FY2016 Project for Ministry of the Environment Japan

FY2016
Feasibility Study of Joint Crediting Mechanism Project by City to City Collaboration (Feasibility study for assisting ports in Thailand to reduce CO2 emissions and to become “Smart Ports”)

Report

March 2017

Yokohama Port Corporation
Green Pacific Co., Ltd.
Overseas Environmental Cooperation Centre, Japan

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Background and Purpose

Thailand is continuing along a smooth path of economic development with its two pillars of the agriculture and manufacturing industries. Thailand with its GDP per capita in 2015 at over US$5,800, is an important position a middle-income country of the ASEAN region, and in the international economy. In recent years, in order to achieve even further economic growth without falling into the so-called "trap of middle-income countries," new developments are desired, such as improvement in production efficiency and seeking higher value- added.

Thailand has both an international production base and a logistics base in the ASEAN region, and the development of logistics infrastructure one of the important issues for promoting new development. In this context, port facilities are "cornerstone" for the smoothly functioning a lot of distribution.

The capital city of Bangkok includes Thailand’s two main ports of Bangkok Port and Laem Chabang Port, through which more than 70% of cargo flows into the country. In addition, river ports located inland along the Chao Phraya River have become a window to Laos, Myanmar and beyond, where future economic growth is expected.

Damage in Bangkok and surrounding areas from the major 2011 flood caused an enormous impact on domestic and overseas supply chains, and the Thai government is actively working on climate change issues as well as economic development. In response to COP 21 in 2015, it has already submitted "Nationally Determined Contribution” (NDC) for 2020 and later, and set the target of reducing greenhouse gas (GHG) emissions by 20% by 2030. This includes emission reductions in the energy sector, including transportation, as one of the important measures. Bangkok City adopted a Climate Change Master Plan in December 2015 with the support of JICA, based on the Bangkok Climate Change Master Plan 2013 - 2023 project. It includes the reduction of GHG emissions in the transport sector as an important issue.

Yokohama City, like Bangkok, is a crucial port city located in the country’s capital region, has experienced rapid urbanization and population growth, and also encountered and tackled and solved various urban issues. Since 2011, Yokohama has been promote international technical cooperation (Y-PORT project) through public-private collaboration, utilizing its various resources and technologies, and making full use of its expertise and know-how on urban management and infrastructure development that has been accumulated through these efforts. This Y-PORT project in particular is actively providing support for urban development in emerging countries in Asia and beyond.

During the Bangkok municipal government’s process of formulating the aforementioned Master Plan, Yokohama City provided technical advice to JICA and Bangkok. In addition, besides climate change, Bangkok’s rapid urbanization is causing other urban problems such as waste, sewage and air pollution, so the two cities signed a "Memorandum of Understanding on Technical Cooperation for Sustainable Urban Development" in October 2013. Based on that arrangement, the Feasibility Study team is working to further promote technical cooperation, making use of Yokohama’s expertise in urban development and the superlative technologies of city enterprises, through inter-city collaboration under the Y-PORT project.

Based on the above background, the three parties of Yokohama Port Corporation (YPC), Co., Ltd. (GP), and Overseas Environmental Cooperation Centre, Japan (OECC) of jointly proposed and adopted the FY2016 Feasibility study for JCM project by city-to-city collaboration (Feasibility study for assisting ports in Thailand to reduce CO2 emissions and to become “Smart Ports”) (hereinafter FS)

This FS was implemented with the purpose of promoting low-carbon and smart approaches to all ports in Thailand, starting with the introduction of Japan's advanced low-carbon technologies and products, through the use of the JCM, starting with Bangkok Port, and the additional purpose of promoting the development of Thailand's ports as low-carbon smart logistics centers/bases within the ASEAN region.

Results of the Feasibility Study

1. PAT Status and Circumstances

1.1 Information Gathering and Coordination Prior to Site Visit

(1) Relationship between Port Authority of Thailand and Yokohama Port Corporation

Thailand's major domestic ports are managed by the Port Authority of Thailand (hereinafter "PAT"). PAT is aiming to further utilize Thailand's port network, including regional ports, as a hub for the ASEAN region. In parallel with that, PAT sees the promotion of environmentally-conscious harbors as an important management strategy. They are promoting ambitious efforts such as setting carbon dioxide (CO2) emissions reduction targets under a plan called the "Green Port Project" (described below).

Yokohama Port Corporation (hereinafter "YPC"), the main proponent of this FS, continues to have positive cooperative relationship with PAT. The Port and Harbor Bureau, City of Yokohama has been part of a wide range of cooperative efforts with PAT, including the conclusion on April 2014 of a memorandum of understanding regarding partnership arrangements with PAT, followed by a basic agreement for implementation in January 2015. For its part, PAT has indicated its strong desire to promote the introduction of port facilities that have lower environmental impacts, making use of the JCM and in collaboration with YPC.

The Port of Yokohama is an example of the move toward low-carbon and "smart" port facilities, and it declares "a safe, secure and environmentally-friendly port" as one of its three pillars for port planning policy. Under that policy, examples of efforts so far by YPC include the installation of photovoltaic panels on the roofs of Container Freight Stations (CFS: facilities for container freight loading) of the Minami Honmoku Pier and Daikoku Pier container terminals, and the installation of LED yard lighting. In addition, the Yokohama Port and Harbor Bureau has installed photovoltaic panels on the roofs of the public buildings at Daikoku Pier, and installed a stand-alone hydrogen fuel-cell system at the Yokohama Logistics Center at the Daikoku Pier. In addition, as an example of efforts by other Yokohama Port stakeholders, operators have started using hybrid tugboats and LNG fuel powered tugboats.

By utilizing YPC's knowledge and experience and promoting efforts to support PAT to move toward low carbon, making use of the JCM, the team can create an innovative model of supporting efforts for low-carbon ports overseas by the Port of Yokohama, as one of Japan's leading ports. By making use of the partnership between Japan's Port of Yokohama and Thailand's PAT, as well as the cooperative relationship between the City of Yokohama and Bangkok Metropolitan Administration (BMA) for urban development, as well as technical cooperation making use of the City of Yokohama's knowhow and technical excellence of Yokohama businesses such as YPC, it is possible to create low-carbon and resilient logistics centers in Bangkok, a leading city in the ASEAN region. These kinds of activities also could

lead to the possibility of future expansion or roll-out in other ports of other countries including the ASEAN region, which gives this initiative added significance.

(2) About the Port Authority of Thailand (PAT)

PAT was established in 19951 as a port administrator under the jurisdiction of Thailand's Ministry of Transport. It manages and operates five ports in Thailand, including international ports such as Bangkok Port and Laem Chabang Port.
The Yokohama Port and Harbor Bureau signed a memorandum of understanding on cooperation in April 2014 (described below), and a basic agreement for its implementation in January 2015. There has been a continuous cooperative relationship with YPC under the above-mentioned memorandum, and since 2015 joint discussions have been underway regarding utilization of the JCM.

PAT is currently working to promote an environmentally-conscious port under a five-year plan (2015-2019) entitled the "Green Port Project." This plan's target is to reduce expected CO2 emissions from PAT's operations in 2019 by 10% of the 2013 emissions (Figure 1). This target is a sign of very high awareness about environmental protection, and strong interest in introducing low-carbon equipment through use of the JCM.

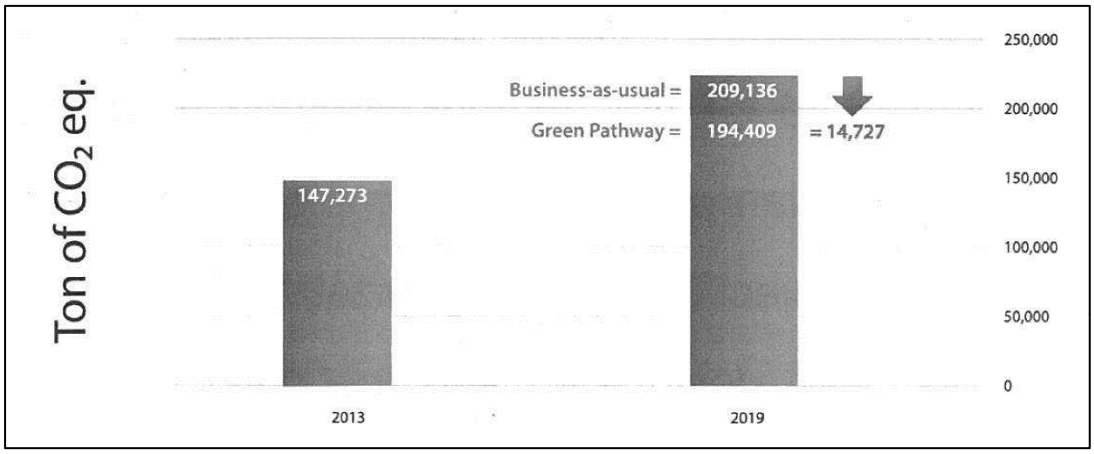


Figure 1. CO2 emissions reduction target under the PAT “Green Port Project”

(Source: PAT documents)

Under this FS, with PAT cooperating as a counterpart in Thailand, PAT has coordinated affairs with Thai government authorities and other parties and cooperated for field surveys, and joint discussions have been conducted with implementing bodies such as YPC on the Japanese side concerning appropriate technologies and project possibility evaluation etc.

It is expected that PAT is would be the local party in an international consortium for implementing JCM funded projects.

(3) Current Cooperation among Cities in the Survey Area

As mentioned above, since 2011, Yokohama City has been implementing international technical cooperation through public-private partnerships using “Yokohama’s Partnership of Resources and Technologies” (Y-PORT Project), with the aim of supporting solutions to urban issues in emerging countries and supporting business overseas business development of Yokohama-based businesses.

Under the Y-PORT project, in 2013, Thailand’s Bangkok Metropolitan Authority signed a “Memorandum of Understanding on Technical Cooperation for Sustainable Urban Development” in 2013, the Bangkok Climate Change Master Plan 2013 - 2023 was prepared, with support from JICA to formulate the cooperation. To realize the master plan, in FY2014 and FY2015, Y-PORT participated in a Ministry of the Environment JCM commissioned project for formulating a feasibility project to realize a low-carbon society, and developed through city-to-city collaboration the “Scheme Consideration Study for Funding for Development of JCM Projects (Energy Conservation, Waste, Sewerage) and Introduction of Low-Carbon Technologies based on the Kingdom of Thailand / Bangkok Municipal Administration Climate Change Master Plan.” As a result of the study this fiscal year, Yokohama-based companies have been selected this fiscal year for JCM equipment funding, and the entire city is making steady progress toward becoming a low-carbon city.

As a recent trend in the Port of Yokohama, in August 2010, through a selection process for target ports for the national government’s “International Container Strategy and Port Policy” program for intensive investment and to strengthen competitiveness, the Port of Yokohama was selected as a Keihin region port. The International Container Strategy and Port Policy is a national port policy of the national government to promote Japanese ports as hub ports for container logistics, in response to a decline in relative status of Japanese ports in the context of the development of other Asian major ports in recent years. Based on the International Container Strategy and Port Policy, initially there were plans to merge/integrate the Port of Yokohama, Port of Kawasaki, and Port of Tokyo as a container terminal operation, but the Port of Tokyo later withdrew, YPC was broken up in January 2016, and the Yokohama-Kawasaki International Port Co., Ltd. (YKIP) was established, centering on The Port of Yokohama.

As for the Port of Yokohama, since 2010, based on the basic policies of the International Container Strategy and Port Policy (consolidating freight, generating freight, boosting international competitiveness), the Port and Harbor Bureau, City of Yokohama, which is the port

authority, has promoted various efforts for freight consolidation and for development of new container terminals. In particular, to increase the volume of freight handled, which is one of the most important issues/challenges, they have been promoting stronger collaboration with Southeast Asian countries which have been experiencing remarkable growth, and on April 22, 2014, the Port and Harbor Bureau, City of Yokohama signed a memorandum of understanding with PAT which manages and operates five major domestic ports including Bangkok Port and Laem Chabang Port, regarding partnership aiming to develop beneficial relationships for the development of the Port of Yokohama and domestic ports in Thailand.

Unlike the traditional sister port relationship, this partnership aims at concrete measures that are beneficial to both sides and sets up a cooperative system with fixed periods in specific fields, with the benefits being constantly measured. In particular, it stipulates that an emphasis is placed on cooperative installations to increase cargo volume and technical information exchanges, and the implementation of concrete measures are in specific areas. Major cooperation components include (1) information exchange for the development of both sides (port management, shipping trend, international trade, the use of IT, technology and environmental measures), and (2) port sales (helping and promoting cooperation with potential local partners and customers in order to achieve local and regional market expansion).

Furthermore, a basic agreement on the following concrete action items for its implementation was signed on January 19, 2015. The main points of agreement include (1) mutual assistance through information provision and the exchange of personnel (human resources development, technical exchanges, information exchanges), and (2) cooperation on port sales (mutual implementation of seminars and promotions).

Based on this agreement, the Port of Yokohama and PAT are undertaking the following efforts on an ongoing basis including trainings to address various issues, receiving study tours, holding port seminars, and regular exchanges of opinion.

Major Initiatives after Signing of Cooperative Partnership Agreement

2014 (April):	Eight-person delegation from PAT led by the acting chief director visited the Port of Yokohama
2014 (August)	Observation tour received from Laem Chabang Port (Port Authority of Thailand) and Thammasat University
2015 (January)	Eight-person delegation including YPC executives led by Port and Harbor Bureau, City of Yokohama, visit Port of Yokohama, and seminar is held on Thailand-Japan trade and port topics.

2015 (July)	Yokohama International Affairs Bureau visits PAT, conducts interviews on technical cooperation with the Bangkok Metropolitan Administration (Thailand) relating to urban development
2015 (October)	City of Yokohama representatives visit PAT to observe overseas government
2015 (July)	YPC, City of Yokohama (Climate Change Office), and Yokohama International Affairs Bureau visit PAT, conduct on-site observation and discuss JCM

In the area of port environment, based on the policy of being "a safe, secure and environmentally-friendly port" as stated in the Yokohama port plan, the City of Yokohama and YPC are promoting efforts to create a low-carbon and "smart" port that is also resilient to disasters, and as technical cooperation with PAT, they are making use of Yokohama's knowhow and experience to conduct discussions to support environmental initiatives being promoted by PAT.

In October 2015, YPC visited PAT and discussed technical cooperation to introduce low-carbon facilities by utilizing the JCM. Joint discussions continued thereafter, and in July 2016, YPC visited PAT again to observe facilities at Bangkok Port and Laem Chabang Port with a view to utilization of the JCM, and discussed with PAT concrete topics relating to future project formulation to utilize the JCM. For these activities, the Climate Change Policy Headquarters and the International Affairs Bureau (both from City of Yokohama) accompanied the missions, and discussed the implementation of support based on the City of Yokohama's efforts.

In addition, the City of Yokohama and the Bangkok Metropolitan Administration are furthering their city-to-city collaboration to realize a low-carbon society, based on the above-mentioned Memorandum of Understanding on Technical Cooperation for Environmentally-Conscious Sustainable Urban Development signed in 2013. As part of these activities, collaboration is being conducted in the form of JICA technical cooperation projects, and in that context, the transport sector, particularly low-carbon initiatives such as those for the Bangkok Port are attracting attention as important initiatives, in terms of emission reductions and as a demonstration of what is possible in the ASEAN region.

Documents including the aforementioned memorandum of understanding are shown as the Attached document.

(4) Achievements and Experience of the Yokohama Port Corporation (YPC)

① From 1986 to 1989, YPC dispatched personnel from the Yokohama Port and Harbor Bureau as JICA experts to the Eastern Seaboard Development Committee of Thailand to support development of Laem Chabang Port.

② In 2013, the City of Yokohama City cooperated in work to formulate the Bangkok Climate Change Master Plan (2013-2023) implemented by the Japan International Cooperation Agency (JICA). The Yokohama City Action Plan for Global Warming Countermeasures was used as a model for the formulation of the Master Plan, and the City of Yokohama created an internal support arrangements consisting of multiple departments to provide extensive cooperation. The City of Yokohama's cooperation is mentioned in the FY2015 White Paper on Development Cooperation published by Japan's Ministry of Foreign Affairs.

③ On October 21, 2013, the City of Yokohama and Bangkok Metropolitan Administration signed a Memorandum of Understanding on Technical Cooperation for Environmentally-Conscious Sustainable Urban Development.

④ On April 22, 2014, the City of Yokohama and PAT signed a memorandum of understanding regarding partnership to develop beneficial relationships for the development of the Port of Yokohama and domestic ports in Thailand.

⑤ On August 4 and 5, 2014, YPC received an observation tour from Laem Chabang Port (Port Authority of Thailand) and Thammasat University. A lecture was conducted relating to the MM21 District and redevelopment plans.

⑥ Seminar organized by PAT on January 19, 2015. Yokohama City Port and Harbor Bureau Director Itoh joined along with YPC's Director Kanno. A presentation was made on "Efforts of the Port of Yokohama to Become an International Hub Port."

⑦ On January 20, 2015, the City of Yokohama signed a basic agreement with PAT on concrete actions to fulfill the agreement in the aforementioned memorandum of understanding.

⑧ In May 2015, YPC received a Port of Yokohama observation tour by professors from Chulalongkorn University in Thailand. Provided information on waterfront development research related to Port Authority of Thailand.

⑨ In October 2015, YPC visited PAT for discussions about the JCM.

⑩ From November 10 to 13, 2015, the City of Yokohama received a delegation from PAT and held a training, based on a memorandum of understanding and the basic agreement with PAT.

⑪ In July 2016, YPC, the City of Yokohama Climate Change Policy Headquarters and Yokohama International Affairs Bureau visited PAT for site research and for discussions about the JCM.

1.2 Checking Project Site Conditions through Site Visit, and Consideration of Issues

In this Feasibility Study, the team conducted four site visits (one of which is to support a site tour of an existing JCM Model Project). Below is a summary of the three site visits (not including the site tour), which included meetings and data collection.

(1) 1st Site Visit

① Schedule

November 13 to 19, 2016 (including travel days)

② Japanese Participants

Yokohama Port Corporation

Yoichi Kannno, Senior Executive Director

Kosuke Shibasaki, Deputy General Manager, Engineering Department

Hayato Nakamura, Assistant Section Chief, Engineering Planning Division, Engineering Department

Katsuyuki Ozaki, Manager, Business Development Division, Business Development Department

Yuki Haji, Assistant Manager, Business Development Division, Business Development Department

Green Pacific Co., Ltd.

Kazuhito Yamada, President

Mariko Fujimori, Executive Vice President, Director

Darmp Phadungsri, Consultant

City of Yokohama

Yoshihiko Takano

Officer, Policy Coordination Division, Policy Coordination Department, Port and Harbor Bureau

Chihiro Masaoka

Officer, Port Promotion Division, Port Promotion Department, Port and Harbor Bureau

③ Sites Visited, Counterparts and Topics

Date	Time	Counterparts	Topics
Nov 14	09:30-11:30	Local affiliate of Japanese forklift sales company in Thailand	・Current situation of the forklift market in Thailand ・Specifications of electric forklifts, etc.

Date	Time	Counterparts	Topics
	14:00-15:00	Mr. Satoshi Yoshida First Secretary, Embassy of Japan in Thailand	・Currents situation of JCM
	15:40-16:40	THAILAND GREENHOUSE GAS MANAGEMENT ORGANIZATION (TGO) Mr. Bongkoch Kittisompun, etc. (Director of Review and Monitoring Office)	・Current situation of JCM
Nov 15	10:00-11:30	State Railway of Thailand Mr. Therawat Overtsuwon, etc. (Ladkrabang Container Marketing Section Chief)	・Site visit to Lat Krabang Inland Container Depot (LICD)
	15:00-16:00	Local affiliate of a Japanese shipping company in Thailand	・Site visit to container terminals at Laem Chabang Port
	16:00-18:00	Local affiliate of a Japanese LED manufacturer in Thailand (factory)	・Plant tour ・Confirmation of LED performance
Nov 16	09:00-12:00	PAT Mr. Prajak Sriwatthana (Assistant Director General, Asset Management and Business Development) Mr. Chaichan Chutong (Deputy Director, Support Services Administration Dep.) Mr. Pongsaruit Sritip (Policy and Planning Dept.) and others	・Briefing about JCM Model Project ・Rules for procurement and bidding in PAT ・Financing methods of PAT ・Construction plan of CFS ・Shore connecting systems for ships
	13:30-16:00	PAT Mr. Poramet Chotirat (Chief, Container Planning Section Container Terminal Div 2, BKP)	・Site visit to Bangkok Port ・Confirmation of possible construction site of CFSs ・Confirmation of facilities including RTGs and yard lighting
Nov 17	09:00-16:00	PAT Mr. Thamsin Sribangpleenoi (Director, Cargo Operation Div. 2 Ship and Cargo Operation Dept.) Mr. Anek Nilsu (Chief, Mechanical Handling Equipment Section1) Mr. Suriya Thongsila (Assistant Director, Repair and Maintenance Mechanical Handling Equipment Div.) Mr. Pongsaruit Sritip (Director, Cargo Operation Div. 3) and others	・Import CFS ・Indoor LED lighting ・Electric forklift ・LED yard lighting ・LED road lighting ・Hybrid tugboats

Date	Time	Counterparts	Topics
Nov 18	13:30-16:00	PAT Mr. Pijit Pinthong (Chief, Power Plant Section) Mr. Nawawee Sanitsuriwong (Director Div. Harbor Service)	・Transformers ・Shore connecting systems for ships ・Hybrid tugboats

④ Major Points Confirmed and Issues Identified, etc.

・Briefing about JCM Model Project

- The team again explained briefly about a possible JCM Model Project, as well as the relevance of this Feasibility Study, which was understood by the counterparts.

・Rules for procurement and bidding in PAT

- The basic rule for procurement in PAT is open bidding. At the time of construction of Laem Chabang Port under ODA more than 25 years ago, some facilities might have been procured through negotiated contracts. However, it is not clear whether a negotiated contract is still available now, which needs to be checked (described below).

・Financing method of PAT

- Past construction by PAT has been self-funded. However, PAT said it was considering the use of various financing methods, including leasing and public and corporate bonds, given that various types of financing will be necessary in future. The team recommended the use of leasing.

・Construction plan of CFS

- The team heard about the construction plan of CFSs Import and Export, and reviewed the feasibility of making it a JCM project. The team checked the specifications of CFS Import as well as the feasibility of installing PV systems. As for CFS Export, it is now under the basic design process with a lot of unsettled issues, and further study and examination will be required in the future (described below).

・Proposal of introducing facilities and equipment using JCM (PV, indoor LED, electric forklifts, etc.)

- The team proposed the introduction of low-carbon facilities and equipment using JCM, and checked the specifications required by PAT and the compatibility of the current CFS construction plan and proposed JCM facilities and equipment (described below).

・Opinion exchange with suppliers of electric forklifts

- The team checked the condition of the forklift market in Thailand, as well as the specifications of electric forklifts.

・Information exchange with suppliers of power conditioners

- The team checked the possibility of the bidding of PV panels with specifications. Since there is a unified standard for PV panels, bidding with specifications is difficult for PV panels. Possibility of bidding with specifications for PV system as a whole – rather than

for panels only – needs to be considered.

・Interviews with TGO and Embassy of Japan

- As for bilateral documents for JCM between Japan and Thailand, Thailand interprets that the country cannot proceed with JCM-related work now under the Paris Agreement taking effect. However, the two countries are now working to revise the document, and it has been confirmed by both TGO and Embassy of Japan that there would be no problem in working under the JCM framework.

(2) 2nd Site Visit and Interim Field Report of Feasibility Study

① Schedule

January 8 to 11, 2017 (including travel days)

② Japanese Participants

Yokohama Port Corporation

Yoichi Kannno, Senior Executive Director

Katsuyuki Ozaki, Manager, Business Development Division, Business Development Department

Hayato Nakamura, Assistant Section Chief, Engineering Planning Division, Engineering Department

Green Pacific Co., Ltd.

Kazuhito Yamada, President

Darmp Phadungsri, Consultant

③ Sites Visited, Counterparts and Topics

Date	Time	Counterparts	Topics
Jan 9	09:30-11:30	PAT Mr. Tirapat Manmit (Electrical Engineer)	・Inspection of electric facilities at Bangkok Port
	13:30-15:30	Local affiliate of Japanese electronics manufacturer in Thailand	・Consideration of PV system and power conditioners, etc.
Jan 10	9:00-12:00	PAT Mr. Komol Sribangpleenoi (Deputy Managing Director, BKP) and others	・Interim report on Feasibility Study ・Progress of studies introducing PV systems, indoor LED lighting, electric forklifts, hybrid RTG, LED lighting, etc.) ・Bidding

	14:00	Mr. Sitsawat Sripanbutra (Deputy Director of Service Dept., LCP) Mr. Nawawee Sahasuriwong (Director of Service Dept., BKP)	・Progress of study on tugboat

④ Major Points Confirmed and Issues Identified, etc.

・Interim report on Feasibility Study

- The team reported on progress of the study on each introduction project, proposing to apply as a JCM Model Project for FY 2017, proposed by the team, and it was agreed to positively consider the application.
- As for bidding, PAT suggested the possibility of private tender (described below).

・Field inspection of electric facilities

- The team implemented field inspections of the current electrical facilities aiming to introduce PV system to CFSs. For interconnecting points, there were no auxiliary power panels, but there is enough room to interconnect PV power without high additional costs (described below).

(3)Final Field Report of Feasibility Study

① Schedule

February 19 to 21, 2017 (including travel days)

② Japanese Participants

Yokohama Port Corporation

Yoichi Kannno, Senior Executive Director
Kosuke Shibasaki, Deputy General Manager, Engineering Department
Katsuyuki Ozaki, Manager, Business Development Division, Business Development Department
Hayato Nakamura, Assistant Section Chief, Engineering Planning Division, Engineering Department

Green Pacific Co., Ltd.

Kazuhito Yamada, President
Darmp Phadungsri, Consultant

③ Sites Visited, Counterparts and Topics

Date	Time	Counterparts	Topics
Feb 20	13:30-18:30	PAT Mr. Sutthinan Hatthawong (Director General) and others 20 PAT managers in total	・Final report of Feasibility Study ・Result of study on introduction projects, such as PV systems, indoor LED lighting, electric forklifts, hybrid RTGs, LED lighting, etc. ・Application as JCM Model Project in future

④ Major Points Confirmed and Issues Identified, etc.

・Final Report of Feasibility Study

- The team reported the result of the Feasibility Study so far to Director General of PAT, and confirmed to proceed with a project related to CFS Export for application as a JCM Model Project in FY 2017. However, the process will require continuous and close coordination with PAT to let PAT budget go in line with JCM application schedules. As for a bidding method, the team received a comment that although there still remained a possibility for negotiated contract, it would take some time for necessary arrangement with the Thai Government. Thinking primarily of procurement through open bidding, the team still needs to continuously seek for a possibility of bidding with specifications to introduce highly reliable products.

1.3 Review of PAT's Existing Construction Plan

（1） Current Situation of Bangkok Port

Bangkok Port consists of West Quay, which is a terminal for break bulk cargos (302 acres = approx. 1.22 million m^2), and East Quay, which is a container terminal (36 acres = 150,000 m^2), with the total area of 338 acres (=1.37 million m^2) (Figure 2).

The length of West Quay is1,660 m with 10 berths, while the length of East Quay is 1,528 m with 8 berths.

Berth	Length(m)	Number of Berth	Size of Vessel Length/Draught(m)	Capacity (Ship)
West Quay	1,660	10	172.26 / 8.23	10
East Quay	1,528	8	172.26 / 8.23 91.46 / 4.75	7 1

Figure 2 Whole Image of Bangkok Port

The amount of cargo handled at Bangkok Port is basically on an increasing trend. Although it temporarily slumped in 2012 due to impact of the that flood occurred in 2011, it recovered as the reconstruction of the industrial complex, etc., progressed, having more than 1.5 million TEU of container cargo handling since 2014 (Figure 3).

Since the demand is expected to increase in future with the economic development of Thailand, the efficient port management of handling more cargo within a limited space is required.

Figure 3　Amount of Cargo Handled at Bangkok Port

（Source： PAT Brochure）

(2) Current Situation of West Quay

West Quay is a terminal for break bulk cargos, where container vessels are not intended to arrive. Therefore, there is no gantry crane (crane specialized in loading/unloading cargos of container ships to/from a terminal) installed.

The yard of West Quay is scattered with warehouses for handling LCL (Less than Container Load) cargos, bulk cargos, and hazardous materials (Figures 4 and 5). The yard originally served for shipping activities such as packing of break bulk cargos (not-in-container). However, since the amount of cargo increased due to a shift to break bulks to containers, warehouses for handling such cargos was constructed in West Quay. Now, the yard of West Quay, therefore, mainly handles cargos for containers such as LCL cargos.

In a space called stuffing yard in the container yard, vanning/devanning of cargos to/from containers with consolidated LCL cargos is implemented. Large-sized forklifts and other equipment, are being operated in this place, which requires a lot of dead space to enable such equipment to be safely operated. Unlike CFS, this place does not allow for stacking of multiple containers. Therefore, its handling capacity per unit of area is low, and motion lines are complicated, which is one of the further areas for improvement regarding safety the team has identified. The work efficiency there is not the best with a lot of old warehouses that have not been upgraded, but simply used differently to adjust to increases in container cargo. Considering the efficiency of loading/unloading of cargo to/from ships, it may be necessary to reconsider the layout of warehouses located close to the quay side.

Figure 4 Layout of Warehouses in West Quay

Figure 5 Yards in West Quay

（3） Current Situation of East Quay

As mentioned above, East Quay was constructed as a container terminal, and has 14 gantry cranes installed. East Quay consists of two terminals: Terminal 1 and Terminal 2 (Figure 6), and the total area for their container yards (for cargo handling) is 147,600 m^2, with 98,600 m^2 for Terminal 1 and 49,000 m^2 for Terminal 2 (Figure 7).

Figure 6 Layout of Container Terminals of East Quay

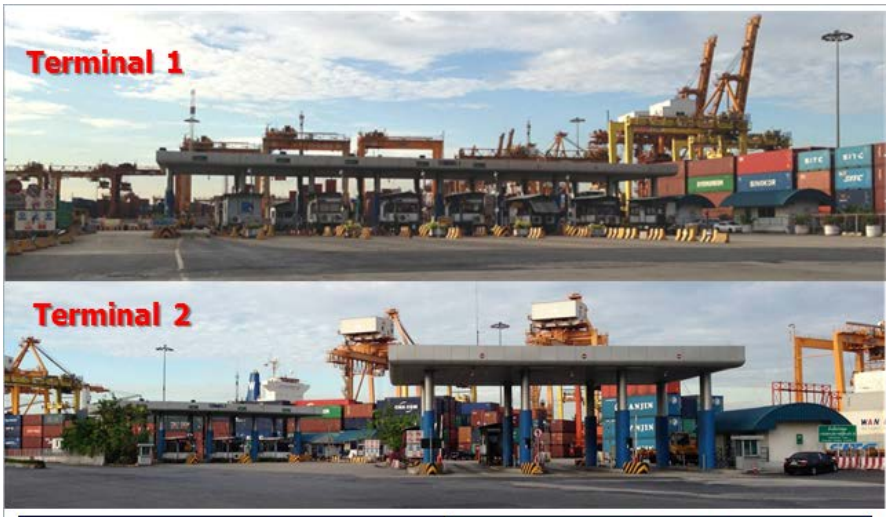
Figure 7 Container Yards of Terminals 1&2 at East Quay

As for reefer plugs (power source) necessary to handle reefer containers for foods and medicines, etc., that require temperature control, a total of 784 units are provided at Terminals 1&2, also allowing for storage of such containers (Figure 8).

As for gates to control external trucks, etc. (trailers carrying containers), there are five inbound lanes and three outbound lanes in Terminal 1, and four inbound lanes and three outbound lanes in Terminal 2 (Figure 9).

TERMINAL 1		TERMINAL 2	
Reefer Plugs	460 Units	Reefer Plugs	324 Units

Figure 8 East Query Reefer Facilities for Terminals 1&2



TERMINAL 1		TERMINAL 2	
Sub In-Gate	5 Units	Sub In-Gate	4 Units
Sub Out-Gate	3 Units	Sub Out-Gate	3 Units

Figure 9 East Query Gates of Terminals 1&2

The following cargo handling equipment is installed in Terminals 1 and 2 (Figure 10).

Terminal 1

- Gantry crane (rated load: 35.5 – 40 t): 8 units
- RTG (rated load: 30 – 40 t) 23 units
  - 4+1 rows, 1 over 3 stacks* 16 units
  - 4+1 rows, 1 over 2 stacks 7 units
- Reach stacker (rated load: 40 t): 1 unit
- Reach stacker for empty container: 1 unit
- Container chassis (head and trailer): 64 units

* Number of rows and stacks of loadable containers

Terminal 2

- Gantry crane (rated load: 35.5 – 40 t): 6 units
- RTG (rated load: 30 t – 40 t): 15 units
  - 4+1 rows, 1 over 3 stacks 5 units
  - 6+1 rows, 1 over 4 stacks 10 units
- Reach stacker (rated load: 40t): 1 unit
- Reach stacker for empty container: 1unit
- Container chassis (head and trailer): 46 units

EQUIPMENT	
Rail Mounted Gantry Crane 35.5-40T	8 Units
Rubber Tyred Gantry Crane 30-40T	23 Units
4 Plus 1 - 1 Over 3	16 Units
4 Plus 1 - 1 Over 2	7 Units
Reach Stacker 40T	1 Unit
Empty Cont. Reach Stacker	1 Unit
Tractor For Contaner	64 Units
Container Chassis	64 Units

EQUIPMENT	
Rail Mounted Gantry Crane 35.5-40T	6 Units
Rubber Tyred Gantry Crane 30-40T	15 Units
4 Plus 1 - 1 Over 3	5 Units
6 Plus 1 - 1 Over 4	10 Units
Reach Stacker 40T	1 Unit
Empty Cont. Reach Stacker	1 Unit
Tractor For Contaner	46 Units
Container Chassis	46 Units

Figure 10 East Quay Cargo Handling Facilities and Equipment of Terminals 1&2

(4) Future Construction Plans

Bangkok Port needs to expand its container terminals to adjust to recent increases in container cargo being handled. In addition, amid the increase of container use with the decrease of break bulk and the increase of container cargo, need for CFS functions has also increased to allow vanning/devanning of LCL cargos to/from containers to realize more efficient operations in the limited space.

Therefore, PAT is planning to newly construct CFSs for import and export in the area which is now being used as stuffing yards, to concentrate LCL cargos handled at LCL warehouses and stuffing yards in West Quay (Figure 11).

PAT plans to construct CFS Export first to transfer a part of container handling function, and then construct CFS Import to complete the transfer of all container handling functions (Figure 12). After that, PAT will remove buildings near the quay side to prepare additional space, and then will construct a container terminal there. At that occasion, the quay side near the container terminal will be modified for container use, to install gantry cranes, etc.

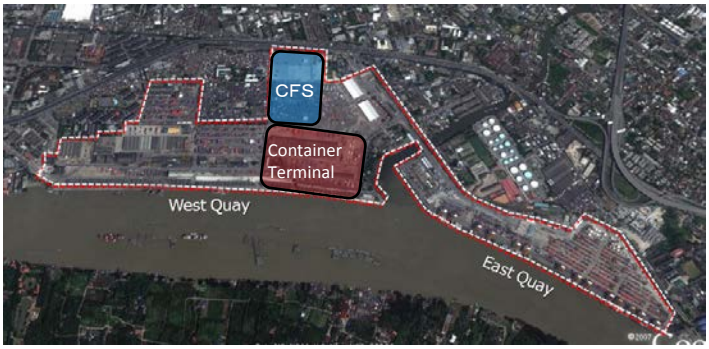


Figure 11　Image of Construction Plan for Bangkok Port

Figure 12　Image of Completed CFS Export and CFS Import at Bangkok Port

（Source: PAT NEWS ISSUE 41, September 2016）

1.4 Review of Preparation Plan Introducing Low-carbon Equipment

Seeing the environmental impact made by ports with the economic development of ASEAN as an important issue, PAT is now promoting a 5-year program of environmental measures called “Green Port Project” (2015-19), to actively promote low-carbon efforts including the introduction of energy efficient cargo handling equipment and the installation of wind power stations in the ports it controls. As mentioned above, the goal of this “Green Port Project” is a 10% reduction of CO2 expected to be emitted from PAT’s operation activity in 2019, compared with its emissions in 2013.

In promoting the above environmental efforts, PAT has been eager to get technological support based on its partnership with Yokohama Port Corporation, and the item for cooperation in the field of technology and environment is also included in their MoU.

In addition, PAT has shown a keen interest in the introduction of low-carbon facilities and equipment under the JCM, and has been proceeding in a joint study with YPC on the use of the JCM. PAT as an entity proactively operates the entire port, being involved in mid-to-long term port improvements, cargo handling, and maintenance and control of the facilities. Thus, PAT is a good counterpart for this project, not only for coordination of the total facilities and operation of the port, including a reduction of CO2 emissions of individual items of equipment, such as cargo handling equipment and lighting, but for the grander idea of a shift to become a low-carbon, smart port.

The team decided to proceed with the low-carbon efforts under JCM including this Feasibility Study, in a step-by-step manner. The team decided to work on reducing CO2 at Bangkok Port first for Phase 1, and then to promote carbon reduction at Laem Chabang Port while aiming to realize carbon reduction in logistics activity between the two ports in Phase 2 (described below).

The team also decided to proceed with efforts to become a smart port through the parallel introduction of energy management systems, and in Phase 3, to realize the ultimate carbon reduction in the five main ports in Thailand controlled by PAT, to make them a low-carbon distribution base in the ASEAN region. Thailand, as one of the major ASEAN economies and also geographically at the center of ASEAN region, is expected to serve as a major logistics hubs for the region, with the future economic development of its neighboring countries such as Myanmar, Laos, and Cambodia. Therefore, the promotion of carbon reduction in ports in Thailand can contribute to the realization of carbon reduction in the logistics of ASEAN region.

This Feasibility Study is seen as a first step for the above-mentioned mid-to-long term project with an eye to ASEAN-wide development. Therefore, the team examined possible measures for Phase 1 and Phase 2, focusing on mature technologies, to prepare an application for a JCM Model Project in the next fiscal year (Figure 13).

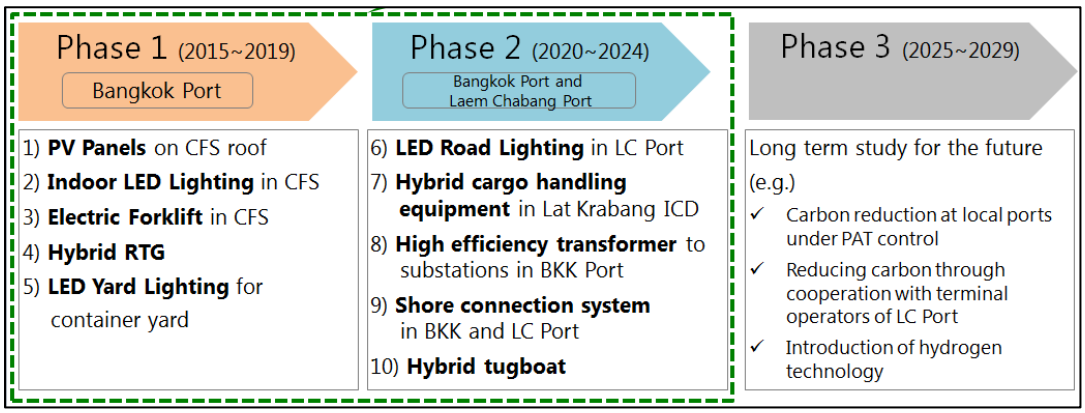


Figure 13 Whole Image of the Project

In this Feasibility Study, the team examined the introduction of measures in line with the new CFS construction plan at Bangkok Port by PAT as the Phase 1 Project. The facilities and equipment examined for introduction were photovoltaic (PV) power stations and LED lighting for the CFS buildings, as well as electric forklifts and hybrid RTGs in line with introduction of new cargo handling equipment for the new CFS construction. At the same time, the team also examined the possibility of replacing container yard lighting of Bangkok Port with LED lamps. Since the container terminals are also scheduled to be expanded after the CFS construction, the continuous progress toward low- carbon and smart approaches in future PAT projects is also expected through supporting the introduction of facilities and equipment for carbon reduction in the port starting at the planning stages for new construction of CFS facilities.

For Phase 2 projects, the team examined the possibility of introducing LED lighting equipment at Laem Chabang Port (Figure 14) – another international port operated by PAT – , and replacing freight handling equipment at Lat Krabang Inland Container Depo (LICD) – an inland container terminal facility that is connected to Laem Chabang Port by railroad – with hybrid-type equipment, as well as introducing high-efficiency transformers (electric facilities), shore connection systems for ships, and hybrid tugboats at Bangkok Port.

Unlike Bangkok Port, Laem Chabang Port is managed by terminal operators instead of PAT (described below). So, in order to replacing the lighting equipment in the terminal facilities including CFSs and yards with LED lamps, coordination with the operators is required. Therefore, the team decided to choose Laem Chabang Port's road lighting, which is directly controlled by PAT, as an initial target for consideration.

Figure 14 Laem Chabang Port

1.5 Review of Procurement Methods (Bidding or Negotiated Contract, etc.)

PAT generally procures all its facilities and equipment through open bidding. The electronic bidding system (called “e-auction”) is used for bidding according to the following steps:

Step 1 Publishing Terms of Reference (TOR)

Conduct interviews with private companies about the content of the TOR, to get it finalized with revisions as appropriate.

Step 2 Application for Bidding by (Potential) Bidders

Companies that wish to make a bid purchase the TOR and apply for bidding. The related documents for bidding are all written in Thai.

Step 3 Screening of Applicants for Bidding by

PAT examines the applicant companies for bidding, and approves their qualifications for bidding if there are no concerns about their reliability/credibility, etc.

Step 4 Implementation of Bidding

The timeframe between the publication of TOR to bidding is about two months.

Step 5 Start of Construction and Delivery

Participation in the bidding process is also allowed for a Japanese company that does not have any local affiliate, but it is stipulated that any contracting party must be a Thai company. Therefore, if a Japanese company makes a bid, it is necessary to have a Thai company as the contracting party. If a Japanese company without any local affiliate in Thailand wins a contract, it will need to establish a local affiliate.

According to interviews with PAT, there have been no foreign companies participating in biddings by PAT, and all bidders to date have been Thai companies (including local affiliates of foreign companies, and joint venture companies, etc.).

Financing for the proposed JCM project examined in this Feasibility Study is discussed in Chapter 4 below.

2. Information Gathering and Summary on Regulatory Matters

For the measures to be adopted for projects described by this Feasibility Study, no specific licenses are required for the installation of port facilities and equipment, such as electric forklifts, hybrid RTGs, and large-scale LED yard lighting, etc. For photovoltaic (hereinafter PV) power stations for captive use to be connected to the above facilities and equipment, however, the acquisition of licenses or the submission of notifications is required for some conditions. The relevant regulator matters and notification procedures, etc., are presented below:

2.1 Energy Regulatory Commission (ERC)

For rooftop PV power stations, licenses are not required only if the following conditions are met. If the equipment to be introduced does not satisfy the following conditions, application for licenses or submission of notifications will be required:

Conditions for equipment to be exempted from license acquisition

- Capacity less than 373 kW
- Area for installation less than 160 m^2
- Weight of PV panels (incl. modules and constructions) less than 20 kg/m^2

For license application, the specified formats in the Thai language are provided (19 pages), in which descriptions about the following are required.

Summary of Application Documents to ERC

(1) Applicant information (business register ID, type of license submission, authorized person, address, tax ID, etc.)
(2) Information about the business (business structure, stakeholder list, investor)
(3) Information about the energy business activity (address, GPS of location, land, construction)
(4) Information about the energy generation - for power generation license (objective and energy production plan, power generation system, capital cost/ installed capacity, efficiency of the system, etc.)
(5) Environmental management (EIA, report, impact management)
(6) Information about the distribution system - for energy distribution system
(7) Information about the energy distribution - for energy distribution license
(8) Qualification and certification of the licensee
(9) Supporting document and evidence

These application documents can be downloaded from the ERC website (in Thai). Timeframe required for the application to be accepted is expected to be about 2.5 months. Figure 15 presents the flow of the application procedures.

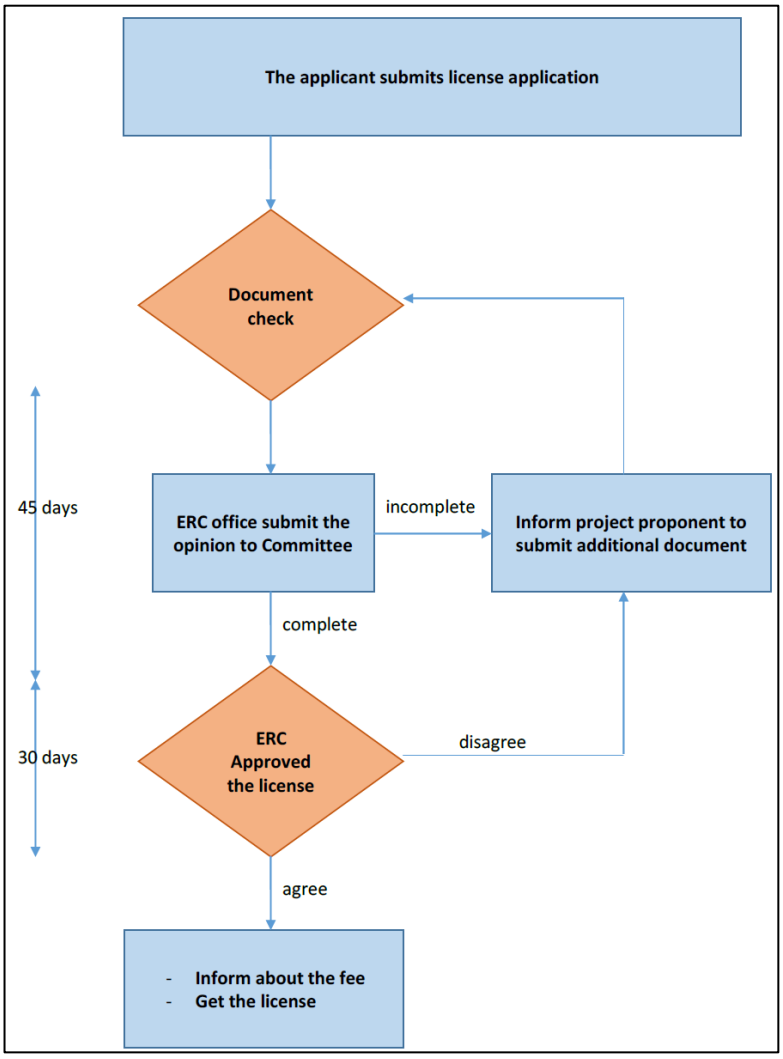


Figure 15 Process of License Application to ERC

(Source: Translated to English from http://www.erc.or.th/ERCWeb2/EN/Front/StaticPage/StaticPageEN.aspx?p=9&Tag=Licensing)

Information about the application procedures shown above and necessary documents are provided in the following websites (only available in Thai):

・Overview of proceedings and necessary documents, etc.

http://www.erc.or.th/ERCWeb2/Front/StaticPage/StaticPage.aspx?p=17 and

http://www.erc.or.th/ERCWeb2/Front/StaticPage/StaticPage.aspx?p=200&Tag=SolarRooftop

・Files for license application

http://www.erc.or.th/ERCWeb2/Upload/Document/11142013130912722.pdf

2.2 Metropolitan Electricity Authority (MEA)

A project proponent who seeks to generate power (more than 1MW) to be connected to the grid, needs to apply to MEA for a license, which administers the project site, or Provincial Electricity Authority (PEA). Since the site of the project proposed in this Feasibility Study is located in Bangkok, license application to MEA is required.

For power generation with the installed capacity of less than 1 MW, the license is not required but a notice must be submitted. For introducing PV system to CFS Export as JCM Model Project for FY 2017, license application to MEA will not be necessary because the capacity of the unit is assumed to be less than 1 MW given the surface area of the roof for installation. For the installation of PV system to CFS Import in FY 2018, license application to MEA will be required because the maximum capacity of the PV system to be installed is estimated to exceed 1 MW.

Documents for such application can be downloaded from the MEA website (in Thai), in which description about the following is required.

Summary of Application Documents to MEA

(1) Applicant information; company name, address, address, purpose of connection to the grid
(2) Technical information; preferable voltage (kV), type of power generation, machines, generators, inverter, etc.
(3) Project load; max-min of kW from MEA/PEA, total installed capacity of electricity generation (kVA)
(4) Contact info; contact person
(5) Additional documents;
- Map of project
- Single line diagram/ metering and relaying diagram
- Control panel, protection function system
- Specification of generation (for the applicant who acquire the generator only)
- Specification of transformer, circuit breaker, CT, PT, relays, power quality meter, tele protection for connecting with 115 kV system

Timeframe required for the application to be accepted is expected to be about 2.5 months. It should be noted that for PV power generation projects, applicants may just submit general information about the specifications of the relevant PV panels, but need to check whether it is the latest information at the time of application.

2.3 Other Application Procedures

（1） Department of Industrial Works (DIW)

The competent agency of licensing for industrial works. If facilities or equipment to be introduced fall under the Factory building type/code, such as power generation facilities of more than 1 MW, the license application as prescribed is required.

（2） Bangkok: Bangkok Metropolitan Administration (BMA)

In case of modifying existing buildings or the configuration of facilities, construction permits must be obtained from the municipal government (BMA in the case of the proposed project in this Feasibility Study).

3. Examination of Applicable Technology & Equipment, and Measures for Cost Reduction

3.1 Project Overview－Examination of Technology and Equipment to be Introduced to the Port Facilities

There are two types of ports under PAT's control: one is river ports like Bangkok Port, where the port management through to operation is directly provided by PAT; and the other is the one like Laem Chabang Port, where PAT prepares the port infrastructure such as sites and quays to lease terminals to private operators, and the preparation of individual facilities and actual operation there is provided by the renters.

PAT is aiming for carbon emission reduction not only at ports under its direct management like Bangkok Port, but also at Laem Chabang Port and other ports in Thailand. Thus, the review of applicable technology and equipment as well as measures for cost reduction targets all ports in Thailand controlled by PAT.

Therefore, the team decided to proceed with the project study in a step-by-step manner, introducing measures with higher feasibility at the terminals directly managed by PAT in Phase 1, and moving forward to next steps, building on the results achieved in the above terminals in Phase 2.

Figure 16 presents the overview of the project, where technologies or equipment with their names surrounded by orange squares are for Phase 1, and those with sky blue squares are for Phase 2. For both phases, all measures to be introduced in Thailand have already been implemented in Japan by YPC and Port & Harbor Bureau, City of Yokohama.

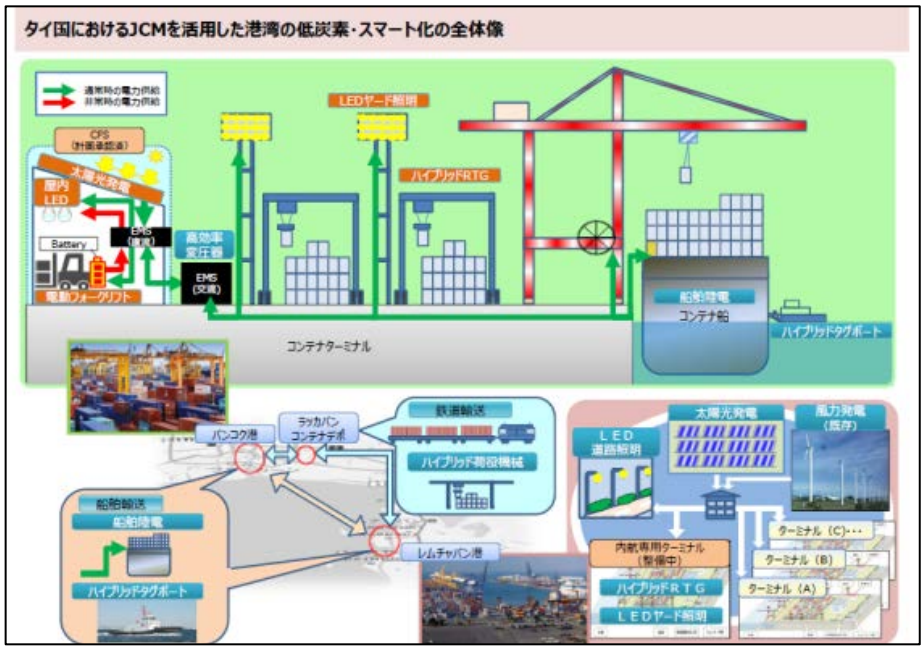


Figure 16 Project Overview: At the beginning of the Study(Phase 1 & Phase 2)

Firstly, in Phase 1, the team will realize carbon emission reduction at Bangkok Port by packaging technologies and equipment with higher feasibility based on the port construction plan of PAT, etc. (PV power station, indoor LED lighting, electric forklift, LED yard lighting, and hybrid RTG).

Then, in Phase 2, the team will target measures that can be made more feasible by a medium-term study (shore connection system, hybrid tugboat, high-efficiency transformer, hybrid cargo handling machine, LED road lighting, hybrid RTG, LED yard lighting, PV power generation, and wind power generation). The carbon emission reduction project will be realized with the addition of other target sites, including Laem Chabang Port, etc.

3.2 Phase 1 Project: Making Bangkok Port a Low Carbon, Smart Port

(1) Summary of Measures to be Introduced

In Phase 1, PV panels will be installed on the roofs of the CFS (container freight station) buildings and the generated power will be supplied to LED lamps adaptable to particular conditions in the CFSs (described below) and electrical forklifts (Figure 17). The team will also examine the possibility of using direct current electricity from the PV system without converting to alternating current. Surplus electricity not used by the above equipment will be supplied to the power network in Bangkok Port to be used as a power source for LED yard lighting, etc.

In addition, the team will also examine the possibility of utilizing stored power in the batteries of electric forklifts as emergency power sources for LED lighting inside the CFSs at a time of a major power outage or other emergency.

As for gantry cranes to be used at container storage yards adjacent to the CFSs, introduction of hybrid RTGs (described below) will be considered. Also, LED lamps will be installed as well for yard lighting at the container terminals of Bangkok Port.

The installation projects of above mentioned facilities and equipment, such as electric forklifts, indoor LED lighting, hybrid RTGs and PV system as their power source, are all directly related to CFS activity and need to be examined as a whole package of measures for realizing a “Smart Port”. The team has already been proceeding with the consideration of the proposed package project with PAT, hoping to apply for JCM Model Project funding for next fiscal year.

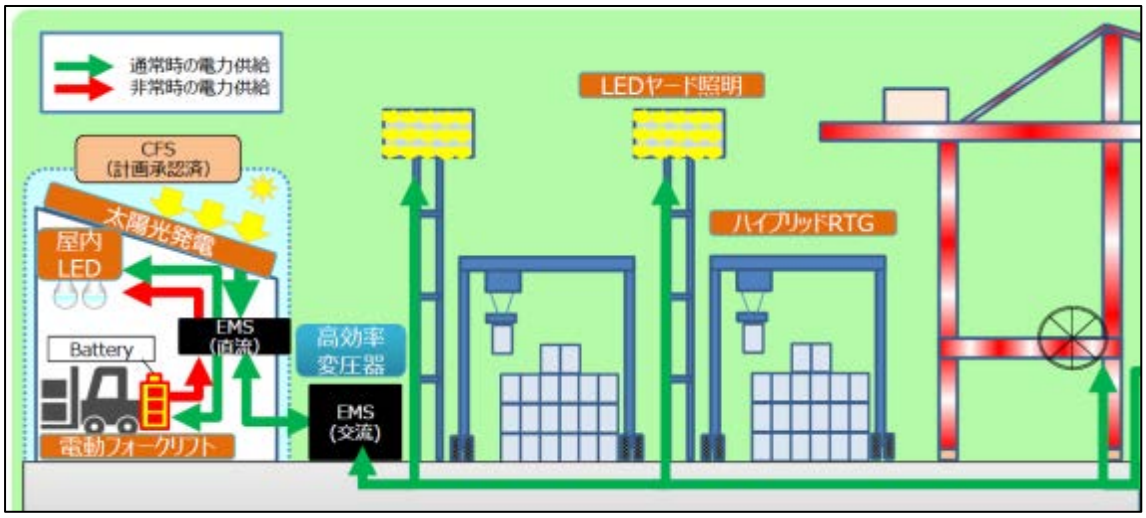


Figure 17 Phase 1: Enlarged Image of Measures at Bangkok Port: At the beginning of the Study

The CFS will serve as the core facility of the proposed project under this Feasibility Study.

CFS is a facility built in a container terminal for vanning/devanning cargos to/from containers with consolidated small cargos. Cargos are vanned/devanned with forklifts, etc., there. In the case of Bangkok Port, there are dedicated yards for containers to be handled at the CFSs (storage area), where dedicated cranes called RTGs are installed.

In Japan, CFS in general refers to a building, but in ports in other countries where there are a lot of needs of vanning/devanning, buildings and surrounding dedicated container storage areas are often regarded as “CFS” as a whole. In the case of Bangkok Port as well, “CFS” means buildings and their surrounding container storage areas as well as their facilities like cargo handling machines, and measures targeting them are regarded to be CFS projects as a package. At the same time, it is also characteristic for CFS buildings to be constructed separately for export only and import only. Both of them are substantially larger in scale compared with that of Japan.

PAT has developed a plan to prepare the CFSs for handling export cargos (CFS Export) and import cargos (CFS Import) to deal with recent increase of cargos (Figure18). CFS Export was designed in 2016, and will be constructed from 2017 to 2018, with a view to start operation in October 2018. CFS Import will be designed in 2017, to start construction in 2018. Since the project feasibility of CFS Export is highly likely, with its design details almost finalized and its budget partially secured, the team conducted the Feasibility Study focusing on CFS Export. For this CFS Export, one warehouse building with a construction area of 10,000 m^2 and a four-storied office building (total floor area for 2,000 m^2) will be constructed. Together with the

construction of the buildings, a part of its container storage area (necessary space for exporting) will be constructed at the same time.

CFS Import, is still at the basic design stage. It was originally planned to have four warehouses with the construction area of 10,000 m^2 to be built, but according to the responsible PAT personnel, a plan of building two warehouses with the construction area of 15,000 m^2 is likely as the latest information. Since it still has more time before facility introduction, chances of including low-carbon facilities in the design can be higher by supporting PAT for its design at the current stage. For CFS Import, where there is a good chance of effectively realizing project development in 2018, further study in more detail will be necessary in the coming fiscal year (FY 2017).

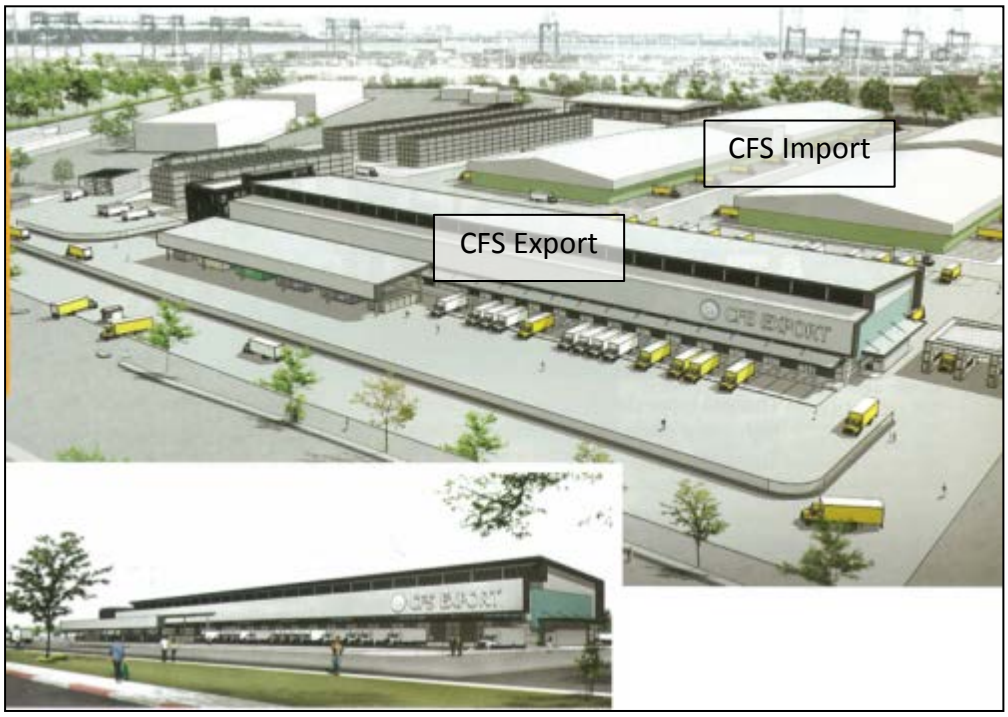


Figure 18 Image of Completed CFS Export and CFS Import at Bangkok Port (same image as Fig. 12)

(Source: PAT NEWS ISSUE 41, September 2016)

An explanation about the elements that constitute the project package is provided below:

(1) Installation of PV System on Roof of CFS

The CFSs are especially large in scale among the constructions in the terminals as shown in Figure 18, and are ideal for installing PV power stations. When the installation of PV system can be included in the design, the shape and structure of the roof can be designed to allow for more panels to be installed. However, when the design has already been finalized or panels are to be installed on existing buildings, attention must be paid for various conditions to be

examined such as loading conditions, size of panels, ways of installation, and securing space for access, etc.

In addition, the roofs of CFS buildings often have skylight windows (top light) to provide the light in the buildings, and PAT is planning to have CFS buildings with skylight windows as well. In such cases, installable PV capacity highly depends on the size and configuration of the skylight windows. It should also be noted that in many cases, panels cannot be installed on a canopied place (at the place of cantilever beams) due to load constraint. Since the CFSs at Yokohama Port have installed the same type system, the team examined necessary conditions for installation based on the design at Minami Honmoku Pier of Yokohama Port (Figure 19) as a reference.

The specifications of CFS Export (Figure 20) are as follows:

- Construction area: 10,000 m^2, of which the surface area of the roof is 9,800 m^2
- with a four-storied office building (gross floor area: 2,000 m^2)
- Strength per unit area of the roof: 25 kg/m^2
- 59 units of forklift, etc., to be introduced as indoor cargo handling machines
- 2 units of RTG to be introduced as cargo handling machines to be used at the container storage area

The team confirmed with the responsible PAT personnel that the CFS roof has enough strength for PV installation. Based on the roof area described above, it is estimated that 0.77 MW in PV power can be installed. Due to lack of information about details, including the exact size of the windows and the size of roof and construction materials, however, the above figure should be noted as only an estimate. At the time of actual installation of PV system, several points will need to be confirmed.

Figure 19　PV Panels on the Roof of the CFS at Minami Honmoku Pier, Yokohama Port

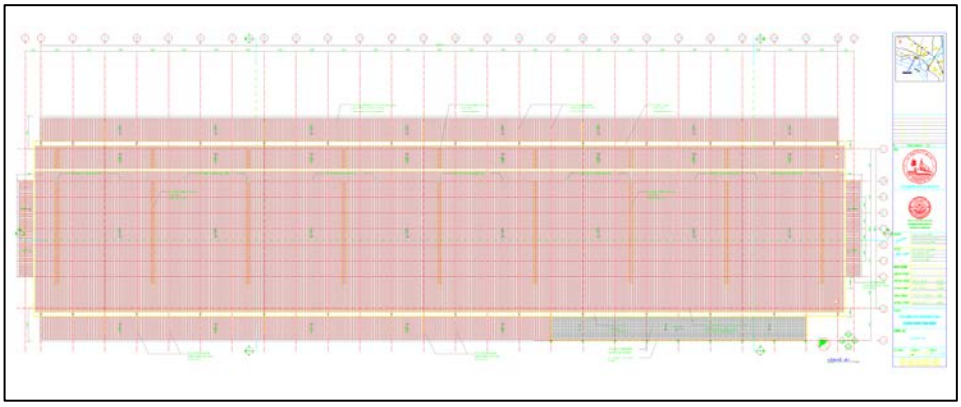


Figure 20　Schematic View of the Roof for CFS Export

(2) LED Lamps in CFS Building at Bangkok Port

Mercury lamps and sodium-vapor lamps have traditionally been used for lighting in the CFSs. The proposed project seeks carbon emission reduction by replacing them with LED lamps to reduce power consumption.

In Thailand, where the temperature is high throughout the year, the temperature in CFSs is high as well, easily reaching 50℃ especially at the height of installing lighting equipment near the high ceiling. In an ordinary type of CFS, since temperature is higher during daytime when lamps are off than time when lamps are on, there is a fear of LED device corruption. Therefore, it is essential to select high-quality LED lamps that can endure such a high temperature.

However, CFS Export has already completed the basic design process, the specifications of its lighting equipment have already been provided in the design. Therefore, the team has deferred the idea of installation of high-quality LED lamps in CFS Export.

Since CFS Import is currently undergoing the basic design process, still having a room for such LED lamps to be included in the design, the team will continue to examine the possibility of their installation.

First, making use of the framework of the Y-PORT project, the team had discussions with Japanese companies base in Yokohama that have manufacturing plants in Thailand, checked the LED lighting equipment used at their local plants, and confirmed the validity of using such LED lamps in the CFSs. In addition, the team had interviews with Thai-based suppliers to extensively collect information. The team will continue further investigation in detail.

Figure 21　LED Lighting Equipment Installable on the Ceiling of CFS

(3) Electric Forklifts for CFS at Bangkok Port

①　Brief Description about Electric Forklift

For vanning/devanning of cargos to/from containers, which is the main purpose of CFS, various types of forklifts with different specifications are used according to types of cargos and operational purposes. So far, PAT has been using forklifts fueled by gasoline and diesel oil, but is now examining to adopt electric forklifts this time from the perspective of improving the working environment. In Thailand, the operation of forklifts requires a license, thus the labor costs for operation management are systematically included in budget together with initial investment costs for installation of the equipment.

As for electric forklifts to be used for CFSs Import and Export at Bangkok Port, PAT is planning to introduce three types of forklifts mentioned below. For CFS Export, for which procurement details will be discussed later, 59 forklifts will be introduced, making the total more than 150 units introduced, when also counting CFS Import. Given the substantial orders expected, cost reductions can be expected due to volume purchases.

②　Electric Forklift: 12 units

・Common equipment for handling cargos loaded in pallets.

・Rated load: 2.5 t

Figure 22　Electric Forklift(Ordinary type)

③ Electric Reach Truck: 8 units

・Cargo handling equipment specialized in vanning/devanning of cargos in higher locations

・Rated load: 2.0 t

Figure 23　Electric Reach Truck

④ Electric Pallet Truck: 39 units

・Cargo handling equipment specialized in horizontal movement of cargos loaded in pallets

・Rated load: 1.0 t

Figure 24　Electric Pallet Truck

⑤　Market Shares of Forklift Manufacturers and Market Situation in Thailand

The market shares of forklift manufacturers in the world are indicated below. In this Feasibility Study, considering convenience in introduction and maintenance after introduction, the team conducted interviews mainly with Japanese companies with higher shares in the world and Thailand.

Table 1　Forklift: World Market Share in 2014 (based on revenue)

Rank in 2014	Manufacturer	Rank in 2013	Headquarters	Share
1	Toyota Industries Corporation	1	Japan	25.0%
2	KION Group	2	Germany	17.2%
3	Jungheinrich AG	3	Germany	9.8%
4	Hyster-Yale Materials Handling, Inc.	4	USA	9.0%
5	Crown Equipment Crop.	5	USA	8.1%
6	Mitsubishi Nichiyu Forklift Co., Ltd.	6	Japan	7.0%
7	UniCarriers Americas Corporation	7	Japan	5.0%
8	Anhui Forklift Truck Group Corp.	8	China	3.6%
9	Hangcha Group Co., Ltd.	9	China	3.2%
10	Komatsu Ltd.	10	Japan	2.9%
11	Clark Material Handling	11	South Korea	2.4%
12	Doosan Industrial Vehicle	12	South Korea	2.2%
13	Hyndai Heavy Industries	13	South Korea	1.5%
14	Lonking Forklift Co., Ltd.	14	China	0.6%
14	Combilift Ltd.	16	Ireland	0.6%
16	Tailift	15	Taiwan	0.6%
17	Hubtex	17	Germany	0.4%
18	Hytsu	18	China	0.3%
19	Godrej & Boyce Manufacturing	19	India	0.2%
20	Paletrans Equipment	20	Brazil	0.2%

(Source: Research from Modern Materials Handlin)
(http://www.mmh.com/article/top_20_lift_truck_suppliers_2015)

Toyota is in the first place in market share in Thailand. Toyota has 13 manufacturing bases in Thailand under its direct management (Figure 25).

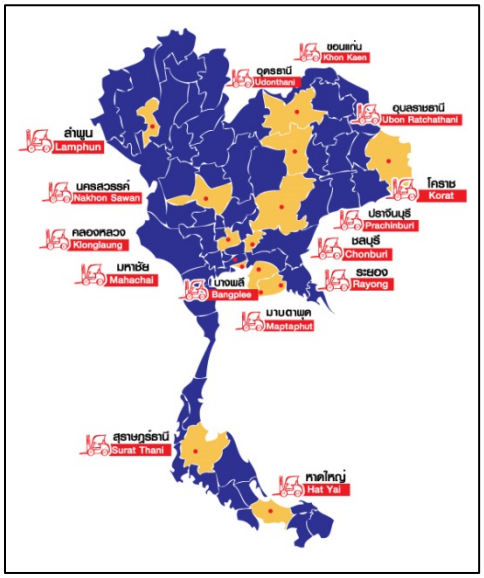


Figure 25
Manufacturing Bases of Toyota in Thailand

Source: http://www.toyotaforkliftthailand.com/products/index.html
http://www.toyotaforkliftthailand.com/about_us/network.html

⑥ Desirable Criteria for Electric Forklifts for CFSs in Bangkok Port

Electric forklifts will serve as core equipment of the project to make Bangkok Port a low-carbon, smart port. The team examined technological conditions suitable for the project's aim, and had technological discussion with a Japanese company with the highest share of the forklift market in Thailand.

The team examined various products as to environmental performance such as energy efficiency, as well as safety for operators and equipment, operational efficiency, and maintenance levels. In addition, since the use of forklift batteries as the emergency power source is sometimes considered as an additional function in adopting electric forklifts in Japan, the team also examined the possible use of this function in this Feasibility Study as well. As the conclusion, the team considers that equipment having the following functions and/or specifications would be desirable for the project.

(a) Environmental Performance: Regeneration Brake

Electric forklifts with regeneration brake systems restore regenerated energy when brakes and accelerators function.

In addition, some manufacturers developed technology to increase regeneration efficiency by controlling regeneration with pedal strokes.

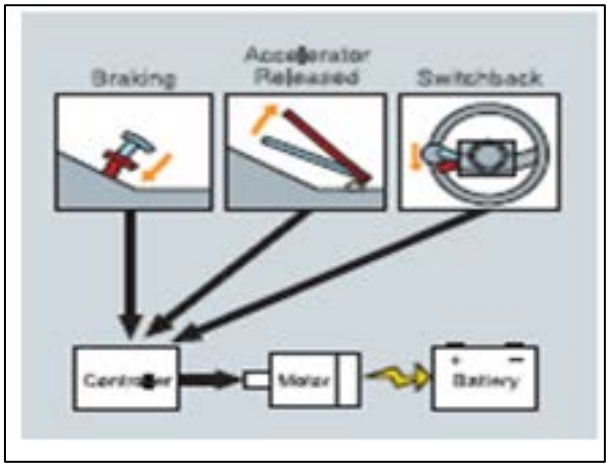


Figure 26 Mechanism of Regeneration Brake

In a forklift, a counterweight is placed at the rear to prevent the gravity center from leaning to the front. For an electric forklift, a lead-acid battery is used to serve as storage battery and as a counterweight, while for reach truck and pallet truck, a lithium ion battery is used in many cases.

(b)Environmental Performance: Battery Capacity Warning

An electric forklift is powered by an installed battery. When battery capacity level drops during operation, an alarm goes off, and the operation gets controlled temporarily to protect the battery.

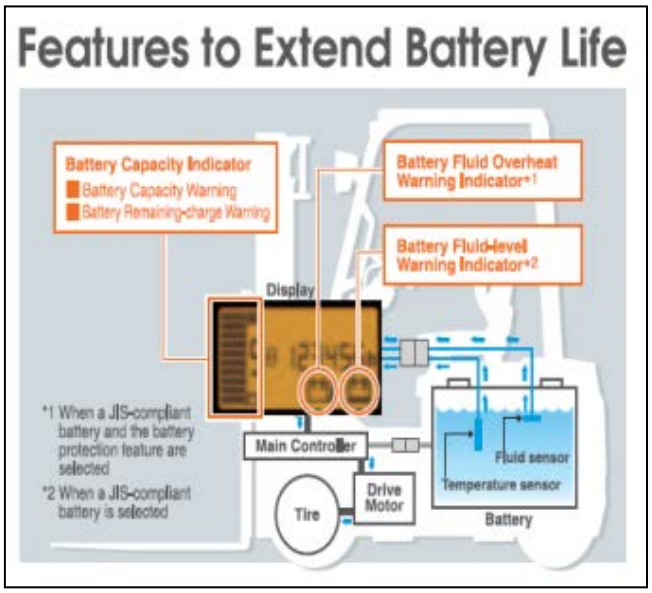


Figure 27 Mechanism of Battery Capacity Warning

(c) Safety: Operator Presence Sensing System

In the use of forklifts, accidents occur frequently, such as overturn of the body while running, falling of cargo hit by a forklift, and drivers' injuries, and each manufacturer is developing safety devices and getting them equipped in their products. In addition, some manufacturers are making efforts to prevent accidents by providing training.

Some forklifts the team has examined in this Feasibility Study have an Operator Presence Sensing System, as a mechanism to ensure safety. It is preferable to have this type of forklift equipped with such system that automatically senses the absence of an operator at the seat when s/he gets on or off the equipment, etc., and controls the operation of the equipment, to protect operators and surrounding workers from sudden acceleration.

Figure 28　Mechanism of Operator Presence Sensing System

(d) Rear Axle

At the time of forklift operation, the stability of equipment is crucial because cargos are carried not only vertically and horizontally but also frequently turned and handled sometimes on a slope.

In this project, a high-mount rear axle is preferentially seen as ensuring increased stability when turning as well as having high environmental performance.

Figure 29　Example of Forklift with Rear Axle

(e) Ease of Maintenance

In general, forklifts need to get their batteries replaced during while in service. Timing of replacement depends on the operating hours of the relevant machine. Also, since there are many movable parts, replacement of parts is frequently required. Therefore, their operation factors will be substantially different depending on the maintenance system and availability of replacement parts. Recently, major manufacturers are becoming capable of “visualizing” the running distances and operational status of each forklift by monitoring system, and storing and analyzing such data as big data, to plan the timing of replacing batteries and other consumables as well as the optimal layout of distribution of forklifts. This will enable not only the conversion to electric power but also efficient operation, thus hopefully leading to further energy saving.

⑤ Use of Forklift Battery as the Emergency Power Source

In port facilities requiring 24/7 operation, it is necessary to secure minimal power sources even when the power supply is interrupted during disasters, etc., to ensure operation of main computers, and for emergency lighting to ensure visibility of workers’ surroundings and safety. Although Bangkok Port is equipped with diesel power generators as emergency power sources, the team considered the possibility of using forklift batteries instead, for carbon emission reduction.

Equipment to retrieve the power stored in the forklift batteries for use at the time of emergency is already available on the market and used in Japan. Therefore, there is no need to develop new equipment or technology for this purpose, and it is ready to be introduced immediately.

To this end, the team first examined case studies in Japan, then, exchanged opinions with responsible PAT personnel based on the findings.

Figure 30　Example of Utilizing Forklift Batteries 1

Figure 31　Example of Utilizing Forklift Batteries 2

Figure 32　Example of Utilizing Forklift Batteries 3

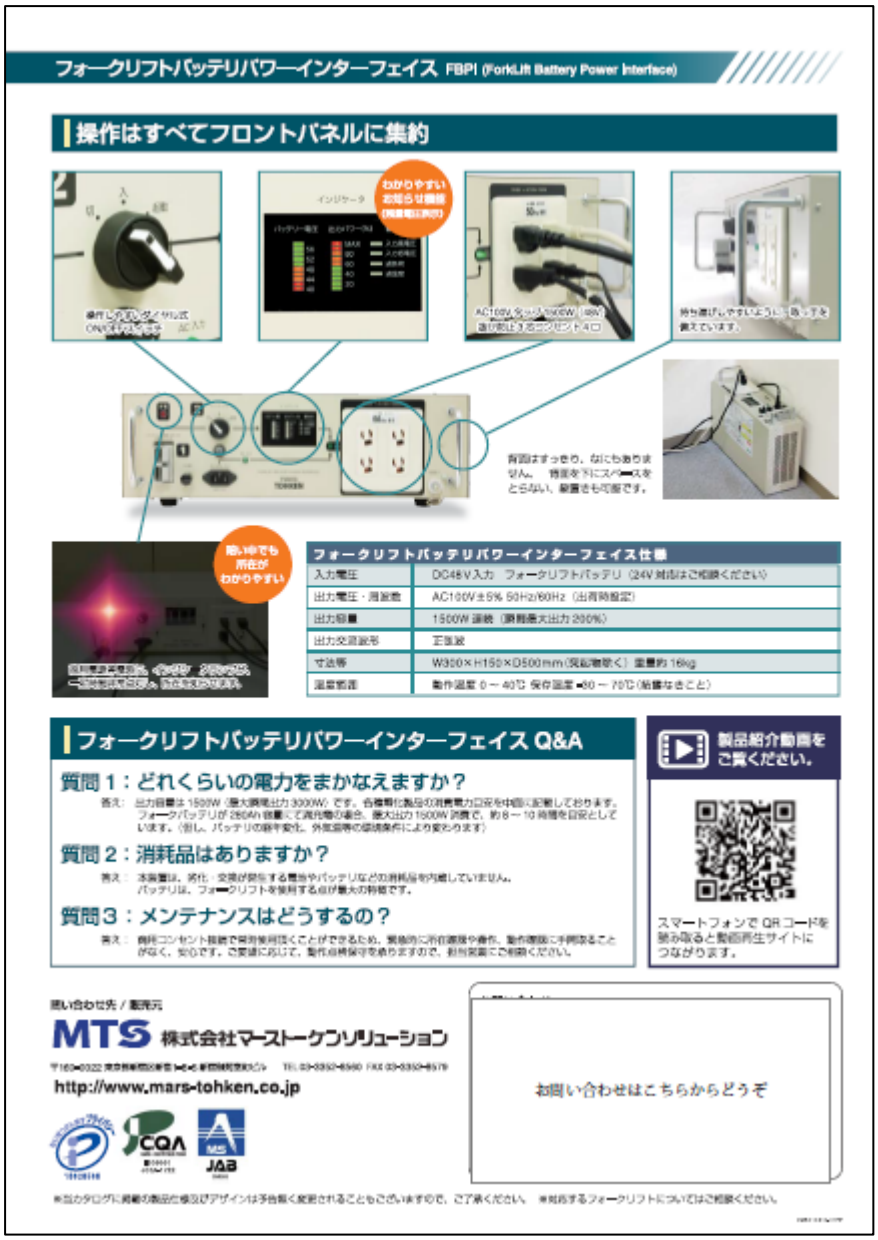


Figure 33　Example of Utilizing Forklift Batteries 4

Based on the above information, the team interviewed manufacturers of electric forklifts and had discussions with responsible PAT personnel.

The team found out that using the battery of a unit of forklift as the power source for personal computers or LED lighting is not technologically difficult, but that connecting the batteries of multiple electric forklifts to provide the power necessary for an entire CFS is likely to cause some problems, or may involve technical difficulties.

In addition, batteries are direct current power sources, which means a higher power loss than with alternating current. Therefore it should be noted that the length of cables should be limited to about 5 meters at the longest.

The biggest problem identified through the interviews, etc., is the conditions for product guarantee by the manufacturers of electric forklifts. It is generally seen that users are getting their electric forklifts equipped with some operational functions like liquid crystal panels using the forklift batteries as the power source on their own right. When such use is not a genuine option provided by their manufacturers, there is a risk of not being able to get the manufacturers' guarantee for the forklifts themselves because the manufacturers cannot afford detailed verification.

The use of batteries as the emergency power source examined in this Feasibility Study is not a genuine option provided by the manufacturers, either. Therefore, if electric forklifts are introduced with the assumption of using their batteries as the emergency power source, the product guarantee cannot be obtained from the manufacturer. So, if any trouble occurs, there might be some difficulties in fixing the problem without such guarantees. Especially when forklifts are introduced in a JCM Model Project, this would present a serious problem if any trouble should occur before the end of their statutory durable life, and discourage the continued use of the equipment.

In addition to this problem, the team confirmed, based on the discussion with PAT, that they were not much interested in securing the new emergency power source because they already had captive power stations.

Based on the result from above study, the team decided to give up on the use of forklift batteries as an emergency power source.

(4) Hybrid RTGs at Bangkok Port

A rubber tired gantry crane (RTG) is a unique crane for ports, designed with a portal shape for handling containers stored in a container yard. Conventional RTGs are operated with diesel fuels, but introduction of hybrid RTGs enables carbon emission reduction.

In this Feasibility Study, the team discussed with a Japanese manufacturer which already has the experience of introducing the equipment to Yokohama Port, and confirmed that it had a highly reliable product with sufficient environmental performance that could meet the requirements for introduction under a JCM Model Project.

Figure 34　Conventional RTG (Diesel Fuel) Currently Used at Bangkok Port

Figure 35　Hybrid RTGs Used at Yokohama Port
Beige-colored box-shaped objects near bottom are batteries.

In this Feasibility Study, hybrid RTGs with the following specifications are assumed to be introduced.

Table 2　Specifications of Hybrid RTGs Assumed to be Introduced

Item	Specifications
Rated load	40.6 t
# of rows and stacks *	6+1 rows、1 Over 6 stacks

* Number of rows and stacks of containers loadable by the RTG.

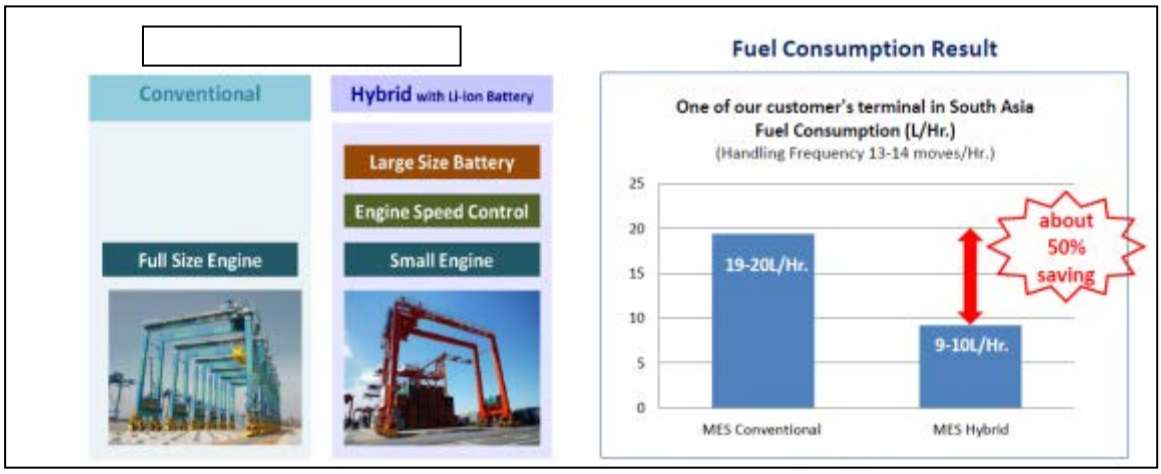


Figure 36　Characteristics and Energy Saving Effect of Hybrid RTG

(5) Yard Lighting at Bangkok Port

The port has large container yards for loading/unloading of containers. Adequate lighting is indispensable to secure safety and efficiency for work here at night.

Yard lighting equipment needs be installed on 30 m-high steel towers currently owned by PAT, to light a wide area. There was a concern that just the replacement of existing lamps with LED lamps could not satisfy the standard because they might not provide sufficient illuminance due to the characteristics of LED lamps. In this Feasibility Study, therefore, the team, utilizing the framework of "Y-PORT Project", obtained cooperation of Japanese companies in Yokohama City which are operating manufacturing plants of LED lamps in Thailand. The team had discussions with the companies and visited their sites to observe the outdoor LED lighting equipment at their local plants.

During the site visit, their outdoor lighting equipment was turned on after the sunset to simulate the condition of real use in the yards, and the responsible YPC personnel made a visual check of illumination, and reviewed the maintenance requirements, etc. As the conclusion, the team found out that the products of these companies satisfy the requirements for yard lighting at ports and could be used for the project proposed under this Feasibility Study.

In addition, the team estimated the illuminance level of the container terminals at Bangkok Port based on the specifications of their products, and confirmed that they could secure an

average of 38 lux, which is PAT's requirement, using the numbers of lamps that can be installed on existing towers.

Figure 37　LED lighting at Container Yard in Yokohama Port

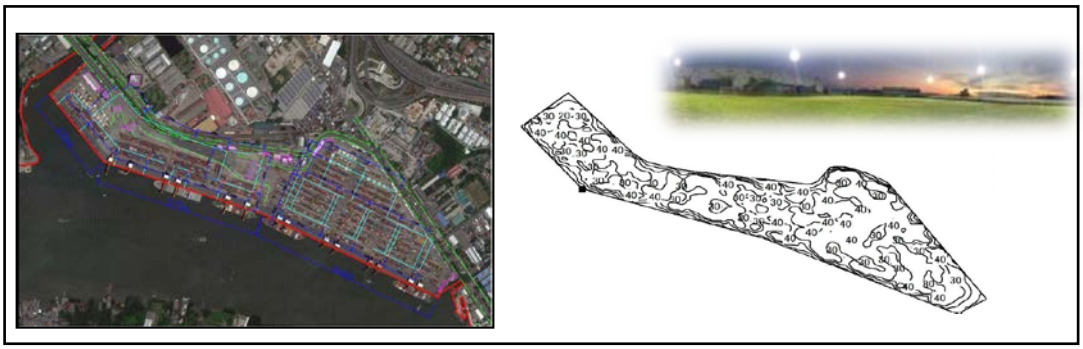


Figure 38　Premises of Bangkok Port and Image of Yard Lighting to be Installed

(6)Study of Various Combinations of Measures at Bangkok Port

Based on the above results from study and examination, the team conducted further discussions with the responsible PAT personnel and design engineers about the introduction of measures for CFS Export in Phase 1. As a result of the discussion, the team decided to adopt an idea of supplying all of the PV power to the "Port Power System" for captive use and then using it for various applications. This is in contrast to the initial idea of supplying PV power directly to LED lamps in the buildings and electric forklifts.

There are two main reasons for the above conclusion: (1) the amount of power use by LED lamps in the buildings and electric forklifts is limited compared to that of power generated by PV; and (2) given that CFS Export has already completed its design process, incorporating the team's initial idea into the design would delay the construction schedule by forcing substantial changes in construction conditions.

An overview of the measures proposed in Phase 1, reflecting the above conclusions, is presented in Figure 39.

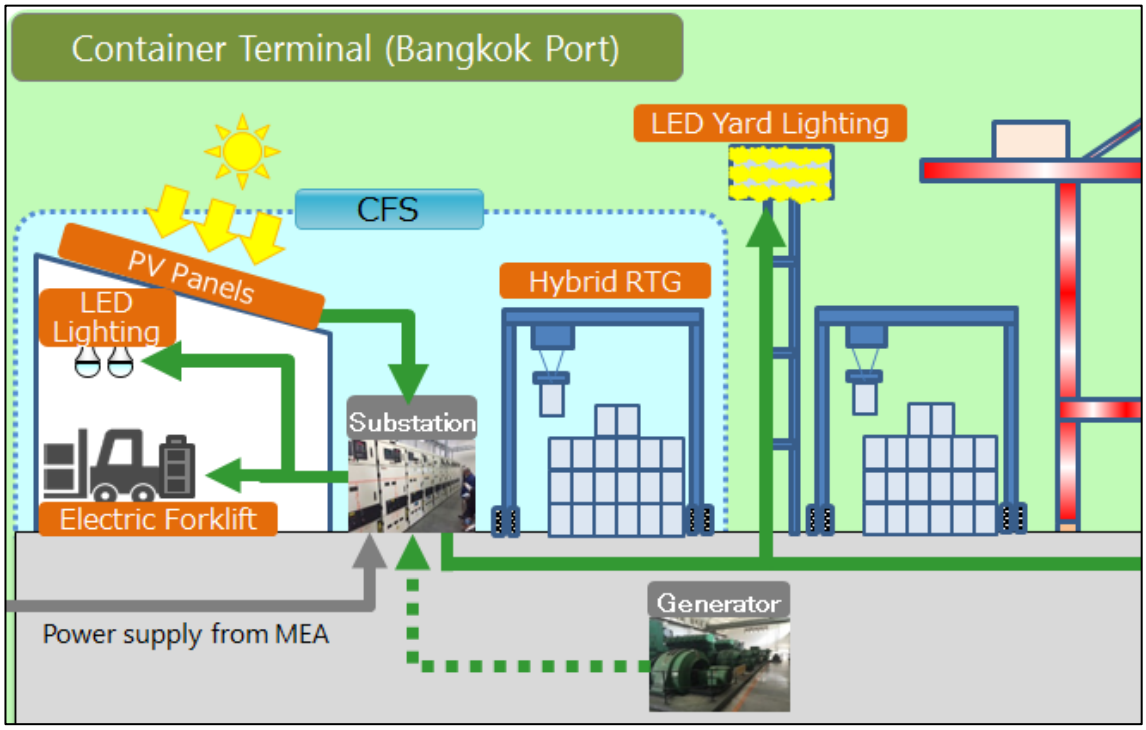


Figure 39 Phase 1: Enlarged Image of Measures at Bangkok Port: Reflecting the Conclusions of the Study

The team had discussions with Japanese companies which have experience installing and constructing PV power stations in Thailand, about technical points for realizing the above plan, especially points requiring attention in connecting the PV power station to the Port Power System, and made further discussions based on schematic diagrams provided by PAT, to identify challenges and measures to be taken as follows:

① Point(s) of Interconnection of PV System to the Port Power System

Auxiliary power panels for interconnection with the Port Power System must be additionally constructed if they are not ready present. If the existing power room does not have enough space for such additions, the costs might be higher.

As for this issue, the team found out, by checking diagrams and the actual facilities, that the existing power rooms have enough space for additions although they do not currently have auxiliary power panels.

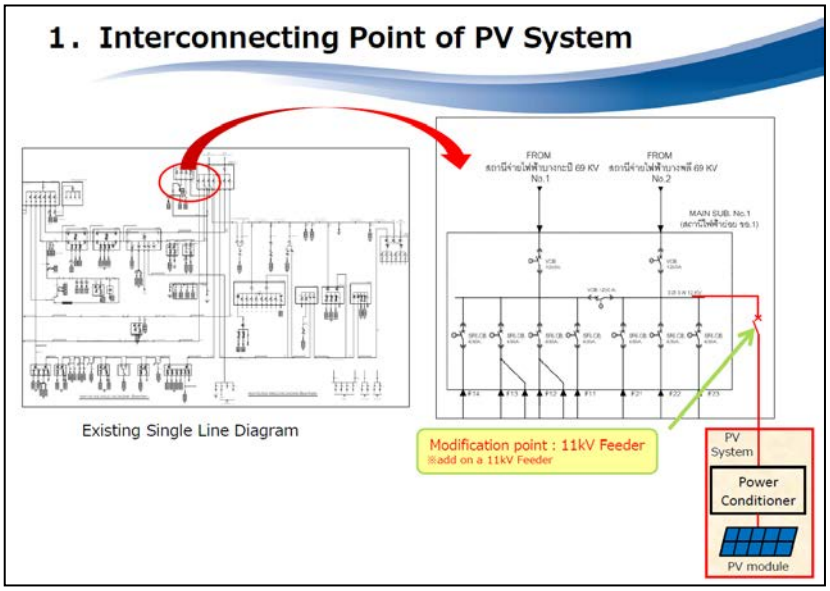


Figure 40　Structure of Interconnections to Port Power System

② Adjustment of Frequency and Power Voltage

The frequency and power voltage of PV power must be aligned with the existing Port Power System for interconnection.

This problem can be solved by installing equipment to synchronize their frequencies and power voltages.

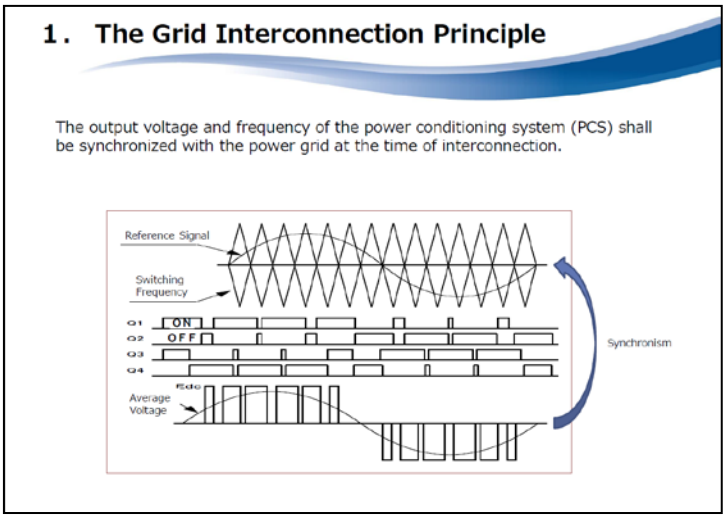


Figure 41 Synchronizing Frequencies and Power Voltages

③ Prevention of Reverse Power Flows

In Thailand, preventing reverse power flow of surplus PV power to Bangkok's Metropolitan Electricity Authority (MEA) power grid is often a condition for installing PV system for captive use. For this project, since the capacity of the PV system to be installed (0.77 MW) is sufficiently lower than the total installed capacity of power consuming facilities and equipment in Bangkok Port (8-9 MB), the possibility of reverse power flow for normal use will be extremely low. However, it is likely that some measures will be required in the event of unforeseen circumstances.

In the proposed project, the power generation by PV and the power demand of power consuming facilities in the port will be monitored. In the event that PV power generation appears likely to exceed power demand, PV power output will be adjusted by an installed voltage regulator and an under-voltage relay, or will be isolated from the Port Power System. This will ensure the prevention of reverse power flow to MEA's distribution network.

2. The Grid Interconnection Protection

When abnormalities occur in the system side or the AC Electric Facilities in the premises, they will be detected by the following protective relays according to the Japanese Standard (JEAC9701).

	Description	Detective Condition	Trip CB	Timer
OC	Over Current	Internal short circuit	Incoming Circuit Breaker	
OCG	Ground Over Current	Internal grounding fault	Incoming Circuit Breaker	
UP	Under Power	Islanding operation	Feeder Circuit Breaker	
OV	Over Voltage	Inverter protection	P C S	0.2 - 2.0 sec
UV	Under Voltage	Inverter protection/ Short circuit of the Grid	P C S	0.2 - 2.0 sec
OF	Over Frequency	Islanding operation	P C S	0.2 - 2.0 sec
UF	Under Frequency	Islanding operation	P C S	0.2 - 2.0 sec

Figure 42 Flow of Preventing Reverse Power Flow 1

3. The Function of the PCS Protection

When abnormalities in the DC side or malfunction of PCS are detected based on the following detective conditions, PCS will be stopped to avoid any damage.

	Detective Condition	Timer
Inverter Error	The error signal of the inverter unit	Under 0.2 sec
Temperature rise in enclosure	The temperature rise inside the enclosure is over 60℃	Under 0.2 sec
DC Over Voltage	DC over voltage	Under 0.2 sec
MCCB trip	AC or DC MCCB opened by over current	-
DC Short Circuit	DC short circuit (The PCS state is stop or standby only)	Under 1 sec
Synchronized Communication Error	No synchronized communication between the master PCS and the other slaves	Under 1 sec
Power Source Error	The error signal of the power source board	Under 1 sec
DC Grounding fault	DC grounding fault	2 - 4 sec
Phase Rotation Error	Phase rotation error	-
MCTT Error	Electromagnetic contactor error	Under 1 sec

Figure 43 Flow of Preventing Reverse Power Flow 2

In addition, in the event of any trouble occurring at PV power stations, etc., safety devices will isolate the PV power stations from the Port Power System, to prevent them from affecting power-consuming equipment and power conditioners at the port.

As for the comprehensive system to operate, manage and maintain such devices, the team aims to design the system, based on high-level technology and knowhow possessed by Japanese companies, to make it reliable and secure. At the same time, however, for individual components such as PV panels, etc., the team aims to reduce total costs, eying the possibility of using foreign products if they meet a certain technological level.

④ Direct Current Power Supply from PV Power Stations

In the CFS related project, many equipment and facilities use DC power sources for charging batteries of electric forklifts and supplying power for LED lamps, etc. Thus, the team examined the possibility of supplying PV power using DC instead of converting it into AC.

As a result of comparing power supply by DC versus AC, the team found that power supply by DC currently faces many technological challenges, such as power loss, etc., concluding that power supply on AC would be more practical and beneficial for this proposed project.

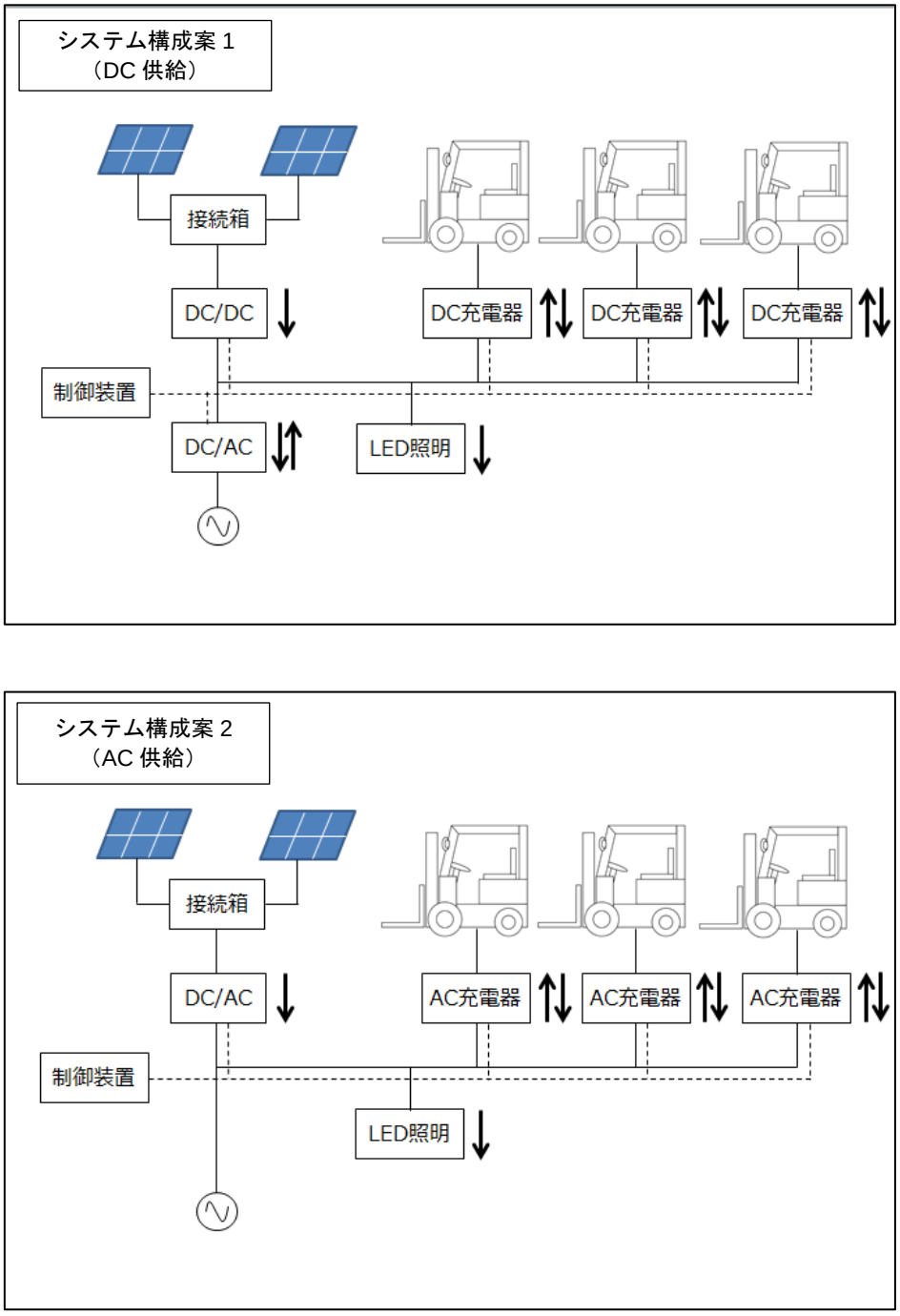


Figure 44　Plan of System Structure of DC Supply and AC Supply

3.3　Phase 2 Project: Making Laem Chabang Port a Low-Carbon, Smart Port

(1) Summary of Measures to be Introduced at Laem Chabang Port

As mentioned in the beginning of this Chapter, the team will also examine the possibility of the mid-to-long term realization of a carbon emission reduction project at Laem Chabang Port in Phase 2. PAT is not directly operating Laem Chabang Port, but providing the port and leasing

the sites for terminals. Actual operation is carried out by private operators, which lease the sites from PAT.

The possible measures to be introduced here are explained below. The team believes that these measures will be elaborated to enhance the possibility of realization by further examination to be continued in next fiscal year.

It should be noted that in the Phase 2 project, measures for Bangkok Port are partially included. This is because the team has determined that it would be appropriate to examine them in Phase 2 rather than in Phase 1 given the plan at Bangkok Port is still at the initial stage at the time of this study.

(2) Hybrid Cargo Handling Equipment to Lat Krabang Inland Container Depot (LICD)

① Overview of Project Site

Inland Container Depot is an inland customs clearing and bonded storage house for containers, where cargo owners can move their containers in and out, just as they can do at a seaport.

The container rail network between Bangkok Port and Laem Chabang Port is one of the core distribution routes between the two ports. Introducing hybrid cargo equipment for use at Lat Krabang Inland Container Depot (LIDC), which is the Bangkok-side base of the railroad, may contribute to carbon emission reduction in logistics activities between the two ports.

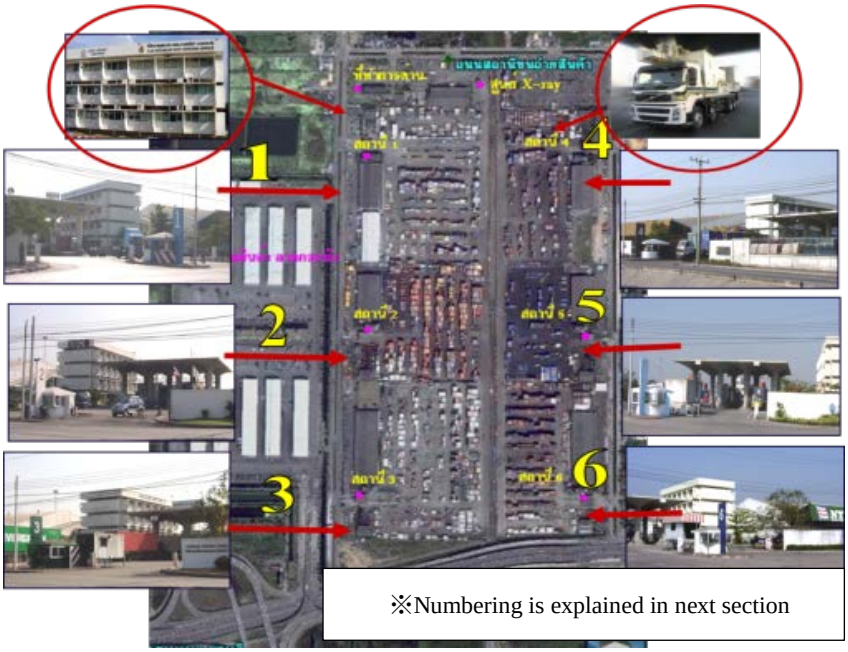


Figure 45 Aerial Photo of Lat Krabang Inland Container Depot (LICD)

② Situation of LICD Operation

Infrastructure development and operation of LICD is done by the State Railway of Thailand (SRT). Buildings and freight handling equipment to be installed here will be prepared by renters, who have 15-year concession agreements with SRT, with their own investment. When the agreements expire after 15 years, the assets will be owned by SRT.

The total area of LICD is about 104 ha, of which about 60 ha is used by six renters. Activity sites (modules) operated by those renters are exclusively used by operators contracting with those renters. Besides the modules, the remaining 44 ha are used as shared facilities for offices of related agencies for customs clearance and quarantine.

The current renters of modules #1 to #6 in Figure 45 are the following 6 companies:

Module 1: Siam Shoreside Services
Module 2: ESCO (joint venture with 50% Japanese capital)
Module 3: Evergreen
Module 4: TIFFA (Thai company)
Module 5: Thai Hanjin
Module 6: NYK Distribution Service

The main contracts with these six companies are currently already expired, and the status is maintained under provisional contracts. With the expiration of the contract period, SRT is making a public solicitation for contract renewals, but is considering reducing the number of renters from the current six to one, to integrate six modules into one for consolidated management.

③ Situation of Decarbonization Efforts at LICD

The length of the freight railway between LICD and Laem Chabang Port is 118 km, with 11 stations. The railway is owned by SRT. It owns six high-powered locomotives and 300 wagons, and connects 34 wagons to one locomotive.

SRT is planning and implementing additional investment to enhance their future transportation capacity. In the beginning of 2016, it purchased 20 state-of-the-art high-powered locomotives (made in China) to replace their currently owned ones, increasing the number of connected wagons to 40 per train. Furthermore, it is planning to increase the number of daily round trips to 34, to increase its annual transportation capacity to 992,800 TEU by the end of 2017.

All 20 of the above-mentioned high-powered locomotives, however, are not being used at LICD. Six of them are being used at LICD to replace old ones, and the remaining 14 are being used in other places for transportation of oil, etc. The six old locomotives replaced are also being used in other places than LICD.

LICD obtained these high-powered locomotives through a tender process GE, Hitachi, Ltd. and CSR (China) submitted bids, and CSR won the contract. The six old locomotives were manufactured by Hitachi, but the new 20 were made in China.

④ Trend in Volume of Container Freight at LICD and Laem Chabang Port

As the volume of container freight handled at Laem Chabang Port increased, LICD increased as well, but it has been steady at almost at the same level of 1.3 million to 1.5 million TEU for the past 10 years (Figure 46). With its expected capacity designed in the 1980s at 600,000 TEU per year at maximum, LICD has been making its own efforts to expand its capacity to 1.1 million TEU to accommodate increasing freight volume. However, due to constraints of the site area, it is almost reaching capacity limits. Since it is difficult to expand the site area, the possibility of developing an additional ICD at a nearby new site is being considered as well.

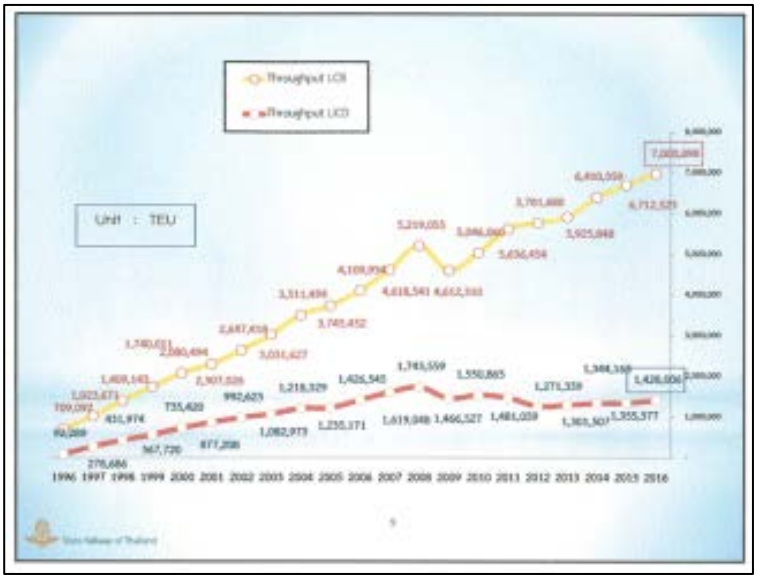


Figure 46 Volume of Container Freight at Laem Chabang Port and LICD

(Source: Provided by LICD)

The volume of rail transport and the number of trains by year have been leveling off at the upper limit as well (Figure 47).

The estimated ratio of road and rail transportation for 2016 is 68.7% for road and 31.3% for rail (Figure 48). It is believed that the reason why the percentage for road transportation is higher is that the capacity of road transportation has increased due to road construction and

improvements around the year 2000, while railway construction and improvements have been slow to increase transportation capacity.

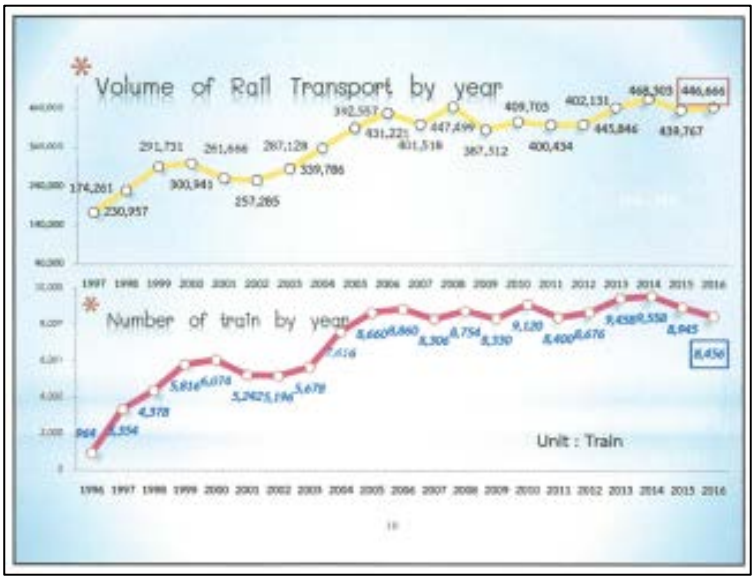


Figure 47 Volume of Rail Transport by Year and Number of Trains by Year (TEU)

(Source: Provided by LICD)

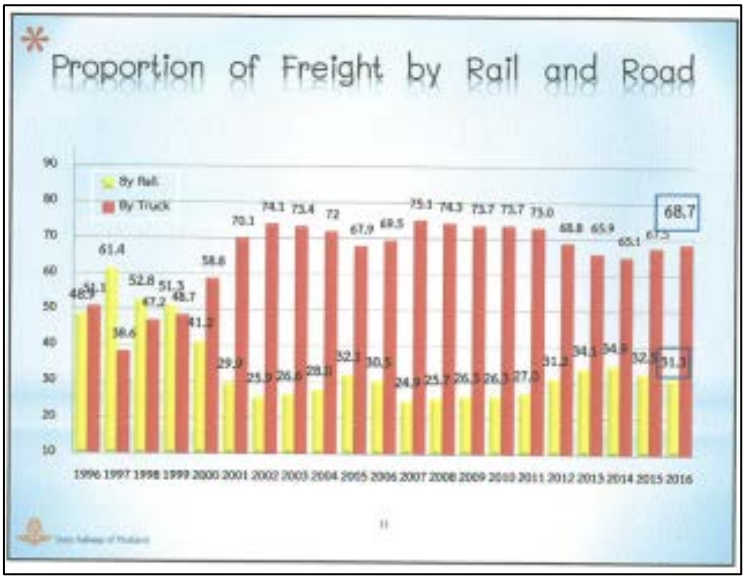


Figure 48 Proportion of Freight by Rail and Road

(Source: Provided by LICD)

⑤ Low-carbon Measures to be Introduced in LICD

For LICD, which is outside of PAT's direct control, in-depth discussion and close coordination with SRT is essential for the introduction of the above measures.

In this Feasibility Study, the team had discussions and interviews with SRT and the current renters, and visited their sites. As the conclusion, the team felt that carbon emission reduction through the introduction of hybrid freight handling equipment, etc., would be effective for LICD. In addition, it is expected that the introduction of low-carbon facilities to a new ICD will also be facilitated by the introduction here.

The team will continue further study toward the introduction of low-carbon equipment in line with the reconstruction plan of LICD.

Figure 49 Freight Handling at LICD (Loading Containers to Wagons)

(3) LED Road Lighting at Laem Chabang Port

The team conducted a feasibility study of introducing low-carbon equipment for road lighting around the terminals at Laem Chabang Port.

Although mercury lamps and sodium-vapor lamps have traditionally been used for lighting, replacing them with LED road lighting and related equipment can reduce CO2 emissions. Carbon-conscious ports like Hamburg Port in Germany, for example, have been introducing various measures such as a system combining LED road lighting equipment and temperature sensors to increase energy efficiency.

After implementing interviews with PAT and site visits, however, the team found that they have already proceeded with partial introduction of such measures. For places without such measures, the number of necessary lamps was small enough for introduction with their own

budget. Therefore, the team decided that this measure would not be suitable for the JCM Model Project.

Figure 50 Road Lighting around Laem Chabang Port

(4) Introduction of Efficient Transformers to Power Distribution Facilities at Bangkok Port

Substation facilities at Bangkok Port receive high voltage power and transform it to supply power to facilities and equipment in the port. Power is lost when it is transformed, but this can be reduced by the replacement with the advanced high-efficiency transformers to save energy.

In order to explore the possibility of introducing high-efficiency transformers, the team visited the project site and collected information about the existing facilities from the responsible PAT personnel. The team confirmed that although there are various old and new facilities, no renewal plan for each facility has been developed so far.

At the current stage where the detailed overview of the facilities has not been defined in the reconstruction plan of the terminals, it is difficult to make accurate estimates of future power demand, making the development of renewal plans also difficult.

As for this measure, the team will continue the study, and will examine specific approaches for introduction as soon as any estimate of power demand becomes available.

Figure 51 Current Substation Facilities at Bangkok Port

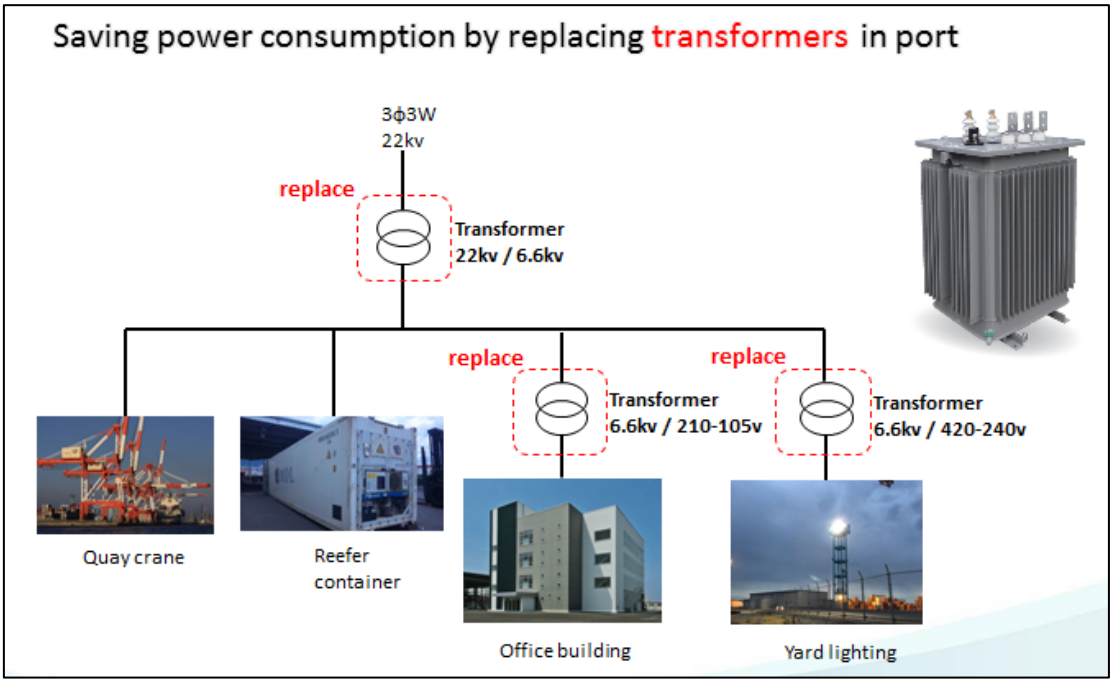
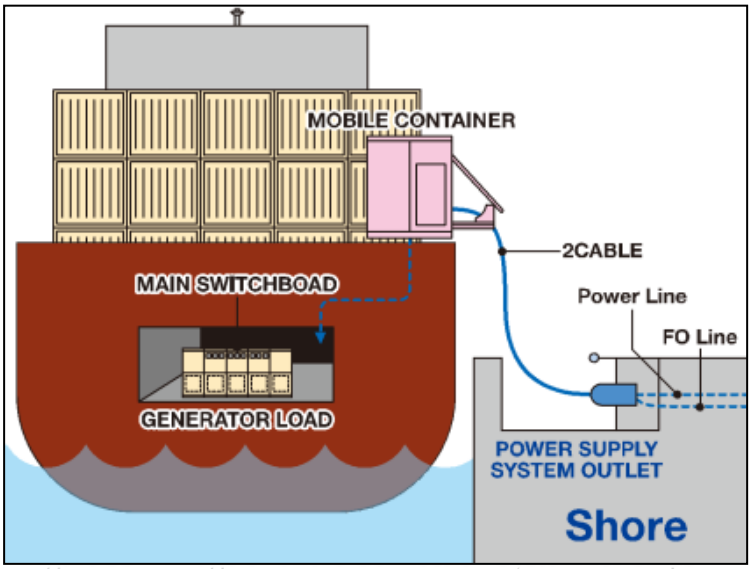


Figure 52 Saving Energy by Introducing High-efficiency Transformers

(5) Introduction of Shore Connection Systems for Ships

While moored, ships are combusting diesel fuel to generate their necessary power with their own auxiliary engines. A shore connection system is a facility to get power supplied from shore. Since a large amount of CO2 is emitted from the consumption of diesel fuel, the shore connection system for ships is an effective climate mitigation measure. However, the system requires the preparation of facilities to be installed both port-side and ship-side, the deployment of this technology has been slow.

The mechanism of shore connection system for ships and an example of its introduction are provided below:



① Example of Introduction at Los Angeles Port

In December 2007, the introduction of shore connection systems was enacted as a state law by the California Air Resource Board (CARB), which mandated the installation of shore connection systems at ports in the State of California by FY 2014.

The percentage figures for the use of the system by ships entering the ports were also stipulated—more than 50% for 2014, more than 70% for 2017, and more than 80% for 2020.

Figure 54 Ship Receiving Power Loaded with Containers for Shore Connection System (Los Angeles)

Figure 55 Sign Indicating That Alternative Marine Power (AMP) Is Available (Los Angeles)

② Example of Introduction at Hamburg Port

At Hamburg Port, in addition to the ordinary shore connection systems, a barge that supplies power for shore connection using low-emission LNG has been developed. The barge supplies power to ships at the harbor.

Figure 56 Barge Generating Power with LNG for Supply to Ships (Front) (Hamburg)

③ Study for Introduction of a System at Bangkok and Laem Chabang Ports

As for methods of reducing CO2 emissions from ships, technologies other than shore connection systems, such as LNG-fueled ships, have also been developed, some of which have already been introduced. It will be necessary to determine which approaches will be effective based on the characteristics of Bangkok and Laem Chabang Ports, and to examine necessary measures.

During this Feasibility Study, the team exchanged opinions about this issue with PAT, but was not able to get enough information to make a decision at this moment. Therefore, the team needs to continue study and examination about shore connecting systems for ships as well.

(6) Introduction of Hybrid Tugboats

A tugboat is a special ship for assisting vessels arriving in and departing from port, etc. It has a small hull but with a high-powered engine, is easy to move and turn in the limited space of ports. Such characteristics of tugboats mean a significant difference of power output between stand-by mode and working mode.

Therefore, replacing the power sources of tugboats to hybrid ones can stop or reduce revolutions of their engines when the power output is low, thus being able to substantially reduce fuel consumption. Even in working mode at high-power as well, fuel consumption can be reduced by combining the use of combustion engines and electric energy.

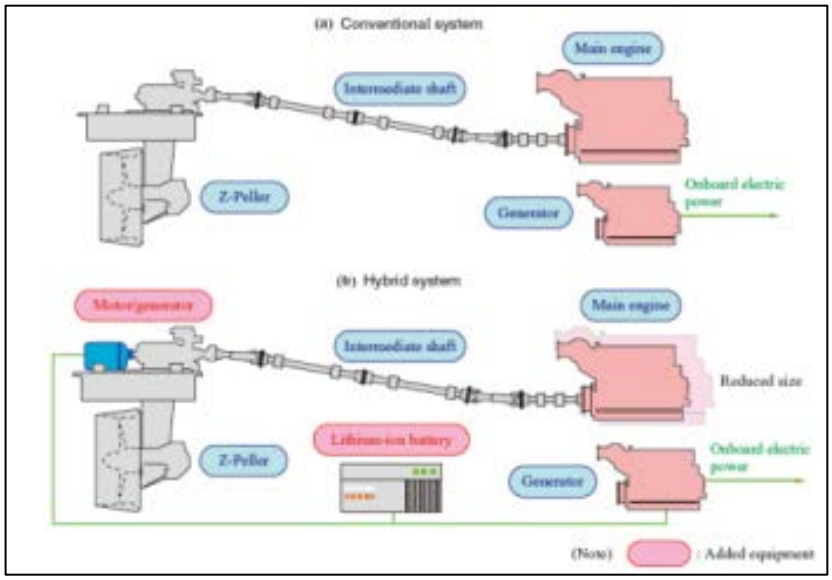


Figure 57 Mechanism of Hybrid system with Lithium Ion Battery

In this Feasibility Study, the team examined the possibility of introducing the above hybrid tugboats to Bangkok and Laem Chabang Ports. The team examined not only the possibility of introducing new boats, but also that of modifying existing tugboats to only a hybrid system. The team had discussions with hybrid system suppliers, shipyards, ship owners and the responsible PAT personnel about two types of tugboats presented below.

Both types of hybrid tugboat have been introduced and used at Yokohama Port, and the team fully provided information on their effectiveness at the time of discussion with PAT.

① Hybrid Tugboat Equipped with Lithium Ion Battery

This type of tugboat stores power produced by a generator in a lithium ion battery, which enables the boat to stop the main engine when the speed is low and to move only with battery power for cruising at a certain distance and speed. When high power output is required, both the main engine and the electric drive are used.

The advantages and disadvantages of introducing this type of hybrid tugboat are as follows:

Advantages

- Substantial reduction of fuel consumption and CO2 emissions
- Significant positive publicity effect to the public by adopting advanced technology

Disadvantages

・Possible necessity of a larger hull for space to accommodate the hybrid unit.

・Possibility of higher costs compared with a boat without lithium ion battery.

Figure 58　Hybrid Tugboat Equipped with Lithium Ion Battery “Tsubasa”
(Example at Yokohama Port)

② Hybrid Tugboat without Lithium Ion Battery

This type of tugboat, equipped with the main engine and high-efficiency electric propulsion system, does not store power produced by the generator but uses it directly as driving force.

The advantages and disadvantages of introducing this type of hybrid tugboat are as follows:

Advantages

・Possible availability of a smaller hull compared with a tugboat with a lithium ion battery, without necessity of space to accommodate the battery.

・Possibility of lower costs compared with a tugboat with a lithium ion battery.

Disadvantages

・Possibility of less reduction of fuel consumption and lower CO2 emissions than tugboats with a lithium ion battery

Figure 59　Hybrid Tugboat without Lithium Ion Battery “Ginga”
(Example at Yokohama Port)

4. Consideration of Methods for Equipment Procurement and Financing

4.1 Procurement Method for JCM Project Implementation

Procurement of facilities and equipment for project implementation by PAT is to be carried out through open bidding as described in Chapter 1, Section 1.5.

For a JCM project proposed under this Feasibility Study, equipment with higher efficiency and quality than certain levels is required. In order to secure this condition, the team will continue discussing with suppliers to check the specifications of each type of equipment.

(1) Key Considerations for the Examination of Procurement Method

Based on the result of interviews with the responsible PAT personnel, the team found out that the amount of initial investment would have a larger impact on the decision making of PAT than the cost reduction effect obtained through continuous operation. In order to introduce facilities and equipment as a JCM project, therefore, it will be important to obtain PAT's understanding to determine manufacturers through a bidding method with comprehensive evaluation that considers not only initial investment amounts but also the energy efficiency performance and reliability of products, etc.

To this end, it is necessary for YPC and GP, which are the implementers of this Feasibility Study, to continuously support PAT now and in future. As for the great importance of the choice of procurement method for implementing a project under JCM, the team had a meaningful discussion with the Director General of PAT on February 20, 2017 in Bangkok, and obtained his understanding. PAT also needs to continue considering this topic.

For any consideration of these issues, YPC is willing to offer advice based on its experience as a port management entity, while fully recognizing and supporting the partnership between PAT and the City of Yokohama.

4.2 Financing Method

To date, PAT has paid all costs necessary for the construction of the port facilities with its own financing. However, it has also begun to consider the possibility of various other methods of financing, including leasing, etc.

In that context, the team presented a financing scheme based on leasing, and discussed the possibility of adopting that option in this Feasibility Study.

At this moment, leasing is not a likely option to be adopted immediately, but it will continue to be examined as a future option.

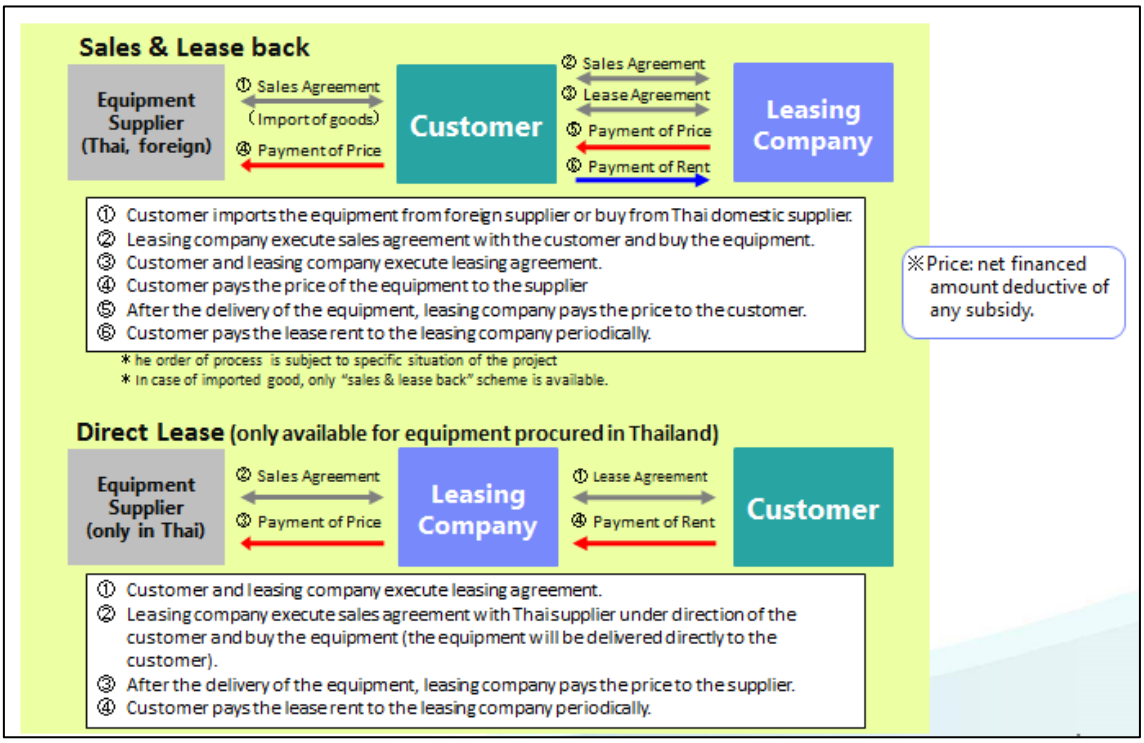


Figure 62 Example of Financing Scheme based on Leasing

5. Feasibility Assessment of the Project

Building on the result of the study so far, the team implemented the feasibility assessment of the JCM project proposed under this Feasibility Study, including estimated GHG emission reductions and energy saving effects, estimated project costs, and estimated project income and expenditures (profitability of the project).

In line with the timing of applications for JCM Model Projects, the team studied the feasibility of two separate projects: a project related to CFS Export to be constructed in 2017, and a project related to CFS Import to be constructed in 2018, especially focusing on the feasibility assessment of CFS Export.

The exchange rate used for the cost estimation was 1THB=3 yen.

5.1 Feasibility Assessment of the Project for CFS Export

For CFS Export, the team examined a PV power station, electric forklifts, and hybrid RTGs, as the components of the proposed JCM project, and also examined LED yard lighting installable at the same time, to be included in the project related to CFS Export.

As for indoor LED lighting, the team has excluded it from the project for CFS Export since its design has already been finalized in an integrated manner with the building.

（1） PV System on CFS

The costs were estimated based on information provided by PAT, including specifications.

・Installed capacity：0.77 MW
・With skylight windows (toplight)
・Initial costs: Set at 69,200,000 THB based on information from suppliers, etc.
・Amount of JCM subsidy: 20,700,000THB with the JCM subsidy ratio assumed to be 30%
・CO2 emission reduction: 9,786t-CO2 over 17 years
・Cost effectiveness: 2,121 THB/t-CO2, (This meets criteria to be a JCM Model Project.)

Costs for power generation are estimated to be 3.5 THB/kWh with the initial costs of installing the PV system, the replacement costs of power conditioners, and the annual reduction of power generation efficiency, taken into consideration.

With the assumption that the power rate in the case of getting power supply from electric companies is 4.7 THB, the reduction in running costs is expected to be 8,640,000 THB over 17 years.

Based on the above estimates, the proposed activities are evaluated to be highly feasible as a whole.

Table 3 Result of Project Feasibility Assessment of Introducing PV System

	PV on CFS
Statutory durable years	17years
Quantity	1 set(0.77MW)
Initial cost	69,200,000 THB
Percentage of Subsidy	30%
JCM subsidy (C)	20,700,000 THB
CO2 reduction (B)	9,786*t-CO2* *(575.6t-CO2/year)*
JCM cost effectiveness (C)/(B)	2,121THB/*t-CO2*
Eligibility for JCM	**Good**
Profitability of running cost	8,640,000 THB
Overall evaluation	**Good**

Figure 63 PV Panels on CFS Roof with Barrel-vaulted Skylight Windows at Minami Honmoku Pier of Yokohama Port

（2） Electric Forklift

The specifications of electric forklifts assumed to be introduced are provided in Table 4.

Table 4 Electric Forklifts Assumed to be Introduced

Type	Rated Load	Description
Electric forklift	2.5 t	Common cargo handling equipment for cargo on pallets
Electric reach truck	1.5 t	Cargo handling equipment specialized in cargos at higher places
Electric pallet truck	1.0 t	Cargo handling equipment specialized in horizontal movement of cargo on pallets

- Total of above three types of electric forklifts to be introduced: 59 units
- Initial cost: 41,530,000 THB
- Amount of JCM subsidy: 8,300,000 THB with the JCM subsidy ratio assumed to be 20%
- CO2 emission reductions: 3,579t-CO2 over five years
- Cost effectiveness: 2,320THB/t-CO2, good for JCM Model Project

The introduction of these forklifts can make fuel costs unnecessary. Therefore, even with the costs for battery replacement once in three years, the cost reduction effect of 51,490,000THB in five years can be expected.

Based on the above estimates, the proposed introduction is evaluated to be highly feasible as a whole.

Table 5 Result of Project Feasibility Assessment of Introducing Forklift

	Electric Forklift
Statutory durable years	5years
Quantity	59 trucks
Initial cost	41,530,000 THB
Percentage of Subsidy	20%
JCM subsidy (C)	8,300,000 THB
CO2 reduction (B)	3,579*t-CO2* *(715.8t-CO2/year)*
JCM cost effectiveness (C)/(B)	2,320THB/*t-CO2*
Eligibility for JCM	**Good**
Profitability of running cost	51,490,000 THB
Overall evaluation	**Good**

（3） Hybrid RTG

The specifications of hybrid RTG assumed to be introduced are provided in Table 6.

Table 6　Specifications of Hybrid RTG Assumed to be Introduced

Item	Specifications
Rated load	40.6 t
# of rows and stacks *	6+1 rows、1 over 6 stacks

・Total to be introduced: 2 units
・Initial costs: 115,700,000 THB
・Amount of JCM subsidy: 11,570,000 THB with the JCM subsidy ratio assumed to be 10%
・CO2 emission reduction: 4,475t-CO2 over 12 years
・Cost effectiveness: 2,585THB/t-CO2, good for JCM Model Project

The introduction of hybrid RTGs is expected to reduce fuel consumption to almost half compared with that of RTGs with diesel engines only, thus reducing running costs by 48,900,000THB in total over 12 years.

Table 7　Result of Project Feasibility Assessment of Introducing Hybrid RTG

	Hybrid RTG
Statutory durable years	12 years
Quantity	2 units
Initial cost	115,700,000 THB
Percentage of Subsidy	10%
JCM subsidy (C)	11,570,000 THB
CO2 reduction (B)	4,475*t-CO_2* *(372.9-CO2/year)*
JCM cost effectiveness (C)/(B)	2,585THB/*t-CO_2*
Eligibility for JCM	**Good**
Profitability of running cost	48,900,000 THB
Overall evaluation	**Good**

（4） LED Yard Lighting

The team estimated the costs of introducing LED lighting that can make use of the existing facilities while securing the safety and operability of the yards.

・Total to be introduced: 260 units
・Initial costs: 16,640,000 THB
・Amount of JCM subsidy: 6,650,000 THB with the JCM subsidy ratio assumed to be 40%
・CO2 emission reduction: 4,029t-CO2 over 15 years
・Cost effectiveness: 1,652 THB/t-CO2, good for JCM Model Project

Based on the above estimates, the running cost reduction effect of introducing LED yard lighting is expected to be 22,540,000THB over 15 years, and the proposed introduction is evaluated to be highly feasible as a whole.

Table 8 Result of Project Feasibility Assessment of Introducing LED Yard Lighting

	LED Yard lighting
Statutory durable years	15years
Quantity	260 set
Initial cost	16,640,000 THB
Percentage of Subsidy	40%
JCM subsidy (C)	6,650,000 THB
CO2 reduction (B)	4,029*t-CO2* *(268.6t-CO2/year)*
JCM cost effectiveness (C)/(B)	1,652THB/*t-CO_2*
Eligibility for JCM	**Good**
Profitability of running cost	22,540,000 THB
Overall evaluation	**Good**

（5） Examination of the Selection of Measures to be Introduced

During the third field investigation conducted on February 20, 2017, the team reported the above result of the study to Director General of PAT. At the same time, taking PAT's request into consideration, the team made examination and proposals on two options for packaging the measures: (1) Option 1: a case only with measures to be directly introduced to CFS Export (PV system, electric forklifts, and hybrid RTGs), and (2) Option 2: measures for Option 1 plus LED yard lighting – for the application for JCM Model Project in FY 2017.

Figure 64 Options for Packaging Measures for Application to JCM Model Project

Table 9 shows the result of comparison between Options 1 and 2 of their annual effects.

Table 9 Result of Comparison between Options 1 & 2

Option 1 CFS Export (PV, e-Forklift, Hybrid RTG) & LED Yard Lighting		Option 2 CFS Export (PV, e-Forklift, Hybrid RTG)	
Initial cost	243,070,000 THB	Initial cost	226,430,000 THB
JCM subsidy	47,220,000 THB	JCM subsidy	40,570,000 THB
Cost after subsidy	195,850,000 THB	Cost after subsidy	185,860,000 THB
CO2 reduction / year	1,932.9t	CO2 reduction / year	1,664.3t
Total profit in legal durable years	131,570,000 THB	Total profit in legal durable years	109,030,000 THB

The cost reduction effect of Option 1 is 131,570,000 THB. For Option 2, it is 109,030,000 THB, smaller than Option 1 by 22,540,000 THB because LED yard lighting is not introduced, but both options have significant effects enough to secure the project feasibility.

The annual CO2 reduction of Option 1 is 1,932.5t-CO2, while that of Option 2 is expected to be 1,664.3t-CO2, smaller than Option 1 by 268.6t-CO2.

Both options above are now under examination by PAT.

In addition, the introduction of PV system and LED yard lighting both require measures for additional budget at PAT. Although it will take some time (about 4-5 months), the team has received an assurance from the Director General that there would be no problem for PAT to secure the budget.

5.2 Feasibility Assessment of the Project for CFS Import

The team estimated the feasibility of the project for CFS Import assuming that the installed capacity of PV system adoptable for CFS Import would be larger (2.57 MW) given its larger roof area than that of CFS Export. Furthermore, the team included LED indoor lighting in the examination in addition to measures to be introduced to CFS Export.

Units of forklift and RTG to be introduced were calculated based on the numbers currently assumed by PAT, for which the updated status must continue to be checked and reexamined.

（1） PV System on CFS

CFS Import is now under the basic design process. Therefore, the team estimated the project feasibility based on information currently available.

The construction area for CFS Import under consideration is assumed to be15,000 $m^2 \times 2$ buildings $=30{,}000\ m^2$, and the team assumed that about 2.5 MW PV panels could be installable based on this figure.

As the result of estimation, the initial cost of introduction is expected to be about 210,000,000 THB, and the amount of JCM subsidy to be about 63,000,000 THB with the subsidy ratio assumed to be 30%.

The resulting CO2 emission reduction is estimated to be about 32,663t-CO2 over17 years, and the cost effectiveness of the JCM project is expected to be about 2,000THB/t-CO2.

Implementation of further examination needs to be continued during and after next fiscal year.

（2） CFS Indoor LED Lighting

Same as the above, since CFS Import is now under the basic design process, the detailed design for LED indoor lighting has not been finalized. Therefore, the team estimated the project feasibility assuming 400 units to be introduced, based on the area of construction (15,000 $m^2 \times 2$ buildings $=30{,}000 m^2$).

As the result of estimation, the initial cost of introduction is expected to be about 9,300,000 THB, and the amount of JCM subsidy to be about 3,720,000THB with the subsidy ratio assumed to be 40%.

The resulting CO2 emission reduction is estimated to be about 2,500t-CO2 over 15 years.

Since the introduction of LED indoor lighting is expected to reduce power consumption to less than half of the conventional lighting, and to reduce the frequency of replacement, the running cost reduction effect is estimated to be about 17,100,000 THB over 15 years.

The team will continue study to make more detailed estimates based on the detailed design data by PAT to be available in future.

（3） Electric Forklift

Based on the result of interviews with PAT, the team estimated the project feasibility, assuming to introduce 126 units (the total of three types: electric forklifts, electric reach trucks, and electric pallets).

As the result of estimation, the initial cost of introduction is expected to be about 130,000,000THB, and the amount of JCM subsidy to be about 26,000,000THB with the subsidy ratio assumed to be is 20%.

The resulted CO2 emission reduction is estimated to be about 10,000t-CO2 over 5 years, and the cost effectiveness of the JCM project is expected to be about 2,500THB/t-CO2, and about 90,000,000THB for 5 years.

As for the number of unit to be introduced, the team will continue study by interviewing PAT as needed since it is likely to change in future as the design details get finalized.

（4） Hybrid RTG

The team estimated the project feasibility assuming four units will be introduced given the capacity of CFS Import.

With the assumption that the specifications of hybrid RTGs to be introduced are the same with those for CFS Export, the initial cost of introduction is expected to be about 230,000,000 THB, and the amount of JCM subsidy is estimated to be about 23,000,000THB with the subsidy ratio of 10%.

The resulted CO2 emission reduction is 8,950t-CO2over 12 years, and the cost effectiveness of the project is estimated to be about 2,500THB/t-CO2.

The running cost reduction effect by reducing fuel consumption is expected to be about 97,000,000THB for 12 years.

（5） Other Points of Consideration

At this moment, there still remain a lot of outstanding issues related to the details of basic design, which require continuous efforts of study with PAT. Since CFS Import is still at the design phase, however, it still has room for flexibility to accommodate design changes for the introduction of facilities and equipment desirable as JCM Model Project. As for this issue, PAT has already requested YPC to assist the design. This can be a good opportunity for the team to aim for effective project development in 2018, making use of strong trusting relationship developed through the past partnership.

CFS Import is expected to have larger CO2 reduction potential because the scale of the facility is three times as large as that of CFS Export, allowing for more units of facilities and equipment to be introduced. Therefore, the team would like to continue detailed study in next fiscal year and to seek for the possibility of JCM project development.

6. MRV Methodology and PDD development

6.1 Design and Development of MRV Methodology

JCM Proposed Methodology Form

Cover sheet of the Proposed Methodology Form	
Form for submitting the proposed methodology	
Host Country	Kingdom of Thailand
Name of the methodology proponents submitting this form	Yokohama Port Corporation
Sectoral scope(s) to which the Proposed Methodology applies	7. Transport
Title of the proposed methodology, and version number	Development of Smart Port
List of documents to be attached to this form (please check):	☐The attached draft JCM-PDD: ☐Additional information
Date of completion	9th March 2017

History of the proposed methodology

Version	Date	Contents revised
1.0	9th March 2017	First edition

A. Title of the methodology

Development of Smart Port

B. Terms and definitions

Terms	Definitions
Smart Port	Port facilities that have realized CO2 reduction by introducing port specific low-carbon facilities and equipment such as electric forklifts, hybrid RTGs, and LED lighting, etc.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Realizing carbon dioxide (CO2) reduction by introducing port specific low-carbon facilities and equipment such as electric forklifts, hybrid RTGs, and LED lighting, etc. Also realizing further CO2 reduction by installing PV power stations for captive use to supply power to low-carbon electric facilities and equipment.
Calculation of reference emissions	The reference emissions are to be calculated for each low-carbon facility and equipment to be installed. The CO2 emission factors and activity amounts necessary to calculate the reference emissions are to be calculated based on historical data owned by the project implementers (in Thailand and/or Japan), or ex-ante/ex-post measurement data obtained during the project activity.
Calculation of project emissions	The CO2 emission factors and activity amounts necessary to calculate the project emissions are to be calculated based on ex-post measurement data obtained in the project activity.
Monitoring parameters	Electric forklift ・ Operating hours of electric forklift i during a time period p after the project implementation. [hours/p] LED for yard lighting and indoor lighting ・ Operating hours of LED lighting equipment i during a time period of p after the project implementation. [hours/p] Hybrid RTG ・ Fuel consumption of hybrid RTG i during a time period of p after the project implementation. [liters/p] PV power generation ・ Power generated by PV power stations in year y after the project implementation. [MWh/year]

D. Eligibility criteria

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

Criterion 1	Target facilities of the project are port facilities.
Criterion 2	The project introduces port specific low-carbon facilities and equipment such as electric forklifts, hybrid RTGs, and LED lighting, etc.
Criterion 3	The project introduces captive power stations like PV power stations to supply power mainly to the low-carbon facilities and equipment.
Criterion 4	The project is implemented with the cooperation and support of Japanese port management organizations that have experiences of smart port management.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Electricity consumption of reference facilities and equipment	CO2
Fossil fuel consumption of reference facilities and equipment	CO2
Project emissions	
Emission sources	GHG types
Electricity consumption of project facilities and equipment	CO2
Fossil fuel consumption of project facilities and equipment	CO2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

The reference emissions are "the amount of CO2 that would otherwise be emitted from the existing facilities and equipment in the absence of the project facilities and equipment".

The reference emissions are to be calculated based on available data according to the following methodology.

1. Forklift

   The forklifts for cargo handling in the current port facilities in Thailand commonly use fossil fuel (diesel oil). The reference emissions of the forklifts are calculated by multiplying the energy consumption intensity of diesel-fueled forklifts (liters/hour) with their operating hours during the project period p (hours/p) and the CO2 emission factor of diesel oil (t-CO2/liter).

2. Indoor lighting equipment

   In the current port facilities in Thailand, mercury lamps are commonly used for indoor lighting. The reference emissions of the indoor lighting equipment are calculated by multiplying the total wattage of q units of mercury lamps (wattage of a mercury lamp for indoor lighting: 400W/unit) with their operating hours during the project period p (hours/p) and the CO2 emission factor of the grid electricity (t-CO2/MWh).

3. Yard lighting equipment

   In the current port facilities in Thailand, mercury lamps are commonly used for yard lighting. The reference emissions of the yard lighting equipment are calculated by multiplying the total wattage of q units of mercury lamps (wattage of a mercury lamp for yard lighting: 940W/unit) with their operating hours during the project period p (hours/p) and the CO2 emission factor of the grid electricity (t-CO2/MWh).

4. RTG

   The RTGs for cargo handling in the current port facilities in Thailand commonly use fossil fuel (diesel oil). The reference emissions of the RTGs are calculated by multiplying

the diesel oil consumption by RTGs during a project period p (liters/p) with the CO2 emission factor of diesel oil (t-CO2/liter).

5. PV power station for captive use

Power generated by PV power stations for captive use during the project period p replaces purchased grid electricity. The reference emissions for the PV power stations for captive use are calculated by multiplying the amount of generated power during the project period p (MWh/p) with the CO2 emission factor of the grid electricity (t-CO2/MWh). If power generated by the PV power stations is consumed by electric forklifts and lighting equipment during the project period p, such consumption must be adjusted for the calculation of the reference emissions.

F.2. Calculation of reference emissions

1. Forklift

Reference emissions of the forklifts (hereinafter, FL) are to be calculated with the following formula:

$$RE_p = \sum_i \left[OT_{p,i} \times EF_{CO2,diesel} \right]$$

RE_p: Reference emissions of the reference FL_i during the project period p [t-CO2/p]

$OT_{p,i}$: Operating hours of the reference FL_i during the project period p [hours/p]

※ For operating hours of FL_t to calculate the reference emissions, use a value obtained from the project monitoring.

$EF_{CO2,Diesel}$: Emission factor of FL_i [t-CO2/hour]

$EF_{CO2,Diesel}$ [t-CO2/hour] = EF_{fl} [liters/hour] × EF_{diesel} [t-CO2/liter]

EF_{fl} [liters/hour]：Energy consumption intensity of FL

※ Use a value obtained from field measurement or a catalogue value (for the latest model).

EF_{diesel} [t-CO2/liter]： CO2 emission factor of diesel oil

※ Use a published value of IPCC, etc.

2. Indoor lighting equipment

Reference emissions of indoor lighting equipment（ILF）are to be calculated with the following formula:

$$RE_p = \sum_i \left[EC_{p,i} \times OT_{p,i} \times EF_{CO2,elec} \right]$$

RE_p: Reference emissions of the reference ILF_i during the project period p [t-CO2/p]

$EC_{p,i}$: Wattage of the reference ILF_i [W]

$OT_{p,i}$: Operating hours of the reference ILF_i during the project period p [hours/p]

※For operating hours of ILF_i to calculate the reference emissions, use a value obtained from the project monitoring, or a predetermined value obtained from study before/after the project.

$EF_{CO2,elec}$: CO2 emission factor of the grid electricity [t-CO2/MWh]

※ Use a published value of the Thai government, such as TGO, etc.

3. Yard lighting equipment

Reference emissions of yard lighting equipment（YLF）are to be calculated with the following formula:

$$RE_p = \sum_i \left[EC_{p,i} \times OT_{p,i} \times EF_{CO2,elec} \right]$$

RE_p: Reference emissions of the reference YLF_i during the project period p [t-CO2/p]

$EC_{p,i}$: Wattage of the reference YLF_i [W]

$OT_{p,i}$: Operating hours of the reference YLF_i during the project period p [hours/p]

※For operating hours of YLF_i to calculate the reference emissions, use a value obtained from the project monitoring, or a predetermined value obtained from study before/after the project.

$EF_{CO2,elec}$: CO2 emission factor of the grid electricity [t-CO2/MWh]

※ Use a published value of the Thai government, such as TGO, etc.

4. RTG

Reference emissions of RTGs are to be calculated with the following formula:

$$RE_p = \sum_i [EC_{p,i} \times EF_{diesel}]$$

RE_p: Reference emissions of the reference RTG_i during the project period p [t-CO2/p]
$EC_{p,i}$: Fuel consumption of the reference RTG_i during the project period p [literss/p]
※For operating hours of RTG_i to calculate the reference emissions, use a value obtained from the project monitoring, or a predetermined value obtained from study before/after the project.
EF_{Diesel}: CO2 emission factor of diesel oil
※ Use a published value of IPCC, etc.

5. PV power station for captive use

Reference emissions of PV power stations (CPV) for captive use are to be calculated with the following formula:

$$RE_p = \sum_i [EP_p \times EF_{CO2,elec}] - ER_{fl} - ER_{ilf} - ER_{ylf}$$

RE_p: Reference emissions of the project CPV during the project period p [t-CO2/p]
EP_p: Power generations of the project CPV during the project period p [MWh/p]
$EF_{CO2,elec}$: Emission factor of the grid electricity [t-CO2/MWh]
※Use a published value of the Thai government, such as TGO, etc.
ER_{fl}: Emission reductions by introducing electric forklifts during the project period p [t-CO2/p]
ER_{ilf}: Emission reductions by introducing LED indoor lighting during the project period p [t-CO2/p]
ER_{ylf}: Emission reductions by introducing LED yard lighting during the project period p [t-CO2/p]

G. Calculation of project emissions

1. Forklift

Project emissions of forklifts（hereinafter, FL）are to be calculated with the following formula:

$$PE_p = \sum_i [OT_{p,i} \times EF_{CO2,elec}]$$

PE_p: Project emissions of the project FL_i during the project period p [t-CO2/p]
$OT_{p,i}$: Operating hours of the project FL_i during the project period p [hours/p]
※For operating hours of FL_t to calculate the project emissions, use a value obtained from the project monitoring.
$EF_{CO2,elec}$: CO2 emission factor of FL_i ＝0 [t-CO2/hour]
※ Using power generated by PV power stations for captive use.

2. Indoor lighting equipment

Project emissions of indoor lighting equipment（ILF）are to be calculated with the following formula:

$$PE_p = \sum_i [EC_{p,i} \times OT_{p,i} \times EF_{CO2,elec}]$$

PE_p: Project emissions of the project ILF_i during the project period p [t-CO2/p]
$EC_{p,i}$: Wattage of the project ILF_i [W]
$OT_{p,i}$: Operating hours of the project ILF_i during the project period p [hours/p]
※ For operating hours of ILF_i to calculate the project emissions, use a value obtained from the project monitoring, or a predetermined value obtained from study before/after the project.
$EF_{CO2,elec}$: CO2 emission factor of power generated by PV power stations for captive use＝0 [t-CO2/MWh]

3. Yard lighting equipment

Project emissions of indoor lighting equipment（YLF）are to be calculated with the following formula:

$$PE_p = \sum_i [EC_{p,i} \times OT_{p,i} \times EF_{CO2,elec}]$$

PE_p: Project emissions of the project YLF_i during the project period p [t-CO2/p]
$EC_{p,i}$: Wattage of the project YLF_i [W]
$OT_{p,i}$: Operating hours of the project YLF_i during the project period p [hours/p]
※For operating hours of YLF_i to calculate the project emissions, use a value obtained from the project monitoring, or a predetermined value obtained from study before/after the project.
$EF_{CO2,elec}$: CO2 emission factor of power generated by PV power stations for captive use＝0 [t-CO2/MWh]

4. RTG

Project emissions of RTGs are to be calculated with the following formula:

$$PE_p = \sum_i [EC_{p,i} \times EF_{diesel}]$$

PE_p: Project emissions of the project RTG_i during the project period p [t-CO2/p]
$EC_{p,i}$: Fuel consumption of the project RTG_i during the project period p [liters/p]
※For operating hours of RTG_i to calculate the reference emissions, use a value obtained from the project monitoring, or a predetermined value obtained from study before/after the project.
EF_{Diesel}: CO2 emission factor of diesel oil [t-CO2/liter]
※ Use a published value of IPCC, etc.

5. PV power station for captive use

Project emissions of PV power stations (CPV) for captive use are to be calculated with the following formula:

$$PE_p = \sum_i [EP_p \times EF_{CO2,elec}]$$

PE_p: Project emissions of the project CPV during the project period p [t-CO2/p]
EP_p: Power generations of the project CPV during the project period p [MWh/p]
$EF_{CO2,elec}$: CO2 emission factor of power generated by PV power stations for captive use＝0 [t-CO2/MWh]

H. Calculation of emissions reductions

Emissions reductions are calculated with the following formula:

$ER_p = RE_p - PE_p$

ER_p : Emissions reductions during the project period p
RE_p : Reference emissions during the project period p
PE_p : Project emissions during the project period 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_{fl}	Energy consumption intensity of forklift [liters/hour]	Value obtained from the project implementer's historical data, ex-ante measurement, or the catalogue. For a catalogue value, use the value for the latest model.
$OT_{p,i}$	Operating hours of project lighting equipment during the project period p [hours/p]	If it is difficult to monitor the operating hours of lighting equipment during the project period, use fixed values obtained in study before/after the project.
$EC_{p,i}$	Fuel consumption of the reference RTG during the project period p [liters/p]	If the historical data on fuel consumption of the reference RTG are not available from the project implementer, use fixed values obtained in study before/after the project.

EF_{diesel}	CO2 emission factor of diesel oil [t-CO2/liter]	Use a published value of IPCC, etc.
$EF_{CO2,elec}$	Emission factor of the grid electricity [t-CO2/MWh]	Use a published value of the Thai government, such as TGO, etc.

6.2 Design and Development of PDD

JCM Project Design Document Form

A. Project description

A.1. Title of the JCM project

Development of Smart Port at Bangkok Port in the Kingdom of Thailand

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

The project introduces low-carbon facilities and equipment specific for port facilities, such as electric forklifts, hybrid RTGs, LED lighting equipment (including that for indoor lighting in CFS Export (CFS: Container Freight Station)) in Bangkok Port in Thailand, to realize CO2 emission reduction. The project also installs a PV power station for captive use to supply power to the low-carbon electric facilities and equipment, to realize further CO2 emission reduction.

1. Introduction of electric forklifts
2. Introduction of indoor LED lighting equipment
3. Introduction of LED lighting equipment for yards
4. Introduction of hybrid RTGs
5. Introduction of a PV power station for captive use

A.3. Location of project, including coordinates

Country	The Kingdom of Thailand
Region/State/Province etc.:	Bangkok
City/Town/Community etc.:	Khlong Toey
Latitude, longitude	-

A.4. Name of project participants

The Kingdom of Thailand	Port Authority of Thailand (PAT)
Japan	Yokohama Port Corporation

A.5. Duration

Starting date of project operation	May 2018
Expected operational lifetime of project	17 years

A.6. Contribution from Japan

This proposed project is partially supported by the Ministry of Environment in Japan as a JCM Model Project, able to receive the financial support of up to 50% of its initial investment in exchange for JCM credits.

Technology transfer and capacity building on operation and monitoring is cooperatively provided by Yokohama Port Corporation, Green Pacific Co., Ltd., and Overseas Environmental Corporation Center.

B. Application of an approved methodology(ies)

B.1. Selection of methodology(ies)

Selected approved methodology No.	Development of Smart Port
Version number	1.0
Selected approved methodology No.	
Version number	

Selected approved methodology No.	
Version number	

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	Target facilities of the project are port facilities.	The project facility is Bangkok Port controlled by Port Authority of Thailand （PAT）
Criterion 2	The project introduces port specific low-carbon facilities and equipment such as electric forklifts, hybrid RTGs, and LED lighting, etc.	The project introduces low-carbon facilities and equipment specific for port facilities, such as electric forklifts, hybrid RTGs, LED lighting equipment.
Criterion 3	The project introduces captive power stations like PV power stations to supply power mainly to the low-carbon facilities and equipment.	The project introduces a PV power station in Bangkok Port mainly to supply power to low-carbon facilities and equipment.
Criterion 4	The project is implemented with the cooperation and support of Japanese port management organizations that have experiences of smart port management.	The project is implemented with the cooperation and support of Yokohama Port Corporation, which have experiences of smart port management.

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
Electricity consumption of reference facilities and equipment	CO2
Fossil fuel consumption of reference facilities and equipment	CO2
Project emissions	
Emission sources	GHG type
Electricity consumption of project facilities and equipment	CO2
Fossil fuel consumption of project facilities and equipment	CO2

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

1. Introduction of electric forklifts

The project introduces electric forklifts (as shown in a picture on the left) to CFS Export to be newly constructed in Bangkok Port. The reference equipment is a diesel forklift, which is commonly used in Bangkok Port. Operating hours of all electric forklifts to be introduced will be monitored.

2. Introduction of indoor LED lighting equipment

The project introduces LED lighting

equipment shown below to CFS Export to be newly constructed in Bangkok Port. Operating hours of the LED lighting equipment will be automatically measured by sensors or determined as a default value based on data of daily operating hours for a certain period of time collected before or after the project implementation.



3. Introduction of LED lighting equipment for yards

The project introduces LED lighting equipment (as shown in a picture on the left) to container yards in Bangkok Port. Operating hours of the LED lighting equipment will be automatically measured by sensors or determined as a default value based on data of daily operating hours for a certain period of time collected before or after the project implementation.

4. Introduction of hybrid RTGs

The project introduces hybrid RTGs (as shown in a picture on the left) for cargo handling at Bangkok Port. Fuel consumption of the hybrid RTGs will be monitored.

5. Introduction of a PV power station for captive use

The project introduces a PV power station (as shown below) to CFS Export to be newly constructed in Bangkok Port. The amount of power generated by the PV power station will be monitored.

PV panels on the CFS in MC-1,2 terminal, Yokohama



C.3. Estimated emissions reductions in each year

Year	Estimated Reference emissions ($tCO2_e$)	Estimated Project Emissions ($tCO2_e$)	Estimated Emission Reductions ($tCO2_e$)
2018	2,913	1,131	1,781
2019	2,913	1,131	1,781
2020	2,913	1,131	1,781

2021	2,913	1,131	1,781
2022	2,913	1,131	1,781
2023	2,913	1,131	1,781
2024	2,913	1,131	1,781
2025	2,913	1,131	1,781
2026	2,913	1,131	1,781
2027	2,913	1,131	1,781
Total ($tCO2_e$)	29,130	11,310	17,810

D. Environmental impact assessment	
Legal requirement of environmental impact assessment for the proposed project	Not necessary

E. Local stakeholder consultation

E.1. Solicitation of comments from local stakeholders

As the project involves the introduction of facilities and equipment into Bangkok Port, local stakeholder consultation will be implemented for stakeholders of the port including the port workers.

E.2. Summary of comments received and their consideration

Stakeholders	Comments received	Consideration of comments received

F. References

-

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

Annex

-

Revision history of PDD		
Version	Date	Contents revised
1.0	10. March 2017	

Attached Documents

Document 1：MOU for Cooperation with PAT, etc.

Memorandum of Understanding between City of Yokohama and Bangkok Metropolitan Authority

日本国横浜市とタイ王国バンコク都との
持続可能な都市発展に向けた技術協力に関する覚書

バンコクは急速に都市化しており、政策立案及び都市開発に携わる者は多くの都市課題に直面している。その一つが都市化による地域環境及び地球環境への影響、すなわち廃棄物、下水、大気汚染及び気候変動である。しかしながら、関係者が協力し、都市発展が適切に管理されるならば、環境にやさしく持続可能な都市成長が可能となり、都市公害を減少させ都市緑化促進と低炭素社会を希求する機会を創出することができる。

横浜市はこれまでの数十年、急速な都市化や人口増加等、様々な都市課題に直面し、乗り越えてきた過程において、都市マネジメントやインフラ整備に関する専門知識やノウハウを蓄積してきた。現在横浜市は、横浜の資源・技術を活用した公民連携による国際技術協力事業であるＹ－ＰＯＲＴ事業を通じて、横浜ならではの知見を積極的に発信している。また横浜市は、日本国政府より、低炭素都市運営を世界に向け実証するための環境未来都市の一つに選定されている。

国際協力機構（ＪＩＣＡ）は、横浜市と包括連携協定を締結しており（2011年10月25日付）、現在、「バンコク気候変動マスタープラン2013－2023」プロジェクトのもと、気候変動マスタープラン策定においてバンコク都を支援している。このプロジェクト、及び先行プロジェクトであるＪＩＣＡトレーニングプログラムにおいて、横浜市はＪＩＣＡ及びバンコク都に技術的な助言を行ってきた。こうした背景を踏まえ、日本国横浜市とタイ王国バンコク都（以下、「両者」とする）は、バンコク都における環境に配慮した持続可能な都市の発展を通じた、両者の経済活動の活性化を希求して、以下の内容において協力することに合意した。

1．横浜市は、バンコク都の持続可能な都市開発を目指し、エネルギーマネジメント、公共交通、廃棄物管理及び下水管理等の分野における技術的な助言を行う。
2．両者は、上記に掲げた目標を遂成するため、低炭素社会の推進に係る知識・経験を持つ民間セクター、学術機関、地域コミュニティの参加を働きかける。
3．両者は、技術協力を実施するに際し適切な支援を得るために、両国の政府及び国際機関に支援を呼びかける。
4．両者は、上記の連携を効率的に行ううえで不可欠となる情報を相互に提供する。

この覚書は、両者の署名の日に効力を発し、2017年３月31日まで有効となり、両者の評価と合意のもとに更新できるものとする。

本覚書は、2013年10月21日、横浜にて日本語、タイ語及び英語で各２部作成され、同等の効力を持つものとする。意見が相違した場合には、両者が英語版に基づいて協議する。

横浜市長	バンコク都知事
林　文子	スクムパン ポリパット

Attachment 2

Memorandum of Understanding between the Port Authority of Thailand and the City of Yokohama

横浜市と PAT（タイ港湾庁）による覚書

横浜市と PAT（タイ港湾庁）は両者間の、貿易と港湾に関する協力の推進のため、ここに覚書を締結する。

両者はそれぞれの港の発展と振興に関する課題の議論に関与し、友好および双方の協力の下、他方の成長を強化するために最善を尽くすこととし、本覚書における協力は以下の事柄を包含する。

1. 両者発展のための情報交換
   （1） 港湾経営に関すること
   （2） 海運動向に関すること
   （3） 国際貿易に関すること
   （4） IT 化に関すること
   （5） 技術や環境対策に関すること
2. ポートセールス（地元や地域内の市場拡大のため、潜在的な地元のパートナーや顧客との協力を手助けし推進すること）に係る相互支援

本覚書による協力は義務や制限、法的拘束力を持たないこととする。協力活動はその都度決定し総括され、両者の合意により変更や拡大が行われる。上記活動にかかる費用は事前に一件一件合意の下両者で負担することとする。

この覚書はお互いの尊重とお互いの国家間の長期的で友好的な関係に基づくものとする。

両者を代表し、我々署名者は、ここに公式に横浜市と PAT（タイ港湾庁）による覚書の締結に合意する。本覚書は 2014 年 4 月 22 日に日本語および英語で複写にて署名され、2019 年 3 月 31 日まで有効となり、両者の評価と合意のもとに更新できるものとする。

横浜市

鈴木伸哉

副市長

PAT（タイ港湾庁）

R. Surapong

副長官

Memorandum of Understanding
between
The Port Authority of Thailand and
The City of Yokohama

The Port Authority of Thailand and the City of Yokohama hereby establish a Memorandum of Understanding to mutually benefit both parties through promoting trade and port maritime cooperation.

The Port Authority of Thailand and the City of Yokohama will be involved in discussing issues relating to the development and promotion of each port, and make every effort to intensify growth of the other, through friendship and mutual cooperation.

The cooperation, which is called "Memorandum of Understanding between the Port Authority of Thailand and the City of Yokohama", embraces the following issues:

1. Both parties agree to exchange information on issues regarding;
   (1) Port management
   (2) Trend of shipping trade
   (3) International trade
   (4) Introduction of IT
   (5) Technology and environmental issues

2. Both parties agree to assist each other in exploring the local and regional market, by facilitating and promoting cooperation with potential local partners/customers.

It is understood that the above endeavors are in no way imperative or have any limiting or legal binding character. The cooperation activities will be established and reviewed from time and amended or expanded in accordance with the Memorandum of Understanding of both partners. Costs involved in any of the above activities shall be borne by both partners on a case-by-case basis as agreed in advance.

This Memorandum of Understanding will initially be based on mutual respect and friendship inspired by the long - standing and friendly relationship between both countries.

On behalf of the two parties, we, the undersigned, hereby formally agree to the establishment of the Memorandum of Understanding between the Port Authority of Thailand and The City of Yokohama. This Memorandum of Understanding is done in duplicate in English and Japanese on 22nd April 2014, and will be valid until the end of March 2019 with the option to renew the Memorandum of Understanding after evaluation, and consent of the Parties.

For and on behalf of
the Port Authority of Thailand

R. Surapong

DEPUTY DIRECTOR GENERAL

For and on behalf of
the City of Yokohama

鈴木伸哉

DEPUTY MAYOR

Letter of Intent of the Implementation of the Memorandum of Understanding between the Port Authority of Thailand and the City of Yokohama

2014年4月22日調印の横浜市とタイ港湾庁による覚書の履行のための基本合意書

2014年4月22日調印の横浜市とタイ港湾庁による覚書（以下、「覚書」という。）を受け、横浜市とタイ港湾庁（以下「両者」という。）は覚書の履行のため、以下の項目に合意する。

1　両者は、書類や情報の提供、人材の交流を通じ相互支援する。

（1）人材育成：両者は、短期の研修プログラムを共同で用意する。横浜市におけるプログラムでは、横浜市がタイ港湾庁のスタッフに、研修にかかる移動手段の支援を提供する。タイにおけるプログラムでは、タイ港湾庁が横浜市のスタッフに、研修にかかる移動手段の支援を提供する。支援の内容については、両者が事前に協議する。
（2）技術交流：両者は特定の分野におけるワークショップや技術視察を行う。分野のトピックについては、両者が事前に協議する。
（3）情報交換：両者は書類や情報の提供を通じて、港湾技術、マーケティング調査及び港湾開発において相互に協力する。

2　両者は、潜在的な地元のパートナーや顧客との連携を促進することにより、地域の市場開拓を相互に支援する。

（1）セミナー：両者は、交互に主催者となり地域的なセミナーを開催する。セミナーのテーマは両者で事前に決定する。
（2）プロモーション：両者は、あらゆる会議や展示の機会を捉え、資料等の配布により、相互に継続的なプロモーションを行う。文書や展示資料は適宜更新されるものとする。

上記のプログラムは、覚書の履行にいかなる制限を設けるものではなく、また、法的拘束力も持たない。また、上記の履行に関する費用については、両者で負担する。案件ごとに事前に考慮され、合意される。タイ港湾庁と横浜市の連携は、国家間そして国民間の長期的な友好関係がもたらす相互の友情と敬意に基づく。

両港のために、2015年1月19日、横浜市とタイ港湾庁は以下に署名し、覚書の履行に関して正式に合意する。合意書は、日本語及び英語で作成され、両言語とも等しく正本とする。

横浜市港湾局　　タイ港湾庁（PAT）

伊東慎介　　[illegible]

港湾局長　伊東慎介　　[illegible]官代理　[illegible]

LETTER OF INTENT

ON THE IMPLEMENTATION OF

THE MEMORANDUM OF UNDERSTANDING BETWEEN

THE PORT AUTHORITY OF THAILAND AND THE CITY OF YOKOHAMA

DATED APRIL 22, 2014

Following the Memorandum of Understanding between the Port Authority of Thailand and the City of Yokohama dated April 22, 2014, the Port Authority of Thailand and the City of Yokohama (hereinafter collectively referred to as "Both parties") agreed on the following program for the implementation of the Memorandum of Understanding.

1. Both parties shall reciprocally assist each other by providing documentation, information, and personnel exchanges.

   (1) TRAINING: Both parties shall jointly set up short-term training programs. During the program period in Japan, the City of Yokohama shall provide transportation support for staff of the Port Authority of Thailand. During the program period in Thailand, the Port Authority of Thailand shall provide transportation support for staff of the Port of Yokohama. The extent of the support provided shall be discussed by Both parties in advance.

   (2) TECHNICAL EXCHANGES: Both parties shall organize workshops and technical visits on specific issues. The issues of workshops and each technical visit shall be discussed by Both parties in advance.

   (3) INFORMATION EXCHANGES: Both parties shall reciprocally assist each other by providing documentation and information on Port Technology, Marketing Research and Port Development.

2. Both parties shall assist each other to explore the local and regional market, by facilitating and promoting cooperation with potential local partners / customers.

(1) SEMINARS: Both parties shall establish a seminar every year and each party shall take turn to be the host. The subjects of each seminar shall be set by Both parties.

(2) PROMOTION: At all appropriate conferences or exhibitions, Both parties shall continue to mutually promote each other by distributing promotion materials such as brochures, newsletters, leaflets etc., and by exchanging information during those events. In this regard, the documentation and exhibition materials shall be updated.

It is understood that the above endeavors are in no way imperative or have any limiting or legal binding character to the implementation of the Memorandum of Understanding.

The costs involved in the implementation of the above shall be borne by Both parties. This shall be considered and agreed upon in advance on a case by case basis.

Both parties reiterate that the cooperation between the Port Authority of Thailand and the City of Yokohama is based on a mutual friendship and respect inspired by the long-standing friendly relationship between the countries and their people.

On behalf of the two ports, we, the undersigned, hereby formally agree to the establishment of the Letter of Intent on the Implementation of the Memorandum of Understanding between the Port Authority of Thailand and the City of Yokohama on the nineteenth day of January 2015, in the Japanese and the English languages, both texts being equally authentic.

For the Port Authority of Thailand,

Adisorn Anothaisintavee
Assistant Director General
Asset Management and Business Development
Port Authority of Thailand

For the Port and Harbor Bureau
City of Yokohama,

伊東 愼介

Shinsuke Itoh
Director General
The Port and Harbor Bureau
City of Yokohama

Document 2-1：Handouts at the 1st Meetings with PAT

JCM Feasibility Study by YPC, GP and OECC in cooperation with PAT,

based on the partnership between PAT and City of Yokohama

16th-18th Nov. 2016
Yokohama Port Corporation
Green Pacific Co., Ltd.
Overseas Environmental Cooperation Center, Japan

横浜港埠頭株式会社
Yokohama Port Corporation
Green Pacific
一般社団法人海外環境協力センター
Overseas Environmental Cooperation Center, Japan

JCM Funding Program: JCM Model Projects by MOEJ

The draft budget for projects starting from FY 2016 is 6.7 billion JPY (approx. USD 63 million) in total by FY2018

※Budget will be fixed after approval by the Parliament

Government of Japan

Finance part of an investment cost (**less than half**)

Conduct MRV and expected to deliver at least half of JCM credits issued

Funded facilities must be used continuously for the period of legal durable years.
Otherwise MOEJ may request to reimburse the given grant.

International consortiums (which include Japanese entities)

- Scope of the financing: facilities, equipment, vehicles, etc. which reduce CO_2 from fossil fuel combustion as well as construction cost for installing those facilities, etc.
- Eligible Projects : starting installation after the adoption of the financing and finishing installation within three years.

*MRV： Measurement, Reporting and Verification

Source: Recent Development of the JCM, Feb. 2016, Government of Japan

Recent development of JCM

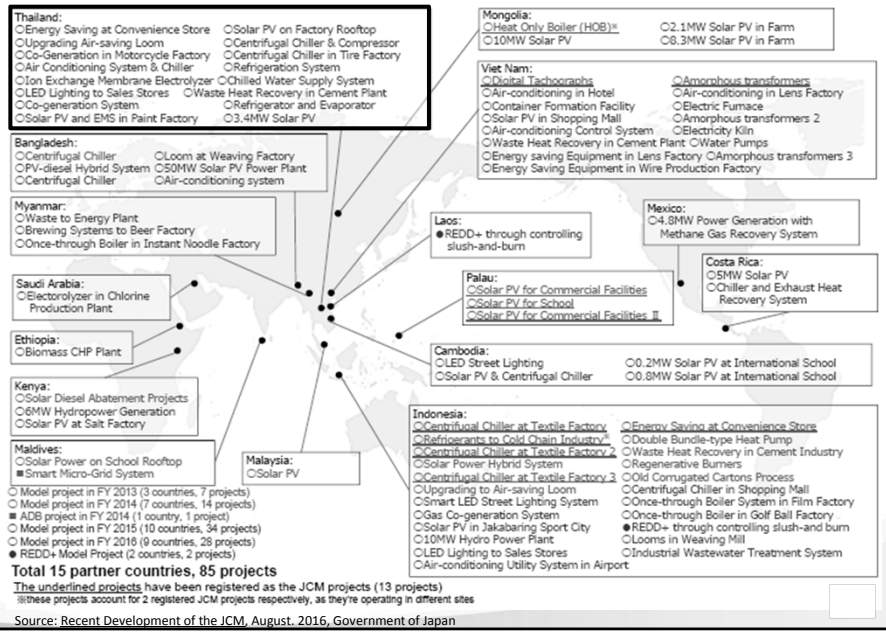
- Maximum percentage of financial support is decided by number of adopted JCM model projects utilizing similar type of technology in each country.

Number of adopted projects utilizing similar technology	0 (The first case)	1 - 3	4 -
Max. percentage of financial support	50%	40%	30%

- Standard cost-effectiveness of financial support is as follows
  - Project with subsidy of 500 million JPY and more ⇒ 1,700 THB / t CO_2
  - Project with subsidy of Less than 500 million JPY ⇒ 3,400 THB/ t CO_2

✓ The above cost-effectiveness standard is not the absolute case as the volume of reduction of GHG emission differs by the calculation method and the volume of reduction which was expected at planning stage may not be achieved.

JCM Funding Program by MOEJ (FY2013-2016)



Source: Recent Development of the JCM, August. 2016, Government of Japan

JCM Funding Program by MOEJ (FY2013-2016)

6 projects in Thailand were adopted for JCM funding program in FY2015, 9 projects in FY2016.

Thailand:

- ○Energy Saving at Convenience Store
- ○Upgrading Air-saving Loom
- ○Co-Generation in Motorcycle Factory
- ○Air Conditioning System & Chiller
- ○Ion Exchange Membrane Electrolyzer
- ○LED Lighting to Sales Stores
- ○Co-generation System
- ○Solar PV and EMS in Paint Factory
- ○Solar PV on Factory Rooftop
- ○Centrifugal Chiller & Compressor
- ○Centrifugal Chiller in Tire Factory
- ○Refrigeration System
- ○Chilled Water Supply System
- ○Waste Heat Recovery in Cement Plant
- ○Refrigerator and Evaporator
- ○3.4MW Solar PV

Red: FY 2015
Purple: FY 2016

Source: Recent Development of the JCM, August. 2016, Government of Japan

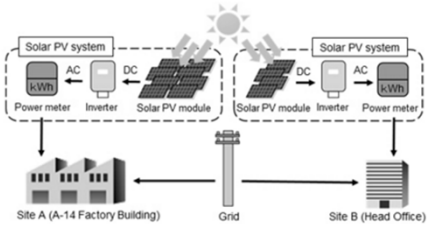
JCM Project in Thailand for introduction of photovoltaic system

PP(Japan) : Pacific Consultants Co., Ltd., InterAct Inc. / PP(Thailand) : Siam Steel International Public Company Limited

Adopted in 2015

○ Outline of GHG Mitigation Activity

The project aims to reduce CO2 emissions by introducing solar photovoltaic (PV) systems at a factory complex manufacturing steel products and furniture in Samutprakarn, Thailand.
A grid-connected solar PV system will be installed on rooftops of the A-14 Factory Building (Site A: 837kW) and Head Office (Site B: 157kW). The total installed capacity will be 994kW.
All of the generated power will be consumed within the factory complex. The project will be a model case utilizing factory roof space and high-efficiency PV modules for self-consumption.



○ Expected GHG Emission Reductions

776 tCO2/ year

CO2 emission factor: 0.5554 (tCO2/MWh)
Project emissions are assumed to be zero.
Reference emission - Project emission = 776 – 0 = 776

Site	Generation of electricity	CO2 emission reductions
A	1,176 (MWh/year)	653.2 (tCO2/year)
B	220.6 (MWh/year)	122.5 (tCO2/year)
合計	1,397 (MWh/year)	775.7 (tCO2/year)

○ Sites of JCM Model Project

Source:GEC Website(http://gec.jp/jcm/projects/15pro_tha_02.html)

Overview of the Feasibility Study (F/S)

The F/S aims to support PAT's environmentally friendly initiative, conducted as an entrusted project from Ministry of the Environment, Government of Japan (MOEJ).

Overview

- Based on the partnership between PAT and City of Yokohama.
- Investigate the feasibility of the projects for JCM funding program by studying project costs, CO2 reduction, etc.
- Utilizing our experience of reducing carbon emissions at the Port of Yokohama.
- The first JCM project applied to the port and harbor sector in the world.

Project Outline

1) Project Participants
- Yokohama Port Corp.
- Green Pacific Co., LTD.
- OECC

2) Period of Activities
- From Oct 6, 2016 to Mar 10, 2017

3) Cost
- All costs to be borne by MOEJ (and YPC)

✓ We are in an advantageous position to apply for the JCM funding program in next year. MOEJ strongly expects to do so.
✓ We are truly grateful for your kind cooperation. Your continued supports will be highly appreciated.

Project Outline (10 projects)

Phase 1 (2015~2019) — Bangkok Port

(1) PV Panels on CFS roof
(2) Indoor LED lightings in CFS
(3) Electric forklifts with charging system
(4) Hybrid RTGs
(5) LED yard lightings for container yard

Phase 2 (2020~2024) — Bangkok Port and Laem Chabang Port

(6) LED road lightings in LC Port
(7) Hybrid cargo handling equipment in Lat Krabang ICD
(8) High efficiency transformers to substations in BKK Port
(9) Shore connection system in BKK and LC Port
(10) Hybrid tugboats




Please refer to the attached A3-sized sheet

Major Examination Items of the F/S

1. PAT's current construction plan
2. PAT' budget and financing scheme
3. PAT's general rules for procurement (tender)

→ PAT is kindly asked to provide information

4. Technologies and products to be applied
5. Effects of CO2 reduction and energy saving
6. Cost of the project
7. Profitability of the project
8. Laws and regulations (Permission, authorization or/and notification to install facilities)

→ YPC, GP, OECC and PAT will jointly examine

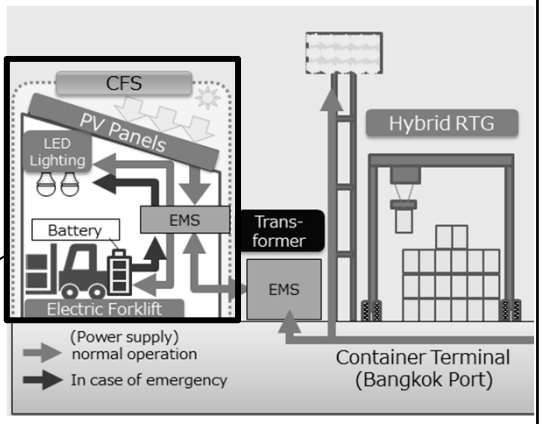
Phase 1 Projects (1st Priority)

Purpose

- Promoting carbon reduction at Bangkok Port
- Making Bangkok Port a "smart port"

Integrated Energy Management System (EMS) for Import CFS（Project 1~4）

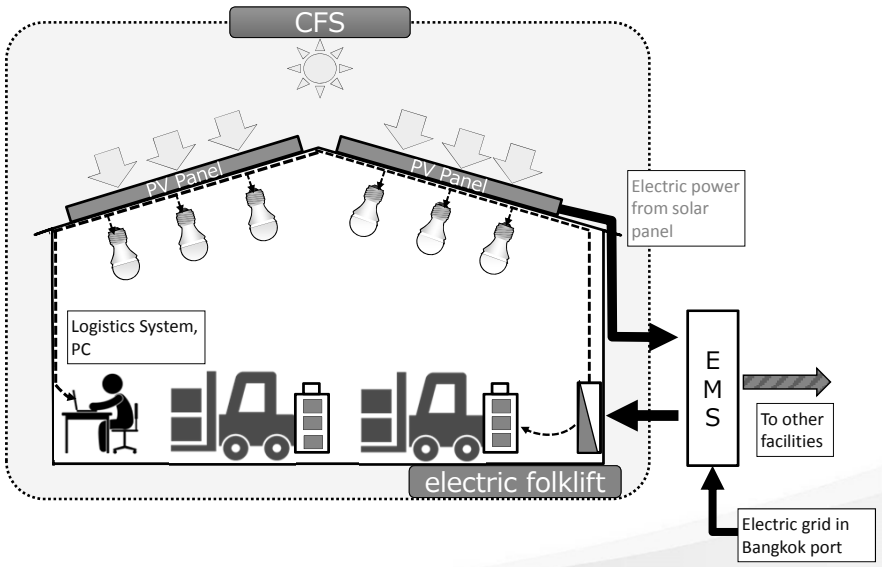
(1) PV Panels on CFS roof
(2) Indoor LED lightings in CFS
(3) Electric forklifts with charging system
(4) Hybrid RTGs



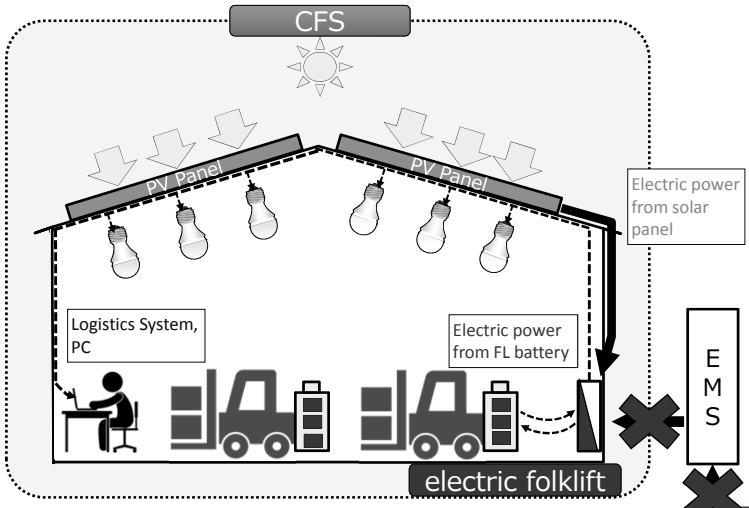
Integrated EMS for CFS

Linking PV power generation with LED lighting and forklifts based on EMS with peak shaving operation and emergency power source

Normal power line



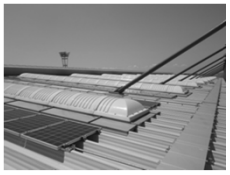
Emergency power line



Utilize the battery of Electric forklifts as emergency power source during the night

Installing PV panels on CFS roof (Project 1)

PV panels on the CFS in MC-1,2 terminal, Yokohama Port


CO2 reduction

43,211t-CO2 / 17years

Cost advantage

electric power company	4.0THB/kWh
PV system	4.2THB/kWh
PV system with JCM subsidy (40% of investment being covered)	2.7THB/kWh

Saving of electricity cost will be:
5,837,000THB/1year
99,229,000THB/17years

Feasibility of JCM utilization

30%-40% of investment for PV system is expected to be covered by JCM subsidy
In case of 40%, cost effectiveness will be approx. 2,600THB / t-CO2

Estimate of installation of PV panel on Import CFS in Bangkok Port

Case1 (Without top light)

Installation area	25,600m^2
Generation capacity	3.4 [MW]
Electric power	76,331,422 [kWh / 17years]
CO_2 reduction(0.00056 t-CO_2 /kWh)	43,211 [t / 17years]
Initial cost (*1)	283,000,000 THB
Running cost	26,180,000 THB
Renewal cost of power conditioner	13,860,000 THB
Total cost（17years）	323,040,000 THB
Electricity cost by PV system	approx. 4.2 [THB / kwh]
Electricity cost by PV system (with JCM subsidy for 40% of investment)	approx. 2.7 [THB / kwh]
Cost effectiveness of JCM	approx. 2,600 THB / t-CO_2

*1: Not including cost of EMS unit

Estimate of installation of PV panel on Import CFS in Bangkok Port

Case2 (With top light)

Installation area	10,400m^2
Generation capacity	1.3 [MW]
Electric power	29,266,543 [kWh / 17years]
CO_2 reduction(0.00056 t-CO_2 /kWh)	16,568 [t / 17years]
Initial cost (*1)	108,000,000 THB
Running cost	10,234,000 THB
Renewal cost of power conditioner	5,500,000 THB
Total cost（17years）	123,734,000 THB
Electricity cost by PV system	approx. 4.2 [THB / kwh]
Electricity cost by PV system (with JCM subsidy for 40% of investment)	approx. 2.7 [THB / kwh]
Cost effectiveness of JCM	approx. 2,600 THB / t-CO_2

*1: Not including cost of EMS unit

Indoor LED lightings in CFS (Project 2)

Temperature in CFS will be very high(40℃～50℃), which makes it essential to install high quality lightings.



CO2 reduction

2,280t-co2/15years

Cost advantage

The initial cost will be **2,980,000THB lower than conventional lightings** if 40% of the cost is covered by JCM subsidy (originally it will be 3,900,000THB higher)

The total cost saving in 15 years will be approx. 28,400,000THB considering maintenance and electricity cost etc.

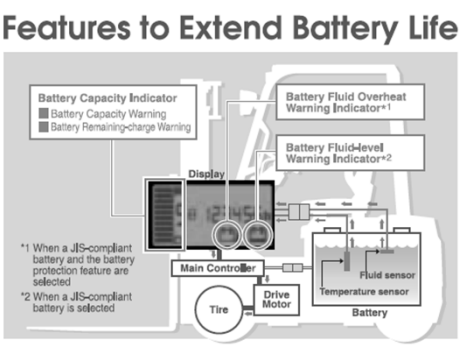
Feasibility of JCM utilization

30%-40% of the initial cost for LED lighting is expected to be covered by JCM subsidy
In case of 40%, cost effectiveness will be approx. 3,000THB / t-CO2

Indoor LED lightings in CFS (Project 2)

	Ordinary lighting	LED	Comparison
Number of lightings	400	400	0
Electric power consumption	7,008,000 [kWh / 15years]	3,153,600 [kWh / 15years]	- 3,854,400 [kWh/15years] - 55%
CO_2 reduction	4,140 [t / 15years]	1,860 [t / 15years]	-2,280 [t / 15years]
Approximate cost	13,300,000THB	17,200,000THB	3,900,000THB
Approximate cost with JCM subsidy (40%)		10,320,000THB	- 2,980,000THB
Maintenance cost (15 years)	18,000,000THB	8,000,000THB	- 10,000,000THB
Electricity cost (15 years)	28,032,000THB	12,614,400THB	- 15,417,600THB
Total cost (15 years)	31,300,000THB	18,320,000THB	**- 28,397,600THB**

Electric forklift（Project 3）



CO2 reduction

10.84t-co2/truck・5years（×70trucks＝758.8t-co2 / 5years）

Cost advantage

The total cost of Electric Forklift including running cost will be **482,200THB/truck lower** than diesel forklift (while the initial cost will be 345,000THB/truck higher)

Feasibility of JCM utilization

Around 6% of the initial cost is expected to be covered by JCM subsidy
The amount of JCM subsidy per 1truck will be approx. 74,100THB/truck
(70trucks ＝ 74,100THB*70trucks= approx. 5,187,000THB)

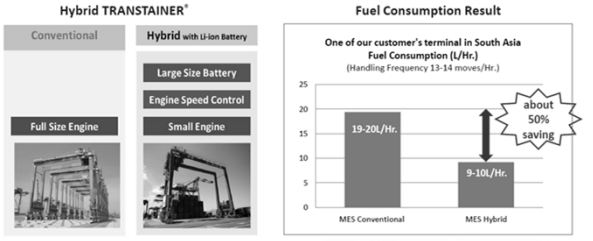
Electric forklift（Project 3）

CASE : 8FBN25　2.5ton	Unit	DIESEL TRUCK	ELECTRIC TRUCK	Improve -ments
Duration of use	*Years*	5		−
Annual working days	*Days*	250		−
Operation hours/day	*Hours*	8.0		−
Energy consumption/hour (*1)	*l/h, kw/h*	3.7	4.5	−
Fuel cost/L or Energy cost/kw	*THB/L , THB/kw*	25.6	4.0	−
Initial (truck) cost(*2)	*THB/truck*	890,000	1,235,000	345,000
Running (fuel) cost 5years	*THB/truck・5years*	947,200	180,000	**- 767,200**
Maintenance cost 5years	*THB/truck・5years*	300,000	240,000	**- 60,000**
Total cost (THB/truck)	*THB/truck・5years*	2,137,200	1,655,000	**- 482,200**
CO_2 emissions	*Kg-CO_2/truck・5years*	41,150	30,310	**- 10,840**

*1: The unit of the data for engine trucks is "L", and for battery trucks "kw".
Figures may vary according to the customer's working conditions.
*2 Electric truck price includes replacing the 1battery in third year

Hybrid RTGs（Project 4）

Mitsui-PACECO HYBRID TRANSTAINER® CRANE
- Low Fuel Consumption and Low CO2 Emission - MES HYBRID



Recent Delivery Records

More than 100 units delivered

Location	Q'ty	Delivery
Long Beach, USA	7	Oct., 2016
Tokyo, Japan	2	Jul., 2016
Osaka, Japan	2	Feb., 2016
Kobe, Japan	2	Feb., 2016
Kobe, Japan	1	Feb., 2016
Tanjung Priok, Indonesia	5	Feb., 2016
Los Angeles, USA	5	Mar., 2015
Mombasa, Kenya	4	Dec., 2015

CO2 reduction

790t-co2/unit・12years（× 4 unit＝3,160t-co2・12years）

Feasibility of JCM utilization

Around 6% of the initial cost is expected to be covered by JCM subsidy

The amount of JCM subsidy per 1unit will be approx. 3,560,000THB

（*1unit＝3,560,000THB*4unit=14,240,000THB*）

Summary of Import CFS project (Project1-4)

Integrated Energy Management system

	(1) PV on CFS	(2) LED lighting in CFS	(3)Electric forklift	(4)Hybrid RTG
Legal durable years	17years	15years	5years	12years
Quantity	1 set	1 set	70 trucks	4 units
Initial cost	283,000,000THB	17,200,000THB	86,450,000THB	237,300,000THB
JCM subsidy(C)	113,200,000THB	6,880,000THB	5,187,000THB	14,238,000THB
Energy-saving effect (B)	43,211*t-co2* *(2541.8t-co2 / year)*	2,280*t-co2* *(152t-co2 / year)*	758.8*t-co2* *(151.8t-co2 / year)*	3,160*t-co2* *(263.3t-co2 / year)*
JCM cost effectiveness (C)/(B)	2,619THB/*t-co2*	3,017THB/*t-co2*	6,835THB/*t-co2*	4,505THB/*t-co2*
Eligibility for JCM	**Good**	**Good**	Not eligible	Not eligible
Profitability of running cost	5,837,000THB / year	1,694,000THB / year	11,580,000THB / year	2,613,000THB / year
Overall evaluation	**Good**	**Good**	**Good**	Not viable

Estimate of project profitability in total (Project1-3)

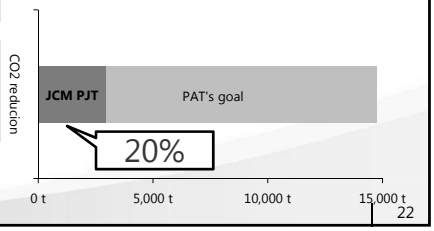
	(1)PV+(2)LED+(3)Fork
Initial cost	386,650,000 THB
JCM subsidy	125,267,000 THB
Cost after subsidy	261,383,000 THB
CO2 reduction / year	2,845.6 t-CO2

CO2 reduction JCM project (1)PV+(2)LED+(3)Fork

2,845.6 (ton / year)

Goal of PAT's Green port project (2019)

14,727 (ton / year)



Proposal for utilizing leasing

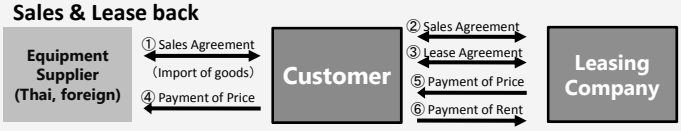
By utilizing leasing, it would be possible to reduce initial investment and avoid the cost risk of facility failure.

	No	Type of Finance	Financing from	Currency	Withholding tax	Merit	issue
Financing from Domestic Source	1	Bank Loan	Local Bank	THB	Y	• Diversification of funding source	<following may be required> • Guarantee from the related organization of borrower • Collateral of land, building • Up-front fee
	2	Finance Lease	Leasing Company	THB	Y	• Long term fixed interest • Flexible payment schedule • Leveling of depreciation in tax	• Interest rate is relatively higher than bank loan
	3	Operating Lease	Leasing Company	THB	Y	• Long term fixed interest • Flexible payment schedule • Leveling of depreciation in tax and accounting	• Operating lease need to be confirmed by Accountant of the client

< Question >
Can PAT utilize leasing for facility procurement?

Leasing Scheme

Sales & Lease back



① Customer imports the equipment from foreign supplier or buy from Thai domestic supplier.
② Leasing company execute sales agreement with the customer and buy the equipment.
③ Customer and leasing company execute leasing agreement.
④ Customer pays the price of the equipment to the supplier
⑤ After the delivery of the equipment, leasing company pays the price to the customer.
⑥ Customer pays the lease rent to the leasing company periodically.

※Price: net financed amount deductive of any subsidy.

＊he order of process is subject to specific situation of the project
＊In case of imported good, only "sales & lease back" scheme is available.

Direct Lease (only available for equipment procured in Thailand)

① Customer and leasing company execute leasing agreement.
② Leasing company execute sales agreement with Thai supplier under direction of the customer and buy the equipment (the equipment will be delivered directly to the customer).
③ After the delivery of the equipment, leasing company pays the price to the supplier.
④ Customer pays the lease rent to the leasing company periodically.

General Term of Lease and the Merits

General Term of Lease	
①Scheme	Finance Lease, Operating Lease
②Lease Asset	Movable goods
③Currency	Thai Baht
④Lease Term	3~5 years
⑤Tax	at the expense of the customer
⑥Insurance	insured by customer (or, leasing company can arrange to insure)
⑦Maturity of Lease	Finance Lease: customer buy the equipment at pre-determined price Operating Lease: customer choose to purchase or return the equipment of continue to lease

Merit of Finance Lease

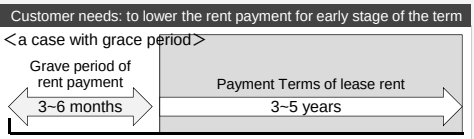
Availability of flexible payment schedule

Flexible payment schedule (e.g. step-up/step-down, grace period, balloon payment) according to cash management planning of the customer.

Availability of long-tem funding

Sales & Lease-back scheme to existing facilities of the customer provide long-term funding and improve cash management of the customer

Customer needs: to lower the rent payment for early stage of the term

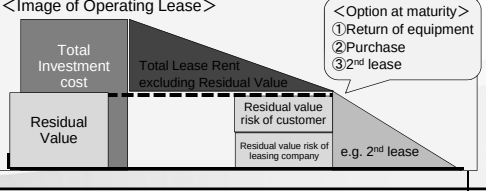


Merit of Operating Lease

Off-Balance treatment

Investment by Operating Lease can avoid deterioration of financial ratio since the added asset and its depreciation expense are not booked in account of the customer (to be confirmed with accountant of the customer).

＜Image of Operating Lease＞

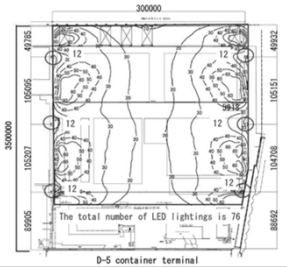


LED Yard lightings for container yard（Project 5）

Estimation in planned case at D-5 terminal in Yokohama Port for FY 2016/2017

Required specifications : Heat resistance against high temp environment of Thai weather.

PAT is kindly asked to provide detailed information (see the next page)



Drawing of D-5 container terminal, Yokohama Port

	Existing lighting	LED	Improvements
Number of lightings	114	76	**38 - 33%**
Electricity consumption	313,000 [kWh / year]	133,000[kWh / year]	**- 180,000 [kWh/y] - 57%**
Electric fee(4 THB / kwh)	1,252,000 [THB / year]	532,000 [THB / year]	**-1,027,000 [THB / year]**
CO_2 emissions	185 [t / year]	79 [t / year]	**-106 [t / year] - 57%**
Approximate cost	6,840,000THB	6,340,000THB	**-500,000THB**

LED Yard lightings for container yard (Project 5)

Necessary information for detailed study

1. Specification of existing lightings
2. Number of lightings
3. Dimensions of Yard, layout of lighting tower
4. Illumination criteria by law

LED lighting

Football park in Sapporo, Japan

Phase 2 Projects (Next Priority)

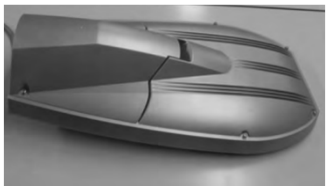
Purpose

- Promoting carbon reduction at Leam Chabang Port
- Reducing carbon emissions in transportation between Bangkok Port and Leam Chabang Port

LED road lightings in Leam Chabang port（Project 6）

Necessary information for detailed study

1．Specification of existing lightings
2．Number of the lightings
3．Illumination criteria by law



Considering the result of estimation of the indoor lightings in CFS (Project 2), reduction of CO2 emission by this project will be limited.

High efficiency transformers to substations in BKK Port (Project 8)

Site Visit in BKK Port in July 2016

High efficiency transformers to substations in BKK Port (Project 8)

	Transformers capacity		
	10,000kVA	20,000kVA	30,000kVA
Reduction of energy consumptions	622,000kWh/year	1,244,000kWh/year	1,866,000kWh/year
Reduction of CO_2 emissions	**340t-CO2/year**	**680t-CO2/year**	**1020t-CO2/year**
Approximate cost	33,300,000THB	66,600,000THB	99,900,000THB

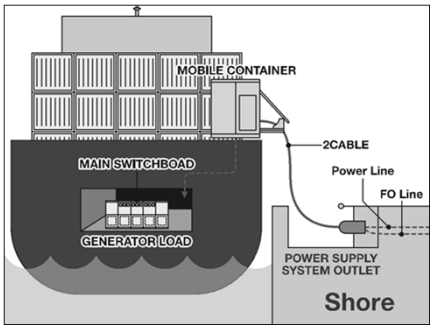
< Challenges >

1. Based on our field study and estimation, the cost effectiveness of CO2 reduction will be higher than current JCM standard
2. Power supply in BKK Port must be stopped when replacing transformers
3. The necessary capacity of transformers may change depending on facilities introduced in the future.

Considering above, it may not be advisable to replace transformers at this point

Shore Power Connection System (Project 9)

Can reduce CO2 emission by 40%, Sox and Nox by 98% by providing electricity to a moored ship from shore.



Challenges for applying to ocean-going vessels

- Conversion of frequency between ship and local grid (ship:60Hz, Thai local grid:50Hz)
- Uninterruptible power supply to ships (to avoid shutdown of systems on ship)
- Large amount of initial investments and cost bearing of electricity expense

< Questions >

1. Target of PAT's Shore Power Connection System
   - tugboats and coastal ships only?
   - or ocean-going ships at BKK and LC Port?
2. PAT's plan to meet IMO's ECA(Emission Control Area) restriction, in terms of technology such as Shore Power Connection, LNG fueled vessels

Hybrid tug（Project 10） (We have to start investigation now)

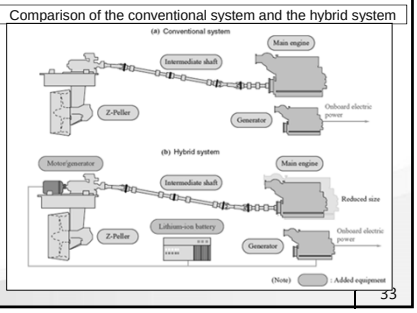
- The hybrid tug driven by diesel and electric motor.
- The engine is smaller than conventional tug boat.
- Hybrid Tug can reduce 20% in CO2 emissions
- Investigate to deliver this hybrid tug with the subsidy from Japanese government

Hybrid Tug "Tsubasa" delivered in 2013

< Questions >

1. How many tug boats are owned & operated by PAT?
2. Fleet list of tug boats (Name, Year of built, builder, Newbuilding or Second hand)
3. Acquisition policy (Newbuilding or Second hand)
4. Do you have a plan to replace or order additionally?
5. Do you have an interest in Hybrid tug with the subsidy of the Japanese Government?

Comparison of the conventional system and the hybrid system



Document 2-2 Handout for the closing meeting with PAT at the first site visit

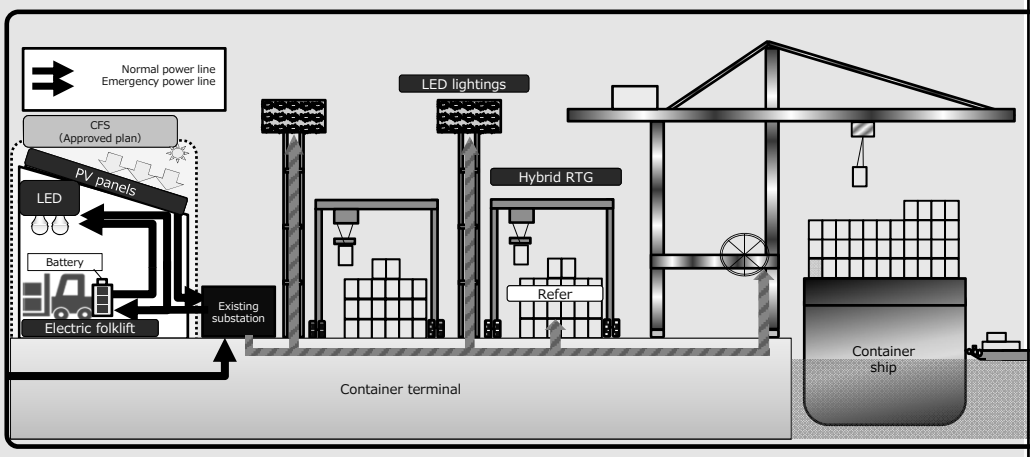
Summary of JCM Project regarding CFS

JCM Feasibility Study by YPC, GP and OECC
in cooperation with PAT,
based on the partnership between PAT and City of Yokohama

18th Nov. 2016
Yokohama Port Corporation
Green Pacific Co., Ltd.
Overseas Environmental Cooperation Center, Japan

横浜港埠頭株式会社
Yokohama Port Corporation
Green Pacific
一般社団法人海外環境協力センター
Overseas Environmental Cooperation Center, Japan

Integrated Energy Management System for BKK port (Revised)



Estimate of installation of PV panel on Import CFS (Project 1)

	Case1 (MAXIMUM DESIGN)	Case3 (MINIMUM DESIGN)
Installation area	25,600m^2	m^2
Generation capacity	3.4 [MW]	[MW]
Legal durable years	17years	PAT is kindly requested to provide necessary information to YPC
Electric power	76,331,422 kWh [/17years]	
CO_2 reduction(0.00056 t-CO_2 /kWh)	43,211 [t /17years]	
Initial cost (*1)	283,000,000 THB	
Total cost（17years）	323,040,000 THB	THB
JCM subsidy(C)	113,200,000 THB	THB
Cost after subsidy [/17year]	**209,840,000 THB**	**THB**
Saving Electlic of Cost [/17year]	**305,325,690 THB**	**THB**

*1: Not including cost of EMS unit

Indoor LED lightings in CFS (Project 2)

	Ordinary lighting	LED	Comparison
Number of lightings	400	400	0
Electric power consumption	7,008,000 [kWh / 15years]	**3,153,600 [kWh / 15years]**	- 3,854,400 [kWh/15years] - 55%
CO_2 reduction	4,140 [t / 15years]	**1,860 [t / 15years]**	-2,280 [t / 15years] - 55%
Approximate cost	13,300,000THB	**17,200,000THB**	3,900,000THB
Approximate cost with JCM subsidy (40%)		**10,320,000THB**	- 2,980,000THB
Maintenance cost (15 years)	18,000,000THB	**8,000,000THB**	- 10,000,000THB
Electricity cost (15 years)	28,032,000THB	**12,614,400THB**	- 15,417,600THB
Total cost (15 years)	31,300,000THB	**18,320,000THB**	**- 28,397,600THB**

Electric forklift（Project 3）

CASE : 8FBN25　2.5ton	Unit	DIESEL TRUCK	ELECTRIC TRUCK	Improve -ments
Duration of use	*Years*	5		–
Annual working days	*Days*	250		–
Operation hours/day	*Hours*	8.0		–
Energy consumption/hour (*1)	*l/h, kw/h*	3.7	4.5	–
Fuel cost/L or Energy cost/kw	*THB/L , THB/kw*	25.6	4.0	–
Initial (truck) cost	*THB/truck*	890,000	1,055,000	165,000
Running (fuel) cost 5years	*THB/truck・5years*	947,200	180,000	**- 767,200**
Maintenance cost 5years(*2)	*THB/truck・5years*	300,000	420,000	120,000
Total cost (THB/truck)	*THB/truck・5years*	2,137,200	1,655,000	**- 482,200**
CO_2 emissions	*Kg-CO_2/truck・5years*	41,150	30,310	**- 10,840**

*1: The unit of the data for engine trucks is "L", and for battery trucks "kw".
Figures may vary according to the customer's working conditions.
*2 Electric truck price includes replacing the 1 battery in third year

Summary of Import CFS project (Project1-4)

	Integrated Energy Management system		
	(1) PV on CFS	**(2) LED lighting in CFS**	**(3)Electric forklift**
Legal durable years	17years	15years	5years
Quantity	1 set	1 set	40trucks
Initial cost	283,000,000THB	17,200,000THB	42,200,000THB
JCM subsidy(C)	113,200,000THB	6,880,000THB	2,532,000THB
Energy-saving effect (B)	43,211*t-co2* *(2541.8t-co2 / year)*	2,280*t-co2* *(152t-co2 / year)*	433.6*t-co2* *(86.7t-co2 / year)*
JCM cost effectiveness (C)/(B)	2,619THB/*t-co2*	3,017THB/*t-co2*	5,840THB/*t-co2*
Eligibility for JCM	**Good**	**Good**	Not eligible
Profitability of running cost	5,837,000THB / year	1,694,000THB / year	5,178,000THB / year
Overall evaluation	**Good**	**Good**	**Good**

Document 2-3 Handout at the 2nd Meeting with PAT

JCM Feasibility Study by YPC, GP and OECC in cooperation with PAT

based on the partnership between PAT and City of Yokohama

10th Jan. 2017
Yokohama Port Corporation
Green Pacific Co., Ltd.
Overseas Environmental Cooperation Center, Japan

横浜港埠頭株式会社 Yokohama Port Corporation　Green Pacific　一般社団法人海外環境協力センター Overseas Environmental Cooperation Center, Japan

Outline of the initiative

- This initiative is proceeded based on the partnership between PAT and the City of Yokohama to support PAT to promote "Green Port Project".
- YPC will utilize its knowledge and experiences about carbon reduction gained through environmentally friendly measures introduced at the Yokohama port.
- To this end, the City of Yokohama and YPC have suggested to PAT to utilize JCM funding program proposed by the Japanese government, and YPC and PAT have been studying the program since 2015.

PAT's advantages for utilizing JCM Funding Program

- PAT can introduce **highly efficient and reliable** low carbon equipment at **reasonable cost.**
- It can increase the possibility for PAT to achieve the goal of Green Port Project.

We are going to examine mainly the Japanese advanced environmentally friendly technologies and products which have been verified by YPC at Yokohama Port.

Outline of JCM

JCM (Joint Crediting Mechanism) by Ministry of the Environment, Japan

JCM Funding Program: JCM Model Projects by MOEJ

The draft budget for projects starting from FY 2016 is 6.7 billion JPY (approx. USD 63 illion) in total by FY2018

※Budget will be fixed after approval by the Parliament

Government of Japan

Finance part of an investment cost (**less than half**)

Conduct MRV and expected to deliver at least half of JCM credits issued

International consortiums (which include Japanese entities)

Funded facilities must be used continuously for the period of legal durable years.
Otherwise MOEJ may request to reimburse the given grant.

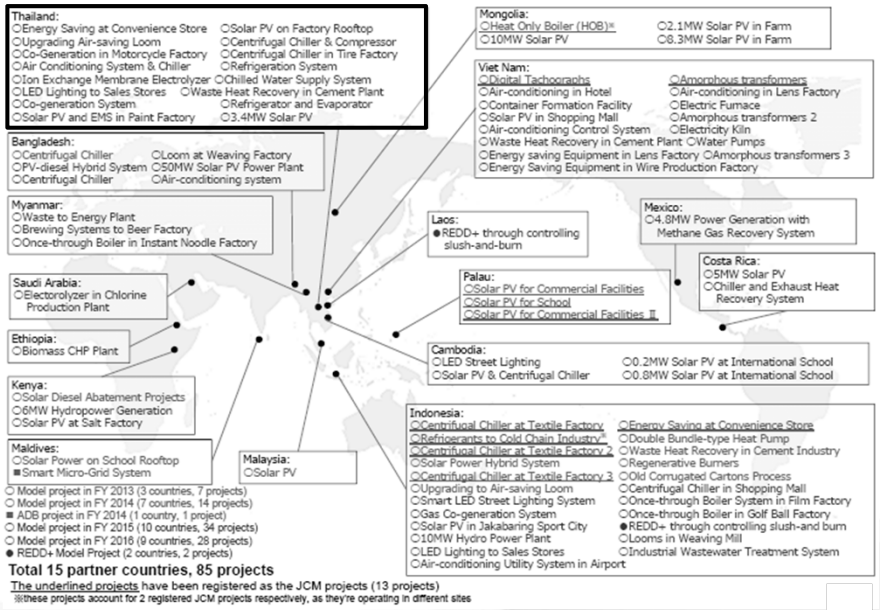


Source: Recent Development of the JCM, Feb. 2016, Government of Japan

- Scope of the financing: facilities, equipment, vehicles, etc. which reduce CO_2 from fossil fuel combustion as well as construction cost for installing those facilities, etc.
- Eligible Projects : starting installation after the adoption of the financing and finishing installation within three years.

*MRV: Measurement, Reporting and Verification

JCM Funding Program by MOEJ (FY2013-2016)



Source: Recent Development of the JCM, August. 2016, Government of Japan

JCM Funding Program by MOEJ (FY2013-2016)

6 projects in Thailand were adopted for JCM funding program in FY2015, 9 projects in FY2016.

Thailand:

○Energy Saving at Convenience Store	○Solar PV on Factory Rooftop
○Upgrading Air-saving Loom	○Centrifugal Chiller & Compressor
○Co-Generation in Motorcycle Factory	○Centrifugal Chiller in Tire Factory
○Air Conditioning System & Chiller	○Refrigeration System
○Ion Exchange Membrane Electrolyzer	○Chilled Water Supply System
○LED Lighting to Sales Stores	○Waste Heat Recovery in Cement Plant
○Co-generation System	○Refrigerator and Evaporator
○Solar PV and EMS in Paint Factory	○3.4MW Solar PV

Red: FY 2015
Purple: FY 2016

Source: Recent Development of the JCM, August. 2016, Government of Japan

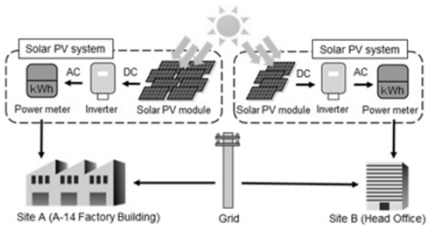
JCM Project in Thailand for introduction of photovoltaic system

PP(Japan) : Pacific Consultants Co., Ltd., InterAct Inc. / PP(Thailand) : Siam Steel International Public Company Limited

Adopted in 2015

Outline of GHG Mitigation Activity

The project aims to reduce CO2 emissions by introducing solar photovoltaic (PV) systems at a factory complex manufacturing steel products and furniture in Samutprakarn, Thailand.
A grid-connected solar PV system will be installed on rooftops of the A-14 Factory Building (Site A: 837kW) and Head Office (Site B: 157kW). The total installed capacity will be 994kW.
All of the generated power will be consumed within the factory complex. The project will be a model case utilizing factory roof space and high-efficiency PV modules for self-consumption.



Expected GHG Emission Reductions

776 tCO2/ year

CO2 emission factor: 0.5554 (tCO2/MWh)
Project emissions are assumed to be zero.
Reference emission - Project emission = 776 – 0 = 776

Site	Generation of electricity	CO2 emission reductions
A	1,176 (MWh/year)	653.2 (tCO2/year)
B	220.6 (MWh/year)	122.5 (tCO2/year)
合計	1,397 (MWh/year)	775.7 (tCO2/year)

Sites of JCM Model Project

Source:GEC Website(http://gec.jp/jcm/projects/15pro_tha_02.html)

Role of YPC and PAT in JCM project

- YPC, Green Pacific and PAT form a international consortium and conclude a long term contract which determines the rights and obligations of each organization.
- The contract term should be until the end of Legal durable years of facilities.

Ministry of the Environment, Government of Japan (MOEJ)

Application& Report

Subsidy

International Consortium

Long term contract

YPC
Green Pacific

- Project review, support PAT
- Applying for JCM funding program
- MRV（Calculating CO2 reduction effect and reporting to MOEJ）

Project Implementation & Report

Payment of Subsidies

PAT

- Introduction, operation, maintenance of facilities（It is necessary that PAT continue to operate facilities during legal durable years）
- Monitoring CO2 reduction effect（Submission report of operating status to YPC）

Delivery of Equipment, Construction etc.

Payment

Supplier

Interim Report on the F/S

Overview of the Feasibility Study (F/S)

The F/S aims to support PAT's environmentally friendly initiative, conducted as an entrusted project from Ministry of the Environment, Government of Japan (MOEJ).

Overview

- Based on the partnership between PAT and City of Yokohama.
- Investigate the feasibility of the projects for JCM funding program by studying project costs, CO2 reduction, etc.
- Utilizing YPC's experience of reducing carbon emissions at the Port of Yokohama.
- The first JCM project applied to the port and harbor sector in the world.

Outline of the F/S

1) Participants
- Yokohama Port Corp. (YPC)
- Green Pacific Co., LTD. (GP)
- Overseas Environmental Cooperation Center (OECC)

2) Period of Activities
- From Oct 6, 2016 to Mar 10, 2017

3) Cost of the F/S
- Funded by MOEJ (and YPC & GP)

- ✓ MOEJ adopts this F/S as their official study because MOEJ believes this project will be feasible. Detailed study report is essential to apply for the JCM Funding Project.
- ✓ We are already in an advantageous position to apply for the JCM funding program in FY2017. MOEJ strongly expects us to apply in 2017. To take advantage of this opportunity, we should apply some projects for the JCM funding program in FY2017.
- ✓ We are truly grateful for your kind cooperation. Your continued supports will be highly appreciated.

On-going status of Phase 1 projects

Phase 1

Item	Application technologies and equipment, and cost reduction plan	Evaluation of business feasibility
(1)PV Panels on CFS roof in Bangkok port	・Discussing with a electronics manufacturer which has experience of PV introduction design and construction. ・It is possible to design the efficient whole system. ・Investigating utilization of foreign products for some components such as PV panel to reduce cost.	・We aim to form a JCM project with PV system, indoor LED, and electric fork lift as an integrated system. ・Plan to use electric forklift's battery as an emergency power supply will be discussed continuously. ・Projects regarding CFS Import has good possibility of JCM project realization. We continue to investigate for applying to JCM funding program. ・Since construction of CFS Import is expected to be started in 2018 or later, it is strongly recommended to apply for JCM funding program for CFS Export related projects in 2017.
(2)Indoor LED lightings in CFS in Bangkok port	・Discussing with a LED manufacturer which has a factory in Thailand. Visited the factory and inspected the Indoor LED lightings. ・Also investigating utilization of products of another LED manufacturer. which has a factory in Thailand to reduce cost,, as one of candidates.	
(3)Electric forklift for CFS in Bangkok port	・Discussing with a forklift sales company which has top class market share in Thailand.	
(4)Hybrid RTGs for CFS in Bangkok port	・Discussing with a RTG manufacturer. ・Performance of product satisfies JCM demand.	・Continue to study cost effectiveness.
(5)LED yard lightings for container yard in Bangkok port	・Discussing with a LED manufacturer which has a factory in Thailand. ・Visited the factory and inspected the LED Yard lightings.	・There is possibility to be applicable to JCM funding program with the result of estimation based on data from PAT. ・Estimated amount of subsidy is small as an individual JCM project. It is advisable to form a combined package with other projects.

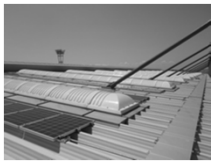
On-going status of Phase 2 projects

Phase 2

Item	Application technologies and equipment, and cost reduction plan	Evaluation of business feasibility
(6)LED road lightings in Laem Chabang Port	・Visited Laem Chabang Port and inspected road lightings. ・LED road lightings were partly introduced already. As the quantity of the rest is few, it seems possible to be introduced by PAT.	・Since PAT introduced at their own expense, it seems difficult to apply for JCM funding program
(7)Hybrid cargo handling equipment in Lat Krabang ICD	・Visited LICD and discussed with management body and operator of LICD.	・Since LICD is not operated by PAT, there is limit to apply for JCM funding program jointly with PAT
(8)High efficiency transformers to substations in BKK Port	・Collecting information of existing facilities from PAT. Various types of new and old electric facilities are existing but renewal plan has not been laid out so far. ・Terminal renewal has been planned but electric power demand of new terminal plan is not estimated.	・It is necessary to have more information from PAT such as the estimated electric power demand of new terminal plan etc. ・YPC and GP will study to apply for JCM funding program based upon further information from PAT
(9)Shore connection system	・Discussed with PAT regarding PAT's plan of Sox and CO2 reduction from vessels including not only shore connection but also LNG bunkering etc. ・Understand that PAT has not yet decided the plan as of today.	・Start discussion with PAT after confirmation of PAT's plan to comply with IMO regulations of SOx emissions in a general sea area (applicable in 2020)
(10)Hybrid tugboats	・Study to build in shipyard in Japan or in Thailand (with supplying hybrid power system from Japan).	・PAT asked about the possibility of conversion of existing tugboat to hybrid tug boat. After the investigation we found that it seems difficult to carry out conversion at the Japanese shipyard.

Installing PV panels on CFS roof (Project 1)

PV panels on the CFS in MC-1,2 terminal, Yokohama


Estimation with 3.4 MW PV panels (without top light)

CO2 reduction

43,200t-CO2 / 17years

Cost advantage

< Price of electricity > *rough estimation

electric power company	4.0THB/kWh
PV system (without JCM subsidy)	3.6THB/kWh
PV system with JCM subsidy (40% of investment being covered)	2.4THB/kWh

Saving of electricity cost will be:
7,247,000THB/1year
123,200,000THB/17years

Feasibility of JCM utilization

30%-40% of investment for PV system is expected to be covered by JCM subsidy.
In case of 40%, the amount of the subsidy will be **93,480,000THB**.

Indoor LED lightings in CFS (Project 2)

Temperature in CFS will be very high(40℃～50℃), which requires the installation of high quality lightings.



Estimation with 400 set of LED lightings for CFS import

CO2 reduction

2,335t-CO2/15years

Cost advantage

The total cost saving of running cost in 15 years will be approx. **18,370,000THB** considering maintenance and electricity cost etc.

Feasibility of JCM utilization

30%-40% of the initial cost for LED lighting is expected to be covered by JCM subsidy.
In case of 40%, the amount of the subsidy will be **7,200,000THB**.

Electric Forklift（Project 3）

CO2 reduction

10.84t-CO2/truck in 5years
(40trucks＝433.6t-CO2 in 5years)

Cost advantage

The total cost of Electric Forklift including running cost will be **544,300THB/truck lower** than diesel forklift (while the initial cost will be 82,900THB/truck higher even with JCM subsidy)

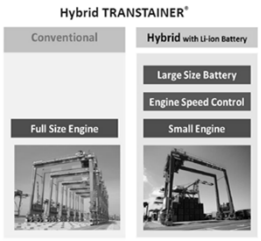
In case of 40 trucks, the total cost advantage will be **21,772,000THB**

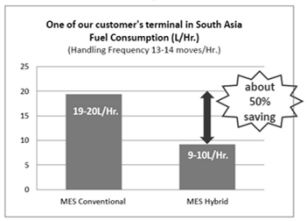
Feasibility of JCM utilization

Around 6% of the initial cost is expected to be covered by JCM subsidy
The amount of JCM subsidy will be approx. 62,100THB/truck
(In case of 40trucks : **approx. 2,484,000THB**）

Hybrid RTGs（Project 4）

Example of Hybrid RTG





Recent Delivery Records

More than 100 units delivered

Location	Q'ty	Delivery
Long Beach, USA	7	Oct., 2016
Tokyo, Japan	2	Jul., 2016
Osaka, Japan	2	Feb., 2016
Kobe, Japan	2	Feb., 2016
Kobe, Japan	1	Feb., 2016
Tanjung Priok, Indonesia	5	Feb., 2016
Los Angeles, USA	5	Mar., 2015
Mombasa, Kenya	4	Dec., 2015

CO2 reduction

790t-CO2/unit in 12years（×2 unit＝1,580t-CO2 in 12years）

Cost advantage

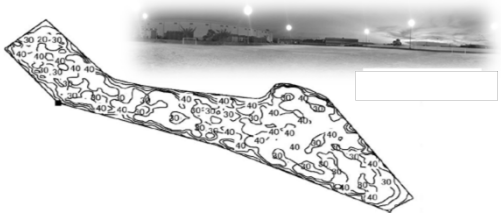
The total cost saving of running cost in 12 years will be approx. **15,679,000THB**

Feasibility of JCM utilization

Around 6% of the initial cost is expected to be covered by JCM subsidy
The amount of JCM subsidy per 1unit will be approx. 3,560,000THB
In case of 2unit, the total amount of the subsidy will be **7,120,000THB**

LED yard lightings（Project 5）

- YPC estimates the illuminance of LED yard lightings on east quay of Bangkok port based on the date provided by PAT.
- It is possible to keep 38lx of average illuminance and clear the PAT's reference illuminance by replacing the existing lightings with LED without changing the number of the lightings.



CO2 reduction

2,760t-CO2/15years

Cost advantage

The total cost saving of running cost in 15 years will be approx. **23,920,000THB** compared with ordinary lightings, considering maintenance cost and saving of electricity.

Feasibility of JCM utilization

30%-40% of the initial cost for LED lighting is expected to be covered by JCM subsidy
In case of 40%, the total amount of the subsidy will be **8,667,000THB**

Summary of the Projects (Project1-5)

	(1) PV on CFS	(2) LED lighting in CFS	(3)Electric Forklift	(4)Hybrid RTG	(5)LED yard lightings
Legal durable years	17years	15years	5years	12years	15years
Quantity	1 set	400 set	40 trucks	2 units	260 set
Initial cost	233,700,000 THB	18,000,000 THB	41,400,000 THB	118,650,000 THB	21,667,000 THB
JCM subsidy (C)	93,480,000 THB	7,200,000 THB	2,484,000 THB	7,119,000 THB	8,667,000 THB
CO2 reduction (B)	43,200*t-CO2* *(2541.1t-CO2/year)*	2,335*t-CO2* *(155t-CO2/year)*	433.6*t-CO2* *(86.7t-CO2/year)*	1,580*t-CO2* *(131.6t-CO2/year)*	2,760*t-CO2* *(184t-CO2/year)*
JCM cost effectiveness (C)/(B)	2,164THB/*t-CO2*	3,083THB/*t-CO2*	5,729THB/*t-CO2*	4,506THB/*t-CO2*	3,140THB/*t-CO2*
Eligibility for JCM	**Good**	**Good**	Not eligible	Not eligible	**Good**
Eligibility for JCM as one package	**Good**	**Good**	**Good**	**Good**	**Good**
Profitability of running cost	123,200,000 THB	21,170,000 THB	25,088,000 THB	15,679,000 THB	23,920,000 THB
Overall evaluation	**Good**	**Good**	**Good**	**Good**	**Good**

FS Result Summary (Prospect of applying to JCM funding program)

- Combination of PV system, Indoor LED lightings and Electric Forklift of CFS Import have high cost effectiveness and high possibility to be applicable to JCM funding Program.
- As the design of CFS Export is already finished, PAT does not have a plan to apply for JCM project which requires minor design change.
- The cost effectiveness of Hybrid RTG for CFS is lower and the amount of subsidy is limited.
- LED Yard Lighting have high cost effectiveness, but the project scale is small. It is necessary to combine with the other projects.

CFS Import


(1)PV panel


(2)Indoor LED lightings


(3)Electric fork lift


(4)Hybrid RTG


(5)LED yard Lighting

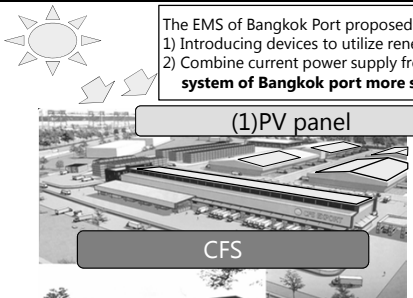
→There is good opportunity for PAT to proceed "Green Port Project" by utilizing JCM funding.
Regarding CFS Import, we would like to proceed study for applying JCM funding program with PAT.
・The scale of (1)PV should be "Mega watt class" when we consider the scale for applying JCM funding program.

(Point to be noticed)Applying JCM funding program for CFS Import will be in 2018 or later

- Since MOEJ strongly expect us to apply for the JCM Funding Program in 2017, they adopted this F/S. There is a risk that MOEJ lowered the priority for our project if we will not apply any project in 2017. It is strongly recommended to apply some projects in 2017

JCM project formation plan (Energy Management System in BKK Port)

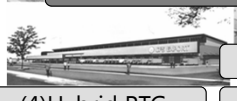
The EMS of Bangkok Port proposed by YPC aims to realize **sustainable port management** by the following measures.
1) Introducing devices to utilize renewable energy(PV) and energy-saving equipment such as LED lightings.
2) Combine current power supply from electric company, existing generator with renewable energy for **making electric system of Bangkok port more stable with lower cost and less CO2 emission.**


(1)PV panel
CFS

Power supply from MEA

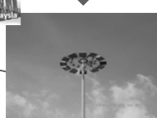

Substation


Generator

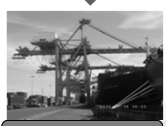

(2)Indoor LED

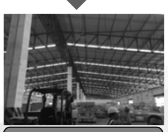
(4)Hybrid RTG

(3) Electric forklift


(5)Yard LED lightings


Reefer


Quay crane


Warehouse

Other facilities

Estimation of JCM projects of CFS Import (case1：maximum PV panels)

CFS import (case1)	(1) PV on CFS	(2) LED lighting in CFS	(3)Electric forklift
Legal durable years	17years	15years	5years
Quantity	3.43MW	400set	40trucks
Initial cost	233,700,000THB	18,000,000THB	41,400,000THB
		293,100,000THB	
JCM subsidy(C)		**40%**	
		117,240,000THB	
Energy-saving effect（B）	43,200t-co2	2,335t-co2	434t-co2
		45,969t-co2	
JCM cost effectiveness (C)/(B)		2,550THB/t-co2	
Eligibility for JCM		**Good**	

※Cost for PV panels is estimated as 67 mil THB /1MW
※Modification cost of Power Receiving Facility for grid connection is included

Estimation of JCM project of CFS Import (case3：minimum PV panels)

CFS import (case3)	(1) PV on CFS	(2) LED lighting in CFS	(3)Electric forklift
Legal durable years	17years	15years	5years
Quantity	0.50MW	400set	40trucks
Initial cost	38,400,000THB	18,000,000THB	41,400,000THB
		97,800,000THB	
JCM subsidy(C)		**40%**	
		39,120,000THB	
Energy-saving effect（B）	6,297t-co2	2,335t-co2	434t-co2
		9,066t-co2	
JCM cost effectiveness (C)/(B)		4,315THB/t-co2	
Eligibility for JCM		**Not eligible**	

It would be eligible with PV panels of 1.1 MW

※Cost for PV panels is estimated as 67 mil THB /1MW
※Modification cost of Power Receiving Facility for grid connection is included

Our proposal

Proposal for applying to JCM Funding Program

・The CFS Import projects are promising. However there may be risk in applying in 2018 or later.

・Since MOEJ strongly expect us to apply in 2017. There is a risk that MOEJ lower the priority for our project if we do not apply any project in 2017.

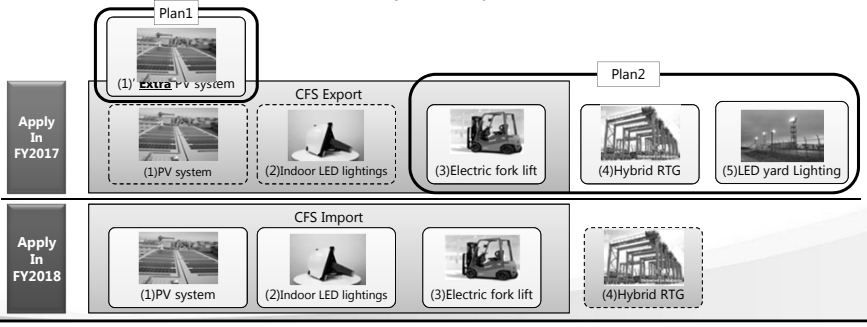
<Proposal>

- To pave the way to apply JCM in 2018 with larger scale projects of CFS Import (project(1)(2)(3)) with this advantageous position, we should apply in 2017 with some projects of the followings as the leading project.

  <Plan 1> Installation of Extra PV panels on CFS Export of a certain scale

  <Plan 2> Combination of (3)Electric Forklift, (4)Hybrid RTG, (5)LED yard lightings

- YPC appeals to MOEJ to adopt as a JCM project in any case.



Proposal for JCM application in 2017

<Plan 1> Installation of extra PV panel on CFS Export

Planned

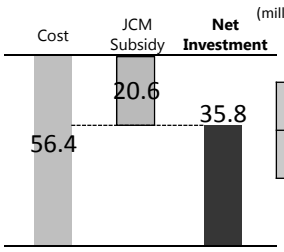
PV panel (0.02MW)

Not applicable for JCM

Extra

PV panel (0.77MW)

Applicable for JCM



Reduction of CO2	9,698t/17years
Cost saving	25.9 mil THB

<Plan 2> Combination of (3)Electric Forklift, (4)Hybrid RTG and (5)Yard LED lighting

Planned

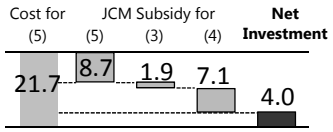
(3) Electric forklift

Planned

(4) Hybrid RTG

Extra

(5) LED yard Lighting



PAT can gain these benefits by investment of 4.0 mil THB

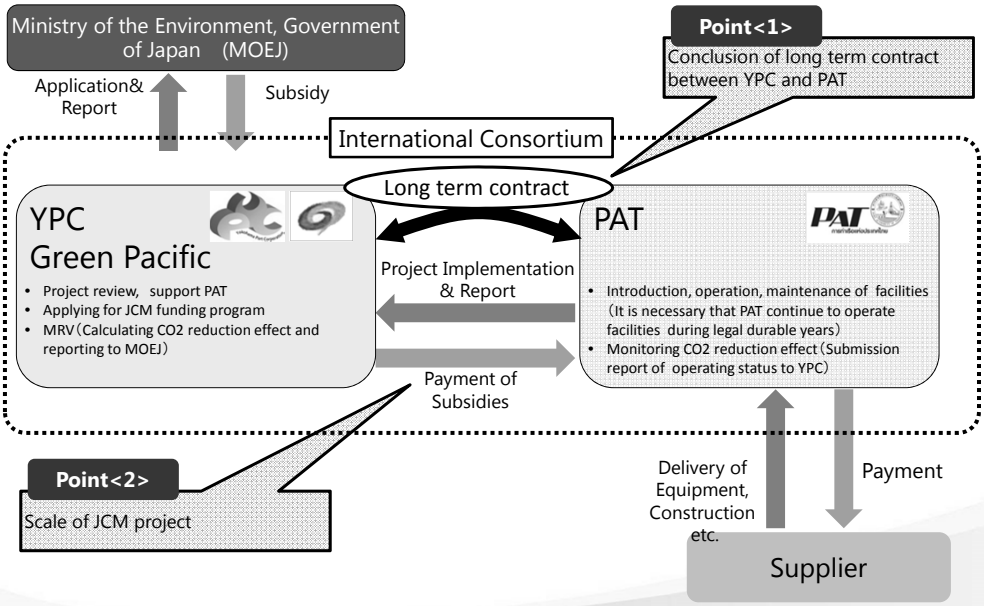
Reduction of CO2	4,665t *
Cost saving	27.2 mil THB*

*Total of the 3 facilities based on their legal durable years

Applicability is subject to the judgement of MOEJ

Points for JCM application

3 Important points for JCM application



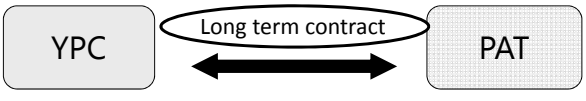
Important Point<1>Conclusion of long term contract between PAT and YPC

PAT is responsible for operating the facilities and conducting monitoring CO2 emissions for legal durable years of the facilities as stipulated by the Japanese law. (for example, 17 years for PV panels)
In case of deliberate failure of the project which is attributable to YPC and PAT, excluding force majeure such as natural disasters, MOEJ may request to return the subsidy.

It is necessary that the contract between YPC and PAT specifies how to deal with the events mentioned above. The contract shall remain in effect during legal durable years of the facilities

Kindly examine to conclude the long tem contract

Major contents of long-term contract between YPC and PAT



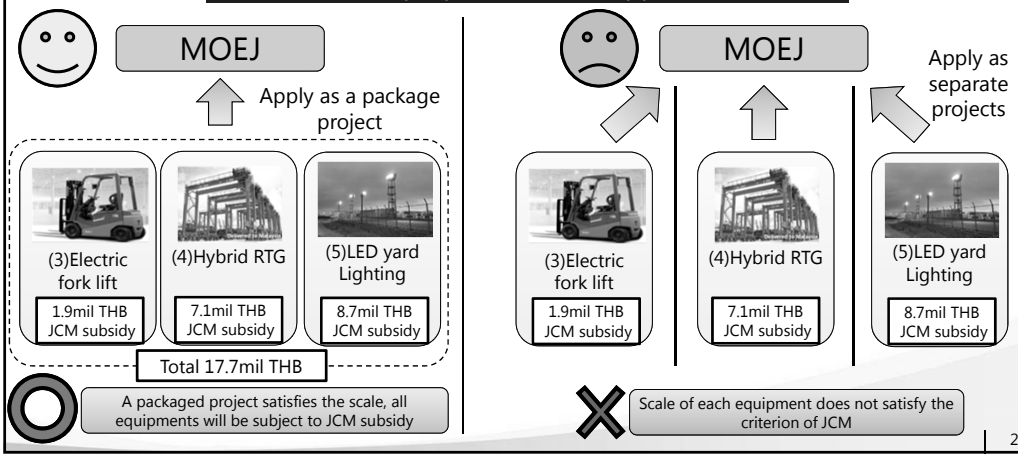
- Conducting monitoring CO2 emissions for legal durable years of the facilities
- Procedure in case of returning the subsidy to MOEJ （PAT→YPC→MOEJ）
- Conditions regarding various cost sharing

Example of Legal durable years
(1) PV system / 17 years
(2) LED lightings / 15 years
(3) Electric fork lift / 5 years
(4) Hybrid RTGs / 12 years

Important Point<2> Scale of JCM projects

- A certain scale of project is required to be adopted as JCM project （Minimum subsidy amount is approx. 17mil THB）
- We should apply with the other projects as one package, if it is difficult to satisfy the aiming amount with only one project.

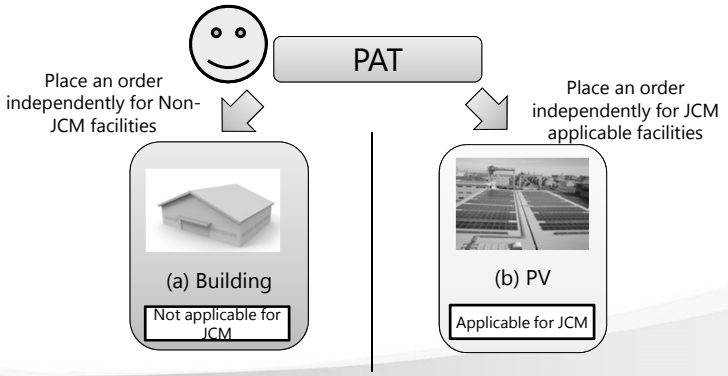
Case: <Plan 2> proposal for JCM application in 2017



Important Point<2> Scale of JCM projects

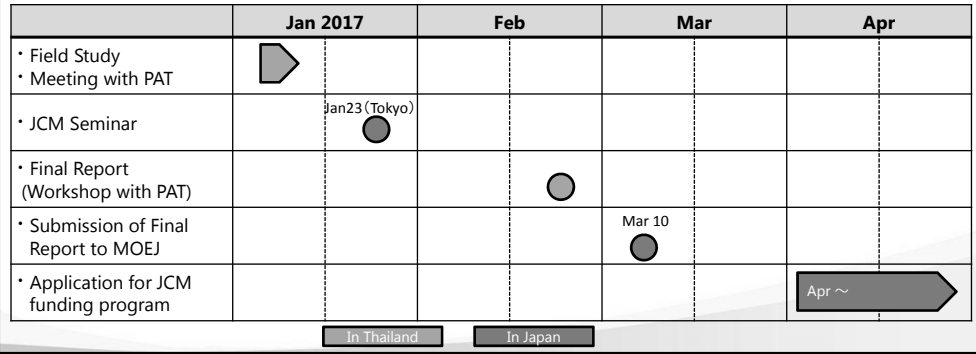
- It is necessary to calculate cost of JCM-applicable facilities for submitting JCM application
- It is requested to place orders for JCM applicable facilities separately from other facilities

<Good example> Place an order respectively for (a) and (b)



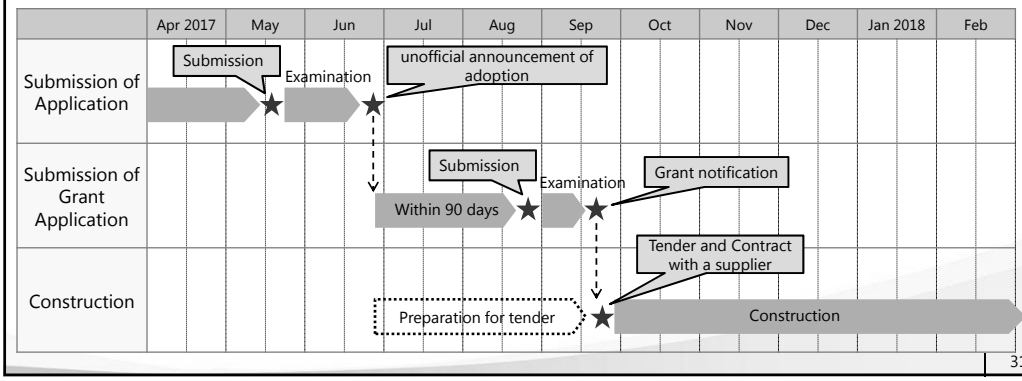
Schedule for the F/S

- On-going Feasibility Study
  - Workshop with PAT in late February for final report
  - Submit final report to MOEJ by 10th March 2017
- Application for JCM funding program
  - 1st application（April ～ early in May, 2017）
  - 2nd application（September ～ early in December, 2017）
    * 2nd application may not be called due to shortage of budget



Tentative Schedule of the 1st application for JCM funding program in FY 2017

- Submit JCM application in May
- Submit Grant Application within 90 days after unofficial announcement of adoption
- Tender shall be called after Grant notification
  - Contract with a supplier can not be made before grant notification by the regulation of JCM funding program



Others

Seminar on JCM City-to-City Collaboration Projects in Jan 2017

- Seminar on JCM City-to-City Collaboration Projects will be held on January 23rd in Tokyo.
- Your attendance would be highly appreciated and important to promote the JCM projects.
- We would like to invite you to visit YPC and Yokohama Port on January 24th for a meeting and site visit.

Date		Agenda	Venue
Jan 22nd (Sun)		Travel day	Tokyo
Jan 23rd (Mon)	AM	Closed Workshop **PART I: Progress Report Presentation (Break-out session)** PART II: Financial Support Schemes	Tokyo
	PM	Open Seminar: **PART I: Presentation by Cities Participation in JCM F/S through City-to-City Collaboration** PART II: Panel Discussion	
Jan 24th (Tue)	AM	Meeting with YPC and CoY	Yokohama
	PM	Site visit to Yokohama port (focus on environmentally friendly facilities)	
Jan 25th (Wed)		Travel day	-

Influence of the Paris Agreement on JCM

- Japanese Government is committed to continue to implement the JCM Funding Program
  - Mr. Yamamoto, Minister of MOEJ expressed that Japanese Government would further support the formation and implementation of the JCM
    - At the 4th JCM Partner Countries' High-level Meeting in Morocco in Nov. 2016
    - The meeting had participants from 16 countries
    - Mrs. Prasertsuk Chamornmarn, executive secretary of TGO participated in the meeting

  - We had a meeting with Embassy of Japan in Thailand in Nov. 2016
    - Japanese Government continue to implement the JCM Funding Program regardless of the progress of amendments to the bilateral document between the Thai and Japanese Governments, which has been discussed since the Paris Agreement came into effect.

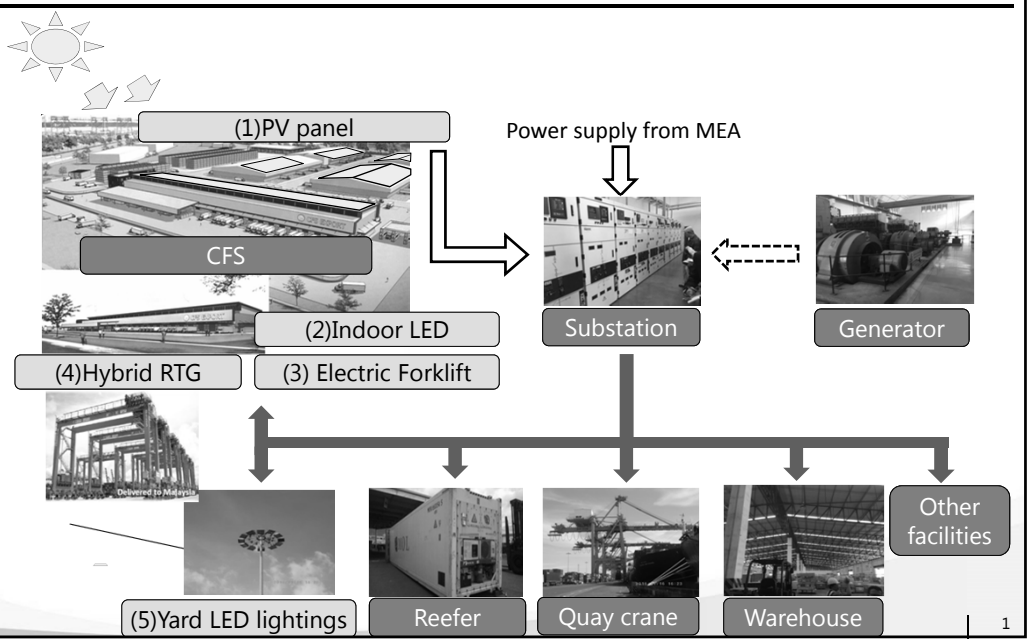
Document 2-4 Handout for PAT engineers at the 2nd meeting

Technical Document on Energy Management System in Bangkok Port

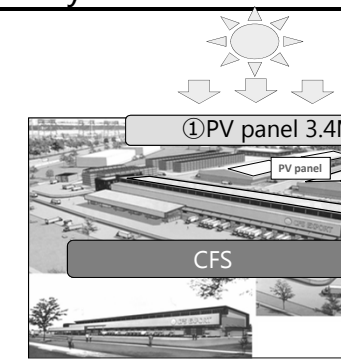
10th Jan. 2017
Yokohama Port Corporation
Green Pacific Co., Ltd.
Overseas Environmental Cooperation Center, Japan

横浜港埠頭株式会社 Yokohama Port Corporation
Green Pacific
一般社団法人海外環境協力センター Overseas Environmental Cooperation Center, Japan

JCM project formation plan (Energy Management System in BKK Port)



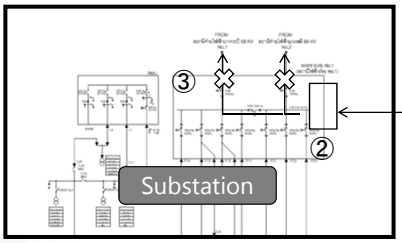
PV system



300V / 11kV
Power conditioner
(Required space is 12,470mm ×14,610mm)
It is desirable to install nearby CFS

Circuit Breaker

①

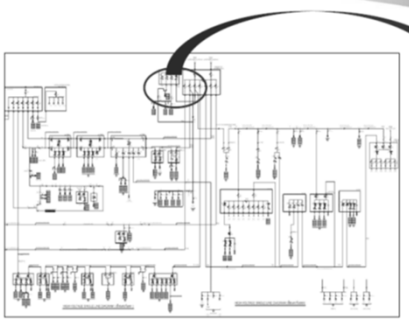


These facilities are necessary to connect electricity generated by PV panel to grid of Bangkok port.
①Laying electrical pipelines
②Installation of feeder panel
③Installation of UP relay(to avoid reverse power from PV to MEA grid because it might be a cause of electrical shock accident and worsening quality of MEA grid)

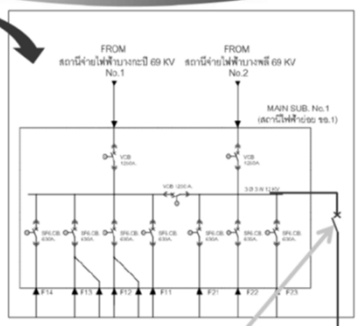
Contents

Interconnecting Point of PV system

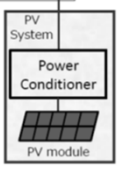
1. Interconnecting Point of PV System



Existing Single Line Diagram



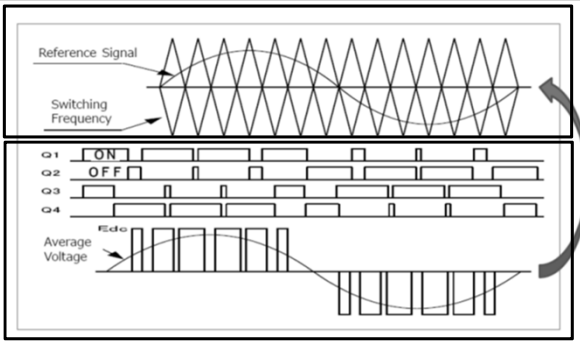
Modification point : 11kV Feeder
※add on a 11kV Feeder



The Grid interconnection principle

2. The Grid Interconnection Principle

The output voltage and frequency of the power conditioning system(PCS) shall be synchronized with the power grid at the time of interconnection.
With this synchronization, we can avoid any trouble / damage on the AC electricity facilities in the premises, caused by over current and over voltage.



Grid of Bangkok Port

Synchronism

Power conditioning System(PCS) in PV system

The grid interconnection protection

3. The Grid Interconnection Protection

When abnormalities occur in the system side or the AC Electric Facilities in the premises, they will be detected by the following protective relays according to the relevant standard such as IEC.

	Description	Detective condition	Trip CB
OC	Over Current	Internal short circuit	Incoming Circuit Breaker
OCG	Ground Over Current	Internal ground fault	Incoming Circuit Breaker
UP	Under Power	Islanding operation (Individual operation)	Feeder Circuit Breaker
OV	Over Voltage	Inverter protection	PCS
UV	Under Voltage	Inverter protection/ Short circuit of the Grid	PCS
OF	Over Frequency	Islanding operation (Individual operation)	PCS
UF	Under Frequency	Islanding operation (Individual operation)	PCS

The function of the PCS protection

4. The Function of the PCS Protection

When abnormalities in the DC side or malfunction of PCS are detected based on the following detective conditions, PCS will be stopped to avoid any damage.

	Detective condition
Inverter Error	The error signal of the inverter unit
Temperature rise in enclosure	The temperature rise inside the enclosure is over 60℃
DC Over Voltage	DC over voltage
MCCB trip	AC or DC MCCB opened by over current
DC Short Circuit	DC short circuit (The PCS state is stop or standby only)
Synchronized Communication Error	Non synchronized communication between the master PCS and the other slaves
Power Source Error	The error signal of the power source board
DC Ground fault	DC grounding fault
Phase Rotation Error	Phase rotation error
MCTT Error	Electromagnetic contactor error

Hybrid tugboat

• Hybrid tugboat without Lithium-ion battery

① A diesel-diesel electric hybrid harbor tugboat. Non-battery type.
② Hybrid Tug “Ginga” delivered in 2013

Builder : Kanagawa Shipbuilding Co., Ltd
Owner : Tokyo Kisen Co., Ltd
Hybrid System : Niigata Power System Co., Ltd

③ The feature of Hybrid tugboat without Lithium-ion battery

・Equipped with the diesel main engine and the high-efficiency electric propulsion system.

・This combination is suitable for an environmental performance. (Using different modes depending on navigation speed and bollard power.)

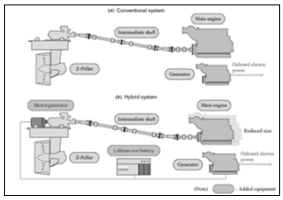
Merits	Demerits
・Smaller hull ・Less expensive price ・Matured technology ・Easier for shipbuilder to construct	・More fuel consumption ・Less CO_2 reduction

• Hybrid tugboat with Lithium-ion battery

① The hybrid tug driven by diesel and electric motor. With the Lithium-ion battery
② Hybrid Tug “Tsubasa” delivered in 2013

Builder : Keihin Dock Co., Ltd
Owner : Wing Maritime Service Company
Hybrid System : Niigata Power System Co., Ltd

③ The feature of Hybrid tugboat with Lithium-ion battery



Merits	Demerits
・Less fuel consumption ・More CO_2 reduction ・Good PR effect	・Bigger hull ・Higher price ・There is possibility that advanced version of Lithium-ion battery will be developed.

Document 2-6 Presentation to the Director of PAT at the 3rd meeting with PAT

JCM Feasibility Study by YPC, GP and OECC in cooperation with PAT

based on the partnership between PAT and City of Yokohama

Full Report

20th Feb. 2017
Yokohama Port Corporation (YPC)
Green Pacific Co., Ltd. (GP)
Overseas Environmental Cooperation Center, Japan (OECC)

横浜港埠頭株式会社 Yokohama Port Corporation
Green Pacific
一般社団法人海外環境協力センター Overseas Environmental Cooperation Center, Japan

Contents

1 Introduction

Outline of the initiative

- Our collaboration has been developed based on the partnership between BMA, PAT and the City of Yokohama (CoY).

Bangkok Metropolitan Administration (BMA) and **CoY**
- "Memorandum of Understanding on Technical Cooperation on Sustainable Urban Development" (2013).

PAT and **CoY**
- "Memorandum of Understanding" for partnership (2014)
- "Letter of Intent of the Implementation of the MOU" (2015)

- To support PAT's "**Green Port Project**", the CoY and YPC have suggested to PAT to utilize JCM funding program provided by the Japanese government, and YPC and PAT have been studying the program since 2015.
- YPC utilizes its knowledge and experiences about carbon reduction gained through environmentally friendly measures introduced at the Yokohama Port.

Advantages for PAT by utilizing JCM Funding Program
- Can introduce **highly efficient and reliable** low carbon equipment at **reasonable cost.**
- Will make progress toward achieving the goal of the Green Port Project.

JCM (Joint Crediting Mechanism) by Ministry of the Environment, Japan

JCM Funding Program: JCM Model Projects by MOEJ

The draft budget for projects starting from FY 2016 is 6.7 billion JPY (approx. USD 63 million) in total by FY2018

※Budget will be fixed after approval by the Parliament

Government of Japan

Finance part of an investment cost (**less than half**)

Conduct MRV and expected to deliver at least half of JCM credits issued

International consortiums (which include Japanese entities)

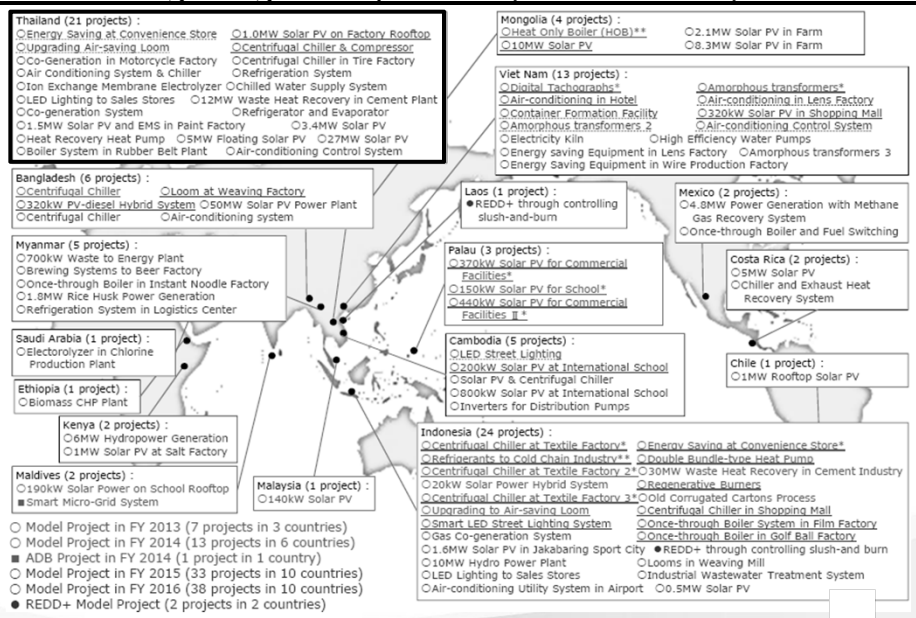
Funded facilities must be used continuously for the period of legal durable years.
Otherwise MOEJ may request to reimburse the given grant.

Source: Recent Development of the JCM, Feb. 2016, Government of Japan

- Scope of the financing: facilities, equipment, vehicles, etc. which reduce CO_2 from fossil fuel combustion as well as construction cost for installing those facilities, etc.
- Eligible Projects : starting installation after the adoption of the financing and finishing installation within three years.

*MRV: Measurement, Reporting and Verification

JCM Funding Program by MOEJ (FY2013-2016) as of 13 January, 2017



Source: "Recent Development of the JCM", January. 2017, Government of Japan

JCM Funding Program by MOEJ (FY2013-2016)

7 projects in Thailand were adopted for JCM funding program in FY2015, 14 projects in FY2016.

Thailand (21 projects) :

○Energy Saving at Convenience Store	○1.0MW Solar PV on Factory Rooftop
○Upgrading Air-saving Loom	○Centrifugal Chiller & Compressor
○Co-Generation in Motorcycle Factory	○Centrifugal Chiller in Tire Factory
○Air Conditioning System & Chiller	○Refrigeration System
○Ion Exchange Membrane Electrolyzer	○Chilled Water Supply System
○LED Lighting to Sales Stores	○12MW Waste Heat Recovery in Cement Plant
○Co-generation System	○Refrigerator and Evaporator
○1.5MW Solar PV and EMS in Paint Factory	○3.4MW Solar PV
○Heat Recovery Heat Pump	○5MW Floating Solar PV ○27MW Solar PV
○Boiler System in Rubber Belt Plant	○Air-conditioning Control System

Red: FY 2015
Purple: FY 2016

Source: "Recent Development of the JCM", January. 2017, Government of Japan

Overview of the JCM Feasibility Study (F/S)

Our JCM F/S is an entrusted study from Ministry of the Environment, Government of Japan (MOEJ).
This is the 1st JCM F/S in port sector in the world.

Outline

- Investigate the feasibility of projects for JCM funding program by studying project costs, CO2 reduction, etc.
- Examine mainly the Japanese advanced environmentally friendly technologies and products which have been verified by YPC at Yokohama Port.

Participants
- Yokohama Port Corporation (YPC)
- Green Pacific Co., LTD (GP)
- Overseas Environmental Cooperation Center (OECC)

Period
- From 6 Oct 2016 to 10 Mar 2017

Cost
- Funded by MOEJ (and YPC & GP)

- MOEJ adopts this F/S as their official study because MOEJ believes this project will be feasible. Detailed study report is essential to apply for the JCM Funding Project.
- We are already in an advantageous position to apply for the JCM funding program in FY2017. MOEJ strongly expects us to apply in 2017. To take advantage of this opportunity, it is advisable to apply some projects for the JCM funding program in FY2017.
- We are truly grateful for your kind cooperation. Your continued supports is highly appreciated.

History of study by YCP and PAT on JCM

Oct. 2015	YPC and the CoY visited PAT • Proposed utilization of JCM funding program to PAT
Jul. 2016	YPC and the CoY visited PAT • Visited Bangkok Port and LC Port for pre-study
Sep. 2016	Ministry of the Environment, Government of Japan (MOEJ) adopted our F/S as their official survey. <Purpose of the F/S > • Investigate the feasibility of projects for JCM funding program by studying project costs, CO2 reduction, etc. • Examine mainly the Japanese advanced environmentally friendly technologies and products which have been verified by YPC at Yokohama Port.
Nov. 2016	YPC GP and CoY implemented the 1st field study in Thailand • Proposed JCM projects (Phase 1 and 2)
Jan. 2017	YPC and GP implemented the 2nd field study in Thailand • Visited Bangkok Port and discussed with PAT PAT attended JCM seminar in Japan held by MOEJ • Mr. Komol and Mr Phatthawut from BKP attended PAT visited the JCM project site in Thailand with YPC • Visited PV power generation facility at Siam Steel International

PAT's visit to JCM Project site in Thailand

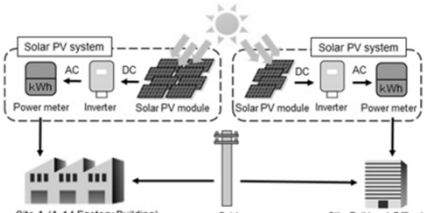
PP(Japan) : Pacific Consultants Co., Ltd., InterAct Inc. / PP(Thailand) : Siam Steel International Public Company Limited

Started operation in 2016
(Adopted by MOEJ in 2015)

Site Visit by PAT on 31 Jan 2017

O Outline of GHG Mitigation Activity

The project aims to reduce CO2 emissions by introducing solar photovoltaic (PV) systems at a factory complex manufacturing steel products and furniture in Samutprakarn, Thailand.
A grid-connected solar PV system will be installed on rooftops of the A-14 Factory Building (Site A: 837kW) and Head Office (Site B: 157kW). The total installed capacity will be 994kW.
All of the generated power will be consumed within the factory complex. The project will be a model case utilizing factory roof space and high-efficiency PV modules for self-consumption.



O Expected GHG Emission Reductions

776 tCO2/ year

CO2 emission factor: 0.5554 (tCO2/MWh)
Project emissions are assumed to be zero.
Reference emission - Project emission = 776 – 0 = 776

Site	Generation of electricity	CO2 emission reductions
A	1,176 (MWh/year)	653.2 (tCO2/year)
B	220.6 (MWh/year)	122.5 (tCO2/year)
合計	1,397 (MWh/year)	775.7 (tCO2/year)

O Sites of JCM Model Project

Source:GEC Website(http://gec.jp/jcm/projects/15pro_tha_02.html)

2 Report on result of the F/S

Outline of the F/S

PAT's "Green Port Project" Term (2015 ~ 2019)

Scope of the feasibility study

Phase 1 (2015~2019)

Bangkok Port

1) **PV Panels** on CFS roof
2) **Indoor LED Lighting** in CFS
3) **Electric Forklift** in CFS
4) **Hybrid RTG**
5) **LED Yard Lighting** for container yard

Phase 2 (2020~2024)

Bangkok Port and Laem Chabang Port

6) **LED Road Lighting** in LC Port
7) **Hybrid cargo handling equipment** in Lat Krabang ICD
8) **High efficiency transformer** to substations in BKK Port
9) **Shore connection system** in BKK and LC Port
10) **Hybrid tugboat**

Phase 3 (2025~2029)

Long term study for the future

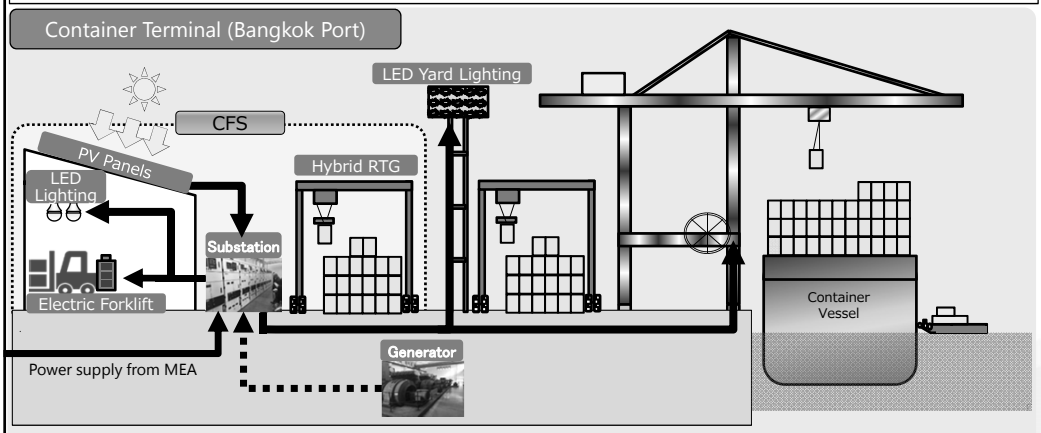
(e.g.)

- ✓ Carbon reduction at local ports under PAT control
- ✓ Reducing carbon through cooperation with terminal operators of LC Port
- ✓ Introduction of hydrogen technology




JCM Projects of the 1st Phase

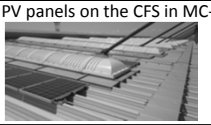
- The 1st Phase Projects are focused on Bangkok Port, in line with the CFS construction plan.
- We consider these projects have good feasibility for applying to JCM funding program.
- With implementation of these projects we aim to **make energy system of Bangkok port more stable with lower cost and less CO2 emission.**

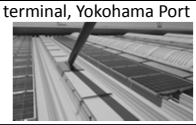


Installing PV panels on CFS roof (Project 1)

Estimated figure

PV panels on the CFS in MC-1,2 terminal, Yokohama Port





Estimation on PV panels on CFS Export and Import with toplight

		CFS Export	CFS Import
Capacity of PV system		0.77MW	2.57MW
CO2 reduction		9,786t-CO2 / 17years	32,663t-CO2 / 17years
Cost saving	Electric power company	4.7THB/kWh	4.4THB/kWh
	PV system with JCM subsidy	3.5THB/kWh	3.3THB/kWh
Feasibility of JCM utilization		30% of initial investment is expected to be covered by JCM subsidy. The amount of the subsidy will be **20,700,000THB**.	30% of initial investment is expected to be covered by JCM subsidy. The amount of the subsidy will be **64,200,000THB**.

Indoor LED lighting in CFS (Project 2)

Estimated figure

Temperature in CFS will be very high(40℃～50℃), which requires the installation of high quality lightings.



Estimation on LED lightings for CFS Export and Import

	CFS Export	CFS Import
CO2 reduction	Not applicable	2,335t-CO2/15years
Cost saving		The total saving of running cost in 15 years will be approx. **17,100,000THB,** considering maintenance and electricity cost etc.
Feasibility of JCM utilization		30%-40% of the initial cost for LED lighting is expected to be covered by JCM subsidy. In case of 40%, the amount of the subsidy will be **3,730,000THB**.

Electric Forklift（Project 3）

Estimated figure

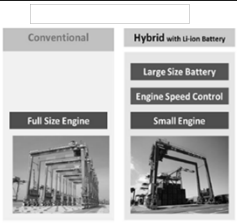
Estimation on Forklifts for CFS Export and Import

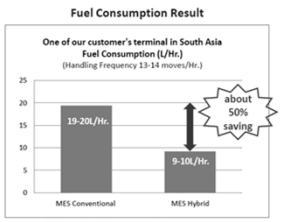
	CFS Export	CFS Import
CO2 reduction	3,579t-CO2 in 5years (59trucks)	10,074t-CO2 in 5years (126trucks)
Cost saving	In case of 59 trucks, the total cost advantage will be **51,490,000THB**	In case of 126 trucks, the total cost advantage will be **92,770,000THB**
Feasibility of JCM utilization	Around 20% of the initial cost is expected to be covered by JCM subsidy. In case of 59 trucks, The amount of JCM subsidy will be **approx. 8,300,000THB**	Around 20% of the initial cost is expected to be covered by JCM subsidy. In case of 126 trucks, The amount of JCM subsidy will be **approx. 25,950,000THB**

Hybrid RTG（Project 4）

Estimated figure

Estimation on Hybrid RTG for CFS Export and Import





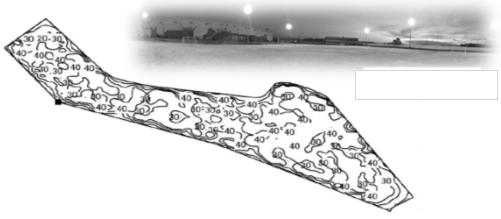
	CFS Export	CFS Import
CO2 reduction	4,475t-CO2 in 12years (2 units)	8,950t-CO2 in 12years (4 units)
Cost saving	The total saving of running cost in 12 years will be approx. **48,900,000THB**	The total saving of running cost in 12 years will be approx. **97,800,000THB**
Feasibility of JCM utilization	Around 10% of the initial cost is expected to be covered by JCM subsidy In case of 2unit, the total amount of the subsidy will be **11,570,000THB**	Around 10% of the initial cost is expected to be covered by JCM subsidy In case of 4unit, the total amount of the subsidy will be **23,140,000THB**

16

LED yard lightings（Project 5）

Estimated figure

- YPC estimates the illuminance of LED yard lightings on east quay of Bangkok port based on the date provided by PAT.
- It is possible to keep 38lx of average illuminance and clear the PAT's reference illuminance by replacing the existing lightings with LED without changing the number of the lightings.



CO2 reduction

4,029t-CO2/15years

Cost advantage

The total saving of running cost in 15 years will be approx. **22,540,000THB** compared with ordinary lightings, considering maintenance cost and saving of electricity.

Feasibility of JCM utilization

30%-40% of the initial cost for LED lighting is expected to be covered by JCM subsidy
In case of 40%, the total amount of the subsidy will be **6,650,000THB**

17

F/S Result Summary (Prospect of applying to JCM funding program)

Phase 1	• CFS-related projects such as **1)PV system, 2)Indoor LED lightings, 3)Electric Forklift and 4)Hybrid RTG) have good cost effectiveness and high possibility** to be applicable for JCM funding Program, subject to MOEJ's judgement. • LED Yard Lighting have high cost effectiveness, but the project scale is relatively small. Therefore it is necessary to combine with the other projects.

CFS Export and Import


1) PV panel


2) Indoor LED Lightings


3) Electric fork lift


4) Hybrid RTG


5) LED Yard Lightings

- These 5 projects have good applicability for JCM, however there is a risk that MOEJ may lower its priority for these projects if we do not apply any project in 2017.
- Therefore it is strongly recommended to apply CFS Export projects for JCM Funding program in 2017 at first, then CFS Import in 2018.

Phase 2	• Further study based on additional information would be necessary to identify feasible projects for JCM funding program. • We would seek for the possibility of further study based on continued cooperation with PAT.

*Applicability is subject to judgement of MOEJ

Summary of the Projects for CFS Export & LED Yard Lighting

Estimated figure

	1) PV on CFS	3)Electric Forklift	4)Hybrid RTG	5)LED Yard lighting
Legal durable years	17years	5years	12years	15years
Quantity	1 set(0.77MW)	59 trucks	2 units	260 set
Initial cost	69,200,000 THB	41,530,000 THB	115,700,000 THB	16,640,000 THB
Percentage of Subsidy	30% (~40%)	20%	10%	40% (~50%)
JCM subsidy (C)	20,700,000 THB	8,300,000 THB	11,570,000 THB	6,650,000 THB
CO2 reduction (B)	9,786*t-CO2* *(575.6t-CO2/year)*	3,579*t-CO2* *(715.8t-CO2/year)*	4,475*t-CO2* *(372.9-CO2/year)*	4,029*t-CO2* *(268.6t-CO2/year)*
JCM cost effectiveness (C)/(B)	2,121THB/*t-CO2*	2,320THB/*t-CO2*	2,585THB/*t-CO2*	1,652THB/*t-CO2*
Eligibility for JCM	**Good**	**Good**	**Good**	**Good**
Profitability of running cost	8,640,000 THB	51,490,000 THB	48,900,000 THB	22,540,000 THB
Overall evaluation	**Good**	**Good**	**Good**	**Good**

*Applicability is subject to judgement of MOEJ

Summary of the Projects for CFS Import

Estimated figure

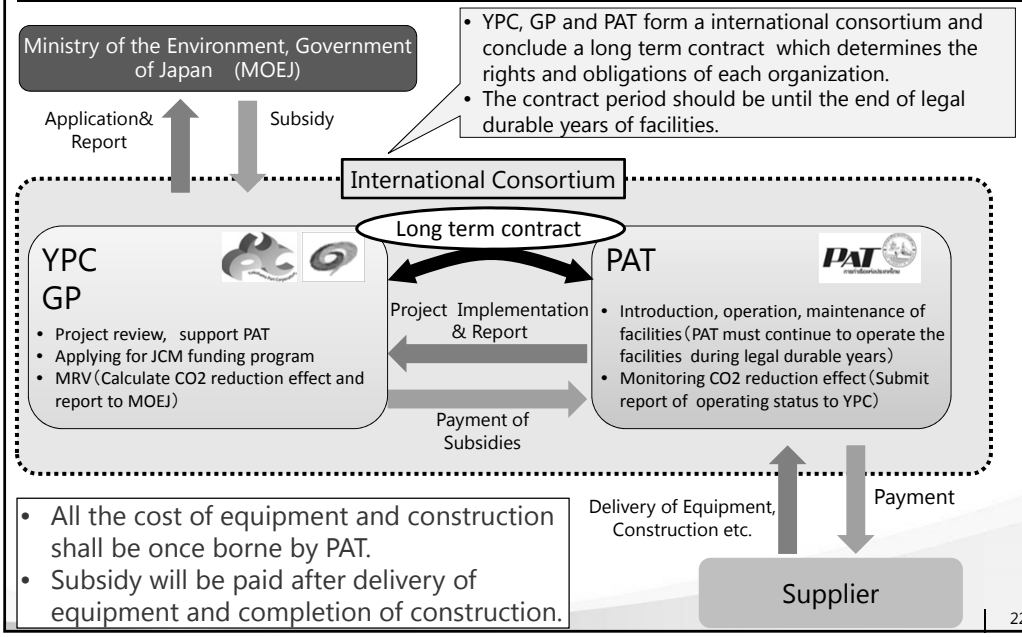
	1) PV on CFS	2) LED lighting in CFS	3)Electric Forklift	4)Hybrid RTG
Legal durable years	17years	15years	5years	12years
Quantity	1 set(2.57MW)	400 set	126 trucks	4 units
Initial cost	214,200,000 THB	9,340,000 THB	130,000,000 THB	231,400,000 THB
Percentage of Subsidy	30%	40%	20%	10%
JCM subsidy (C)	64,200,000 THB	3,730,000 THB	25,950,000 THB	23,140,000 THB
CO2 reduction (B)	32,663*t-CO2* *(1,921.3t-CO2/year)*	2,335*t-CO2* *(155t-CO2/year)*	10,074*t-CO2* *(2,014.8t-CO2/year)*	8,950*t-CO2* *(745.8-CO2/year)*
JCM cost effectiveness (C)/(B)	1,967THB/*t-CO2*	1,599THB/*t-CO2*	2,576THB/*t-CO2*	2,585THB/*t-CO2*
Eligibility for JCM	Good	Good	Good	Good
Profitability of running cost	40,380,000 THB	17,100,000 THB	92,770,000 THB	97,800,000 THB
Overall evaluation	Good	Good	Good	Good

*Applicability is subject to judgement of MOEJ

Result of the study on each project

	Project	Result of the study
Phase 1	1) PV panels on CFS roof	• PV panels and Indoor LED lightings have good possibility of JCM project realization. • Performance of Electric Forklifts and Hybrid RTG seem to satisfy JCM requirements. Further study for cost effectiveness would be necessary. • It is advisable to form an integrated JCM project by combining these CFS-related projects.
	2) Indoor LED lighting in CFS	
	3) Electric Forklift in CFS	
	4) Hybrid RTG	
	5) LED yard lighting for container yard	• This project has good possibility for applying to JCM funding program.
Phase 2	6) LED Road Lighting in LC Port	・Some LED road lightings already introduced.
	7) Hybrid cargo handling equipment in Lat Krabang ICD	• Will Seek for the possibility of application to JCM funding program through discussion with an operator and SRT with an advice of PAT.
	8) High efficiency transformer to substations in BKK Port	・It is necessary to have more information from PAT such as the estimated electric power demand based on new terminal plan etc. ・YPC and GP will study to apply for JCM funding program based upon further information from PAT.
	9) Shore connection system	・Will start discussion with PAT after confirmation of PAT's plan to comply with IMO regulations of SOx emissions in a general sea area (applicable in 2020) .
	10) Hybrid tugboat	・Studied PAT's tugboat operation and plan to build new tugboats. ・Seeking possibility to introduce hybrid tugboat.

Role of YPC and PAT in JCM project



- All the cost of equipment and construction shall be once borne by PAT.
- Subsidy will be paid after delivery of equipment and completion of construction.

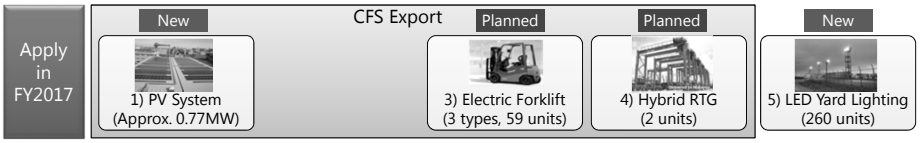
3 Proposal by YPC

Proposal for applying for JCM Funding Program

・Based on the discussion with PAT so far, we would like to propose to apply for JCM funding program with the following steps;
(1) In FY 2017, apply for JCM with **CFS Export** projects and **LED Yard Lighting**
(2) In FY 2018, apply for JCM with **CFS Import** projects

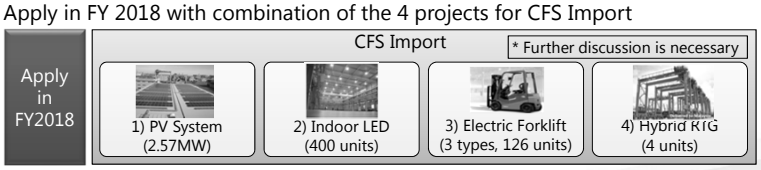
<Proposal>

(1) Apply in FY 2017 with combination of the 3 projects for CFS Export and LED Yard Lighting



- We Propose **2 options** in the following page based on discussion with PAT
- Budget for PV system and LED Yard lighting need to be approved

(2) Apply in FY 2018 with combination of the 4 projects for CFS Import



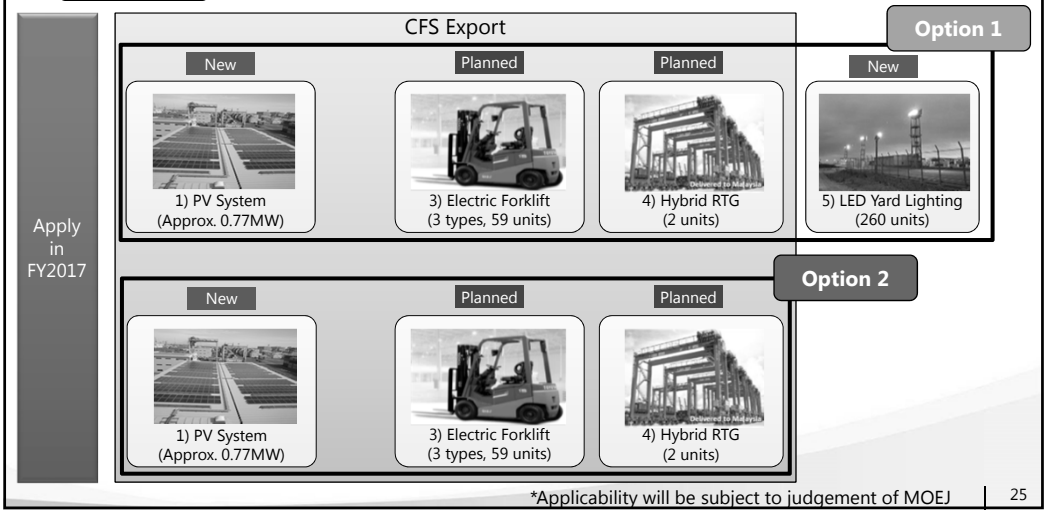
- YPC appeals to MOEJ to grant JCM subsidy for those projects.
- Applicability is subject to the judgement of MOEJ.

Applying options for JCM in FY2017

- We propose 2 options for JCM application in 2017

Option 1 : 3 projects for CFS Export **and** LED Yard Lightings

Option 2 : 3 projects for CFS Export **only**



*Applicability will be subject to judgement of MOEJ

Application for JCM in FY 2017: CFS Export & LED Yard Lighting

Estimated figure

	1) PV on CFS	3)Electric Forklift	4)Hybrid RTG	5)LED yard lightings
Legal durable years	17years	5years	12years	15years
Quantity	1 set (Approx. 0.77MW)	59 trucks (3types)	2 units	260 set
Initial cost (A)	69,200,000 THB	41,530,000 THB	115,700,000 THB	16,640,000 THB
Percentage of JCM subsidy (B)	30% (~40%)	20%	10%	40% (~50%)
JCM subsidy (C)=(A)*(B)	20,700,000 THB	8,300,000 THB	11,570,000 THB	6,650,000 THB
CO2 reduction	9,786*t-CO2* *(575.6t-CO2/year)*	*3,579t-CO2* *(715.8t-CO2/year)*	4,475*t-CO2* *(372.9-CO2/year)*	4,029*t-CO2* *(268.6t-CO2/year)*
Total Profit in legal durable years	8,640,000 THB	51,490,000 THB	48,900,000 THB	22,540,000 THB

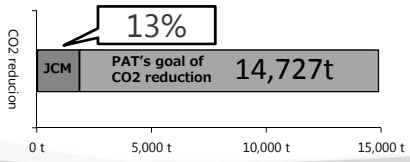
Percentage of subsidy is basically correlated to CO2 reduction but is subject to judgement of MOEJ.
We will negotiate seriously with MOEJ.

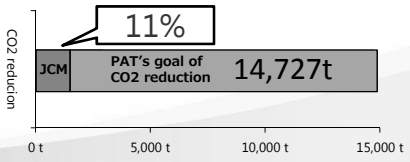
Project profitability of JCM in FY 2017

Estimated figure

Option 1 CFS Export (PV, e-Forklift, Hybrid RTG) & LED Yard Lighting	
Initial cost	243,070,000 THB
JCM subsidy	47,220,000 THB
Cost after subsidy	195,850,000 THB
CO2 reduction / year	1,932.9t
Total profit in legal durable years	131,570,000 THB

Option 2 CFS Export (PV, e-Forklift, Hybrid RTG)	
Initial cost	226,430,000 THB
JCM subsidy	40,570,000 THB
Cost after subsidy	185,860,000 THB
CO2 reduction / year	1,664.3t
Total profit in legal durable years	109,030,000 THB





Application for JCM in FY 2018: CFS Import

Estimated figure

	1) PV on CFS	2) LED lighting in CFS	3)Electric Forklift	4)Hybrid RTG
Legal durable years	17years	15years	5years	12years
Quantity	1 set(2.57MW)	400 set	126 trucks	4 units
Initial cost (A)	214,200,000 THB	9,340,000 THB	130,000,000 THB	231,400,000 THB
Percentage of JCM subsidy (B)	30%	40%	20%	10%
JCM subsidy (C)=(A)*(B)	64,200,000 THB	3,730,000 THB	25,950,000 THB	23,140,000 THB
CO2 reduction	32,663*t-CO2* *(1,921.3t-CO2/year)*	2,335*t-CO2* *(155t-CO2/year)*	10,074*t-CO2* *(2,014.8t-CO2/year)*	8,950*t-CO2* *(745.8-CO2/year)*
Total Profit in legal durable years	40,380,000 THB	17,100,000 THB	92,770,000 THB	97,800,000 THB

*Applicability will be subject to judgement of MOEJ

Total benefits gained from Phase 1 projects in 2017 and 2018

Estimated figure

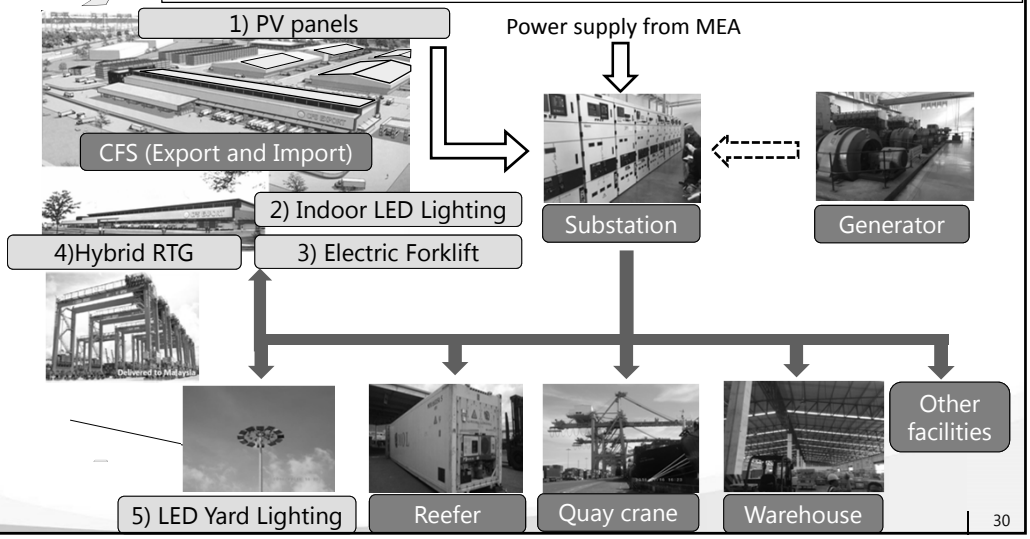
Phase 1 (2015~2019) Bangkok Port			Total CO2 Reduction	Total Saving of running cost
1) PV Panels on CFS roof	Apply in 2017	Apply in 2018	2,497.0t/Year	2,880,000 THB/year
2) Indoor LED Lighting in CFS		Apply in 2018	155.0t/Year	1,140,000 THB/year
3) Electric Forklift in CFS	Apply in 2017	Apply in 2018	2,730.6t/Year	28,850,000 THB/year
4) Hybrid RTG	Apply in 2017	Apply in 2018	1,118.7t/Year	12,230,000 THB/year
5) LED Yard Lighting for container yard	Apply in 2017		268.6t/Year	1,500,000 THB/year

- Reduction of CO2 emission by 33,849.5t
- Saving of running cost by 233,000,000THB

in 5 years since 2020 (after completion of the projects)

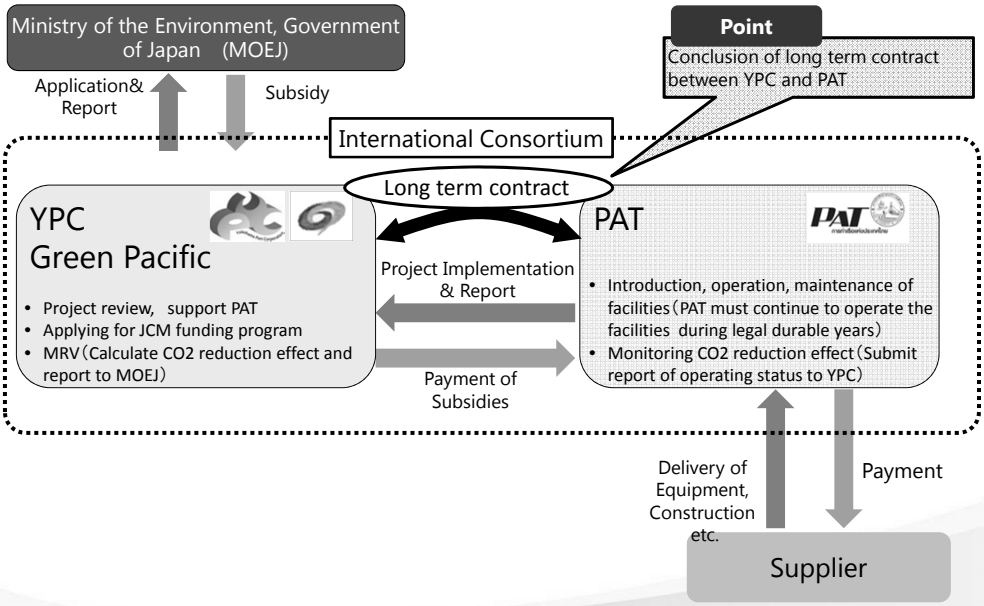
Energy Management System in BKK Port achieved by JCM projects

The EMS of Bangkok Port proposed by YPC aims to realize **sustainable port management** by the following measures.
1) Introducing devices to utilize renewable energy(PV) and energy-saving equipment such as LED lightings.
2) Combine current power supply from MEA and existing generator with the renewable energy for **making energy system of Bangkok port more stable with lower cost and less CO2 emission.**



4 Points for JCM application

Important point for JCM application



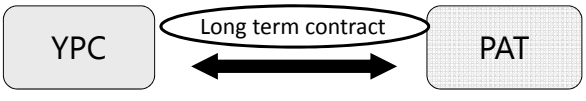
<Important Point> Conclusion of long term contract between PAT and YPC

PAT is responsible for **operating the facilities** and conducting **monitoring CO2 emissions** for legal durable years of the facilities as stipulated by the Japanese law. (for example, 17 years for PV panels)
In case of deliberate failure of the project which is attributable to YPC and PAT, excluding force majeure such as natural disasters, MOEJ may request to return the subsidy.

It is necessary that the contract between YPC and PAT specifies how to deal with the events mentioned above. The contract shall remain in effect during legal durable years of the facilities

Kindly examine to conclude the long tem contract

Major contents of long-term contract between YPC and PAT



- Conducting monitoring CO2 emissions for legal durable years of the facilities
- Procedure in case of returning the subsidy to MOEJ （PAT→YPC→MOEJ）
- Conditions regarding various cost sharing such as MRV

Example of Legal durable years
(1) PV system / 17 years
(2) LED lightings / 15 years
(3) Electric fork lift / 5 years
(4) Hybrid RTGs / 12 years

Summary of our proposal

1. Apply for JCM funding program in FY 2017 for CFS Export-related 3 projects and LED Yard Lighting
2. Kindly approve budget for PV panels on CFS Export and LED Yard Lighting for JCM application in 2017

New

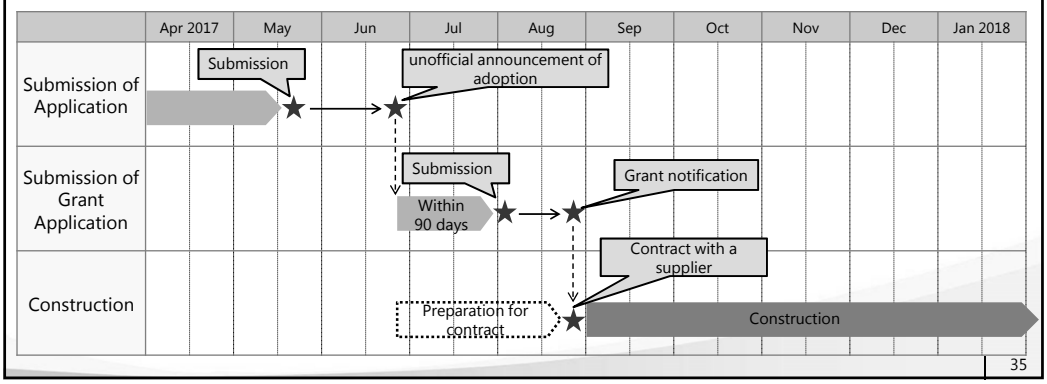
Planned

Planned

New

Tentative Schedule of application for JCM funding program in FY 2017

- Submit JCM application in May
- Submit Grant Application within 90 days after unofficial announcement of adoption
- Contract with a supplier can not be made before grant notification by the regulation of JCM
- Schedule will be basically determined by MOEJ. YPC will discuss it with them.

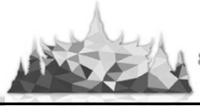


5 Others

PAT's attendance to seminars held by MOEJ in 2017

1. MOEJ held a seminar on JCM City-to-City Collaboration Projects in Tokyo on 23rd January and invited delegates of PAT.
   - Attendance of Mr. Komol and Mr. Phatthawut from PAT BKP was highly appreciated by MOEJ and us.

2. A High-Level Seminar on Sustainable Cities ware held in Chiang Rai on 8-9th February by Thai and Japanese Government and other governmental entities.
   - Ms. Suphattra was invited to make a presentation on PAT's Green Port Project. Her attendance highly appreciated by MOEJ.



8TH EAST ASIA SUMMIT HIGH-LEVEL SEMINAR ON SUSTAINABLE CITIES

Influence of the Paris Agreement on JCM

- Japanese Government is committed to continue to implement the JCM Funding Program
  - Mr. Yamamoto, Minister of MOEJ expressed that Japanese Government would further support the formation and implementation of the JCM
    - At the 4th JCM Partner Countries' High-level Meeting in Morocco in Nov. 2016
    - The meeting had participants from 16 countries
    - Mrs. Prasertsuk Chamornmarn, executive secretary of TGO participated in the meeting

  - We had a meeting with Embassy of Japan in Thailand in Nov. 2016
    - Japanese Government continue to implement the JCM Funding Program regardless of the progress of amendments to the bilateral document between the Thai and Japanese Governments, which has been discussed since the Paris Agreement came into effect.

Document 3-1 Electricity load of PAT

รหัสเครื่องวัด	วัน/เดือน/ปี	เวลา	คาบเวลา	kilo-watts	kilo-vars
"MEA-TOU-047053"	"01/01/16"	"00:15"	15	2.544	1.644
"MEA-TOU-047053"	"01/01/16"	"00:30"	15	2.532	1.62
"MEA-TOU-047053"	"01/01/16"	"00:45"	15	2.568	1.644
"MEA-TOU-047053"	"01/01/16"	"01:00"	15	2.592	1.656
"MEA-TOU-047053"	"01/01/16"	"01:15"	15	2.616	1.68
"MEA-TOU-047053"	"01/01/16"	"01:30"	15	2.52	1.62
"MEA-TOU-047053"	"01/01/16"	"01:45"	15	2.544	1.644
"MEA-TOU-047053"	"01/01/16"	"02:00"	15	2.508	1.632
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"MEA-TOU-047053"	"01/01/16"	"08:15"	15	1.572	0.948
"MEA-TOU-047053"	"01/01/16"	"08:30"	15	1.572	0.924
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"MEA-TOU-047053"	"01/01/16"	"10:30"	15	1.632	0.996
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"MEA-TOU-047053"	"01/01/16"	"11:15"	15	1.668	1.044
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"MEA-TOU-047053"	"01/01/16"	"13:30"	15	1.824	1.116
"MEA-TOU-047053"	"01/01/16"	"13:45"	15	1.812	1.104
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"MEA-TOU-047053"	"01/01/16"	"14:15"	15	1.836	1.104
"MEA-TOU-047053"	"01/01/16"	"14:30"	15	1.836	1.128
"MEA-TOU-047053"	"01/01/16"	"14:45"	15	1.86	1.116
"MEA-TOU-047053"	"01/01/16"	"15:00"	15	1.86	1.128
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"MEA-TOU-047053"	"01/01/16"	"15:30"	15	1.836	1.128
"MEA-TOU-047053"	"01/01/16"	"15:45"	15	1.812	1.104
"MEA-TOU-047053"	"01/01/16"	"16:00"	15	1.824	1.116
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"MEA-TOU-047053"	"01/01/16"	"18:00"	15	1.92	1.236
"MEA-TOU-047053"	"01/01/16"	"18:15"	15	2.4	1.608
"MEA-TOU-047053"	"01/01/16"	"18:30"	15	2.58	1.68
"MEA-TOU-047053"	"01/01/16"	"18:45"	15	2.664	1.752
"MEA-TOU-047053"	"01/01/16"	"19:00"	15	2.664	1.74
"MEA-TOU-047053"	"01/01/16"	"19:15"	15	2.664	1.74
"MEA-TOU-047053"	"01/01/16"	"19:30"	15	2.748	1.788
"MEA-TOU-047053"	"01/01/16"	"19:45"	15	2.784	1.812
"MEA-TOU-047053"	"01/01/16"	"20:00"	15	2.736	1.788
"MEA-TOU-047053"	"01/01/16"	"20:15"	15	2.712	1.776
"MEA-TOU-047053"	"01/01/16"	"20:30"	15	2.616	1.68
"MEA-TOU-047053"	"01/01/16"	"20:45"	15	2.652	1.716
"MEA-TOU-047053"	"01/01/16"	"21:00"	15	2.628	1.656
"MEA-TOU-047053"	"01/01/16"	"21:15"	15	2.616	1.644
"MEA-TOU-047053"	"01/01/16"	"21:30"	15	2.592	1.62
"MEA-TOU-047053"	"01/01/16"	"21:45"	15	2.652	1.656
"MEA-TOU-047053"	"01/01/16"	"22:00"	15	2.58	1.62
"MEA-TOU-047053"	"01/01/16"	"22:15"	15	2.568	1.62
"MEA-TOU-047053"	"01/01/16"	"22:30"	15	2.544	1.596

"MEA-TOU-047053"	"01/01/16"	"22:45"	15	2.58	1.632
"MEA-TOU-047053"	"01/01/16"	"23:00"	15	2.532	1.596
"MEA-TOU-047053"	"01/01/16"	"23:15"	15	2.568	1.62
"MEA-TOU-047053"	"01/01/16"	"23:30"	15	2.556	1.632
"MEA-TOU-047053"	"01/01/16"	"23:45"	15	2.532	1.608
"MEA-TOU-047053"	"01/01/16"	"24:00"	15	2.52	1.608
"MEA-TOU-047053"	"02/01/16"	"00:15"	15	2.496	1.584
"MEA-TOU-047053"	"02/01/16"	"00:30"	15	2.484	1.572
"MEA-TOU-047053"	"02/01/16"	"00:45"	15	2.472	1.56
"MEA-TOU-047053"	"02/01/16"	"01:00"	15	2.46	1.56
"MEA-TOU-047053"	"02/01/16"	"01:15"	15	2.484	1.572
"MEA-TOU-047053"	"02/01/16"	"01:30"	15	2.448	1.548
"MEA-TOU-047053"	"02/01/16"	"01:45"	15	2.424	1.476
"MEA-TOU-047053"	"02/01/16"	"02:00"	15	2.448	1.5
"MEA-TOU-047053"	"02/01/16"	"02:15"	15	2.424	1.5
"MEA-TOU-047053"	"02/01/16"	"02:30"	15	2.424	1.512
"MEA-TOU-047053"	"02/01/16"	"02:45"	15	2.424	1.512
"MEA-TOU-047053"	"02/01/16"	"03:00"	15	2.448	1.56
"MEA-TOU-047053"	"02/01/16"	"03:15"	15	2.436	1.548
"MEA-TOU-047053"	"02/01/16"	"03:30"	15	2.448	1.572
"MEA-TOU-047053"	"02/01/16"	"03:45"	15	2.448	1.536
"MEA-TOU-047053"	"02/01/16"	"04:00"	15	2.436	1.572
"MEA-TOU-047053"	"02/01/16"	"04:15"	15	2.424	1.524
"MEA-TOU-047053"	"02/01/16"	"04:30"	15	2.388	1.5
"MEA-TOU-047053"	"02/01/16"	"04:45"	15	2.424	1.512
"MEA-TOU-047053"	"02/01/16"	"05:00"	15	2.448	1.536
"MEA-TOU-047053"	"02/01/16"	"05:15"	15	2.448	1.536
"MEA-TOU-047053"	"02/01/16"	"05:30"	15	2.436	1.56
"MEA-TOU-047053"	"02/01/16"	"05:45"	15	2.34	1.476
"MEA-TOU-047053"	"02/01/16"	"06:00"	15	2.136	1.368
"MEA-TOU-047053"	"02/01/16"	"06:15"	15	1.848	1.188
"MEA-TOU-047053"	"02/01/16"	"06:30"	15	1.68	1.068
"MEA-TOU-047053"	"02/01/16"	"06:45"	15	1.548	0.972
"MEA-TOU-047053"	"02/01/16"	"07:00"	15	1.488	0.96
"MEA-TOU-047053"	"02/01/16"	"07:15"	15	1.512	0.96
"MEA-TOU-047053"	"02/01/16"	"07:30"	15	1.524	0.96
"MEA-TOU-047053"	"02/01/16"	"07:45"	15	1.548	0.972
"MEA-TOU-047053"	"02/01/16"	"08:00"	15	1.608	1.02
"MEA-TOU-047053"	"02/01/16"	"08:15"	15	1.644	1.008
"MEA-TOU-047053"	"02/01/16"	"08:30"	15	1.764	1.092
"MEA-TOU-047053"	"02/01/16"	"08:45"	15	1.884	1.164
"MEA-TOU-047053"	"02/01/16"	"09:00"	15	2.052	1.26
"MEA-TOU-047053"	"02/01/16"	"09:15"	15	2.232	1.392
"MEA-TOU-047053"	"02/01/16"	"09:30"	15	2.304	1.488
"MEA-TOU-047053"	"02/01/16"	"09:45"	15	2.304	1.464
"MEA-TOU-047053"	"02/01/16"	"10:00"	15	2.448	1.536

"MEA-TOU-047053"	"02/01/16"	"10:15"	15	2.532	1.56
"MEA-TOU-047053"	"02/01/16"	"10:30"	15	2.592	1.572
"MEA-TOU-047053"	"02/01/16"	"10:45"	15	2.556	1.548
"MEA-TOU-047053"	"02/01/16"	"11:00"	15	2.52	1.524
"MEA-TOU-047053"	"02/01/16"	"11:15"	15	2.58	1.572
"MEA-TOU-047053"	"02/01/16"	"11:30"	15	2.724	1.836
"MEA-TOU-047053"	"02/01/16"	"11:45"	15	2.724	1.968
"MEA-TOU-047053"	"02/01/16"	"12:00"	15	2.796	2.028
"MEA-TOU-047053"	"02/01/16"	"12:15"	15	2.796	2.016
"MEA-TOU-047053"	"02/01/16"	"12:30"	15	2.688	1.896
"MEA-TOU-047053"	"02/01/16"	"12:45"	15	2.712	2.016
"MEA-TOU-047053"	"02/01/16"	"13:00"	15	2.7	2.052
"MEA-TOU-047053"	"02/01/16"	"13:15"	15	2.688	2.076
"MEA-TOU-047053"	"02/01/16"	"13:30"	15	2.832	2.076
"MEA-TOU-047053"	"02/01/16"	"13:45"	15	2.832	2.1
"MEA-TOU-047053"	"02/01/16"	"14:00"	15	2.892	2.172
"MEA-TOU-047053"	"02/01/16"	"14:15"	15	2.94	2.208
"MEA-TOU-047053"	"02/01/16"	"14:30"	15	2.964	2.208
"MEA-TOU-047053"	"02/01/16"	"14:45"	15	2.952	2.208
"MEA-TOU-047053"	"02/01/16"	"15:00"	15	2.988	2.136
"MEA-TOU-047053"	"02/01/16"	"15:15"	15	3	2.136
"MEA-TOU-047053"	"02/01/16"	"15:30"	15	3.024	2.172
"MEA-TOU-047053"	"02/01/16"	"15:45"	15	3.048	2.184
"MEA-TOU-047053"	"02/01/16"	"16:00"	15	2.796	1.932
"MEA-TOU-047053"	"02/01/16"	"16:15"	15	2.592	1.692
"MEA-TOU-047053"	"02/01/16"	"16:30"	15	2.532	1.668
"MEA-TOU-047053"	"02/01/16"	"16:45"	15	2.64	1.812
"MEA-TOU-047053"	"02/01/16"	"17:00"	15	2.844	2.112
"MEA-TOU-047053"	"02/01/16"	"17:15"	15	2.844	2.172
"MEA-TOU-047053"	"02/01/16"	"17:30"	15	2.88	2.112
"MEA-TOU-047053"	"02/01/16"	"17:45"	15	2.856	2.196
"MEA-TOU-047053"	"02/01/16"	"18:00"	15	3.144	2.388
"MEA-TOU-047053"	"02/01/16"	"18:15"	15	3.888	2.904
"MEA-TOU-047053"	"02/01/16"	"18:30"	15	4.044	2.976
"MEA-TOU-047053"	"02/01/16"	"18:45"	15	4.14	3.036
"MEA-TOU-047053"	"02/01/16"	"19:00"	15	4.104	3.06
"MEA-TOU-047053"	"02/01/16"	"19:15"	15	4.128	3.108
"MEA-TOU-047053"	"02/01/16"	"19:30"	15	4.092	3.072
"MEA-TOU-047053"	"02/01/16"	"19:45"	15	4.044	2.964
"MEA-TOU-047053"	"02/01/16"	"20:00"	15	4.056	2.94
"MEA-TOU-047053"	"02/01/16"	"20:15"	15	4.02	2.832
"MEA-TOU-047053"	"02/01/16"	"20:30"	15	4.068	2.928
"MEA-TOU-047053"	"02/01/16"	"20:45"	15	4.08	2.916
"MEA-TOU-047053"	"02/01/16"	"21:00"	15	3.972	2.808
"MEA-TOU-047053"	"02/01/16"	"21:15"	15	3.78	2.568
"MEA-TOU-047053"	"02/01/16"	"21:30"	15	3.936	2.964

"MEA-TOU-047053"	"02/01/16"	"21:45"	15	3.792	2.748
"MEA-TOU-047053"	"02/01/16"	"22:00"	15	3.636	2.76
"MEA-TOU-047053"	"02/01/16"	"22:15"	15	3.624	2.772
"MEA-TOU-047053"	"02/01/16"	"22:30"	15	3.564	2.748
"MEA-TOU-047053"	"02/01/16"	"22:45"	15	3.66	2.82
"MEA-TOU-047053"	"02/01/16"	"23:00"	15	3.528	2.484
"MEA-TOU-047053"	"02/01/16"	"23:15"	15	3.36	2.28
"MEA-TOU-047053"	"02/01/16"	"23:30"	15	3.324	2.268
"MEA-TOU-047053"	"02/01/16"	"23:45"	15	3.204	2.196
"MEA-TOU-047053"	"02/01/16"	"24:00"	15	3.228	2.22
"MEA-TOU-047053"	"03/01/16"	"00:15"	15	3.3	2.328
"MEA-TOU-047053"	"03/01/16"	"00:30"	15	3.348	2.58
"MEA-TOU-047053"	"03/01/16"	"00:45"	15	3.324	2.496
"MEA-TOU-047053"	"03/01/16"	"01:00"	15	3.324	2.532
"MEA-TOU-047053"	"03/01/16"	"01:15"	15	3.288	2.472
"MEA-TOU-047053"	"03/01/16"	"01:30"	15	3.348	2.508
"MEA-TOU-047053"	"03/01/16"	"01:45"	15	3.396	2.592
"MEA-TOU-047053"	"03/01/16"	"02:00"	15	3.42	2.592
"MEA-TOU-047053"	"03/01/16"	"02:15"	15	3.396	2.616
"MEA-TOU-047053"	"03/01/16"	"02:30"	15	3.288	2.424
"MEA-TOU-047053"	"03/01/16"	"02:45"	15	3.264	2.484
"MEA-TOU-047053"	"03/01/16"	"03:00"	15	3.276	2.52
"MEA-TOU-047053"	"03/01/16"	"03:15"	15	3.264	2.436
"MEA-TOU-047053"	"03/01/16"	"03:30"	15	3.252	2.448
"MEA-TOU-047053"	"03/01/16"	"03:45"	15	3.276	2.496
"MEA-TOU-047053"	"03/01/16"	"04:00"	15	3.228	2.28
"MEA-TOU-047053"	"03/01/16"	"04:15"	15	3.168	2.292
"MEA-TOU-047053"	"03/01/16"	"04:30"	15	3.144	2.364
"MEA-TOU-047053"	"03/01/16"	"04:45"	15	3.096	2.364
"MEA-TOU-047053"	"03/01/16"	"05:00"	15	3.132	2.256
"MEA-TOU-047053"	"03/01/16"	"05:15"	15	3.084	2.328
"MEA-TOU-047053"	"03/01/16"	"05:30"	15	3.12	2.448
"MEA-TOU-047053"	"03/01/16"	"05:45"	15	3.048	2.376
"MEA-TOU-047053"	"03/01/16"	"06:00"	15	2.856	2.208
"MEA-TOU-047053"	"03/01/16"	"06:15"	15	2.592	2.028
"MEA-TOU-047053"	"03/01/16"	"06:30"	15	2.136	1.512
"MEA-TOU-047053"	"03/01/16"	"06:45"	15	1.98	1.392
"MEA-TOU-047053"	"03/01/16"	"07:00"	15	1.968	1.356
"MEA-TOU-047053"	"03/01/16"	"07:15"	15	1.956	1.368
"MEA-TOU-047053"	"03/01/16"	"07:30"	15	1.86	1.272
"MEA-TOU-047053"	"03/01/16"	"07:45"	15	1.812	1.224
"MEA-TOU-047053"	"03/01/16"	"08:00"	15	1.848	1.236
"MEA-TOU-047053"	"03/01/16"	"08:15"	15	1.812	1.188
"MEA-TOU-047053"	"03/01/16"	"08:30"	15	1.92	1.26
"MEA-TOU-047053"	"03/01/16"	"08:45"	15	1.98	1.368
"MEA-TOU-047053"	"03/01/16"	"09:00"	15	2.004	1.38

"MEA-TOU-047053"	"03/01/16"	"09:15"	15	2.148	1.644
"MEA-TOU-047053"	"03/01/16"	"09:30"	15	2.208	1.68
"MEA-TOU-047053"	"03/01/16"	"09:45"	15	2.316	1.74
"MEA-TOU-047053"	"03/01/16"	"10:00"	15	2.352	1.776
"MEA-TOU-047053"	"03/01/16"	"10:15"	15	2.412	1.764
"MEA-TOU-047053"	"03/01/16"	"10:30"	15	2.424	1.668
"MEA-TOU-047053"	"03/01/16"	"10:45"	15	2.544	1.812
"MEA-TOU-047053"	"03/01/16"	"11:00"	15	2.628	1.752
"MEA-TOU-047053"	"03/01/16"	"11:15"	15	2.604	1.824
"MEA-TOU-047053"	"03/01/16"	"11:30"	15	2.736	1.896
"MEA-TOU-047053"	"03/01/16"	"11:45"	15	2.76	1.968
"MEA-TOU-047053"	"03/01/16"	"12:00"	15	2.736	1.884
"MEA-TOU-047053"	"03/01/16"	"12:15"	15	2.7	1.812
"MEA-TOU-047053"	"03/01/16"	"12:30"	15	2.76	1.896
"MEA-TOU-047053"	"03/01/16"	"12:45"	15	2.784	1.788
"MEA-TOU-047053"	"03/01/16"	"13:00"	15	2.736	1.74
"MEA-TOU-047053"	"03/01/16"	"13:15"	15	2.724	1.728
"MEA-TOU-047053"	"03/01/16"	"13:30"	15	2.76	1.788
"MEA-TOU-047053"	"03/01/16"	"13:45"	15	2.796	1.836
"MEA-TOU-047053"	"03/01/16"	"14:00"	15	2.868	1.836
"MEA-TOU-047053"	"03/01/16"	"14:15"	15	2.88	1.836
"MEA-TOU-047053"	"03/01/16"	"14:30"	15	2.916	1.848
"MEA-TOU-047053"	"03/01/16"	"14:45"	15	2.88	1.824
"MEA-TOU-047053"	"03/01/16"	"15:00"	15	2.856	1.8
"MEA-TOU-047053"	"03/01/16"	"15:15"	15	2.892	1.824
"MEA-TOU-047053"	"03/01/16"	"15:30"	15	2.94	1.872
"MEA-TOU-047053"	"03/01/16"	"15:45"	15	2.88	1.824
"MEA-TOU-047053"	"03/01/16"	"16:00"	15	2.748	1.764
"MEA-TOU-047053"	"03/01/16"	"16:15"	15	2.58	1.656
"MEA-TOU-047053"	"03/01/16"	"16:30"	15	2.58	1.632
"MEA-TOU-047053"	"03/01/16"	"16:45"	15	2.676	1.692
"MEA-TOU-047053"	"03/01/16"	"17:00"	15	2.7	1.776
"MEA-TOU-047053"	"03/01/16"	"17:15"	15	2.712	1.812
"MEA-TOU-047053"	"03/01/16"	"17:30"	15	2.772	1.836
"MEA-TOU-047053"	"03/01/16"	"17:45"	15	2.856	1.92
"MEA-TOU-047053"	"03/01/16"	"18:00"	15	3.132	2.22
"MEA-TOU-047053"	"03/01/16"	"18:15"	15	3.732	2.628
"MEA-TOU-047053"	"03/01/16"	"18:30"	15	4.008	2.736
"MEA-TOU-047053"	"03/01/16"	"18:45"	15	3.948	2.652
"MEA-TOU-047053"	"03/01/16"	"19:00"	15	3.96	2.7
"MEA-TOU-047053"	"03/01/16"	"19:15"	15	3.972	2.76
"MEA-TOU-047053"	"03/01/16"	"19:30"	15	4.176	3
"MEA-TOU-047053"	"03/01/16"	"19:45"	15	4.152	3.024
"MEA-TOU-047053"	"03/01/16"	"20:00"	15	4.056	2.976
"MEA-TOU-047053"	"03/01/16"	"20:15"	15	3.96	2.964
"MEA-TOU-047053"	"03/01/16"	"20:30"	15	3.984	3.012

"MEA-TOU-047053"	"03/01/16"	"20:45"	15	3.96	2.916
"MEA-TOU-047053"	"03/01/16"	"21:00"	15	3.972	2.988
"MEA-TOU-047053"	"03/01/16"	"21:15"	15	3.912	2.904
"MEA-TOU-047053"	"03/01/16"	"21:30"	15	3.792	2.796
"MEA-TOU-047053"	"03/01/16"	"21:45"	15	3.672	2.7
"MEA-TOU-047053"	"03/01/16"	"22:00"	15	3.672	2.568
"MEA-TOU-047053"	"03/01/16"	"22:15"	15	3.708	2.82
"MEA-TOU-047053"	"03/01/16"	"22:30"	15	3.684	2.844
"MEA-TOU-047053"	"03/01/16"	"22:45"	15	3.708	2.808
"MEA-TOU-047053"	"03/01/16"	"23:00"	15	3.552	2.616
"MEA-TOU-047053"	"03/01/16"	"23:15"	15	3.372	2.28
"MEA-TOU-047053"	"03/01/16"	"23:30"	15	3.348	2.256
"MEA-TOU-047053"	"03/01/16"	"23:45"	15	3.372	2.256
"MEA-TOU-047053"	"03/01/16"	"24:00"	15	3.3	2.232
"MEA-TOU-047053"	"04/01/16"	"00:15"	15	3.396	2.376
"MEA-TOU-047053"	"04/01/16"	"00:30"	15	3.504	2.604
"MEA-TOU-047053"	"04/01/16"	"00:45"	15	3.492	2.52
"MEA-TOU-047053"	"04/01/16"	"01:00"	15	3.468	2.556
"MEA-TOU-047053"	"04/01/16"	"01:15"	15	3.48	2.556
"MEA-TOU-047053"	"04/01/16"	"01:30"	15	3.456	2.532
"MEA-TOU-047053"	"04/01/16"	"01:45"	15	3.444	2.532
"MEA-TOU-047053"	"04/01/16"	"02:00"	15	3.444	2.496
"MEA-TOU-047053"	"04/01/16"	"02:15"	15	3.456	2.52
"MEA-TOU-047053"	"04/01/16"	"02:30"	15	3.432	2.508
"MEA-TOU-047053"	"04/01/16"	"02:45"	15	3.42	2.496
"MEA-TOU-047053"	"04/01/16"	"03:00"	15	3.42	2.46
"MEA-TOU-047053"	"04/01/16"	"03:15"	15	3.408	2.52
"MEA-TOU-047053"	"04/01/16"	"03:30"	15	3.408	2.46
"MEA-TOU-047053"	"04/01/16"	"03:45"	15	3.42	2.424
"MEA-TOU-047053"	"04/01/16"	"04:00"	15	3.432	2.46
"MEA-TOU-047053"	"04/01/16"	"04:15"	15	3.42	2.424
"MEA-TOU-047053"	"04/01/16"	"04:30"	15	3.384	2.436
"MEA-TOU-047053"	"04/01/16"	"04:45"	15	3.42	2.412
"MEA-TOU-047053"	"04/01/16"	"05:00"	15	3.456	2.448
"MEA-TOU-047053"	"04/01/16"	"05:15"	15	3.648	2.544
"MEA-TOU-047053"	"04/01/16"	"05:30"	15	3.768	2.592
"MEA-TOU-047053"	"04/01/16"	"05:45"	15	3.72	2.568
"MEA-TOU-047053"	"04/01/16"	"06:00"	15	3.696	2.616
"MEA-TOU-047053"	"04/01/16"	"06:15"	15	3.372	2.352
"MEA-TOU-047053"	"04/01/16"	"06:30"	15	3	2.16
"MEA-TOU-047053"	"04/01/16"	"06:45"	15	2.892	1.932
"MEA-TOU-047053"	"04/01/16"	"07:00"	15	3.084	1.992
"MEA-TOU-047053"	"04/01/16"	"07:15"	15	3.372	2.196
"MEA-TOU-047053"	"04/01/16"	"07:30"	15	3.6	2.304
"MEA-TOU-047053"	"04/01/16"	"07:45"	15	3.732	2.34
"MEA-TOU-047053"	"04/01/16"	"08:00"	15	3.972	2.508

"MEA-TOU-047053"	"04/01/16"	"08:15"	15	4.2	2.556
"MEA-TOU-047053"	"04/01/16"	"08:30"	15	4.632	2.808
"MEA-TOU-047053"	"04/01/16"	"08:45"	15	4.92	2.94
"MEA-TOU-047053"	"04/01/16"	"09:00"	15	5.184	3.156
"MEA-TOU-047053"	"04/01/16"	"09:15"	15	5.304	3.228
"MEA-TOU-047053"	"04/01/16"	"09:30"	15	5.46	3.336
"MEA-TOU-047053"	"04/01/16"	"09:45"	15	5.58	3.48
"MEA-TOU-047053"	"04/01/16"	"10:00"	15	5.556	3.396
"MEA-TOU-047053"	"04/01/16"	"10:15"	15	5.712	3.432
"MEA-TOU-047053"	"04/01/16"	"10:30"	15	5.856	3.372
"MEA-TOU-047053"	"04/01/16"	"10:45"	15	5.916	3.432
"MEA-TOU-047053"	"04/01/16"	"11:00"	15	5.94	3.396
"MEA-TOU-047053"	"04/01/16"	"11:15"	15	6.012	3.492
"MEA-TOU-047053"	"04/01/16"	"11:30"	15	6	3.564
"MEA-TOU-047053"	"04/01/16"	"11:45"	15	5.976	3.516
"MEA-TOU-047053"	"04/01/16"	"12:00"	15	6.06	3.516
"MEA-TOU-047053"	"04/01/16"	"12:15"	15	6	3.456
"MEA-TOU-047053"	"04/01/16"	"12:30"	15	6.06	3.516
"MEA-TOU-047053"	"04/01/16"	"12:45"	15	6.072	3.432
"MEA-TOU-047053"	"04/01/16"	"13:00"	15	6.012	3.384
"MEA-TOU-047053"	"04/01/16"	"13:15"	15	6.108	3.54
"MEA-TOU-047053"	"04/01/16"	"13:30"	15	6.096	3.552
"MEA-TOU-047053"	"04/01/16"	"13:45"	15	6.144	3.504
"MEA-TOU-047053"	"04/01/16"	"14:00"	15	6.216	3.564
"MEA-TOU-047053"	"04/01/16"	"14:15"	15	6.084	3.48
"MEA-TOU-047053"	"04/01/16"	"14:30"	15	6.024	3.492
"MEA-TOU-047053"	"04/01/16"	"14:45"	15	6.012	3.504
"MEA-TOU-047053"	"04/01/16"	"15:00"	15	5.964	3.432
"MEA-TOU-047053"	"04/01/16"	"15:15"	15	6.192	3.66
"MEA-TOU-047053"	"04/01/16"	"15:30"	15	5.712	3.384
"MEA-TOU-047053"	"04/01/16"	"15:45"	15	5.544	3.288
"MEA-TOU-047053"	"04/01/16"	"16:00"	15	5.1	2.94
"MEA-TOU-047053"	"04/01/16"	"16:15"	15	4.824	2.808
"MEA-TOU-047053"	"04/01/16"	"16:30"	15	4.632	2.724
"MEA-TOU-047053"	"04/01/16"	"16:45"	15	4.392	2.592
"MEA-TOU-047053"	"04/01/16"	"17:00"	15	4.26	2.448
"MEA-TOU-047053"	"04/01/16"	"17:15"	15	4.008	2.376
"MEA-TOU-047053"	"04/01/16"	"17:30"	15	3.9	2.34
"MEA-TOU-047053"	"04/01/16"	"17:45"	15	3.756	2.352
"MEA-TOU-047053"	"04/01/16"	"18:00"	15	4.092	2.58
"MEA-TOU-047053"	"04/01/16"	"18:15"	15	4.632	2.76
"MEA-TOU-047053"	"04/01/16"	"18:30"	15	4.836	2.868
"MEA-TOU-047053"	"04/01/16"	"18:45"	15	4.8	2.808
"MEA-TOU-047053"	"04/01/16"	"19:00"	15	4.74	2.772
"MEA-TOU-047053"	"04/01/16"	"19:15"	15	4.728	2.76
"MEA-TOU-047053"	"04/01/16"	"19:30"	15	4.68	2.76

"MEA-TOU-047053"	"04/01/16"	"19:45"	15	4.584	2.7
"MEA-TOU-047053"	"04/01/16"	"20:00"	15	4.284	2.664
"MEA-TOU-047053"	"04/01/16"	"20:15"	15	4.08	2.64
"MEA-TOU-047053"	"04/01/16"	"20:30"	15	4.056	2.64
"MEA-TOU-047053"	"04/01/16"	"20:45"	15	4.056	2.556
"MEA-TOU-047053"	"04/01/16"	"21:00"	15	3.972	2.544
"MEA-TOU-047053"	"04/01/16"	"21:15"	15	3.816	2.52
"MEA-TOU-047053"	"04/01/16"	"21:30"	15	3.888	2.604
"MEA-TOU-047053"	"04/01/16"	"21:45"	15	3.828	2.712
"MEA-TOU-047053"	"04/01/16"	"22:00"	15	3.816	2.796
"MEA-TOU-047053"	"04/01/16"	"22:15"	15	3.708	2.772
"MEA-TOU-047053"	"04/01/16"	"22:30"	15	3.708	2.784
"MEA-TOU-047053"	"04/01/16"	"22:45"	15	3.588	2.64
"MEA-TOU-047053"	"04/01/16"	"23:00"	15	3.516	2.484
"MEA-TOU-047053"	"04/01/16"	"23:15"	15	3.456	2.34
"MEA-TOU-047053"	"04/01/16"	"23:30"	15	3.468	2.328
"MEA-TOU-047053"	"04/01/16"	"23:45"	15	2.94	1.776
"MEA-TOU-047053"	"04/01/16"	"24:00"	15	3.156	2.064
"MEA-TOU-047053"	"05/01/16"	"00:15"	15	3.3	2.292
"MEA-TOU-047053"	"05/01/16"	"00:30"	15	3.312	2.4
"MEA-TOU-047053"	"05/01/16"	"00:45"	15	3.312	2.46
"MEA-TOU-047053"	"05/01/16"	"01:00"	15	3.276	2.388
"MEA-TOU-047053"	"05/01/16"	"01:15"	15	3.228	2.304
"MEA-TOU-047053"	"05/01/16"	"01:30"	15	3.276	2.304
"MEA-TOU-047053"	"05/01/16"	"01:45"	15	3.432	2.52
"MEA-TOU-047053"	"05/01/16"	"02:00"	15	3.42	2.556
"MEA-TOU-047053"	"05/01/16"	"02:15"	15	3.42	2.616
"MEA-TOU-047053"	"05/01/16"	"02:30"	15	3.444	2.64
"MEA-TOU-047053"	"05/01/16"	"02:45"	15	3.432	2.616
"MEA-TOU-047053"	"05/01/16"	"03:00"	15	3.432	2.64
"MEA-TOU-047053"	"05/01/16"	"03:15"	15	3.384	2.592
"MEA-TOU-047053"	"05/01/16"	"03:30"	15	3.42	2.676
"MEA-TOU-047053"	"05/01/16"	"03:45"	15	3.372	2.676
"MEA-TOU-047053"	"05/01/16"	"04:00"	15	3.348	2.604
"MEA-TOU-047053"	"05/01/16"	"04:15"	15	3.396	2.688
"MEA-TOU-047053"	"05/01/16"	"04:30"	15	3.288	2.592
"MEA-TOU-047053"	"05/01/16"	"04:45"	15	3.36	2.544
"MEA-TOU-047053"	"05/01/16"	"05:00"	15	3.336	2.58
"MEA-TOU-047053"	"05/01/16"	"05:15"	15	3.264	2.496
"MEA-TOU-047053"	"05/01/16"	"05:30"	15	3.456	2.544
"MEA-TOU-047053"	"05/01/16"	"05:45"	15	3.468	2.616
"MEA-TOU-047053"	"05/01/16"	"06:00"	15	3.36	2.484
"MEA-TOU-047053"	"05/01/16"	"06:15"	15	3.06	2.052
"MEA-TOU-047053"	"05/01/16"	"06:30"	15	3.072	2.076
"MEA-TOU-047053"	"05/01/16"	"06:45"	15	3.144	2.052
"MEA-TOU-047053"	"05/01/16"	"07:00"	15	3.264	2.088

"MEA-TOU-047053"	"05/01/16"	"07:15"	15	3.492	2.208
"MEA-TOU-047053"	"05/01/16"	"07:30"	15	3.588	2.244
"MEA-TOU-047053"	"05/01/16"	"07:45"	15	3.816	2.436
"MEA-TOU-047053"	"05/01/16"	"08:00"	15	4.02	2.472
"MEA-TOU-047053"	"05/01/16"	"08:15"	15	4.464	2.676
"MEA-TOU-047053"	"05/01/16"	"08:30"	15	4.692	2.844
"MEA-TOU-047053"	"05/01/16"	"08:45"	15	4.776	2.928
"MEA-TOU-047053"	"05/01/16"	"09:00"	15	4.896	3.216
"MEA-TOU-047053"	"05/01/16"	"09:15"	15	5.016	3.264
"MEA-TOU-047053"	"05/01/16"	"09:30"	15	5.136	3.384
"MEA-TOU-047053"	"05/01/16"	"09:45"	15	5.148	3.252
"MEA-TOU-047053"	"05/01/16"	"10:00"	15	5.304	3.276
"MEA-TOU-047053"	"05/01/16"	"10:15"	15	5.4	3.42
"MEA-TOU-047053"	"05/01/16"	"10:30"	15	5.484	3.408
"MEA-TOU-047053"	"05/01/16"	"10:45"	15	5.508	3.456
"MEA-TOU-047053"	"05/01/16"	"11:00"	15	5.604	3.528
"MEA-TOU-047053"	"05/01/16"	"11:15"	15	5.748	3.54
"MEA-TOU-047053"	"05/01/16"	"11:30"	15	5.796	3.684
"MEA-TOU-047053"	"05/01/16"	"11:45"	15	5.784	3.612
"MEA-TOU-047053"	"05/01/16"	"12:00"	15	5.736	3.492
"MEA-TOU-047053"	"05/01/16"	"12:15"	15	5.76	3.612
"MEA-TOU-047053"	"05/01/16"	"12:30"	15	5.712	3.672
"MEA-TOU-047053"	"05/01/16"	"12:45"	15	5.688	3.372
"MEA-TOU-047053"	"05/01/16"	"13:00"	15	5.7	3.564
"MEA-TOU-047053"	"05/01/16"	"13:15"	15	5.82	3.684
"MEA-TOU-047053"	"05/01/16"	"13:30"	15	5.892	3.672
"MEA-TOU-047053"	"05/01/16"	"13:45"	15	5.916	3.648
"MEA-TOU-047053"	"05/01/16"	"14:00"	15	5.88	3.636
"MEA-TOU-047053"	"05/01/16"	"14:15"	15	5.952	3.732
"MEA-TOU-047053"	"05/01/16"	"14:30"	15	5.88	3.66
"MEA-TOU-047053"	"05/01/16"	"14:45"	15	5.76	3.696
"MEA-TOU-047053"	"05/01/16"	"15:00"	15	5.712	3.636
"MEA-TOU-047053"	"05/01/16"	"15:15"	15	5.772	3.624
"MEA-TOU-047053"	"05/01/16"	"15:30"	15	5.664	3.564
"MEA-TOU-047053"	"05/01/16"	"15:45"	15	5.688	3.624
"MEA-TOU-047053"	"05/01/16"	"16:00"	15	5.4	3.372
"MEA-TOU-047053"	"05/01/16"	"16:15"	15	5.136	3.084
"MEA-TOU-047053"	"05/01/16"	"16:30"	15	5.004	3.036
"MEA-TOU-047053"	"05/01/16"	"16:45"	15	4.872	2.916
"MEA-TOU-047053"	"05/01/16"	"17:00"	15	4.824	3.012
"MEA-TOU-047053"	"05/01/16"	"17:15"	15	4.656	2.94
"MEA-TOU-047053"	"05/01/16"	"17:30"	15	4.512	3.084
"MEA-TOU-047053"	"05/01/16"	"17:45"	15	4.308	2.964
"MEA-TOU-047053"	"05/01/16"	"18:00"	15	4.452	3.204
"MEA-TOU-047053"	"05/01/16"	"18:15"	15	5.196	3.456
"MEA-TOU-047053"	"05/01/16"	"18:30"	15	5.316	3.36

รายงานสรุปผลการตรวจสอบดวงโคมไฟฉาย

ลำดับ	รหัสเสาไฟฟ้า		ตรวจสภาพชุดโคมไฟฟ้า							
			ชนิดเสาไฟฟ้า	ชนิดหลอด	ขนาดแรงดัน	ขนาดวัตต์	จำนวนหลอด	ติด	ดับ	หมายเหตุ
1	A01	หน้าท่า T2	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
2	A02	หน้าท่า T2	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
3	A03	หน้าท่า T2	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
4	A04	หน้าท่า T2	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
5	A05	หน้าท่า T2	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
6	A06	หน้าท่า T2	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
7	A07	หน้าท่า T2	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
8	A08	หน้าท่า T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
9	A09	หน้าท่า T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
10	A10	หน้าท่า T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
11	A11	หน้าท่า T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
12	A12	หน้าท่า T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
13	B01	ถนนสายกลาง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
14	B02	ถนนสายกลาง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
15	B03	ถนนสายกลาง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
16	B04	ถนนสายกลาง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
17	C02	เชิงสะพาน ขอ.	เสาไดร์ฟ	SON-T	220 V	1000W.	8			High Mast
18	C03	ริมกำแพง T2	เสาไดร์ฟ	SON-T	220 V	1000W.	6			High Mast
19	C04	ริมกำแพง T2	เสาไดร์ฟ	SON-T	220 V	1000W.	6			High Mast
20	C05	ริมกำแพง T2	เสาไดร์ฟ	SON-T	220 V	1000W.	6			High Mast
21	C06	ซับเกรท T1	เสาไดร์ฟ	SON-T	220 V	1000W.	6			High Mast
22	C07	ริมกำแพง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
23	C08	ริมกำแพง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
24	C09	ริมกำแพง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	6			High Mast
25	C10	ริมกำแพง T1	เสาไดร์ฟ	SON-T	220 V	1000W.	6			High Mast

<u>ชุดโคมไฟฉายลานวางตู้สินค้าเขื่อนตะวันออก</u>

A01-A06 บริเวณหน้าท่าเขื่อนตะวันออก กตส.2 ชุดดวงโคม 72 ชุด

A07-A12 บริเวณหน้าท่าเขื่อนตะวันออก กตส.1 ชุดดวงโคม 72 ชุด

B01-B04 บริเวณลานตู้สินค้า กตส.1 ชุดดวงโคม 48 ชุด

C02-C04 บริเวณลานตู้สินค้า กตส.2 ชุดดวงโคม 32 ชุด

C05-C10 บริเวณลานตู้สินค้า กตส.1 ชุดดวงโคม 48 ชุด

หลอด โซเดียมแรงดันสูง ขนาด 1,000 วัตต์ 220 โวลท์ 1 เฟส รวมจำนวน 260 ชุด (เสา HIGHTMASK 25 ต้น)

รายงานสรุปผลการตรวจสอบดวงโคมไฟฉาย

ลำดับ	รหัสเสาไฟฟ้า	ตรวจสภาพชุดโคมไฟฟ้า							
		ชนิดเสาไฟฟ้า	ชนิดหลอด	ขนาดแรงดัน	ขนาด วัตต์	จำนวนหลอด	ติด	ดับ	หมายเหตุ
1	C01 สามแยกเชิงสะพาน ขต.	เสาไดร์ฟ	SON-T	220 V	1000W.	12			High Mast
2	D01 หลังองค์พระ	หอถัก	SON-T	220 V	1000W.	6			กตส.3
3	D02 หลัง ร.ส.8-9	หอถัก	SON-T	220 V	1000W.	6			กตส.3
4	D03 หลัง ร.ส.8	หอถัก	SON-T	220 V	1000W.	6			กตส.3
5	D04 หลัง ร.ส.7	หอถัก	SON-T	220 V	1000W.	6			กตส.3
6	D05 หลัง ร.ส.6	หอถัก	SON-T	220 V	1000W.	6			กตส.3
7	D06 หลัง ร.ส.6	หอถัก	SON-T	220 V	1000W.	6			กตส.3
8	D07 หน้า ร.ส.11	หอถัก	SON-T	220 V	1000W.	6			กตส.3
9	D08 หน้า ร.ส.17	หอถัก	SON-T	220 V	1000W.	6			กตส.3
10	D09 หน้า ร.ส.16	หอถัก	SON-T	220 V	1000W.	6			กตส.3
11	D10 หน้า ร.ส.15	หอถัก	SON-T	220 V	1000W.	6			กตส.3
12	D11 หมวดยานยนต์	หอถัก	SON-T	220 V	1000W.	6			กตส.3
13	D12 โรงอาหาร	หอถัก	SON-T	220 V	1000W.	6			กตส.3
14	D13 หลัง ร.ส.17	หอถัก	HPI-T	380 V	2000W.	5			กตส.3
15	D14 หลัง ร.ส.16	หอถัก	HPI-T	380 V	2000W.	6			กตส.3
16	D15 ลานทราย	หอถัก	SON-T	220 V	1000W.	4			กตส.3
17	ลานบรรจุ NO.1 (E01)	หอถัก	HPI-T	380V	2000W	9			กตส.3
18	ลานบรรจุ NO.2 (E02)	หอถัก	HPI-T	380V	2000W	9			กตส.3
19	ลานบรรจุ NO.3 (E03)	หอถัก	HPI-T	380V	2000W	9			กตส.3
20	ลานบรรจุ NO.4 (E04)	หอถัก	HPI-T	380V	2000W	9			กตส.3
21	ลานบรรจุ NO.5 (E05)	หอถัก	HPI-T	380V	2000W	9			กตส.3
22	ลานบรรจุ NO.6 (E06)	หอถัก	HPI-T	380V	2000W	9			กตส.3
23	ลานบรรจุ NO.7 (E07)	หอถัก	HPI-T	380V	2000W	9			กตส.3
24	ลานบรรจุ NO.8 (E08)	หอถัก	HPI-T	380V	2000W	9			กตส.3
25	G01 ร.ส.1-2	เสาไดร์ฟ	SON-T	220V	1000W	9	8	1	High Mast
26	G02 ลานC	เสาไดร์ฟ	SON-T	220V	1000W	9			High Mast
27	G03 ลานC	เสาไดร์ฟ	SON-T	220V	1000W	9			High Mast
28	G04 ร.ส. 14	เสาไดร์ฟ	SON-T	220V	1000W	9			High Mast
29	G05 ร.ส.13	เสาไดร์ฟ	SON-T	220V	1000W	9			High Mast
30	G06 สี่แยก ร.ส. 13	เสาไดร์ฟ	SON-T	220V	1000W	9			High Mast
31	G07 ข้างคลองพระโขนง	เสาไดร์ฟ	SON-T	220V	1000W	6			High Mast

<u>ชุดโคมไฟฉายลานวางตู้สินค้าเขื่อนตะวันตก</u>

D01-D12,D15 บริเวณถนนสาย 2 และถนนสาย 3 (โรงอาหารท่าเรือกรุงเทพ)

รวมจำนวน 13 ต้น (หอถักปีน) รวมชุดดวงโคม 1,000 W 220 V 76 ชุด

D13-D14 และ E01-E08 รวมจำนวน 10 ต้น (หอถักปีน) รวมชุดดวงโคม 2,000 W 380 V 83 ชุด

G01-G07 ,C01 รวมจำนวน 8 ต้น (เสาไดร์ฟ) รวมชุดดวงโคม 1,000 W 220 V 72 ชุด

รายงานสรุปผลการตรวจสอบดวงโคมไฟฉาย

ลำดับ	รหัสเสาไฟฟ้า		ตรวจสภาพชุดโคมไฟฟ้า							
			ชนิดเสาไฟฟ้า	ชนิดหลอด	ขนาดแรงดัน	ขนาด วัตต์	จำนวนหลอด	ติด	ดับ	หมายเหตุ
1	H01	หน้าท่าเข้าเกาะลาว	เสาไดร์ฟ	SON-T	220V	1000W	12			High Mast
2	H02	สี่แยกซ่อง ร.ส.2-3	เสาไดร์ฟ	SON-T	220V	1000W	12			High Mast
3	H03	ปั้มน้ำมัน	เสาไดร์ฟ	SON-T	220V	1000W	12			High Mast
4	H04	ร.ส. 11	เสาไดร์ฟ	SON-T	220V	1000W	12			High Mast
5	I01	เกาะลาว ริมกำแพง	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
6	I02	เกาะลาว ริมกำแพง	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
7	I03	เกาะลาว ริมกำแพง	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
8	I04	เกาะลาว	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
9	I05	เกาะลาว	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
10	I06	เกาะลาว	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
11	I07	เกาะลาว	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
12	I08	เกาะลาว	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
13	I09	เกาะลาว	เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
14	ลาน 45 ไร่ No 1 (J01)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
15	ลาน 45 ไร่ No 2 (J02)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
16	ลาน 45 ไร่ No 3 (J03)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
17	ลาน 45 ไร่ No 4 (J04)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
18	ลาน 45 ไร่ No 5 (J05)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
19	ลาน 45 ไร่ No 6 (J06)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
20	ลาน 45 ไร่ No 7 (J07)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast
21	ลาน 45 ไร่ No 8 (J08)		เสาไดร์ฟ	HPI-T	220V	1000W.	12			High Mast

ชุดโคมไฟฉายลานวางตู้สินค้าเขื่อนตะวันตก

H01-H04 รวมจำนวน 4 ต้น (เสาไดรฟ์) รวมชุดดวงโคม 1,000 W 220 V 48 ชุด

I01-I09 รวมจำนวน 9 ต้น (เสาไดรฟ์) รวมชุดดวงโคม 1,000 W 220 V 108 ชุด

J01-J08 รวมจำนวน 8 ต้น (เสาไดร์ฟ) รวมชุดดวงโคม 1,000 W 220 V 96 ชุด

สรุป รวมเสาหอถักปีน จำนวน 23 ต้น

รวมเสาไดร์ฟ จำนวน 29 ต้น

รวมเสาทั้งหมด จำนวน 52 ต้น

รวมชุดดวงโคมหลอด เมทัลฮาไลด์ ขนาด 2,000 วัตต์ 380 โวลท์ 3 เฟส รวมจำนวน 83 ชุด (ขาว)

รวมชุดดวงโคมหลอด โซเดียมแรงดันสูง ขนาด 1,000 วัตต์ 220 โวลท์ 1 เฟส รวมจำนวน 184 ชุด (เหลือง)

รวมชุดดวงโคมหลอด เมทัลฮาไลด์ ขนาด 1,000 วัตต์ 220 โวลท์ 1 เฟส รวมจำนวน 204 ชุด (ขาว)

รวมชุดดวงโคมหลอดทั้งหมด รวมจำนวน 471 ชุด

ความสูงของหอไฟฉาย

ความสูงหอไดรฟ์ (High Mast)	สูง	30	เมตร
ความสูงหอถักปีน	สูง	22	เมตร

สรุป รวมเสาไฟฉายและชุดโคมไฟฉายทั้งหมดของการท่าเรือฯ

รวมชุดดวงโคมหลอด เมทัลฮาไลด์ ขนาด 2,000 วัตต์ 380 โวลท์ 3 เฟส	รวมจำนวน	83	ชุด	(ขาว)
รวมชุดดวงโคมหลอด โซเดียมแรงดันสูง ขนาด 1,000 วัตต์ 220 โวลท์ 1 เฟส	รวมจำนวน	456	ชุด	(เหลือง)
รวมชุดดวงโคมหลอด เมทัลฮาไลด์ ขนาด 1,000 วัตต์ 220 โวลท์ 1 เฟส	รวมจำนวน	204	ชุด	(ขาว)

รวมชุดดวงโคมหลอดทั้งหมด จำนวน 743 ชุด

รวมจำนวนเสาหอถักปีนทั้งหมด	รวมจำนวน	23	ต้น
รวมจำนวนเสาหอไดร์ทท้งหมด (High Mast)	รวมจำนวน	54	ต้น

รวมเสาไฟฉายทั้งหมด จำนวน 77 ต้น

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MINAMI Syunichi：Principal Engineer, Quality & Environment Issue Department, Niigata Power Systems Co., Ltd.
KODERA Masanori：Electronic and Electrical Technology Group, Niigata Power Systems Co., Ltd
“Development of the Hybrid Tugboat System”
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