

**Appendix-5  
Soft Component  
(Technical Assistance)  
Plan**

**THE PREPARATORY SURVEY  
ON  
THE PROJECT FOR INTRODUCTION OF CLEAN  
ENERGY BY SOLAR ELECTRICITY  
GENERATION SYSTEM  
IN  
BELIZE**

**Soft Component Plan**

**October 2010**

**Japan International Cooperation Agency**

**NIPPON KOEI CO., LTD.**

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## **1. Background of the Soft Component Plan**

“The Project for Introduction of Clean Energy by Solar Electricity Generation System in Belize” aims to introduce solar PV system with 350 kW capacity to be installed in the area of University of Belize (UB) in Belmopan City. The generated power will be supplied to the existing power grid. This project is the first attempt towards the installation of grid-connected solar PV system in Belize. Therefore, it is necessary to assist capacity improvement and basic technical training for engineers in the aspect of technical transfer.

### **(1) Current Condition**

Belize imports electricity for approximately 50% of its national power consumption from the neighboring country of Mexico. The rest of the required electricity is supplied by hydropower and diesel power stations in the country. The problem of electrification still remains in areas which are far in distance to the national grid.

### **(2) Need for Soft Component**

This is the first attempt to introduce a grid-connected solar PV system in Belize. To secure smooth operation, it is necessary to introduce further technical information, documents and human resources on PV system as shown below.

- i. Lack of technical engineers who work on O&M and repair
- ii. Lack of manuals on the training for O&M engineers
- iii. Lack of human resources to act as guide to visitors of PV system and enable them to explain the effect

Thus, following activities have to be conducted for (i) smooth operation in initial stage and (ii) secure the sustainability of project outcomes as soft component program.

- i. Training for O&M engineers
- ii. Prepare and organize necessary manuals for O&M
- iii. Training for the person in charge of guiding visitors to the facility and explaining its effectiveness

The details of activities to be implemented are explained below.

#### **A. Operational Management / Monitoring**

An appropriate management structure system on solar PV system is necessary to secure sustainability of the project outcome. Therefore, the Ministry of Works (MOW) and UB have to confirm the activities by referring to O&M reports submitted by daily and periodic maintenance staff members of BEL (Belize Electricity Limited) and UB. In addition, it is

necessary to collect data on power generation and the amount of CO<sub>2</sub> emission reduction for analysis.

#### B. Basic Technology / O&M / Troubleshooting

It is necessary to transfer appropriate O&M skills for sustainable use of solar PV system. It is desirable to conduct repair or replacement of faulty parts of the PV system locally. Therefore, in addition to O&M techniques, troubleshooting techniques have to be transferred. A troubleshooting table has to be prepared in the project. Moreover, it is necessary to maintain the manuals on O&M and troubleshooting, which will be utilized as materials for training technicians locally.

#### C. Education / Awareness-Raising

As for the PV system which was introduced in this project, a show case effect of the Japanese technical cooperation is expected. It is necessary to train the persons in charge of guiding visitors to the installed facility and explaining its effects. In the project, brochures have to be prepared as guide to those visiting the installed facility.

### **2. Objectives of Soft Component**

The following objectives have to be accomplished within two months during and after installation of the PV system.

- Management of operation and monitoring of data can be conducted by MOW and UB staff.
- Daily inspection can be conducted by MOW or UB staff.
- Periodic inspection can be conducted by the staff of BEL.
- Finding of malfunctioning parts and determining corresponding countermeasures can be conducted by BEL.
- Visitors can be guided to by UB personnel to see the PV system.

### **3. Output of Soft Component**

#### A. Operational Management / Monitoring

Management of operation and monitoring data at the PV facility are conducted by MOW and UB. It is necessary to transfer the technology for confirming operational data such as power output, solar irradiation and the amount of reduction of CO<sub>2</sub> emission. In addition, inspection reports written by O&M staff have to be confirmed and adequate countermeasures have to be carried out.

- Understanding of PV system, power conditioner, grid connection technology
- Understanding of the inspection report, countermeasure of the troubles

- Analysis of monitored data (power output, irradiation, CO<sub>2</sub> emission reduction)
- Training system of O&M technicians

#### B. Basic Technology / O&M / Troubleshooting

The technical staff of UB and BEL will understand basic technology of solar PV to carry out O&M appropriately. In accordance with the prepared manual, periodic inspection has to be conducted by BEL. The process of installation and O&M training will be filmed for use as technical training documents for dissemination and accession of transferred technologies. In addition, a troubleshooting table will be prepared to find malfunctioning parts and the corresponding countermeasures. The outputs through the above training are expected as shown below.

- Understanding of the PV system, power conditioning, and PV system technology
- Understanding of daily maintenance and confirmation of generating condition
- Acquisition of knowledge on maintenance check points such as operating panel, indicator panels, and protection instruments and detailed operational instruction for each facility and equipment
- Acquisition of knowledge on measurement device for maintenance, equipment adjustment device, special tool, machine proof, adjustment, etc.
- Acquisition of reporting skill for operation records, accidents, repairs and inspection
- Acquisition of knowledge on management of spare parts and tools
- Acquisition of knowledge on locating faulty parts and their corresponding replacement
- Acquisition of knowledge on the forecast of the exchange period for parts; identification of faulty parts and the necessary countermeasures

#### C. Education / Awareness-Raising

Using the installed solar PV system in UB, explanation on installed system and the effectiveness will be conducted to visitors and concerned people. Brochures which introduce the installed facility will be prepared. Furthermore, a trial seminar to raise awareness will be held using the developed brochure. The outputs through the above training are expected as shown below.

- Development of the person in charge of guiding visitors to the installed system
- Development of human resources who can explain the effectiveness of the installed system
- Brochures for the activities mentioned above are developed

#### 4. Confirmation Methods for Achievement

The confirmation methods for achievement of the soft components will be prepared and the results will be reported in the final reports. The contents are as shown in Table -1.

**Table-1 Confirmation Methods for Achievement**

Term of Technical Transfer	Confirmation Methods	Items to be Confirmed
Operational management / Monitoring	Conduct analysis and the confirmation of the monitored data at the end of training.	Acquisition level of data analysis
Basic technology / O&M / Trouble shooting	<ul style="list-style-type: none"> <li>•Comprehension test</li> <li>•Conduct inspection and maintenance services at the end of training</li> <li>•Conduct technical transfer using prepared manuals at the end of training</li> <li>•Conduct O&amp;M simulation using troubleshooting table at the end of training</li> </ul>	<ul style="list-style-type: none"> <li>•Acquisition level of basic knowledge</li> <li>•O&amp;M operation acquisition level</li> <li>•Training system for O&amp;M engineer</li> <li>•Acquisition level for repair and replacement of faulty parts</li> </ul>
Awareness-Raising	•At the end of training, the trainee organizes a simulation seminar	•To confirm contents of the simulation seminar

(JICA Study Team)

#### 5. Activity

##### 5.1 Contents and Activities for the Soft Component

Two persons participate from each organization for soft component. Depending on the role of organization, required technologies to be transferred are different.

Table-2 shows the contents of activities, number of attendance and organization for the soft components. During the training at site, mainly practical training will be conducted. Since there are no electrical technicians in the Belizean Government, BEL which is publicly recognized as the only power supply organization in Belize, can be one of the candidates who will participate during the implementation of the soft component.

As an implementation organization, the person in charge of the project in MOW has to have knowledge on O&M for its management. Technical transfer will be conducted using prepared manuals and the troubleshooting table.

**Table-2 Number of participants according to technical transfer**

	Technical transfer	No. of participants	Organization (no.)
A	Operational Management/Monitoring	4	MOW (2), UB (2)
B	Basic technology of PV system / O&M /Trouble Shooting	4	BEL (2), UB (2)
C	Education / Awareness-Raising	2	UB (2)

(JICA Study Team)

Details of the technology transfer work items are presented and discussed below.

A. Operational Management/Monitoring

Technical skills on operational management and monitoring will be transferred. After training, it is possible to confirm contents of the O&M report and monitoring data such as the power output. The table below shows the details of training.

**Table-3 Operational Management/Monitoring**

	Item	Contents and Activities
1.	Basics of Solar PV	Basic knowledge of solar PV
2.	Operation and Maintenance	Contents of O&M reports based on daily and periodic maintenance; Understand necessary procedure for carrying out countermeasures against malfunctions.
3.	Data Analysis / Operational Management	Confirm procedure for data collection and analysis in the PV system.

(JICA Study Team)

B. Basic technology of PV system / O&M / Trouble shooting

The basic technology of a PV system is taught. At first, a comprehension test on basic knowledge of the PV system is conducted to grasp current knowledge level of the trainee. Training items and contents are shown in the table below.



**Table -4 Basic Technology of PV System**

	Item	Contents and Activities
1.	Comprehension test	Confirmation of the basic technical knowledge of trainee
2.	Basics of the PV system	Actual system; international trend
3.	PV system, Power conditioner	Specifications and details of the PV system and power conditioner
4.	Grid connection	The principle of the grid-connected system, its specifications and details

(JICA Study Team)

After completion of the trial operation, O&M training will be conducted with emphasis on the purpose of improvement of O&M and troubleshooting skills. The training will be conducted by a consultant and a qualified engineer on management and O&M. The important training activities will be filmed/recorded as training documents. Training items and contents are as shown in the following table.

**Table-5 O&M and Troubleshooting Training Activities**

	Item	Contents and Activities
1.	Daily maintenance	Confirmation of generation facilities, operational and surrounding conditions.
2.	Periodic inspection, maintenance	Periodic inspection, maintenance
3.	Handling of measuring equipment and special tools	Handling of electrical and adjustment equipment.
4.	Reporting	Report writing related to O&M
5.	Operating inspection	Operating inspection and testing Testing and confirmation of safety operation
6.	Troubleshooting	Determining probable troubles/problems
7.	Repair and replacement of faulty parts	Prepare table guide for troubleshooting
8.	Manual and video document	Prepare manual and video documents as guide for installation and O&M
9.	Confirmation of O&M	Confirmation of the results of soft component

(JICA Study Team)

### C. Education / Awareness-Raising

Brochures for introduction of the PV system and manuals on raising awareness will be developed. Consequently, each staff officer can guide the PV facility and explain the effectiveness. Training items and contents are shown in the table below.

**Table-6 Awareness- Raising Activities**

	Item	Contents and Activities
1.	Comprehension test	Confirmation of basic knowledge
2.	Preparation of brochure for awareness-raising activity.	Preparation of brochure on solar PV and the project for dissemination to visitors.
3.	Hold an awareness-raising seminar	A seminar for the UB staff is conducted using the prepared manuals and brochure.

(JICA Study Team)

## 5.2 Input Plan

### (1) Operation Management and Maintenance for PV System (A, B)

#### (Japanese side)

- Necessary technology/ category of business : PV system / O&M Engineer
- Needed technical level :
  - A. Operational management / Monitoring of data
  - B. Periodic inspection of PV system  
Technical knowledge on spare parts
- Implementation measure :  
Transfer basic technology of PV system and O&M for daily maintenance and periodic inspection. Prepare manual and video materials. Transfer the technology on troubleshooting
- Implementation resource :
 

Dispatched engineer:	Solar Energy Engineer (1 person)
Dispatch period:	2.0 M/M
Local assistance:	1 person
Contract period:	2.0 M/M

- Implementation contents

**Table-7 Operational Management/Monitoring**

	Contents	M/M
1.	Basics of Solar PV	0.1
2.	O&M	0.1
3.	Data Analysis and Management	0.1

(JICA Study Team)

**Table-8 Basic Technology of PV system**

	Contents	M/M
1.	Comprehension Test	0.1
2.	Basics Information on PV system	0.1
3.	PV System, Power Conditioner	0.1
4.	Grid Connection	0.1

(JICA Study Team)

**Table -9 O&M/Troubleshooting**

	Contents	M/M
1.	Daily maintenance	0.2
2.	Periodic inspection and maintenance	0.1
3.	Handling of measuring equipment and special tools	0.1
4.	Reporting skills	0.1
5.	Operating inspection	0.1
6.	Troubleshooting	0.2
7.	Repair and replacement of malfunctioning parts	0.2
8.	Preparation of manual and video materials	0.2
9.	Confirmation of O&M knowledge	0.1

(JICA Study Team)

(Belizean side)

- Necessary technology/ category of business :  
Periodic inspection of PV system / Electrician
- Current technical level : O&M of power distribution equipment
- Needed technical level : Periodic inspection of PV system, technical skills on repair and replacement of malfunctioning parts
- Target person :  
A. Operational management / Monitoring: MOW, UB

B. Basic technology / O&M / Troubleshooting: UB, BEL

- Implementation measure :  
Using installed PV facility and prepared O&M manual
- Trainee Resource :
  - A. Operational management / Monitoring:  
MOW, UB / 4 persons (2 for each)
  - B. Basic technology / O&M / Trouble Shooting:  
BEL, UB / 4 persons (2 for each)

**(2) Education / Awareness- Raising**

(Japanese side)

- Necessary technology/ category of business :  
Environmental awareness-raising and education through reduction of GHG emission using PV system /consultant
- Needed technical level :  
Environmental education on energy conservation or global warming
- Implementation measure :  
Explanation and guidance using brochure and trial seminar
- Implementation resource :
  - Dispatched engineer      Environmental Educator (1 person)
  - Dispatched period      0.8MM
- Implementation contents

**Table -10 Education / Awareness-Raising**

	Contents	M/M
1.	Comprehension test	0.1
2.	Preparation of brochure for awareness-raising activity.	0.4
3.	Hold an awareness-raising seminar activity	0.3

(JICA Study Team)

(Belizean side)

- Necessary technology/ category of business :  
Environment / Education / Awareness-raising / Environment and publication
- Current technical level: University personnels
- Needed technical level: Basics of PV system

Implementation of awareness-raising activities using  
prepared brochure

- Target person : UB staff
- Implementation measure : Awareness-raising using installed PV system  
and prepared brochure
- Trainee Resource : Target number : 2 personnels

## 6. Procurement Method of Implementation Resource

In the soft component plan, the direct support method is applied since it is difficult to find any sub-contractor because it is the first attempt on PV system installation in Belize. Under the project, main components will be procured in Japan. Therefore, it is necessary to dispatch experts from Japan to transfer O&M technology.

## 7. Draft Implementation Schedule

### A. Operational Management/Monitoring

Technical transfer will commence after the trial operation of solar PV facility.

### B-1. Basic technology of PV system / O&M / Troubleshooting

Technical transfer on daily maintenance will commence after completion of the PV system installation. The training schedule for periodic inspection is planned to be overlapped with the installation period for deeper understanding on the PV system. The training on troubleshooting will be commenced after the installation and conducted in parallel with the field test, acceptance test and initial operation test term.

### C. Awareness-raising

The training on awareness-raising has to coincide with the initial operation term since visitors are expected at that time. The soft component has to be completed within three months after completion of installation.

## 8. Output

### Output documents

Manual :	• Manual of daily and periodic O&M (in English)
	• Awareness-raising materials (Brochure, etc.) ( in English)
Progress Report :	English 10 copies
	Japanese (Summary) 10 copies
Final Report :	English 10 copies
	Japanese (Summary) 10 copies

## 9. Responsibilities of Implementation Organization

Requirement :

The targets of the soft component are the O&M staff of UB and technical staff of MOW.

The responsibilities of the implementation organization are as follows:

- (1) Selection of candidate trainee considering sustainability;
- (2) Provide spaces for training and working; and
- (3) Training system for O&M technician in each organization

Disincentive :

- (1) Continuous O&M is not executed because of job changes and dislocation of trained staff.
- (2) In the soft component, language to be used is English. Manuals and seminar materials have to be prepared in English.

Necessity measure :

- (1) Technologies have to be transferred to several persons. The training manuals and system for O&M technicians have to be maintained in each organization.

## 10. Implementation Schedule of Soft Component

The schedule for implementing the soft component is shown in Table-11.

**Table-11 Implementation Schedule of Soft Component**

Work Items		Months	1	2	3	4	5	6	7	8	9	10	11	12	13	
Procurement & Construction	Contract with a Tenderer		▼													
	Procurement of PV System															
	Design		■	■												
	Manufacturing			■	■	■	■	■								
	Pre-ship inspection and Transportation					■	■	■	■							
	Construction of PV System															
	1. Preparation Works															
	(1) Preparation and Cleaning							■	■					■		
	(2) Procurement and Transportation								■	■						
	2. Installation Works															
	(1) Foundation and Assembling of Mounting Structure							■	■	■	■					
	(2) Installation of PV module and Grid interconnection equipment									■	■	■	■	■		
	(3) Installation of Monitoring Display Panel											■	■			
3. Adjustment and Test/Trial Operation and Training													■	■	■	
4. Completion															▼	
Soft Component	Basic Knowledge/O&M/Trouble Shooting	Preparation of Manual												■	■	
		Lecture/Lesson												■	■	
		Final Report													▼	
	Rising Awareness Activity	Seminar/Preparation of Phanphlet												■	■	
	Final Report														▼	

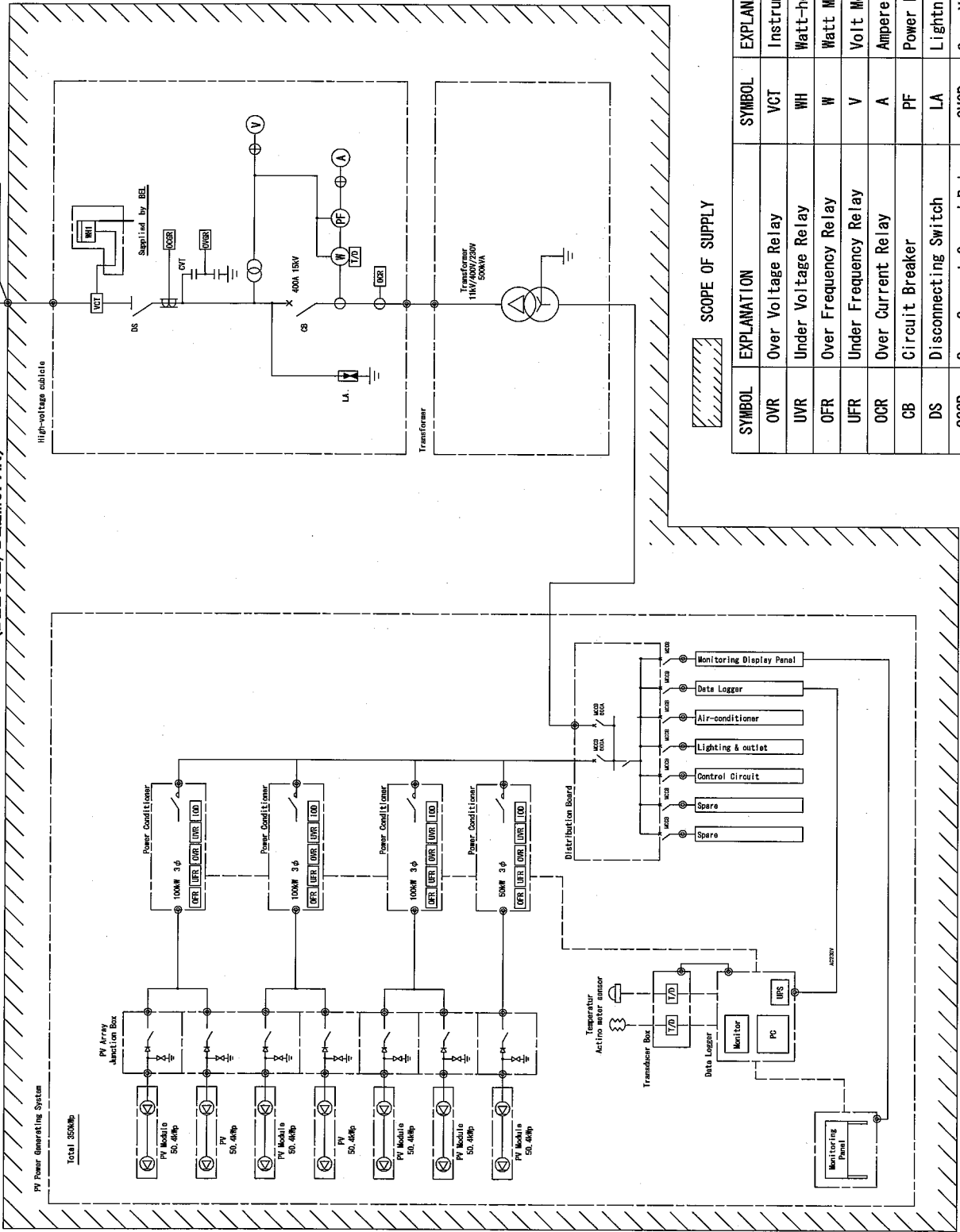
(JICA Study Team)

## Appendix-6 Drawings

NO	DWG NO.	TITLE
1	BZ-E-101	SINGLE LINE DIAGRAM
2	BZ-E-102	PV SYSTEM ARRANGEMENT
3	BZ-E-103	CIVIL WORKS & PV SYSTEM FOUNDATION
4	BZ-E-104	LAYOUT DRAWING OF PV SYSTEM (350 KW)

# Single Line Diagram (BELIZE/BELMOPAN)

3 φ 11kV60Hz  
BELIZE ELECTRICITY LIMITED  
Existing Tr. (200kVA)  
Jaguar Building



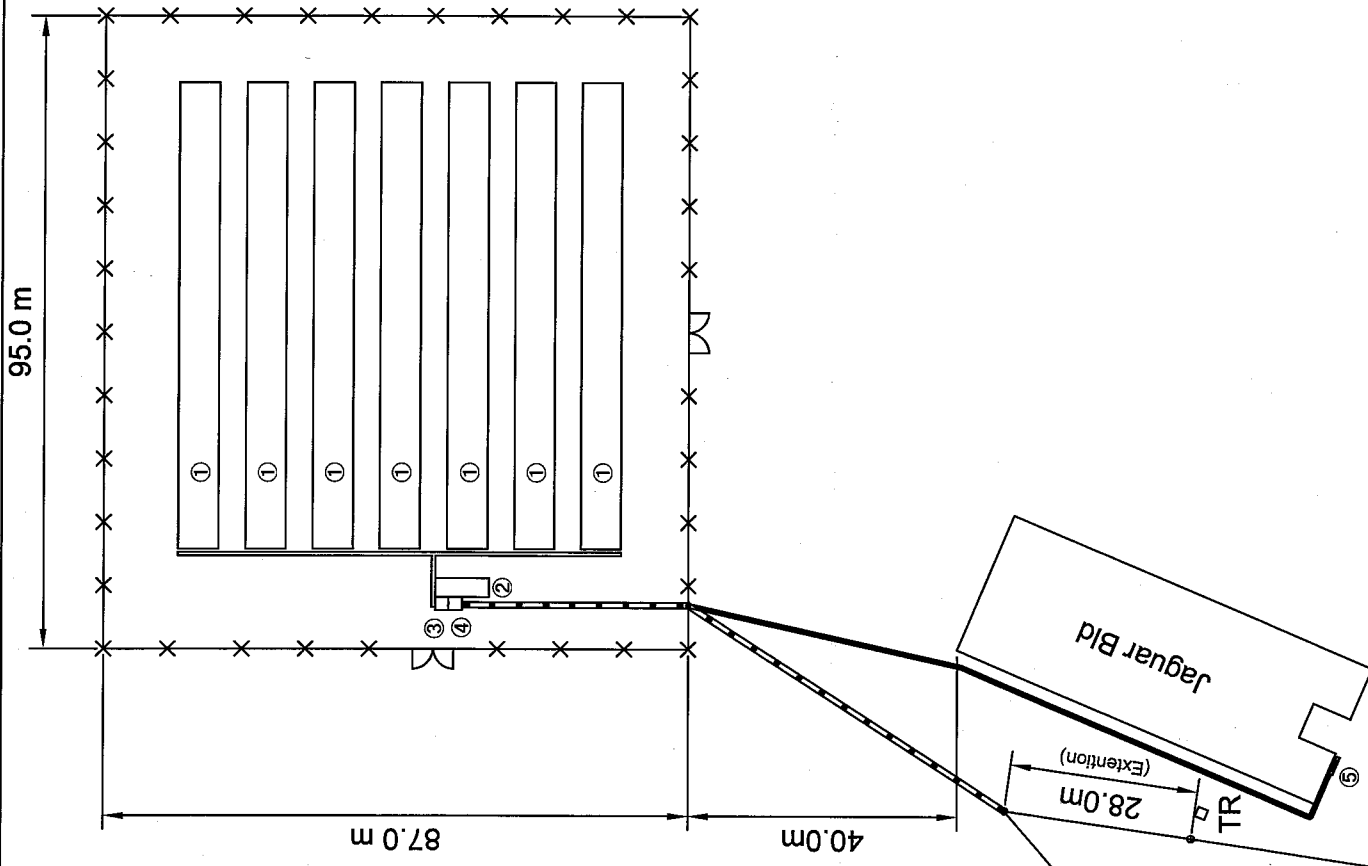
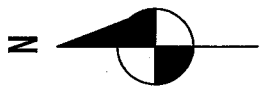
## SCOPE OF SUPPLY

SYMBOL	EXPLANATION	SYMBOL	EXPLANATION
OVR	Over Voltage Relay	VCT	Instrument Transformer
UVR	Under Voltage Relay	WH	Watt-hour Meter
OFR	Over Frequency Relay	W	Watt Meter
UFR	Under Frequency Relay	V	Volt Meter
OCR	Over Current Relay	A	Ampere Meter
CB	Circuit Breaker	PF	Power Factor Meter
DS	Disconnecting Switch	LA	Lightning Arrestor
OCGR	Over Current Ground Relay	OVGR	Over Voltage Ground Relay
LOD	Islanding Oper. Detector	LBS	Load Break Switch

THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM	DRAWING TITLE		UNIVERSITY OF BELIZE SINGLE LINE DIAGRAM	DRAW. NO. BZ-E-101	PREPARED BY	KUMASU
	CHECKED BY	EGAWA				
		APPROVED BY	KOBAYASHI	DATE	Aug-24, 2010	







①	PV Array 350kWp (50kWpx7)
②	Control House
③	Transformer 500kVA
④	High Voltage Cubicle
⑤	Display Board
⑥	Power Conditioner
⑦	Data Logger
⑧	PC Console / Desk
⑨	Distribution Board
—	22kV Power Cable
—	Communication Cable

95.0 m

87.0 m

40.0m

28.0m (Extension)

TR

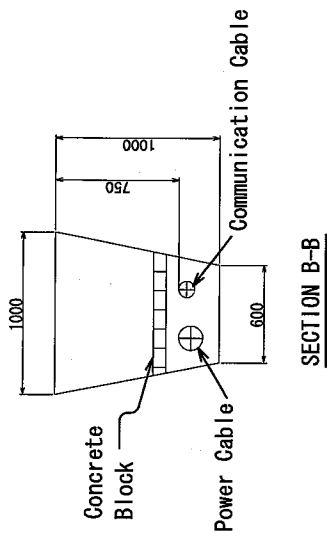
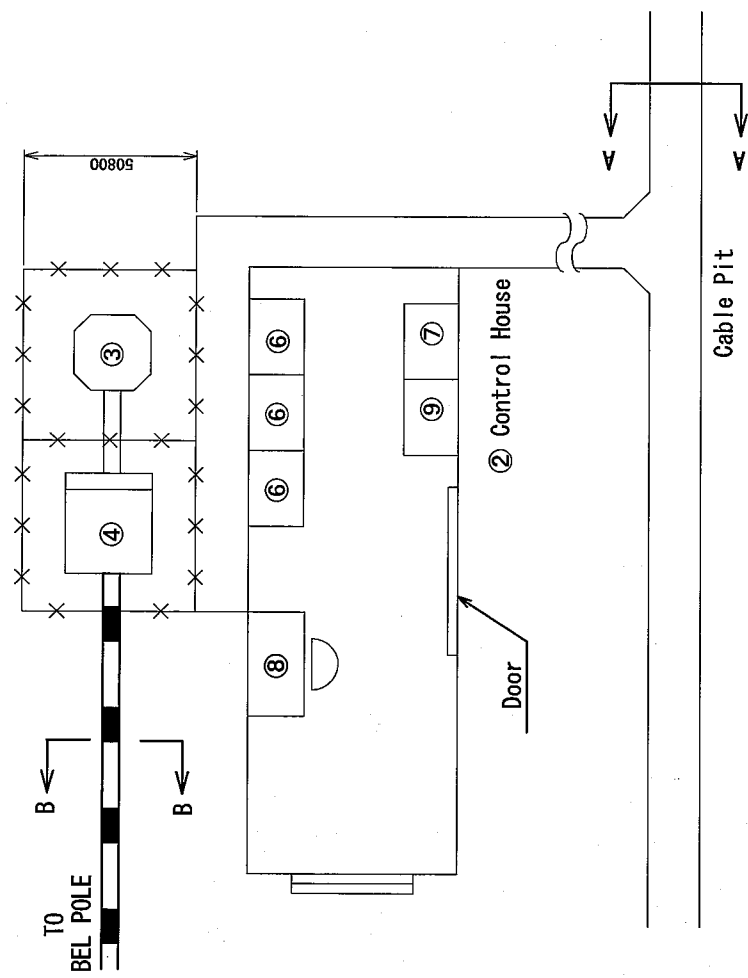
Jaguar Bld

⑤

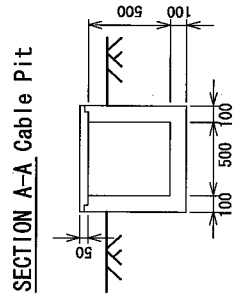
Connection Point

THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM	DRAWING TITLE UNIVERSITY OF BELIZE LAYOUT DRAWING OF PV SYSTEM(350kW)		DRAW. NO. BZ-E-102	PREPARED BY CHECKED BY APPROVED BY DATE
			KOBAYASHI Jun-22, 2010	NIPPON KOEI CO., LTD.

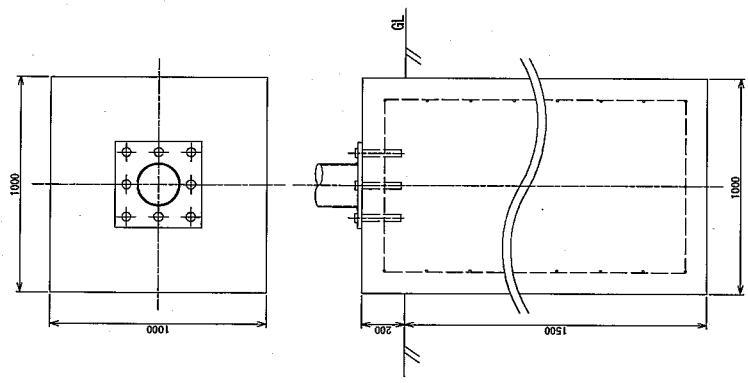
- ② Control House
- ③ Transformer 400KVA
- ④ High Voltage Cubicle(Outdoor type)
- ⑤ Power Conditioner 100KWx3sets
- ⑥ Date logging Panel
- ⑦ PC Console / desk
- ⑧ Low Voltage Distribution Board



SECTION B-B



SECTION A-A Cable Pit

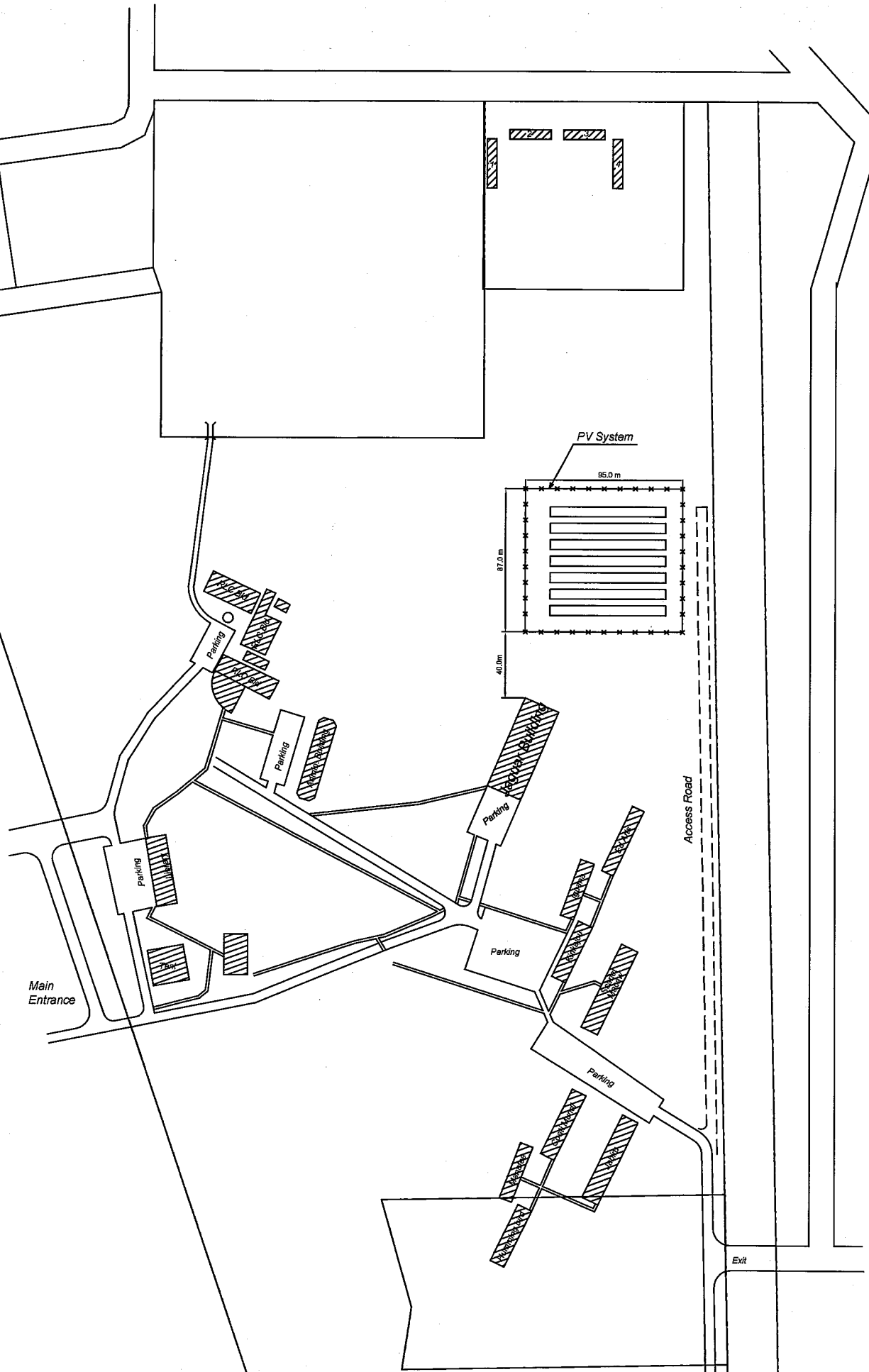


PV SYSTEM Foundation

THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM	DRAWING TITLE UNIVERSITY OF BELIZE CIVIL WORKS & PV SYSTEM FOUNDATION	DRAW. NO. BZ-E-103	PREPARED BY KUMASU CHECKED BY EGAWA APPROVED BY KOBAYASHI DATE Aug-24, 2010
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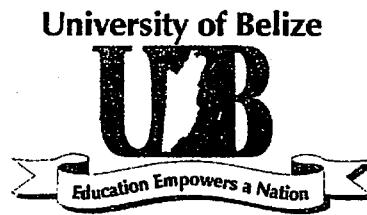
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THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM	DRAWING TITLE		DRAW. NO.	PREPARED BY	
	UNIVERSITY OF BELIZE		BZ-E-104	CHECKED BY	
	LAYOUT DRAWING OF PV SYSTEM (350kW)			APPROVED BY	KOBAYASHI
				DATE	Aug-24, 2010
NIPPON KOEI CO., LTD.					

## **Appendix-7**

### **References**



**Santos Mahung**  
**President**

September 3, 2010

Mr. Joseph Waight  
Financial Secretary  
Ministry of Finance  
Belmopan, Belize

Dear Mr. Waight:

This is further to my letter of June 25, 2010 informing you of the approval of the use of UB land for the construction of the photovoltaic system in connection with the project entitled "Project for Clean Energy Promotion Using Solar Photovoltaic System".

I am pleased to further inform you that the Board of Directors of the University of Belize has approved the use of the increased area of land required to accommodate the additional panels resulting from the expansion of the system. The area approved is 2.04 acres measuring 87m x 95m.

Sincerely,



Santos Mahung

Cc: Imani Fairweather-Morrison, Chairman, UB Board of Trustees  
Yvonne Hyde, CEO, Ministry of Economic Development  
Cadet Henderson, CEO, Ministry of Works  
Takishita Yoshinobu, Resident Representative, JICA  
Tadayuki Ogawa, Leader, Preparatory Survey Team, JICA

**BELIZE**

Please Quote: *PRO/DEV/02/319/10 (4)*  
Telephone Numbers: 822-2542 / 2816  
Fax Number: 822-2862  
E-mail: [envirodept@btl.net](mailto:envirodept@btl.net)



*Department of the Environment  
10/12 Ambergris Avenue  
Belmopan,  
Belize, C. A.*

September 9<sup>th</sup>, 2010

Mr. Cadet Henderson  
Chief Executive Officer  
For and On Behalf of  
Japan International Cooperation Agency  
Ministry of Works  
#1 Power Lane  
Belmopan City

Dear Mr. Henderson,

Please be informed that *Environmental Clearance* is hereby granted to the Ministry of Works for execution of the proposed "Clean Energy by Solar Electricity Generation System," a solar energy generation project which includes the installation of a 350 kWp interconnected Solar Photovoltaic System, to be located at the University of Belize, Central Campus, Belmopan City.

Kindly note that this Environmental Clearance is being granted under the following conditions:

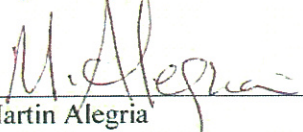
1. Solar panels will be positioned in such a manner so as not to become a hazard or nuisance to the University of Belize campus/classrooms or neighboring private homes due to glaring effect from the panels. In an effort to minimize such solar glare, it is encouraged that all panels be constructed with black fabric covering the inside and bottom surface of the panels to prevent these unwanted reflections
2. The construction area shall be clearly demarcated and secured to prevent unauthorized access and for public safety.
3. Adequate signage is to be placed in conspicuous areas advising the students and the general public of the on-going construction and operational activities related to this project.
4. All electrical installations and wiring shall meet the Belize's required standards.
5. The underground transmission line boundaries will be clearly identified using survey pegs and mapped in an official document for ease of reference.
6. In an effort to minimize any possible nuisance to students as a result of noise from the operation of heavy equipment, construction activities shall as much as possible be kept within the hours of 6:30 am and 5:00 pm. In the event that noise becomes a nuisance, the contractor will take the necessary measures to alleviate the situation.
7. As long as there are qualified and available Belizean workers, no labor force will be imported. If this labor force is not sufficient, then only residents and/or foreigners with a valid work permits will be employed.

8. Personnel working on the project premises will be responsible to conduct proper maintenance to ensure a safe, clean, healthy and environmentally friendly operation.
9. It is the responsibility of contractors to immediately report any activity that has the potential to negatively impact or may damage or has damaged the environment, whether accidentally or intentionally, to the Department of the Environment and all other relevant agencies.

No changes or alterations to what has been stated within this Environmental Clearance letter may be permitted without the written approval of the Department of the Environment.

Thank you for your kind attention.

Respectfully,

  
\_\_\_\_\_  
Martin Alegria  
Chief Environmental Officer  
Department of the Environment