JCM Project Design Document Form

A. Project description

A.1. Title of the JCM project

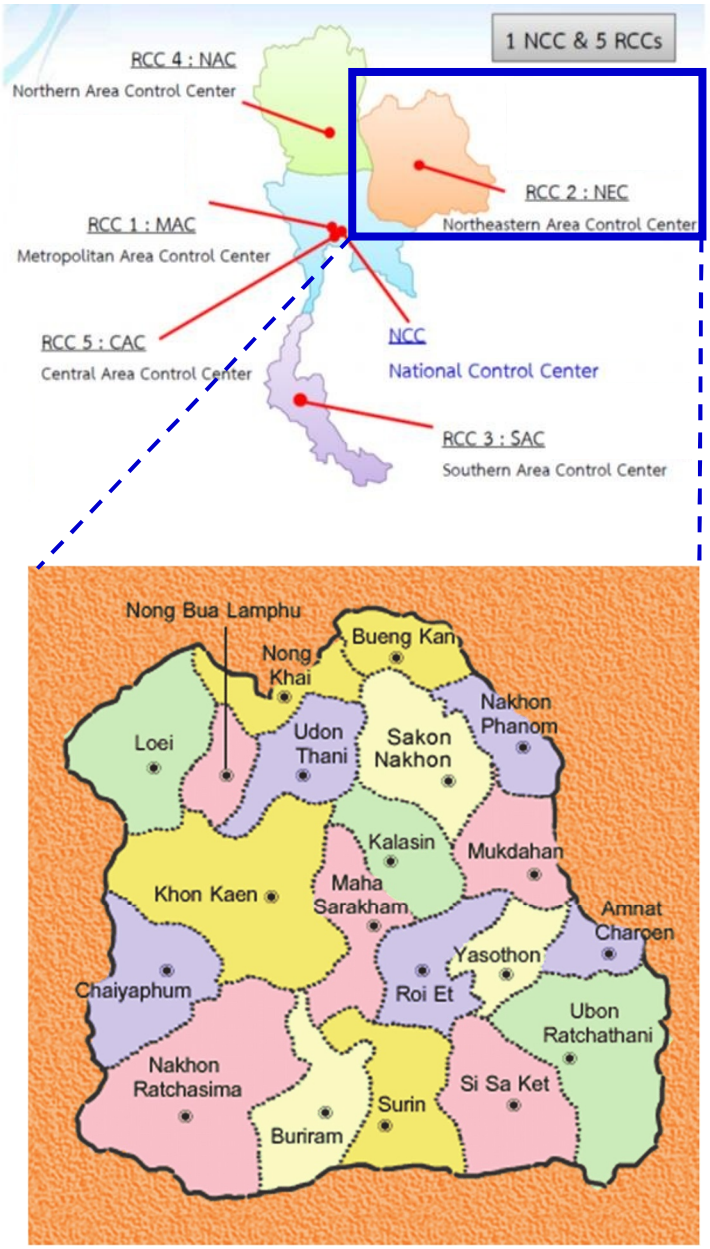
Low-carbon Operation for Power Grid Utilizing Online Voltage-var(Q) Optimal Control (OPENVQ) with ICT

A.2. General description of project and applied technologies and/or measures

The proposed JCM project aims to reduce CO_2 emissions by reducing transmission loss through installation of online voltage-var (Q) optimal control (OPENVQ) system to the transmission system of the Electricity Generating Authority of Thailand (EGAT). The OPENVQ system forecasts the future power flow and supply-demand balance by using facility and measurement data in the transmission network obtained from the grid control system and by combining such data with power generation plans and weather forecasts. Then, optimally controlling voltages and reactive power online while securing voltage stability, it will make power system operation more sophisticated and efficient, leading to the reduction of power loss. In the proposed project, OPENVQ is planned to be linked with Supervisory Control and Data Acquisition (SCADA) used in the Northeastern Area Control Center (NEC), which is one of the Regional Control Centers (RCC) operated by EGAT, to optimize voltages and reactive power in the transmission network in pursuit of reduction of power losses by utilizing measurement data, an accurate demand forecasting technology and reliable optimal current calculations. The project is expected to reduce a total of 21,462 tCO_2 annually on average.

A.3. Location of project, including coordinates

Country	Kingdom of Thailand
Region/State/Province etc.:	20 provinces that are covered by NEC of EGAT, namely Amnat Charoen, Bueng Kan, Buriram, Chaiyaphum, Kalasin, Khon Kaen, Loei, Maha Sarakham, Mukdahan, Nakhon Phanom, Nakhon Ratchasima, Nong Bua Lamphu, Nong Khai, Roi Et, Sakon Nakhon, Si Sa Ket, Surin, Ubon Ratchathani, Udon Thani, and Yasothon Provinces.

	 (Source: EGAT)
City/Town/Community etc:	N/A
Latitude, longitude	N 16°24'43.9" E 102°49'01.8" (Latitude and longitude of NEC)

A.4. Name of project participants

The Kingdom of Thailand	Electricity Generating Authority of Thailand (EGAT)
Japan	Hitachi, Ltd.

A.5. Duration

Starting date of project operation	14/11/2022

Expected operational lifetime of project	8 years

A.6. Contribution from Japan

The proposed project receives financial support from the government of Japan. The project has been selected as one of the JCM demonstration projects by the New Energy and Industrial Technology Development Organization (NEDO). As a result of the financial support provided by NEDO's program, implementation cost of the proposed project has been partially financed by the Japanese government. Furthermore, implementation of the proposed project promotes technology transfer of low carbon technologies in Thailand. Through the NEDO program, operation of OPENVQ will be monitored during the project operation. During the construction, installation, and operation of OPENVQ, Hitachi will provide technical knowhow to EGAT, and help EGAT to implement proper operation and monitoring.

B. Application of an approved methodology(ies)

B.1. Selection of methodology(ies)

Selected approved methodology No.	TH_AM017
Version number	01.0

B.2. Explanation of how the project meets eligibility criteria of the approved methodology

Eligibility criteria	Descriptions specified in the methodology	Project information
Criterion 1	The project installs OPENVQ to the control system of transmission network.	The project installs OPENVQ to the control system of the project transmission network.
Criterion 2	The project transmission network is one of the five regional networks served by EGAT, in which each network is controlled by respective regional control center (RCC). The project transmission network has delivery points which are connected to the regional distribution network corresponding to each of the five regions managed by Metropolitan Electricity Authority (MEA), and four Provincial Electricity Authorities (PEA), Northeast, South, North, and Central,	The project installs OPENVQ to the Northeastern Area Control Center (NEC), which is one of the EGAT's RCCs, to control the northeastern part of transmission network of EGAT. The project transmission network controlled by NEC has delivery points which are connected to the Northeast

	respectively. The project transmission network consists of transmission lines of 500kV, 230kV, and115kV, and substations.	PEA. The project transmission network consists of transmission lines of 500kV, 230kV, and115kV, and substations.
Criterion 3	The project transmission network is monitored and operated on-line, and the data of active power, reactive power, voltage, resistance, and susceptance of the transmission line is collected remotely.	The project transmission network is monitored and operated on-line through OPENVQ which is linked with SCADA system of NEC. The data of active power, reactive power, voltage, resistance, and susceptance of the transmission line is collected remotely by SCADA system and sent to OPENVQ system automatically.
Criterion 4	The difference between reference transmission line loss calculated based on the procedure described in F.2 and calculated transmission line loss based on the data measured during sampling period is less than the difference between measured substation loss and simulated substation loss in the case of installing OPENVQ based on the data measured during sampling period. This is confirmed by satisfying the following formula: $PL_{RE,X,lines} - PL_{measured,X,lines} < PL_{measured,X,substations} - PL_{OPENVQ,X,substations}$	Based on the measured data during sampling period from June2021 to May2022, the calculation was conducted following the procedure described in F.2. The result is as follows: $PL_{RE,X,lines} - PL_{measured,X,lines} = 1.5(MWh)$ $PL_{measured,X,substations} - PL_{OPENVQ,X,substations} = 251.3(MWh)$ Therefore, it is confirmed that the difference between reference

	$PL_{RE,X,lines}$= Reference transmission line loss (W) $PL_{measured,X,lines}$= Measured transmission line loss in the sampling period (W) $PL_{measured,X,substations}$= Measured substation loss in the sampling period (W) $PL_{OPENVQ,X,substations}$= Simulated substation loss in the case of installing OPENVQ (W) The detail steps to confirm validity of calculation method of reference emissions are described in Additional Information.	transmission line loss and calculated transmission line loss based on the data measured during sampling period is less than the difference between measured substation loss and simulated substation loss in the case of installing OPENVQ based on the data measured during sampling period.

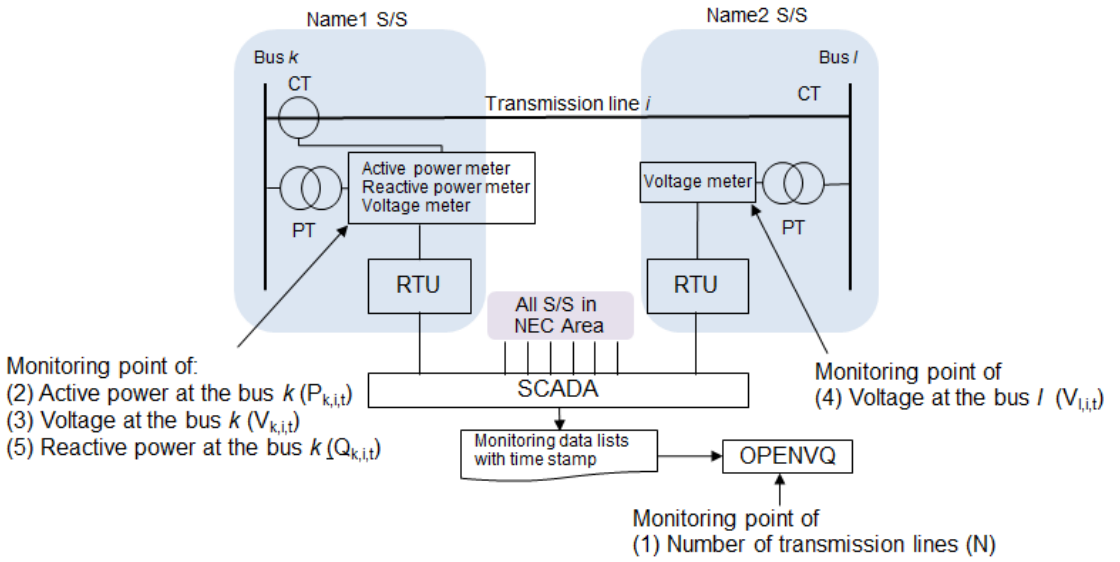
C. Calculation of emission reductions

C.1. All emission sources and their associated greenhouse gases relevant to the JCM project

Reference emissions	
Emission sources	GHG type
Transmission loss of transmission line	CO_2
Project emissions	
Emission sources	GHG type
Transmission loss of transmission line	CO_2

C.2. Figure of all emission sources and monitoring points relevant to the JCM project

The measurement points are shown below.



S/S: Substation
SCADA: Supervisory Control and Data Acquisition
CT: Current Transformer
PT: Potential Transformer
RTU: Remote Terminal Unit

C.3. Estimated emissions reductions in each year

Year	Estimated Reference emissions (tCO_2e)	Estimated Project Emissions (tCO_2e)	Estimated Emission Reductions (tCO_2e)
2022	34,579.6	31,869.0	2,710
2023	300,442.5	278,882.7	21,559
2024	301,265.6	279,646.7	21,618
2025	300,442.5	278,882.7	21,559
2026	300,442.5	278,882.7	21,559
2027	300,442.5	278,882.7	21,559
2028	301,265.6	279,646.7	21,618
2029	300,442.5	278,882.7	21,559
2030	250,231.5	232,274.9	17,956
Total (tCO_2e)			171,697

D. Environmental impact assessment	
Legal requirement of environmental impact assessment for the proposed project	No

E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

The local stakeholder consultation was held to introduce the OPENVQ project and JCM scheme and solicit their comments. Notices were sent to stakeholders a month before the meeting via e-mail.

Outline of the meeting is as below:

Date: 28/09/2022

Time: 10:00-12:00

Venue: Meeting room of the Hitachi Asia (Thailand) Co., Ltd.

Agenda:

Time	Agenda	Presenter
10:00-10:15	Confirmation of Attendance	All
10:15-10:25	Opening Remarks	Hitachi Asia (Thailand) Co., Ltd.
10:25-11:00	Introduction of the project	Hitachi, Ltd. and EGAT
11:00-11:10	Q&A	All
11:10-11:45	Introduction of JCM MRV methodology	EY ShinNihon LLC
11:45-11:55	Q&A	All
11:55-12:00	Closing Remarks	Hitachi, Ltd.

List of participants:

	Organizations	Number of Participants
1	Ministry of Energy (MoEN)	4
2	Energy Policy and Planning Office (EPPO)	2
3	Energy Regulatory Commission (ERC)	3
4	Thailand greenhouse Gas Management Organization (TGO)	3
5	New Energy and Industrial Technology Development Organization (NEDO) Representative Office in Bangkok	1
6	Hitachi, Ltd. (Hitachi)	3
7	Hitachi Asia (Thailand) Co., Ltd.	5
8	Electricity Generating Authority of Thailand (EGAT)	3
9	EY ShinNihon LLC	1
Total		25

At the meeting, the details of the proposed project and the technology to be introduced and JCM procedures including the project emission reduction effects were explained. The comments received during the local stakeholders meeting are summarized in the following section E.2. Most comments showed high expectation toward introduction of the technology. No negative opinions towards the project were received during the meeting.

E.2. Summary of comments received and their consideration

Stakeholders	Comments received	Consideration of comments received
MoEN	It is glad to hear the progress of Hitachi and EGAT's project. It is good ambition for Hitachi and EGAT to promote OPENVQ in Thailand and ASEAN. I am very proud that Thailand will be the first country to install OPENVQ.	Positive comment was received. No further action is needed.
	How much CO2 emissions will be reduced by introduction of OPENVQ?	5% power loss can be expected by introduction of OPENVQ. According to the preliminary calculation, 20,000tCO2 emission reductions is expected annually. No further action is needed.
	Are there any constrains on the introduction of OPENVQ depending on the type of power plant connected to transmission line?	There are no constrains on the introduction of OPENVQ with respect to type of power plants. No further action is needed.
	It was mentioned that the TPE will verify the data, but who will actually do this work?	There are accredited TPEs under Thai-Japan JCM scheme and listed on the website. One of accredited TPEs will conduct verification for this project. No further action is needed.
	In the presentation, a figure of CO2 emission reduction for 5 years was shown, but how much will the actual cost of OPENVQ be paid off?	The potential revenue from credit sales is not known at this stage, however the project can provide benefit by reducing fuel cost and

		increasing sales of electricity by reducing transmission loss. No further action is needed.
EPPO	How do you handle data corrections, for instance uncertainty of load due to renewable energy?	A feature of OPENVQ is its ability to forecast substation demand. By taking snapshot of transmission, and using its data, OPENVQ can forecast grid edge condition with high accuracy. OPENVQ is able to forecast within 5% error margin and it is considered as Hitachi's cutting-edge technology. No further action is needed.
	Is there a possibility of introducing OPENVQ to the power distribution side?	Currently, Hitachi is focusing on transmission line because the system on the power distribution side is slightly different. However, fundamental technology is same and can also be expanded to distribution side. No further action is needed.
	EGAT has forecasting system for renewable energy. Is there any difference?	We know EGAT has forecasting system for renewable energy, but this system is to maintain frequency. On the other hand, OPENVQ's purpose is to maintain voltage and var and requires forecasting for each substation, which is different. In future, there may be possibility to merge both technology and function. Therefore, Hitachi would like to continue discussion with EGAT. No further action is needed.
TGO	What if reference transmission line loss is more than BaU transmission line loss?	Criteria 4 of the methodology is set to ensure that difference between reference transmission line loss and BaU transmission line loss is smaller

		than the loss reductions at the substations in order to ensure the conservativeness and net emission loss. No further action is needed.

F. References
N/A

Reference lists to support descriptions in the PDD, if any.

Annex

Revision history of PDD		
Version	Date	Contents revised
1.0	05/12/2022	First edition