T-VER-P-METH-06-01

Energy Efficiency Improvement from District Cooling System

Version 01

Scope: 03 - Energy demand

Entry into force on 25 September 2024

1. Methodology	Energy Efficiency Improvement from District Cooling System
2. Project Type	Increasing energy efficiency in buildings and factories and in the household
3. Scope	03 – Energy demand
4. Project Outline	Project activity is aimed to increase the energy efficiency in air conditioning systems with a district cooling system.
5. Applicability	Project activity must have one of the following characteristics: 1) New installation of a district cooling system including chilled water piping network. 2) New installation of a district cooling system using the existing chilled water piping network. 3) New installation of a district cooling system using the existing chilled water piping network or expansion of the chilled water piping network.
6. Project Conditions	1) Installing a district cooling system in an existing building group, the traditional cooling system for the baseline activity is: • Split type air conditioning system or • District cooling system for each building. 2) Types of chillers in a district cooling system that are eligible including: • Vapor compression cooling system or • Thermal cooling system 3) Requirements of refrigerants used in district cooling systems must be that: • Global Warming Potential (GWP) 's value not exceeding GWP for Difluoromethane: CH_2F_2 (commercial name of R32 refrigerant) equaled to 675. • No ozone depletion (Ozone Depleting Potential: OPD is equal to zero). 4) The project owner or project developer must demonstrate the good scientific practice for refrigerant management in the baseline cooling system such as collection for reclaim, destruction with high temperatures incineration, etc.

	5) The project owner or project developer must demonstrate the monitoring practice for refrigerant that recharges and leaks out throughout the crediting period.
7. Project Starting Date	The date the project owner (employer) and contractor have jointly signed a contract for construction or installation of a greenhouse gas reduction project that will be developed into a T-VER project.
8. Definition	**Building:** Individual construction that is either a residential or commercial consumer of district cooling **A group of buildings**: Several buildings that are designed to use chilled water from the project. **Buildings that use cooling:** Buildings within the scope of the project that use cooling system from the base case before the start of the project and have cooling from project activities. **New buildings:** Buildings within the project boundaries that are newly built. After the project activities are carried out and the cooling from the project activities is used. **Refrigerant:** Liquid chemicals used in the refrigeration cycle to transfer heat from chilled water in cooling systems. **Cold water:** Water or water mixed with additives which has a low temperature from exchanging heat with refrigerant through the cold production system and is sent through a network of chilled water pipes for use in air conditioning systems. **Coolant:** the liquid used to remove heat from a cooling system. **District cooling system:** Producing chilled water at central utility buildings and sending it through a network of chilled water pipes for use in air conditioning. Does not include systems that deliver refrigerant directly to the cold distribution section such as variable refrigerant volume (VRV), variable refrigerant flow (VRF), etc. **Total air-conditioned area**: the total area that is air-conditioned, including the thickness of the walls, including service areas such as meeting rooms, corridors, etc.
9. Note:	

Details of T-VER methodology for

Energy Efficiency Improvement from District Cooling System

1. Greenhouse gas emission reduction activities used in the calculations

Table 1 Sources and types of greenhouse gases

Greenhouse gas emission	Source	Type of greenhouse gas	Details of activities that emit greenhouse gas emissions
Baseline emission	Using of electricity	CO_2	Electricity use in the cooling system from the baseline activity.
Project emission	using of electricity	CO_2	Electricity use in the district cooling system.
	Using of fossil fuels	CO_2	Production of heat duty from fossil fuel combustion for district cooling system.
Leakage	Leakage of refrigerant	HFCs และ PFCs	Leakage of refrigerant in the district cooling system.
	Using of water	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3	Using water in water cooled condenser of district cooling system.

2. Applicability and Scope of Project

Project activity must be the new installation of a district cooling system and chilled water piping network or the new installation of a district cooling system using the existing chilled water piping network or the installation of a new chilled water piping network or the additional installation district cooling using the existing chilled water pipe network or expanding the chilled water piping network. The project scope covers chiller system, chilled water piping network, cooling distribution station, buildings that use cooling and buildings that will use cooling.

3. Additionality

The project activity must be proven the additionality using “Guidelines to Additionality Demonstration under the Thailand Voluntary Emission Reduction Program: T-VER” published by the TGO. In addition, project owners or project developers applying the district cooling system gaining subsidies from government agencies must create guidelines to prove additional financial operations including amount of all direct and indirect support, such as direct subsidies and various

tax deductions, etc. as well as the income of the lost area for commercial use resulting to the installation of the district cooling system and chilled water piping networks.

4. Baseline Scenario

Referring to the guidelines for determining the baseline scenario with the concept of Below Business as Usual or Below BAU, the baseline cooling system at the highest operating efficiency consuming the electricity released the lowest greenhouse gas emissions has been considered. Therefore, the baseline data is the greenhouse gas emissions from the use of electricity produced by natural gas power plants in the national grid system for operating the baseline cooling system with the maximum efficiency.

5. Baseline Emission

Baseline emissions from electricity consumption in the cooling system for the baseline activity that can be calculated as follows:

$$BE_y = EC_{BL,y} \times EF_{grid,y} \times (1+TDL_y) \quad \text{Equation (1)}$$

Where:

BE_y = Baseline emissions in year y (tCO_2/year)

$EC_{BL,y}$ = Electricity consumption in the cooling system for the baseline activity in year y (MWh/year)

$EF_{grid,y}$ = Emission factor for electricity generation/consumption in year y (tCO_2/MWh)

TDL_y = Proportion of power loss in the national grid for transmission in year y

5.1 Electricity consumption in the cooling system for the baseline activity ($EC_{BL,y}$)

Electricity consumption in the cooling system for the baseline activity are calculated as follows:

$$EC_{BL,y} = \sum_r C_{p,r,y} \times SEER_{BL} \quad \text{Equation (2)}$$

Where:

$EC_{BL,y}$ = Electricity consumption in the cooling system for the baseline activity in year y (MWh/year)

$C_{p,r,y}$ = Cooling output of new district cooling plant r in year y (MWh/year)

$SEER_{BL}$ = Seasonal energy efficiency ratio of the cooling system for the baseline activity

5.1.1 Cooling output of new district cooling plant r ($C_{p,r,y}$)

There are two options to calculate $C_{p,r,y}$ as follows:

Option 1: Direct measure the amount of cooling through the measurement devices and control system in the cooling system.

Option 2: Calculate based on measured data for temperature differences, flow rate of chilled water and annual operating hours of cooling system

$$C_{p,r,y} = Cp \times F_{r,y} \times \Delta T_{r,y} \times h_{r,y} \times 3.6 \times 10^{9} \quad \text{Equation (3)}$$

Where:

$C_{p,r,y}$ = Cooling output of new district cooling plant r in year y (MWh/year)

$F_{r,y}$ = Average chilled water flow rate (integrated over the year) of new district cooling plant r in year y (g/hour)

$\Delta T_{r,y}$ = Temperature difference between supply and return of chilled water for new district cooling plant r in year y (°C)

$h_{r,y}$ = Number of the operating hours of the new district cooling plant r in year y (hours)

Cp = Specific heat capacity of chilled water (J/g)

5.1.2 Seasonal Energy Efficiency Ratio ($SEER_{BL}$)

$SEER_{BL}$ of the cooling system in the baseline activity is considered with two cases: a building with existing cooling systems and a new building. It can be calculated as follows.

Case 1: A building with existing cooling systems, there are two options as follows:

Option 1: Refer to the manufacturer's information of the cooling system.

Option 2: SEER of the best available technology (BAT) in a host country for a building with the same function (e.g. office, apartments) and similar gross floor area (GFA) in the range from 50 to 150 percent of GFA for the baseline building.

Case 2: A new building, Refer to SEER of the BAT for a building with the same function (e.g. office, apartments) and similar GFA, i.e. in the range from 50 per cent to 150 per cent of the baseline building GFA.

6. Project Emission

Project emissions only consider CO_2 emissions from electricity use and fossil fuel use related to the new district cooling system.

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} \quad \text{Equation (4)}$$

Where:

PE_y = Total project emissions in year y (tCO_2e/year)

$PE_{EC,y}$ = Project emissions from electricity consumption associated with the generation of cooling output in the new district cooling system in year y (tCO_2e/year)

$PE_{FC,y}$ = Project emissions from fossil fuel combustion for generating heat duty supplying to the new district cooling system in year y (tCO_2e/year)

6.1 Emissions from electricity consumption associated with the generation of cooling output in the new district cooling system. ($PE_{EC,y}$)

Emissions from electricity consumption in the district cooling systems from project implementation can be calculated using the amount of electricity use, emissions factor of electricity production and loss of power in the electrical grid which can be calculated as follows.

$$PE_{EC,y} = EC_{PJ,y} \times EF_{grid,y} \times (1+TDL_y) \quad \text{Equation (5)}$$

Where:

$PE_{EC,y}$ = Emissions from electricity consumption associated with the generation of cooling output in the new district cooling system. (tCO_2/year)

$EC_{PJ,y}$ = Electricity consumption for the project activity in year y (MWh/year)

$EF_{grid,y}$ = Emission factor for electricity generation/consumption in year y (tCO_2/MWh)

TDL_y = Proportion of power loss in the national grid for transmission in year y

6.2 Project emissions from fossil fuel combustion for generating heat duty supplying to the new district cooling system ($PE_{FC,y}$)

$PE_{FC,y}$ is determined using the calculation tool of T-VER-TOOL-02-01 "Calculating CO_2 emissions from fossil fuel combustion from project emission or leakage emission" latest edition.

7. Leakage Emission

Leakage emission are calculated as follows:

$$LE_y = LE_{Ref,y} + LE_{water,y} \quad \text{Equation (6)}$$

Where:

LE_y = Leakage emissions in year y (tCO_2/year)

$LE_{Ref,y}$ = Emission due to refrigerant leaking from the project district cooling system in year y (tCO_2/year)

$LE_{water,y}$ = Emission due to the freshwater consumption in the project district cooling system in year y (tCO_2/year)

7.1 Refrigerant leakage emission from the project ($LE_{Ref,y}$)

Refrigerant leakage emission from the chiller under project activity is calculated as follows:

$$LE_{Ref,y} = \sum_k R_{k,y} \times GWP_k \quad \text{Equation (7)}$$

Where:

$LE_{Ref,y}$ = Refrigerant leakage emissions from the project in year y (tCO_2)

$R_{k,y}$ = Quantity of refrigerant k filled in the district cooling system year y (tonnes)

GWP_k = Global Warming Potential of the refrigerant k

7.2 Emission due to the freshwater usage in the project system ($LE_{water,y}$)

Emission from the water consumption in the chiller system that is used in water-cooled condenser system, where water is lost through the evaporation process in the cooling tower is calculated as follows.

$$LE_{water,y} = Q_{water} \times EF_{water} \quad \text{Equation (8)}$$

Where:

$LE_{water,y}$ = Emissions due to the freshwater consumption in the project district cooling system in year y (tCO_2e/year)

Q_{water} = Amount of water make up into the water-cooled condenser system of the district cooling system under the project activity (m^3/year)

EF_{water} = Emission factor of the production of freshwater (tCO_2e/m^3)

8. Emission Reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (9)}$$

Where:

ER_y = Emission reductions in year y (tCO_2e/year)

BE_y = Baseline Emissions in year y (tCO_2e/year)

PE_y = Project Emissions in year y (tCO_2e/year)

LE_y = Leakage emissions in year y (tCO_2e/year)

9. Monitoring Plan

9.1 Measurement Procedures

1) The project developer explains and specifies the steps for following up on project activity data (Activity data) or checking all measurement results in the project proposal document and including the type of measuring equipment used, person responsible for following up and verifying information, calibration of measuring instruments (if any) and quality assurance and control procedures. Where the method has different options, such as using default values or measuring on site. The project developer must specify which option to use. **In addition, the installation, maintenance and calibration of measurement equipment should be carried out in accordance with the equipment manufacturer's instructions and in accordance with national standards. or international standards such as IEC, ISO**

2) All data collected as part of monitoring greenhouse gas reduction results. The data should be stored in electronic file format and have a retention period in accordance with the guidelines set by the TGO or according to the organization's quality system, but for a period not less than that specified by the TGO. The data should also be checked to be correct. Must follow measurement procedures: specified in data / parameter: that require follow-up as specified in Table 9.3

9.2 Data and parameters not monitored

Data / Parameter:	Building type
Data unit:	-
Description:	Categories grouped by type of buildings (new/existing)
Source of data:	Maps or schematic plan diagrams of the district cooling system

Data / Parameter:	Baseline cooling technologies
Data unit:	-
Description:	Categories grouped by type of baseline cooling technologies
Source of data:	Information from project developers

Data / Parameter:	Cp
Data unit:	J/g
Description:	Specific heat capacity of chilled water used in cooling system
Source of data:	In case of fresh water, apply specific heat capacity of fresh water and water referred to the table of physical properties. In case of water mixed with cooling additive, apply specific heat capacity of fresh water including cooling additive referred to manufacturers or sellers.

Data / Parameter:	EF_{water}
Data unit:	tCO_2e/m^3
Description:	Emission factor of the production of water
Source of data:	Latest version on emission factor for the carbon footprint product (CFP) announced by TGO.

Data / Parameter:	$EC_{BL,y}$
Data unit:	MWh/year
Description:	Electricity consumption in the cooling system for the baseline activity
Source of data:	Measurement report for electricity consumption

Data / Parameter:	$SEER_{BL}$
Data unit:	-
Description:	Seasonal energy efficiency ratio of the cooling system for the baseline activity
Source of data:	Refer to section 5.1.2

9.3 Data and parameters monitored

Data / Parameter:	$C_{P,r,y}$
Data unit:	MWh/year
Description:	Cooling output of new district cooling plant r in year y
Source of data:	Values are recorded by measuring instruments for flow rate and chilled water temperature equipped in the control system of the chiller system. And, the instruments can be measuring in real time, continuously.
Measurement Procedures:	Used for option 1, the values are measured as follows. 1) Different temperatures between the chilled water output and the returned

	chilled water 2) Chilled water flow rate The measured values are used to calculate the amount of cooling load according to the frequency record of the instrument referring to the calculation method from Case 2
Monitoring frequency	Continuous monitoring and monthly recording at least

Data / Parameter:	$F_{r,y}$
Data unit:	g/hr
Description:	Average chilled water flow rate (integrated over the year) of new district cooling plant r in year y
Source of data:	Recorded data measured by flow meters or calculation based on volumetric meters.
Measurement Procedures:	Summary of annual average flow rate data
Monitoring frequency	Continuous monitoring and monthly recording at least

Data / Parameter:	$\Delta T_{r,y}$
Data unit:	°C
Description:	Temperature difference between supply and return of chilled water for new district cooling plant r in year y
Source of data:	Recorded data measured by temperature instrument
Measurement Procedures:	Summary of annual average temperature data
Monitoring frequency	Continuous monitoring and monthly recording at least

Data / Parameter:	$h_{r,y}$
Data unit:	hr
Description:	Number of the operating hours of the new district cooling plant r in year y
Source of data:	Recorded data collected by the plant operator
Measurement Procedures:	Summary of working hours data for the year
Monitoring frequency	Continuous monitoring and monthly recording at least

Data / Parameter:	$EC_{PJ,y}$
Data unit:	MWh/year
Description:	The amount of electricity consumed by the project activity from electricity consumption sources in year y
Source of data:	Measurement report of electricity consumption using electrical power meter
Measurement	Summary of annual electricity production data

Procedures:	
Monitoring frequency	Continuous monitoring and monthly recording at least

Data / Parameter:	$R_{k,y}$
Data unit:	tonnes
Description:	Quantity of refrigerant k used in the project in year y
Source of data:	Records from the plant operator
Measurement Procedures:	Summary of data on the amount of refrigerant used or added annually.
Monitoring frequency	Every time checking when it is refilled and monthly recording at least

Data / Parameter:	Q_{water}
Data unit:	m^3/year
Description:	Amount of water make up into the water-cooled condenser system of the district cooling system under the project activity
Source of data:	**In the case of project design document preparation** The design data are applied. **In the case of emission reduction monitoring** Measurement report of water consumption is applied.
Measurement Procedures:	Summary of annual water consumption
Monitoring frequency	Continuous monitoring and monthly recording at least

Data / Parameter:	GWP_k
Data unit:	-
Description:	Global Warming Potential of the refrigerant k
Source of data:	Report on the global warming potential values of refrigerants is announced by the TGO.
Measurement Procedures:	**For preparing project proposal documents** Use the latest GWP value announced by the TGO **For following up on the results of reducing greenhouse gas emissions** Use the GWP value announced by the TGO according to the year of the period for which carbon credit certification is requested.
Monitoring frequency	-

Data / Parameter:	$EF_{FF,y}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fossil fuel
Source of data:	Table 1.4 2006 IPCC Guidelines for National GHG Inventories
Measurement	-

Procedures:	
Monitoring frequency	-

Data / Parameter:	TDL_y
Data unit:	-
Description:	Proportion of power loss in the electrical network
Source of data:	Option 1: Measurement report which there is information on the amount of electricity issued by the producer and the amount of electricity that the electricity consumer receives Option 2: Use the latest value announced by the TGO.
Measurement Procedures:	1) If using option 1, the project developer must monitor the value every year throughout the crediting period. 2) If using option 2, the project developer must use this value throughout the crediting period.
Monitoring frequency	Set once in the first year of the crediting period.

Data / Parameter:	$EF_{grid,y}$
Data unit:	tCO_2/MWh
Description:	CO_2 emission factor for electricity use in year y
Source of data:	Report on greenhouse gas emissions (Emission Factor) from electricity production in national grid and from heat production for greenhouse gas reduction projects and activities announced by the TGO.
Measurement Procedures:	**For preparing project proposal documents** Use the latest $EF_{grid,y}$ value announced by the TGO. **For following up on the results of reducing greenhouse gas emissions.** Use the $EF_{grid,y}$ value announced by the TGO according to the year of the period for which carbon credit certification is requested. In the case that the year of the period for which carbon credit certification is requested does not yet have the $EF_{grid,y}$ value announced by the TGO, use the latest $EF_{grid,y}$ value announced by the TGO instead in that year.

Reference documents

1. AM0117: Large-scale methodology: Introduction of a new district cooling system, Version 01.0

Document information T-VER-P-METH-06-01

Version	Amendment	Entry into force	Description
01	-	25 September 2024	Initial adoption.