PE_p	Project emissions during the period *p* [tCO_2/p]
$EC_{PJ,i,j,p}$	Electricity consumption by the project recovery pump *j* in the project IMP line *i* during the period *p* [MWh/p]
EF_{elec}	CO_2 emission factor for consumed electricity [tCO_2/MWh]
i	Identification number of the project IMP line
j	Identification number of project recovery pump in the project IMP line

If $EC_{PJ,i,j,p}$ is not monitored, it is calculated by the following equation.

$$\boldsymbol{EC_{PJ,i,j,p} = RPC_{PJ,i,j} \div 1000 \times N_{PJ,i,p} \times OH_{PJ,i,j}}$$

Where:

$EC_{PJ,i,j,p}$	Electricity consumption by the project recovery pump *j* in the project IMP line *i* during the period *p* [MWh/p]
$RPC_{PJ,i,j}$	Rated power consumption of the project recovery pump *j* in the project IMP line *i* [kW]
$N_{PJ,i,p}$	Total number of batch processes implemented in the project IMP line *i* during the period *p* [times/p]
$OH_{PJ,i,j}$	Operating hours per a batch process of the project recovery pump *j* in the project IMP line *i* [h/time]
i	Identification number of the project IMP line
j	Identification number of project recovery pump in the project IMP line

H. Calculation of emissions reductions

$$\boldsymbol{ER_p = RE_p - PE_p}$$

Where:

ER_p	: Emission reductions during the period *p* [tCO_2/p]
RE_p	: Reference emissions during the period *p* [tCO_2/p]
PE_p	: Project emissions during the period *p* [tCO_2/p]

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
EF_{elec}	CO_2 emission factor for consumed electricity [tCO_2/MWh] When the recovery pump consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When the recovery pump consumes both grid electricity and captive electricity, the project participant applies the CO_2 emission factor with higher value. **[CO_2 emission factor]** For grid electricity: the most recent value available from the source stated in this table at the time of validation. For captive electricity, it is determined based on the following options: a) Calculated from its power generation efficiency (η_{cap} [%]) obtained from manufacturer's specification The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; $$EF_{elec} = 3.6 \times \frac{100}{\eta_{cap}} \times EF_{fuel,cap}$$ b) Calculated from measured data The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{cap,p}$) and the amount	**[Grid electricity]** The data is sourced from "Emission Factors of Electricity Interconnection Systems", National Committee on Clean Development Mechanism (Indonesian DNA for CDM), based on data obtained by Directorate General of Electricity, Ministry of Energy and Mineral Resources, Indonesia, unless otherwise instructed by the Joint Committee. **[Captive electricity]** For the option a) Specification of the captive power generation system, provided by the manufacturer (η_{cap} [%]). CO_2 emission factor of the fuel consumed by the captive power generation system ($EF_{fuel,cap}$ [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the project participants; 3) regional or national

	of electricity generated ($EG_{cap,p}$) during the monitoring period p is applied. The measurement is conducted with the monitoring equipment to which calibration certificate is issued by an entity accredited under national/international standards; $EF_{elec} = FC_{cap,p} \times NCV_{fuel,cap} \times EF_{fuel,cap} \times \frac{1}{EG_{cap,p}}$ Where: $NCV_{fuel,cap}$: Net calorific value of the fuel consumed by the captive power generation system [GJ/mass or volume] **c)** <u>Conservative default value:</u> A value of <u>1.3 tCO_2/MWh</u> is applied.	default values; 4) IPCC default values provided in table1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied. For the option b) Generated and supplied electricity by the captive power generation system ($EG_{cap,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{cap,p}$ [mass or volume/p]). Net calorific value ($NCV_{fuel,cap}$ [GJ/mass or volume]) and CO_2 emission factor of the fuel ($EF_{fuel,cap}$ [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the project participants; 3) regional or national default values; 4) IPCC default values provided in tables 1.2 and 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Upper value is applied. <u>For the option **c)**</u>

		CDM methodological tool "TOOL 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, version 03.0"
$EF_{fuel,PJ,k}$	CO_2 emission factor for fuel consumed by the boiler *k* [tCO_2/GJ]	IPCC default value provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower limit value is applied.
$NCV_{fuel,k}$	Net calorific value of fuel consumed by the boiler *k* [GJ/mass or volume]	In the order of preference: a) value provided by fuel supplier; b) value measured by the project participants; c) regional or national default value; or d) IPCC default value provided in table 1.2 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.
$\Delta T_{PJ,i}$	Temperature difference between the temperature specified in the GMP guideline and the temperature of recovered hot water flowing into the heat exchanger in the project IMP line *i* [degree Celsius] $\Delta T_{PJ,i}$ is set *ex-ante* or *ex-post* by averaging the data monitored for at least 30 batches at recovered hot water tank.	Monitored data.
ΔT_{RE}	Temperature difference between the temperature specified in the GMP guideline	Monitored data.

	and the temperature of pure water flowing into the heat exchanger in the first batch after drainage [degree Celsius] ΔT_{RE} is set *ex-ante* or *ex-post* by averaging the data monitored for at least 30 days at pure water tank.	
SG_{PJ}	Specific gravity of pure water [kg/L]	Theoretical value.
SH_{PJ}	Specific heat of water under the project condition [kJ/(kg*K)] SH_{PJ} | 4.184	Theoretical value provided in table 6 of Cabinet Order No. 357 of 1992, Japan
$WI_{PJ,i}$	Water quantity per a batch process of autoclave in the project IMP line *i* [L/time]	Specification of the autoclave in the project IMP line *i*.
$RPC_{PJ,i,j}$	Rated power consumption of the project recovery pump *j* in the project IMP line *i* [kW]	Specification of the recovery pump *j* in the project IMP line *i*.
$OH_{PJ,i,j}$	Operating hours per a batch process of the project recovery pump *j* in the project IMP line *i* [h/time] $OH_{PJ,i,j}$ is set *ex-ante* or *ex-post* by averaging the data monitored for at least 30 batches at recovery pump.	Monitored data.