UMARU MUSA YAR' ADUA UNIVERSITY, KASTSINA STATE
FEDERAL MINISTRY OF POWER
THE FEDERAL REPUBLIC OF NIGERIA

PREPARATORY SURVEY ON THE PROJECT FOR CLEAN ENERGY PROMOTION USING SOLAR PHOTOVOLTAIC SYSTEM IN THE FEDERAL REPUBLIC OF NIGERIA

FINAL REPORT

MARCH 2012

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

YACHIYO ENGINEERING CO., LTD.

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on the project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria and organized a survey team headed by Mr. Kyoji Fujii of Yachiyo Engineering Co., Ltd. between December 2009 and December 2011.

The survey team held a series of discussions with the officials concerned of the Government of Nigeria, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Federal Republic of Nigeria for their close cooperation extended to the survey team.

March 2012

Kyoko KUWAJIMA
Director General,
Industrial Development Department
Japan International Cooperation Agency

Summary

SUMMARY

① Outline of the Country

The Federal Republic of Nigeria (hereafter referred to as Nigeria) covers an area of 923,773 square kilometers (approximately 2.5 times the size of Japan), has a population of approximately 158.3 million (2010, UNFPA) and per capita GNI of US$1,190 (2009, World Bank), and is one of Africa's foremost countries with the largest production of petroleum and reserves of natural gas and the second highest GDP in the continent. In geopolitical terms, since Nigeria has a complicated mixture of more than 250 ethnic groups including Hausa, Yoruba and Ibo and numerous religions, government administration is carried out in consideration of six geopolitical zones. Concerning crude oil production, Nigeria produces approximately 2,130,000 barrels of oil a day, making it the seventh largest OPEC producer (2009), and it relies on petroleum-related business (including gas) to provide approximately 71 percent of total revenue and 88 percent of total export value (2009). Therefore, the economy of Nigeria is greatly dependent on crude oil production.

Economic growth in Nigeria has fluctuated around the 6 percent level in recent years, however, due to the effects of the global financial crisis and economic downturn that began in 2009 and reduction of the OPEC production quota and so on; economic growth is expected to fall to 2.9 percent. Meanwhile, concerning the trade balance, the value of petroleum-related exports, which account for 98 percent of total export value, exceed the total value of imports, ensuring that Nigeria perennially has a trade surplus.

② Background and outline of the Project

As the seventh largest producer of oil in OPEC and holder of the ninth largest reserves of natural gas in the world, Nigeria is a major energy resource power; however, energy supply that is based on such fossil fuels is finite. Furthermore, due to the effects of climate change, water flow in the Niger River system is diminishing and power generation at hydropower plants, which constitute important power sources in Nigeria, is falling, thus making it increasingly difficult to realize sustainable energy supply and energy security. As a result, Nigeria is faced with a need to adjust its conventional energy policy based on fossil fuels. Against such a background, Nigeria designated renewable energy as a pillar of sustainable energy supply in the National Energy Plan that was compiled in 2003, while in 2005 it compiled the Renewable Energy Master Plan, under which it is promoting the introduction of renewable energies such as solar power, wind power, micro hydropower and biomass, etc. According to the Renewable Energy Master Plan, targets for the introduction of renewable energy have been established and it is intended to raise the share of renewable energy out of total power supply from 0.8 percent in 2007 to 5 percent in 2015 and 10 percent in 2025. However, introduction of renewable energy is not advancing as expected due to the following impediments: ① the policies, regulations and institutional framework for

expanding the renewable energy market do not exist; ② introductory costs are high and it is difficult to raise funds; and ③ there are no regulations concerning technical standards for product quality, and so on.

The Government of Japan has established funding schemes such as the Cool Earth Partnership and Hatoyama Initiative in order to support developing countries that are striving to balance reduction of greenhouse gas emissions with economic growth and contribute to climate stabilization. In view of this policy by the Government of Japan, JICA has made it a policy principle to actively utilize advanced Japanese technologies for clean energy including renewable energy. Within this, there is particular need to make use of photovoltaic power technology, which is an area in which Japan is highly advanced, in international cooperation projects.

Against such a background, the Ministry of Foreign Affairs implemented a survey of needs for Program Grant Aid for Environment and Climate Change utilizing photovoltaic power, etc. in Cool Earth Partner countries. As a result, a request was received from the Government of Nigeria, and the preparatory survey regarding assistance for introduction of clean energy using photovoltaic power was implemented.

The requested Project aims to procure and install a grid-connected photovoltaic system with output of 1.0 MWp at the Umaru Musa Yar'Adua University (UMYU) in Katsina State.

③ Outline of the Study findings and contents of the Project

JICA dispatched the preparatory survey team to Nigeria from June 12 to July 6, 2011. During this dispatch, the team reconfirmed the contents of the request and discussed the contents of implementation with related officials on the Nigerian side (responsible government agency: the Federal Ministry of Power and implementing agency: UMYU), surveyed and investigated the project site and collected related data and materials.

On returning to Japan, based on the data and materials obtained in the field investigation, the team conducted examination on the necessity of the Project, its social and economic effects and its validity and compiled findings into the Preparatory Survey Report (Draft). JICA dispatched the survey team to Nigeria again from December 11 to December 18, 2011 to explain and discuss the Preparatory Survey Report (draft) and reach a basic agreement with the related officials on the Nigerian side.

As a result of the study, the Project will entail the procurement and installation of a photovoltaic system (output 850 kWp) and related transformer, 11 kV circuit breaker, 415 V circuit breaker and 11 kV/415 V distribution lines, etc. at Umaru Musa Yar'Adua University (UMYU) in Katsina State. Since this photovoltaic system will be the biggest of its kind in Nigeria and will entail grid interconnection for the first time in that country, the contents have been designed upon giving full consideration to ensure that the system can be operated and maintained without any problems after completion. Moreover, it has been decided to conduct technology transfer concerning operation, maintenance and grid interconnection to ensure that the Project contributes to the future dissemination of grid-connected photovoltaic systems in Nigeria from now on.

Outline of the Basic Plan

	Procurement and installation of the following photovoltaic equipment	Quantity
Equipment procurement and installation	Solar power modules and mounting structure	1 set
	Junction box (Quantity will vary depending on the manufacture)	1 set
	Collecting box (Quantity will vary depending on the manufacture)	1 set
	Power conditioner and Combination operating panel	1 set
	Grid-connected transformer	1 set
	11kV switchgear and 11kV Under voltage protective relay for receiving panel	1 set
	33kV Watt hour meter panel (WHM)	1 set
	Ground-fault and overvoltage protective relay for 33kV line	1 set
	Data display system and Instrumentation equipment	1 set
	Wiring materials, Grounding work materials, Buried protective pipes	1 set
Equipment procurement plan	PV system replacement parts, maintenance tools, test devices and safety devices	1 set

④ Project implementation period and rough project cost

In the case where the Project is implemented under the Government of Japan's Grant Aid scheme, the total project cost will be approximately (**confidential**) yen (Japan's burden: approximately: (**confidential**) yen, Nigeria's burden: approximately 2.4 million yen). The main items to be handled by the Nigerian side will be the clearing of plants and trees on the PV panel installation site (approximately 1.4 million yen) and payment of commission fees to the Japanese bank that is used to transfer funds (approximately 1.0 million yen). The Project implementation period including the detailed design and the tendering periods will be roughly 19.5 months.

⑤ Project Evaluation

As is indicated below, since the Project will contribute to the realization of Nigeria's development plans and energy policy and impart benefits to the general public, it is deemed to have high validity as an aid undertaking.

1-1-1 [Relevance]

● Benefiting population

Project implementation will enable employees (approximately 690) and students (approximately

4,300) of UMYU receive power supply from PV generation. Moreover, the reduction in emissions of greenhouse gases enabled by PV generation will benefit all the people of Nigeria.

- Contribution to stable operation of public facilities

In addition to contributing to power supply for the university (a public facility), the Project will aid in the dissemination and public education of renewable energy because the Center for Renewable Energy Research inside UMYU will be able to collect data, conduct research and publish findings based on utilizing the Project PV system.

- Operation and maintenance capacity

Since the equipment and materials to be procured in the Project can be comfortably operated and maintained under the present technical capacity in Nigeria, they will present no particular problems regarding implementation of the Project.

- Contribution to development plans in Nigeria

The project will contribute to the national energy policy and renewable energy plans being implemented by the Government of Nigeria.

- Government of Japan's Grant Aid Scheme

The Government of Japan's Grant Aid Scheme will not hinder implementation of the Project. Moreover, since the Project contents and schedule are feasible for implementation under the Grant Aid Scheme, the Project can be implemented without any major difficulty.

- Necessity and superiority of Japanese technology

In the Project it will be possible to utilize Japanese advanced technology in the field of clean energy including renewable energy. In particular, it will be possible to utilize extremely superior Japanese technology in the field of PV generation.

1-1-2 [Effectiveness]

The anticipated quantitative effects of Project implementation are as indicated below.

Indicator	Reference value (2010)	Target value (2016)
Net generated electric energy (MWh/year)*	0	561
CO_2 reduction (t/year)*	0	232

As for the qualitative effects, Project implementation will serve to enlighten people about PV generation, contribute to the accumulation of technical know-how on grid-connected photovoltaic systems, and lead to the future dissemination of such technology.

As can be seen above, since implementation of the Project can be expected to impart massive effects, its implementation under the grant aid scheme of the Government of Japan is confirmed to be valid. Furthermore, the setup on the Nigeria side in terms of personnel and budget planning is deemed to be sufficient for implementing the Project and conducting post-implementation operation and maintenance.

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LOCATION MAP

LIST OF FIGURES AND TABLES

ABBREVIATIONS

DAC	Development Assistance Committee
E/N	Exchange of Notes
ECN	Energy Commission of Nigeria
ECOWAS	Economic Community of West African States
EIA	Environmental Impact Assessment
EPA	Environment Protection Agency
EU	European Union
FMP	Federal Ministry of Power
FMST	Federal Ministry of Science and Technology
G/A	Grant Agreement
GDP	Gross Domestic Product
GNI	Gross National Income
IDA	International Development Association
IEC	International Electro technical Commission
IMF	International Monetary Fund
ISO	International Organization for Standardization
JCS	Japanese Electrical Wire and Cable Maker's Association Standards
JEC	Japanese Electro technical Committee
JEM	Standards of Japan Electrical Manufacturer's Association
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
NPC	National Planning Commission
LIWV	Lightning Impulse Withstanding Voltage
MW	Mega Watt
OJT	On the Job Training
OPEC	Organization of the Petroleum Exporting Countries
O&M	Operation and Maintenance
PV	Photovoltaic
UNFPA	United Nations Population Fund
UNICEF	United Nations International Children's Emergency Fund
UMYU	Umaru Musa Yar'Adua University

CHAPTER 1 BACKGROUND OF THE PROJECT

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1-1 Background of the Project

The Federal Republic of Nigeria is seventh largest producer of oil in OPEC and holder of the ninth largest reserves of natural gas in the world. However, energy supply that is based on such fossil fuels is finite. Furthermore, due to the effects of climate change, water flow in the Niger River system is diminishing and power generation at hydropower plants, which constitute important power sources in Nigeria, is falling, thus making it increasingly difficult to realize sustainable energy supply and energy security. As a result, Nigeria is faced with a need to adjust its conventional energy policy based on fossil fuels. Against such a background, Nigeria designated renewable energy as a pillar of sustainable energy supply in the National Energy Plan that was compiled in 2003, while in 2005 it compiled the Renewable Energy Master Plan, under which it is promoting the introduction of renewable energies such as solar power, wind power, micro hydropower and biomass, etc. According to the Renewable Energy Master Plan, targets for the introduction of renewable energy have been established and it is intended to raise the share of renewable energy out of total power supply from 0.8 percent in 2007 to 5 percent in 2015 and 10 percent in 2025. However, introduction of renewable energy is not advancing as expected due to the following impediments:

① The policies, regulations and institutional framework for expanding the renewable energy market do not exist;

② Introductory costs are high and it is difficult to raise funds; and

③ There are no regulations concerning technical standards for product quality, and so on.

The Government of Japan has established funding schemes such as the Cool Earth Partnership and Hatoyama Initiative in order to support developing countries that are striving to balance reduction of greenhouse gas emissions with economic growth and contribute to climate stabilization. In view of this policy by the Government of Japan, JICA has made it a policy principle to actively utilize advanced Japanese technologies for clean energy including renewable energy. Within this, there is particular need to make use of photovoltaic power technology, which is an area in which Japan is highly advanced, in international cooperation projects.

Against such a background, the Ministry of Foreign Affairs implemented a survey of needs for Program Grant Aid for Environment and Climate Change utilizing photovoltaic power, etc. in Cool Earth Partner countries. As a result, a request was received from the Government of Nigeria, and the preparatory survey regarding assistance for introduction of clean energy using photovoltaic power was implemented. The requested Project aims to procure and install a grid-connected photovoltaic system with output of 1.0 MWp at the Umaru Musa Yar'Adua University (UMYU) in Katsina State.

After the fourth field survey held in June 2011, the generation capacity of photovoltaic system was tentatively set to be 500kWp as a basis of planning and design through the discussion with the Nigerian side with due consideration of electricity demand at UMYU, installation area of the solar panels and available scale project budget. After all, it turned out that the generation capacity could be increased up to around 850kWp with the same amount of budget as a result detailed project cost estimation.

1-2 Environmental and Social Consideration

(1) Regulatory Regime concerning Environmental Impact Assessment, etc.

In Nigeria, the Federal Ministry of Environment is in charge of environmental impact assessment (EIA), which is implemented based on the Environmental Impact Assessment Act No. 86 (Decree No. 86) of 1992 and guidelines that were promulgated in 1995. Development projects are classified into the following three categories based on these guidelines:

Category 1: Projects that require a full-scale EIA

Category 2: Projects that require implementation of a partial EIA based on environmental impact mitigation measures and environment planning (a full-scale EIA is required in cases where the project site is located close to an area that needs special environmental and social consideration).

Category 3: Projects that impart an essential beneficial impact on the environment (an Environmental Impact Statement is prepared).

EIA is usually implemented according to the following procedure:

a The project implementing body submits the project proposal to the Federal Ministry of Environment and applies for implementation of EIA. The items that need to be stated in the proposal are as follows: project title, implementing agency, location, outline, sector, forecast project life, source of materials to be used, scheduled EIA implementer (consultant, etc.,)

b The Federal Ministry of Environment scrutinizes the contents, conducts field reconnaissance according to necessity, and makes a final decision on which of the three categories the project belongs to.

c Based on the decision, the project implementing agency prepares the TOR for the EIA.

d The project implementing agency implements the EIA following approval of the TOR by the Federal Ministry of Environment.

(2) Environmental Impact Assessment for the Project

Renewable energy development projects including those for photovoltaic energy are classified as Category 2 out of the aforementioned three categories; in other words, they are deemed to be projects that have medium level impacts and require partial EIA. Accordingly, a partial EIA will also be necessary in the Project too.

However, when JICA implemented a pilot project under the Master Plan Survey for Solar Energy Utilization in Nigeria in 2007, the Federal Ministry of Environment stated that there was no need to implement either a full-scale EIA or partial EIA as it was forecast that the photovoltaic power generation would create no major environmental impacts providing that the used batteries were properly disposed. In the Project, although there will be some minor environmental impact during the preparatory works (site reclamation), the photovoltaic system will not use batteries and there will be no major impacts in line with the disposal of waste batteries. Accordingly, similar to the abovementioned pilot project, there is a strong likelihood that the EIA will be waived.

In any case, the following procedure will be followed:

a. The Federal Ministry of Power will register the Project with the Federal Ministry of Environment (registration fee: 50,000 Naira); and

b. The Federal Ministry of Environment will review the environmental impact based on the Project information that is submitted. The results of review will be notified to the Federal Ministry of Power

CHAPTER 2 CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Superior Objectives and Project Objectives

The goal of energy policy in Nigeria is to promote development of diverse energy sources with a view to achieving energy security and efficient energy supply, and renewable energy is introduced under this policy.

The Government of Nigeria aims to increase the ratio of renewable energy out of total electricity supply to 10 percent by 2025, and the Project will contribute to the attainment of this goal.

2-1-2 Outline of the Project

The Project aims to install a grid-connected photovoltaic system with output capacity 850 kWp at Umaru Musa Yar'Adua University (UMYU) in Katsina State. Through doing so, it is intended to raise the ratio of renewable energy in power supply and reduce emissions of carbon dioxide. The Grant Aid component is intended to procure and install the photovoltaic generating equipment.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

Based on the request from the Government of Nigeria, the Project aims to procure and install a photovoltaic system on the Project site inside UMYU in Katsina City, Katsina State in the north of Nigeria.

The Project entails the procurement and installation of a photovoltaic system (output 850 kWp), auxiliary/control equipment for the said system, a transformer for raising the voltage of power generated by the photovoltaic panels to 11 kV, 11 kV circuit breaker, and 11 kV distribution line equipment, with the objective of supplementing the commercial power supply provided by PHCN to UMYU.

2-2-1-2 Policy regarding Natural Environmental Conditions

(1) Temperature and humidity conditions

The target area is a hot region with daily maximum temperature ranging between 30~40℃ throughout the year. A power conditioner and other equipment that contains precision instruments will be installed inside a building (power conditioner room) to be constructed in the

Project and it will be necessary to plan the building specifications, etc. so that the equipment is protected from the outside temperature and dust. When designing indoor ventilation, consideration will be given to secure an indoor temperature of no more than 40℃ when the outside design temperature is 43.1℃.

(2) Rainfall conditions

Since large amounts of concentrated rain fall during the rainy season in Nigeria, it will be necessary to take steps to ensure that rainwater doesn't infiltrate the photovoltaic panel installation area from outside. The panel area will be installed alongside the main road inside the university campus, and rainwater drainage will be planned so that the drainage ditches alongside the said road are effectively utilized.

2-2-1-3 Policy regarding Socioeconomic Conditions

Roughly 50 percent of Nigerians are Muslims (mainly in the north and west of the country) while 40 percent are Christians, and the percentage of Muslims increases more in the north. Since Katsina, at the northernmost point, has many Muslims, Ramadan is likely to have an impact on the construction works schedule, etc. When planning the work, it will be necessary to bear in mind that the Project site is on the grounds of Umaru Musa Yar'Adua University (UMYU) in Katsina City and that many Muslims will be involved in the photovoltaic power plant construction and distribution line installation works.

2-2-1-4 Policy regarding the Construction Situation / Procurement Conditions

Katsina has no industries in particular, and many residents are engaged in small-scale agriculture. As there aren't many foreign affiliated general works companies in Katsina City, the Japanese contractor will need to display ample consideration towards securing works deadlines, quality and safety when outsourcing work to local subcontractors, including dispatchment of Japanese engineers.

2-2-1-5 Policy regarding Utilization of Local Contractors

Katsina City has no Nigerian general construction firms and only a few small-scale works companies, however, in the capital Abuja and Kano State; it is relatively easy to locally procure laborers, haulage vehicles and construction materials. Accordingly, it will be possible to outsource the Project building works, foundation works and distribution line works to local operators in Abuja and Kano State.

On the other hand, local operators have no experience of installing photovoltaic panels and related equipment on the scale planned in the Project; moreover, since skilled engineers are required in order to install equipment and conduct adjustment and testing, etc. following installation, it will be difficult to utilize local operators except for laborers. Therefore, it will be necessary to dispatch engineers from Japan in order to carry out quality control, technical guidance and schedule control.

During the Survey, the Team visited a steel tower manufacturing company on the outskirts of Lagos and surveyed quality control, environmental control and safety control, etc. in the steel products manufacturing and molten zinc plating processes. It found there to be no technical problems regarding the manufacture of frames for the installation of PV panels in the Project.

2-2-1-6 Policy regarding Operation and Maintenance

UMYU currently doesn’t have any large-scale photovoltaic generating equipment. Normal operation power from PHCN via a 33 kV overhead line is received in the switch room on the university grounds and voltage is lowered to 11 kV so that power can be supplied to the university via the ring main unit. In readiness for cases where power supply from PHCN is stopped, the university operates two diesel engine generators with rated output of 1.0 MVA. These are constantly operated and maintained by a single operator in a three-shift setup manned by four operators, although the current setup doesn’t go far enough to include periodical inspections, etc. The operation and maintenance staff at the university have no experience of photovoltaic systems and do not have sufficient technical levels to operate and maintain the photovoltaic equipment following the Project. Accordingly, it will be necessary to conduct appropriate technology transfer via the soft component with respect to the maintenance department that will be responsible for operation and maintenance of the photovoltaic power equipment.

Since the Project equipment will be operated in tandem with the existing distribution lines inside the university, an appropriate operation and maintenance manual will be furnished and recommendations given on the setup following the start of services in the soft component, to ensure that the constructed equipment can be operated more effectively and efficiently.

2-2-1-7 Policy regarding the Grading of Facilities and Equipment, etc.

While bearing in mind the conditions described above, the procurement and installation scope and technical level of Project equipment will be formulated as the following basic policy.

(1) Policy regarding the scope of facilities and equipment, etc.

In order to realize a design that is both technically and economically appropriate, standard items of equipment and materials that comply with IEC and other international standards shall be adopted as far as possible. The number of models shall be minimized to promote compatibility and the minimum required equipment mix, specifications and quantities shall be selected.

(2) Policy regarding technical levels

Concerning the specifications of photovoltaic system instruments procured in the Project, in consideration of the technical level of the operation and maintenance department that will manage the equipment after installation, care shall be taken to avoid a complicated system composition and specifications.

2-2-1-8 Policy regarding Implementation /Procurement Methods and Implementation Schedule

Equipment procured in Japan and other third countries will primarily be transported to Nigeria by sea. From the port of landing at Lagos to the Project site of UMYU in Katsina, since the equipment will need to be carried overland for approximately 1,200 kilometers, it will be necessary to give ample consideration to safety when transporting the equipment.

The Project target site of UMYU is one of the universities responsible for higher education in Katsina State. When carrying out the works, it will be necessary to carefully explain the works methods to university personnel, jointly compile a detailed implementation schedule, and confirm the methods for minimizing power interruption times when connecting the photovoltaic system to the existing power grid.

Regarding the implementation schedule, since the heaviest rainfall in the Project target area occurs between July and October, it will be necessary to plan excavation and backfilling work, etc. outside of this time frame.

Moreover, since more than 90 percent of people in the target area are Muslims and a mosque is even constructed on the university grounds, work efficiency is likely to drop during the period of Ramadan. Accordingly, this will also need to be taken into account when compiling the works schedule.

2-2-2 Basic Plan (Equipment Plan)

2-2-2-1 Preconditions

(1) Power demand of the target facilities

Power to the UMYU facilities is supplied via the PHCN 33 kV distribution system, 11 kV roadside distribution lines and private generating equipment. Moreover, power to streetlights is supplied via a separate network from the UMYU system from the PHCN 33 kV distribution system.

The Survey Team measured the power demand and load factor of UMYU using a digital multi meter (commercial power from June 18 to June 21, 2011, and generator power from June 24 to June 27, 2011), and Figure 2-2-2.1 and Table 2-2-2.1 show the measurement results.

Concerning the graph data, since there were extremely frequent power interruptions during the survey, measurements were taken for nine hours each during the daytime.

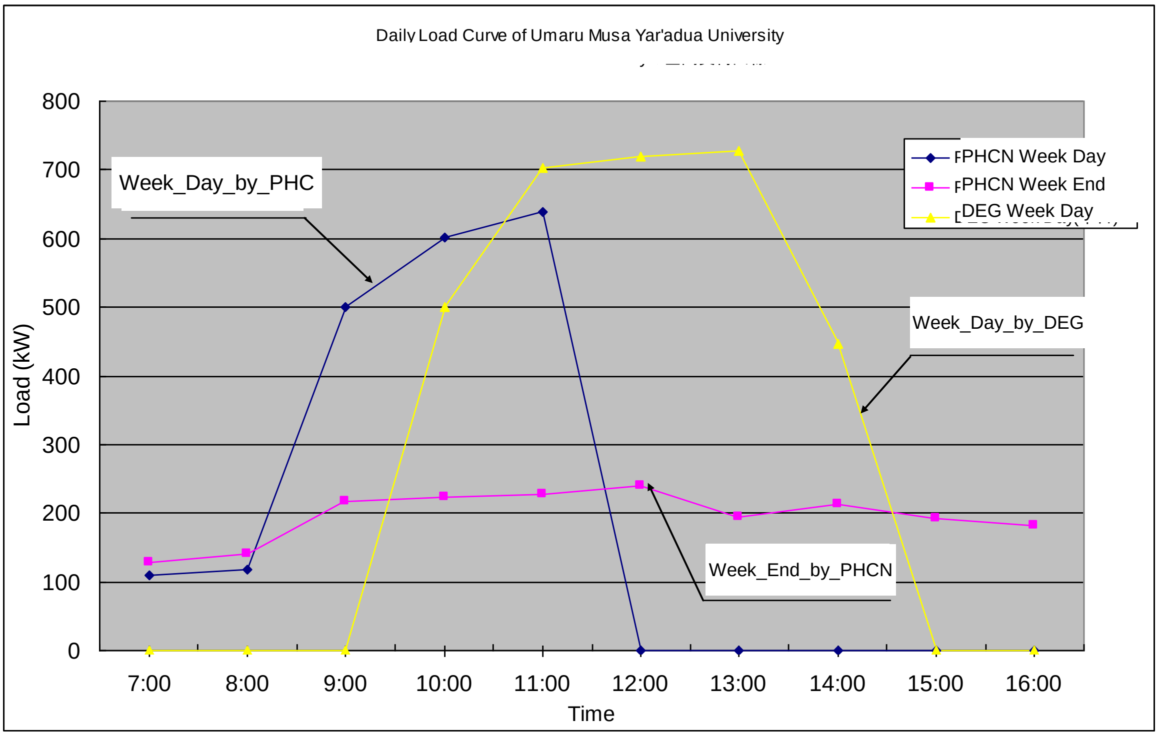

Figure 2-2-2.1 Daily Load Curve of UMYU Commercial Power Supply

Power interruptions on weekdays in Nigeria tend to occur from around 11:00 when the power demand starts to rise (daytime mean power interruption time is approximately 4.0 hours), and UMYU responds by operating emergency generators in order to sustain the university power supply. However, as a result of conducting a hearing survey at the Department of Physical Planning and Development (DPPD) of UMYU, it was found that the emergency generators are only operated for five hours from 09:00 to 14:00 on weekdays. Moreover, concerning power interruptions on holidays, since daytime interruptions are relatively short (around 2.5 hours on average), it should be possible to maintain grid-connected operation of the photovoltaic system for at least five hours.

Table 2-2-2.1 Multi Meter Measurement Results (Daytime Load Data)

Item		Measured Value	PHCN Operating Standard(*)
Distribution voltage (V)	PHCN	9.483~10.930	10.45~11.45(±5%)
	Private generation	10.960~11.180	
Frequency (Hz)	PHCN	49.20~50.50	48.75~51.25(±2.5%)
	Private generation	50.00~50.10	
Peak power (kW)	Weekdays (PHCN)	0.64	—
	Weekdays (Private generation)	0.73	—
	Holidays	0.24	—
Load factor (%)		0.872~0.976	0.85 or more

*): The PHCN standard adopts standard values of the Grid Code and Distribution Code issued by the Nigerian Electricity Regulatory Commission (NERC).

According to the above measurement findings, since peak power is 730 kW (790 kVA assuming a mean power factor of 0.924) with respect to UMYU distribution equipment capacity (total 5,000 kVA of 33/11.5 kV transformers), it will not be necessary to display special consideration regarding exiting distribution equipment in the Project.

Concerning voltage in the PHCN distribution system too, although voltage fluctuation sometimes deviates from the national standard of ±5.0 percent on the side of voltage deficiency, the inverter and protective device of the power conditioner scheduled for installation in the Project can offer protection up to voltage deficiency of 20 percent. Accordingly, current voltage deficiencies can be addressed.

1) Measured solar irradiation

The Survey Team directly measured solar irradiation inside UMYU using an actinometer on June 19 (Sunday), 2011 during the Survey period. Weather on this day was clear with light cloud, and the measured results are as shown in Table 2-2-2.2.

Table 2-2-2.2 Flat Surface and Incline Solar Irradiation at UMYU

Incline position	Unit/Hour	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Horizontal	kWh/m2	276	391	502	651	810	834	632	420	112	306	128
13° angle of inclination	kWh/m2	261	378	494	633	770	815	626	395	106	311	130
15° angle of inclination	kWh/m2	257	362	478	588	745	808	620	355	119	342	120

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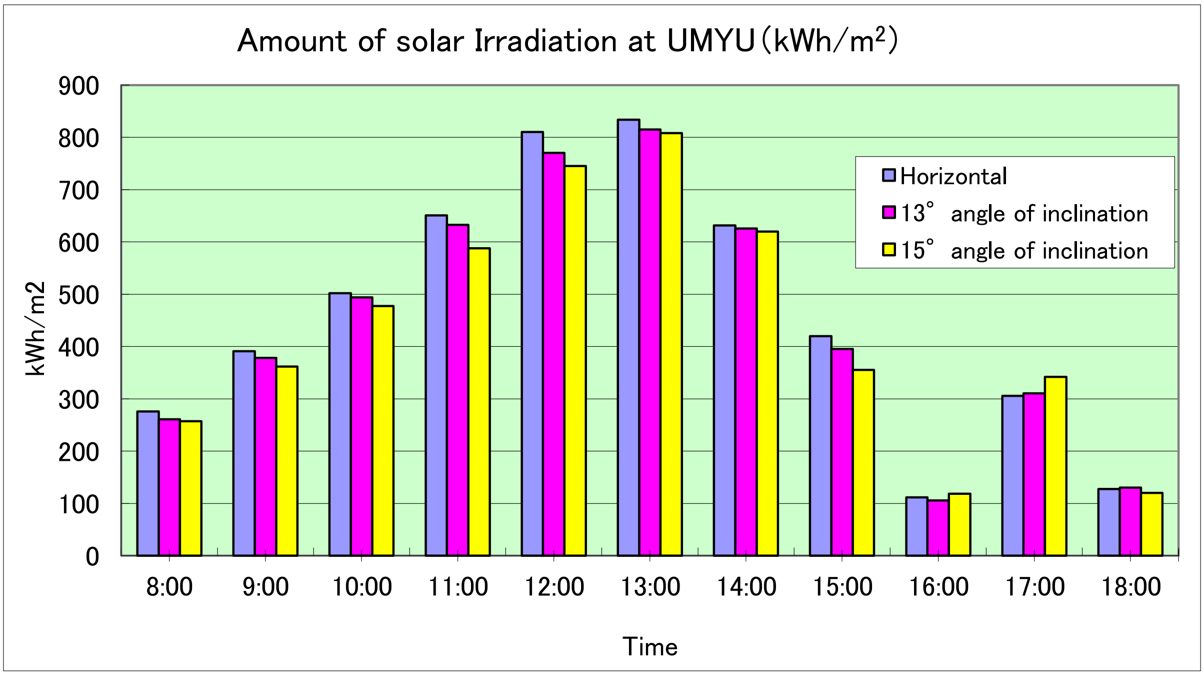


Figure 2-2-2.2 Solar Irradiation Measurement Results

The weather on June 19 (Sunday) was fine, however, since this was still during the rainy season, there was light cloud cover that caused solar irradiation to decline by 25~29 percent. Using the 13°angle of inclination of June 19, generated output (kW) from solar irradiation assuming the reted capacity of 850kWp was calculated and comparison was carried out between the UMYU load on weekdays and weekends and generating output. The results are shown in Table 2-2-2.3 and Figure 2-2-2.3.

Table 2-2-2.3 Power Load and Generated Electricity Balance at UMYU

Item / Hour	8:00	9:00	10:0	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
Amount of Solar Irradiation (Wh/m²)	261	378	494	633	770	815	626	395	106	311	130
Photovoltaic Electric Energy(kW)	163	234	305	388	470	495	380	240	65	191	80
PHCN weekday power(kW)	117	501	601	638	720	728	446	0	0	0	0
PHCN weekends power(kW)	114	218	224	227	240	194	213	193	182	163	0

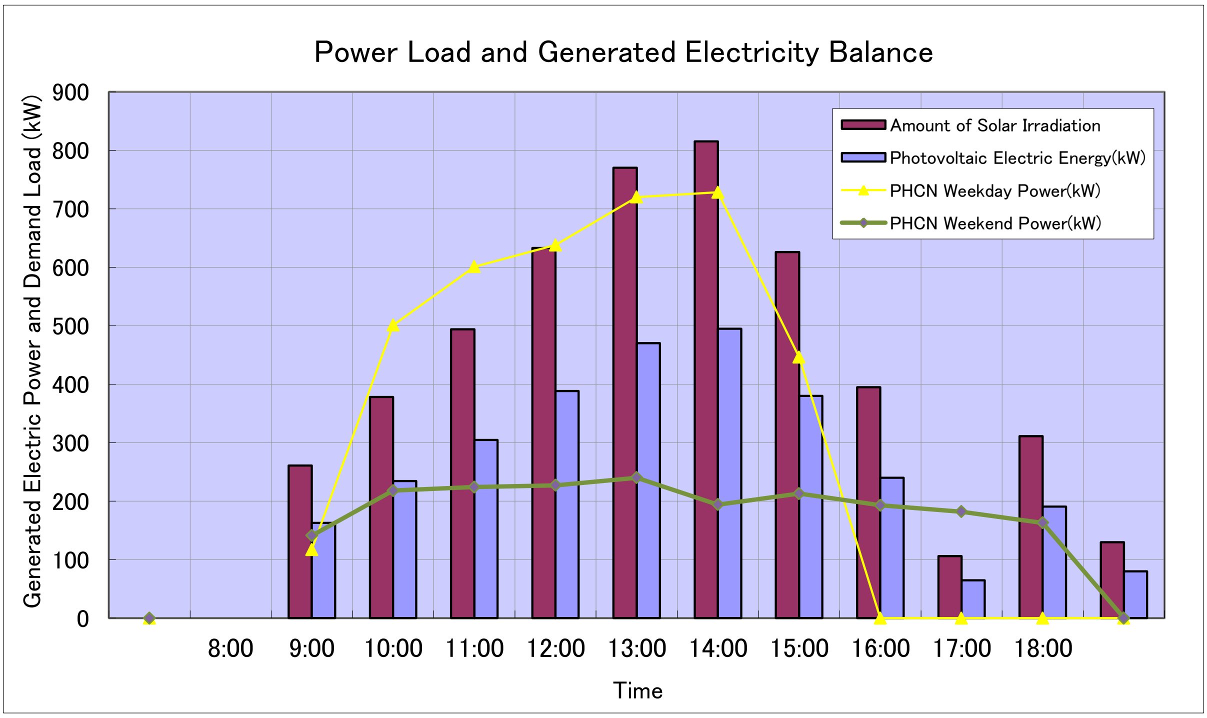


Figure 2-2-2.3 Power Load and Generated Electricity Balance at UMYU on Holidays

According to the above results, the photovoltaic power output is greater than the power load of UMYU between 9:00~17:00 on Saturdays and Sundays when the power load is low. Even though measurements were taken during the rainy season, it was possible to transmit power back to the distribution network. It should be possible to expect even higher generated power during the dry season.

(2) Systems and technical examination regarding grid connection

1) Legal systems and regulations concerning grid connection

Nigeria currently has the following two legal systems concerning private power generation and grid connection.

① NERC (Nigeria Electricity Regulatory Commission) Regulation R-0108

Regulation R-0108 targets private generation systems with output of 1 MW or higher for authorization. As the Project system is less than 1 MW, it is not subject to this regulation, however, since NERC needs to confirm the technical specifications, installation site and safety measures of private generating systems, it advises operators to submit an application for authorization that includes the equipment specifications even when output is less than 1 MW. Additionally, when selling surplus power to distribution companies, it is necessary to obtain a license when output is more than 1 MW, however, when it is less than 1 MW, it is only necessary to notify NERC.

② Systems and regulations for private power generation and grid connection based on NERC distribution code.

The Distribution Code for the Nigeria Electricity Distribution System

The NERC distribution code is applied when rotating generators with capacity of 50 kW or more are connected to the grid. When making applications, it is necessary to indicate the generating plan details (generating capacity, minimum stable load, reactive power, voltage, current, etc.).

The above systems and regulations exist with respect to private generation and grid connections; however, there are no systems and regulations concerning grid connection of renewable energy. Since the photovoltaic system in the Project is less output than 1 MW and entails no rotating generator equipment, it has been confirmed with Abuja distribution company (PHCN) that the above regulations will not be applicable. However, since it is necessary to conduct examination concerning grid operation stability, it is necessary to give notification of installation of grid-connected generating equipment to the transmission company.

NERC is currently conducting a survey on renewable energy purchase charges (feed-in tariffs) and systems under support from the United States, and this is scheduled for completion by the end of 2011. In the event where regulations on power generation and sale based on renewable energy are institutionalized on considering the results of this survey, such a system will be complied with.

2) Examination of power quality

Items that need to be examined when introducing a grid connection system to photovoltaic generating equipment are flicker and higher harmonics. The Grid Code of Nigeria allows for a voltage fluctuation of ±6 percent and frequency fluctuation of ±0.5 percent on 33 kV distribution lines. Concerning flicker and higher harmonics, the Grid Code and Distribution Code prescribe that the IEC standards are complied with. As there are no large factories or construction sites near UMYU, there is no danger of higher harmonic currents arising from the load side. Concerning the photovoltaic system to be installed in the Project, power quality equivalent to that in Japan will be secured concerning higher harmonics through keeping the general current distortion rate of the power conditioner higher harmonics output current to no more than 5 percent and each current distortion rate to no more than 3 percent based on the Electric Technology Research Association Report (Volume 46, Edition 2, Higher Harmonics and Countermeasures in Power Systems). Concerning flicker, the Electric Technology Research Association report level of $\Delta V_{10} \leqq 0.45V$ (Volume 20, Edition 8) and IEC standard of IEC 61000-4-15 will be satisfied.

3) Examination of voltage increase near the grid point

As the preconditions for examination, commercial grid power to UMYU is received from the 132/33 kV PHCN substation in Katsina City via the 33 kV distribution line. During power interruptions, one out of two 906 kW(1132 kVA) 415 kV emergency generators (the other one is currently broken down) situated next to the UMYU 33/11 kV substation is used to generate power, which is stepped up by a 1000 kVA 0.415/11 kV transformer for supply.

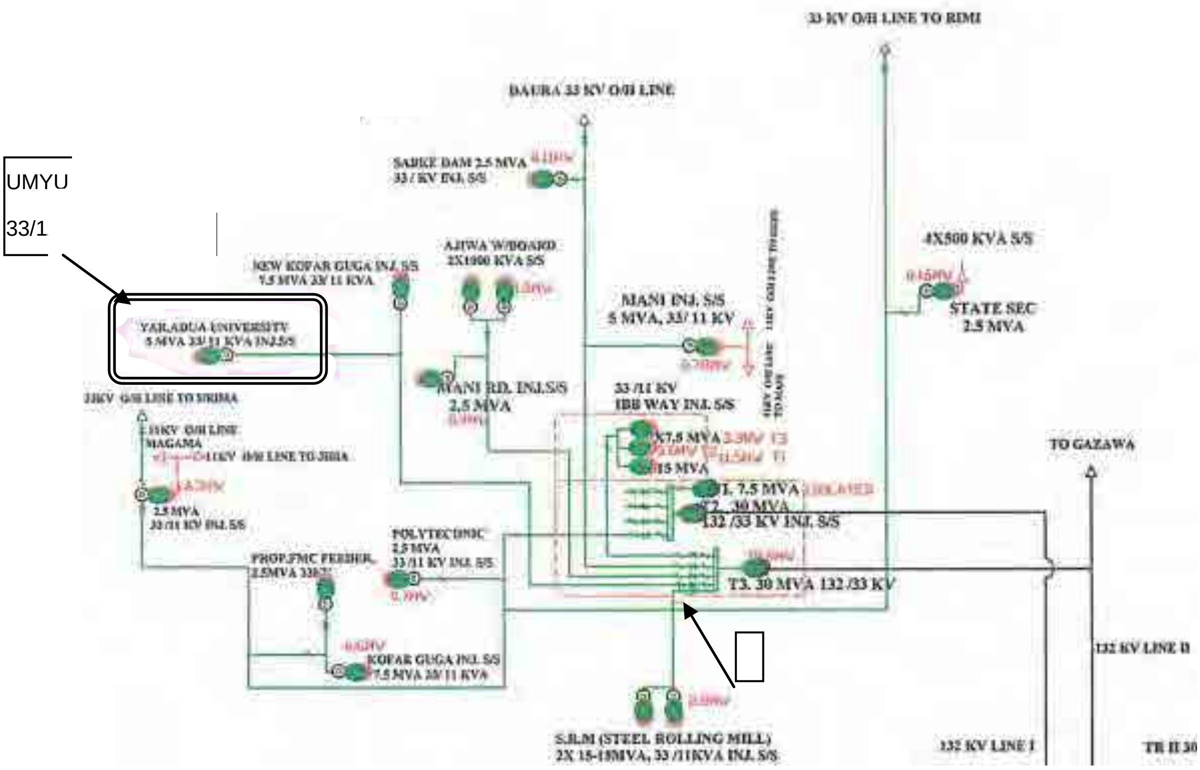


Figure 2-2-2.4 PHCN Distribution System Diagram

Table 2-2-2.4 Multi Meter Measurement Results

Item		Measured Value	PHCN Operating Criteria *)
Distribution voltage (kV)	PHCN (daytime)	9.483~0.930	10.45~1.45(±5%)
	PHCN (nighttime)	9.047~2.360	
	Private generation	10.960~1.180	

*) The PHCN standard adopts standard values of the Grid Code and Distribution Code issued by the Nigerian Electricity Regulatory Commission (NERC).

According to these results, the voltage rise in 33 kV voltages near the PHCN grid connection point during daytime when photovoltaic power generation is conducted is as follows:

33kV peak voltage (kV) = $10.930kV(daytime) \times (33/11.5)kV = 31.36kV(-4.97\%)$

Since the outcome is 31.36 kV (- 4.97%), which is within the power conditioner system output control range of 106 percent, it should be possible to conduct operation without any problems.

① Examination of 1,000 kVA transformer tap on the power conditioner side

In the power conditioner room, lighting, air conditioner, DC power supply, data logger and power supply to panels will be conducted for 24 hours. Accordingly, the low voltage power supply (415-240 V) voltage drop and voltage rise of the 1,000 kVA transformer are examined as follows.

The peak voltage is the PHCN nighttime voltage level of 12.360 kV (+12.36%), while the minimum voltage is the PHCN nighttime voltage level of 9.047 kV (- 17.75%). However, considering the daytime voltage fluctuation, it is aimed to provide a high quality power in the Project. Accordingly, the tap voltage setting will be examined using the PHCN daytime maximum voltage of 10.930 kV (- 0.64%) and the daytime minimum voltage of 9.483kV (- 13.80%).

When the aforementioned data is substituted for the voltage on the low voltage side, the following calculation results are obtained:

415 V maximum voltage (V) = $10.930kV \times (11(Tap0\%)/0.415)kV \fallingdotseq 412.30V(-0.65\%)$

240 V maximum voltage (V) = $412.30V \div \sqrt{3} \fallingdotseq 237.88V(-0.81\%)$

415 V minimum voltage (V) = $9.483kV \times (11(Tap0\%)/0.415)kV \fallingdotseq 357.71V(-13.80\%)$

240 V minimum voltage (V) = $357.71V \div \sqrt{3} \fallingdotseq 206.53V(-13.95\%)$

The control value for low voltage equipment voltage shall be 415-240 V ± 20% (332~498V, 92~88V).

Since the above results are within the low voltage equipment voltage control value, the tap voltage shall be set at 11,000 V.

(Reference examination)

The nighttime low voltage equipment voltage level is confirmed as follows:

415 V maximum voltage (V) = $12.360kV \times (11(Tap0\%)/0.415)kV \fallingdotseq 466.24V(+12.35\%)$

240 V maximum voltage (V) = $466.24V \div \sqrt{3} \fallingdotseq 269.1988V(+12.16\%)$

415 V minimum voltage (V) = $9.047kV \times (11(Tap0\%)/0.415)kV \fallingdotseq 341.27V(-17.77\%)$

240 V minimum voltage (V) = $341.27V \div \sqrt{3} \fallingdotseq 197.04V(-17.90\%)$

Since the above results are within the nighttime low voltage equipment voltage control value, there is no problem in setting the tap voltage at 11,000 V.

4) Potential installation capacity of grid-connected renewable power generation

The PHCN Kano Distribution Company conducts the power supply to UMYU, and the distribution company receives power supply from PHCN and private generators. According to the Nigerian Grid Code, Part 3, Section 2.1 Frequency and Voltage, the transmission and distribution network operator aims to maintain the system frequency between 49.75 Hz and 50.25Hz (50Hz±0.5%), and the introduction of renewable energy must not hinder operation of this system frequency.

In Nigeria, steam turbine generators are operated, and the generated energy occupies about 70% of the total output. The lower permissible limit for frequency drop in thermal generators is usually around -1.5 Hz. If frequency drops below this, since it becomes too close to the turbine rotor frequency of resonance, it becomes impossible to conduct continuous operation. According to the Grid Code of Nigeria, the operating range of frequency in emergencies is stipulated as 50Hz±2.5% (50Hz±1.25Hz), so the frequency fluctuation scope allowed in emergencies is at a dangerous level too close to the lower permissible limit for frequency drop in thermal generators. Meanwhile, according to measurements made by digital multi meter, the fluctuation in frequency of PHCN power supply is held in the range of 49.2~50.5 Hz (-1.6%~+1%). Therefore, as the operating scope of grid frequency used for examining the potential installation capacity of grid-connected photovoltaic power, it has been decided to adopt the operation target value prescribed in the Grid Code (50Hz±0.5% or ±0.25Hz).

In cases where generating equipment drops off the network due to accidents and so on, the frequency declines because the balance between power demand and supply is upset. The following formula is used to express this relationship:

$$\Delta F = -\frac{1}{K} \times \frac{\Delta P}{P} \times 100$$

Where,

ΔF: Grid frequency fluctuation (Hz)

ΔP: Output or load of the generator concerned (MW)

P: Total load of grid (MW)

K: Grid constant (KG + KL) (%MW/0.1Hz)

KG: Frequency characteristics of the generator (%MW/0.1Hz)

KL: Frequency characteristics of the network (%MW/0.1Hz)

The generating output of photovoltaic systems is subject to sudden drops due to changes in the weather. In such cases, it is necessary to limit the drop in generating output so that the grid frequency stays within the range of 50±0.25 Hz, i.e. to limit the capacity of the photovoltaic system connected to the grid. The grid constant (K) in Nigeria is unknown, however, K generally ranges 0.85～1.4% MW/0.1 Hz and 1%MW/0.1 Hz is statistically the most frequent level[1]. Therefore, assuming the grid constant in Nigeria to be 1%MW/0.1 Hz, the potential installation capacity of photovoltaic power generation shall be examined. The potential installation capacity of grid-connected photovoltaic power generation (ΔP), assuming fluctuation in grid frequency to be ΔF, is expressed by the following formula:

$$\Delta P = -\frac{\Delta F \times K \times P}{100}$$

Where,

ΔF＝-0.25Hz

P＝4,500MW (estimated peak power in Nigeria in 2010)

K＝1.0%MW/0.1Hz

In this case, ΔP＝112.5 MW; therefore, the potential installation capacity of grid-connected

[1] In Japanese power companies, 7 out of 9 companies adopt a grid constant of 1% MW/0.1Hz for load frequency control (LFC) (Institute of Electrical Engineers (March 2002) Load Frequency Control at Normal Times and Emergencies in Power Grids, Institute of Electrical Engineers Technical Report No. 869)

photovoltaic power generation (power generation based on renewable energy) in the current situation is around 112.5 MW. Currently only around 50 kWp of grid-connected photovoltaic system capacity is connected to the grid in Nigeria, and the 10 MW wind power plant currently under construction in Katsina will be the largest grid-connected renewable energy system in the country. Even so, it will still only account for less than 10 percent of the above potential installation capacity. Therefore, even if another 850 kWp of capacity is installed in the Project, the above potential installation capacity will still be greatly undercut and the Nigerian power grid will not be badly affected.

5) Examination of technical requirements concerning grid connection

As was mentioned in 2-2-1(2)1), since Nigeria has no technical standards or regulations concerning grid connection of generating systems, the technical requirements for connecting the photovoltaic system to the grid will be examined according to Japanese grid-connection regulations. In the Project, voltage on the distribution grid that will be connected to the photovoltaic system is 11 V, however, since UMYU receives power from PHCN at 33 kV, Japanese high voltage grid connection regulations (6.6 kV) shall be applied.

In connections with high voltage distribution lines, it is required to install protective devices for ensuring disconnection of the generating system from the grid when problems occur in the generating equipment or grid. Moreover, when the circuit breakers in distribution transformer stations detect an earth fault in the distribution grid and respond by breaking for a set time and then closing again, if generators connected to the grid have continued operation, there is risk that the circuit breakers will come on at asynchronous times. Accordingly, it is also compulsory to install line non-voltage confirmation devices.

Table 2-2-2.5 shows the protective relay that is required for the high voltage interconnection of generating equipment. In the Project, as there is a possibility that reverse flows to the grid will occur, the examination here will assume the ‘with reverse flow’ case. As is shown in Table 2-5, protective relays other than ground-fault overvoltage relays can be substituted by power conditioner protective devices for converting direct current into alternating current. Concerning protection against ground-fault on the grid side, because the 33 kV distribution grid in Nigeria is directly grounded, ground-fault overvoltage relays detect ground-fault on the grid side and cause generators to be disconnected.

Concerning the line non-voltage confirmation device, this can be omitted in cases where the system has two or more islanding operation detection functions and connection is broken by separate circuit breakers. Since the power conditioner planned for installation in the Project fulfills this condition, it will also be possible to omit the line non-voltage confirmation device.

Table 2-2-2.5 Devices for Ensuring Parallel-Off of Generating Equipment, etc. at Times of Trouble (assuming connection with high voltage distribution lines)

With or without electronic power inverter	With or without reverse flows	Protective relay required by interconnection regulations	Handling in the Project
With	With (※1)	Overvoltage relay(※3)	Detection/protection by the power conditioner's protective device
		Under-voltage relay (※3) (※4)	Ditto
		Ground-fault overvoltage relay (※5)	Detection/protection by the ground-fault overvoltage relay
		Frequency rise relay (※6)	Detection/protection by the power conditioner's protective device
		Frequency drop relay	Ditto
		Transfer circuit breaker or islanding operation detection device (※7)	Detection/protection by the power conditioner's islanding operation detection function
	Without (※2)	Overvoltage relay(※3)	
		Under-voltage relay (※3) (※4)	
		Ground-fault overvoltage relay (※5)	
		Reverse power relay (※8)	
		Frequency drop relay	

※1: Even when there are reverse flows, in the distribution transformer of the distribution substation that connects the generating system to the grid, always ensure that no reverse currents occur.

※2: Even when there are no reverse flows, a device can be installed for enabling the parallel-off of generating equipment at times of trouble assuming the condition with reverse flows.

※3: This can be omitted in cases where the protective device of the generating equipment can conduct detection and protection.

※4: It is possible to share with the under-voltage relay for detecting troubles in the generating system, etc. (abnormal generating voltage, etc).

※5: This can be omitted in cases where the grid is connected to the low voltage system in a facility, the output capacity of generating equipment is much smaller than the receiving power capacity, and an islanding operation detection device detects islanding operation at high speed and stops or causes parallel-off the generating equipment, etc.

※6: This can be omitted when connecting with a dedicated line.

※7: The islanding operation detection device should include at least one active detection method and satisfy all the following conditions:

a) It can definitely detect within the required time upon taking the state of grid impedance and load, etc. into account.

b) It has enough detection sensitivity not to cause frequent unnecessary parallel-offs.

c) Active signals do not having a problematic impact on the grid.

※8: This can be omitted in cases where the grid is connected to the low voltage system in a facility, the output capacity of generating equipment is much smaller than the receiving power capacity (around 5% or less), and an islanding operation detection device that includes at least one passive method and active method each detects islanding operation at high speed and stops or causes parallel-off the generating equipment, etc.

[Source] Grid Interconnection Regulations JEAC 9701-2006

(3) Preconditions for selection of specifications in primary equipment

Projects conducted under the Program Grant Aid for Environment and Climate Change scheme make a contribution towards preventing global warming and also help advertise and vitalize Japanese corporations and products. The preconditions for selecting the specifications of primary equipment will be determined in consideration of the compatibility of instruments, natural conditions in Nigeria, the electricity situation and installation space, etc.

1) Solar cell module

As is shown in Table 2-2-2.6, photovoltaic cell modules are divided into silicon types, compound semiconductors and organic photovoltaic cells.

Table 2-2-2.6 Types of Solar Cells

	Silicon				Compound Types		Organic Types	
	Crystal silicon		Membrane Silicon		CIS	III-V Crystal	Pigment Sensitization	Organic Membrane
	Monocrystal	Polycrystal	Amorphous	Multi-joined				
Features	Use a thin (200 µm~300µm) silicon monocrystal base plate. This is the PV cell with the longest history. The base plate is expensive, however, it has excellent performance and reliability.	PV cell built on a base plate of polycrystals comprising relatively small-size crystal. Since it is cheaper and easier to make than monocrystals , it is now the mainstream. Conversion efficiency is slightly inferior to that of monocrystals .	PV cell formed as a thin membrane of 1 um of amorphous (non-crystal) silicon on a base plate of glass, etc. A feature is that large areas can be mass produced, and compared to crystal silicon, it has performance issues.	PV cells made from laminated amorphous silicon and fine crystal silicon. The amount of silicon used is small (approx. 1/100 of the amount of crystal silicon) and large areas can be mass produced. Since the absorbed wavelength is wide, efficiency is higher than amorphous silicon PV cells.	A type of compound semiconductor, this thin membrane PV cell is made from copper, indium and selen, etc. Since the manufacturing process is simple and high performance, technical development is well advanced.	Ultra-high performance (conversion efficiency: 30~40%) PV cells using semiconductor base plates made from special compound such as gallium arsenide, etc. Costs are high and these types were originally developed for special uses such as space. Currently, cost reduction is being advanced through combination with light collection systems.	In these PV cells, energy is generated when pigment on titanium oxide (seminconductors) absorbs light and emit electrons. Since they are easy to make, there is anticipation over cost reduction, however, issues are achieving higher efficiency and durability.	PV cells made through PN joining of organic semiconductors. There is anticipation over cost reduction, however, issues are achieving higher efficiency and durability.
Module conversion efficiency (Research levels shown in brackets)	~15%	~14%	~6%	~10%	~11%	~30% ~37% (when collecting light)	(11%)	(5%)
Situation regarding practical application	Dissemination stage	Dissemination stage	Dissemination stage	Dissemination stage	Dissemination stage	Research stage	Research stage	Research stage
Maker	Sharp SANYO Electric Co. (HIT type)	Sharp Kyocera Mitsubishi Electric	Mitsubishi heavy Industries KANEKA	Mitsubishi heavy Industries KANEKA Fuji Electric Holdings Sharp	Showa Shell Honda	Sharp	Sharp Fujikura Sony AISIN Seiki	Panasonic Electric Works ENEOS Mitsubishi Chemical Corporation Sumitomo Chemical Co., Ltd.

Source: Agency for Natural Resources and Energy

Silicon Silicon modules are divided into crystal silicon and membrane silicon types.

Crystal silicon includes monocrystal silicon and polycrystal silicon types and is currently used in numerous modules. Crystal silicon modules have conversion efficiency of 14~15 percent and good weather resistance, and they also have the longest history of use. Membrane silicon PV cells comprise amorphous and multi-joint PV cells. As is shown in the table, membrane silicon PV cells can be mass produced from a small amount of materials, however, they are inferior in terms of conversion efficiency. In the area of compound PV modules, there are numerous compound semiconductors, however, now mostly CIS PV cells and GaAs PV cells are used. CIS and CIGS are almost the same: CIS is a compound made from copper, indium and selen, while CIGS semiconductors are made by adding gallium to CIS. CIS PV cells went into mass production in Japan in fiscal 2009 and they have started to be used in ordinary households. GaAs PV cells are used in artificial satellites and generate power through absorbing photovoltaic waves over a wide scope. They have good conversion efficiency, however, they are not commonly used due to the prohibitively high price. Organic PV cells are currently attracting a lot of attention, however, research is still being conducted into improving generating efficiency and durability, etc. These PV cells have great potential for inexpensive manufacture in the future.

2) Solar cell modules for UMYU

Katsina is situated at north latitude 13 degrees and the climate is divided into the rainy season and the dry season. Violent squalls occur during the rainy season, while the dry season is dominated by sand storms from the Sahara Desert. Maximum mean temperature is 34.0℃and the natural environment is extremely harsh. Preconditions for selecting the module specifications in the Project are the existence of past performance, reliability, durability, good conversion efficiency and ability to withstand harsh natural conditions. Furthermore, modules will be selected while giving consideration to the local installation area and natural environment. Bearing in mind these conditions, the specifications indicated in Table 2-2-2.7 have been selected for the Project.

Table 2-2-2.7 Module Specifications

Specifications	Conditions
Country of manufacture	Japan (all parts including cells shall be made in Japan)
Module type	Silicon single crystal or polycrystal type
Reference technical standards	IEC or equivalent
Module output	No less than 180W Measurement conditions (AM: 1.5, temperature 25℃, solar irradiation 1000W/m^2)
Total output	No less than 850kW
Module conversion efficiency	No less than 12%
Module weight	Weight per module: 15kg ～20kg
Size	According to maker specifications

3) Junction box and collecting box

Nigeria is subject to very harsh natural conditions. The seasons are divided into the rainy season and dry season. In the rainy season, violent squalls occur, while in the dry season, sand storms blow off the Sahara Desert. In particular, fine sand from the Sahara infiltrates gaps in buildings, junction boxes and collection boxes, etc. Since the junction boxes and collection boxes will be installed outdoors, it will be necessary to protect them from this wind, rain and sand. The protection class shall be set at IP44 or higher in order to protect the junction boxes and collection boxes from the harsh environment, high temperatures, high humidity, sand and squalls, etc. Japanese products are equally matched in terms of reliability and quality and can be used in the natural environment of Nigeria. For detailed equipment specifications, see 2-2-3 Equipment Plan.

4) Power conditioner

Since the power conditioner is the heart of the grid-connected photovoltaic system, any troubles or operating errors can impact the entire system operation. Natural conditions in Nigeria are harsh and the power supply situation is poor and subject to frequent power interruptions. The power conditioner will be installed indoors away from the wind and rain, however, it is still possible that the fine Sahara sand will infiltrate the building and have a negative impact on instruments. The protection class shall be set at IP21 or higher in order to protect instruments from the natural environment. For detailed equipment specifications, see 2-2-3 Equipment Plan.

5) Combination operating panel and control panel (COP)

The COP is the mechanism geared to ensuring that the grid-connected photovoltaic system is operated smoothly. Any troubles or operating errors in the COP can impact the power conditioner cycle rotation and the entire system for transmitting temperature and solar irradiation data, etc. Natural conditions in Nigeria are harsh and the power supply situation is poor and subject to frequent power interruptions. The COP will be installed indoors away from the wind and rain, however, it is still possible that the fine Sahara sand will infiltrate the building and have a negative impact on instruments. The protection class shall be set at IP21 or higher in order to protect instruments from the natural environment. For detailed equipment specifications, see 2-2-3 Equipment Plan.

6) DC power supply

The DC power supply is the mechanism for continuously sending control power to smoothly operate the grid-connected photovoltaic system. Any troubles or operating errors in the DC power supply can impact entire operation of the power conditioner and other panels. Natural conditions in Nigeria are harsh and the power supply situation is poor and subject to frequent power interruptions. The DC power supply will be installed indoors away from the wind and rain, however, it is still possible that the fine Sahara sand will infiltrate the building and have a negative impact on instruments. The protection class shall be set at IP21 or higher in order to protect instruments from the natural environment. For detailed equipment specifications, see

7) Transformer

The transformer is used to step-up the AC power converted in the power conditioner according to the voltage of the distribution grid. The transformer will be installed in a building close to the power conditioner room. Terminals on the 11 kV side will be divided over five voltage stages in 2.5% taps (11kV±2.5%) in order to conform to voltage fluctuations on the grid side. For detailed equipment specifications, see 2-2-3 Equipment Plan.

8) 11 kV related system panel

The 11 kV related system panel is the panel for connecting power that has been stepped up by the transformer by 11kV from the power conditioner to the existing equipment. Any troubles or operating errors in the 11 kV related system panel can impact operation of the of the entire grid-connected photovoltaic system. Natural conditions in Nigeria are harsh and the power supply situation is poor and subject to frequent power interruptions. The 11 kV related system panel will be installed indoors away from the wind and rain, however, it is still possible that the fine Sahara sand will infiltrate the building and have a negative impact on instruments. The protection class shall be set at IP21 or higher in order to protect instruments from the natural environment. For detailed equipment specifications, see 2-2-3 Equipment Plan.

9) 33 kV supply meter panel

The 33 kV supply meter panel is intended to measure the amount of electric power transmitted in reverse from the grid-connected photovoltaic system (in reverse flow). Any troubles in this panel can lead to errors in the power charge and thus have an impact on the entire grid-connected photovoltaic system and UMYU as the operator. Natural conditions in Nigeria are harsh and the power supply situation is poor and subject to frequent power interruptions. The 33 kV supply meter panel will be installed adjacent to the PHCN supply meter panel outside of the existing power house, and it will need to be protected from wind, rain and dust. The protection class shall be set at IP23 or higher in order to protect the supply meter panel from the harsh environment, high temperature, high humidity, sand and dust and squall; moreover, as the panel will be installed outdoors, measures to address dust prevention and horizontal water sprinkling will incorporated into the design. For detailed equipment specifications, see 2-2-3 Equipment Plan.

10) Display system

The display system, which displays the operating status of the photovoltaic system on a liquid crystal panel, will be installed with the goal of showing the numerous visitors to UMYU the merits, edification and permeation of photovoltaic power generation. It is desirable to adopt a Japanese display liquid crystal panel in order to raise awareness of Japanese products among Nigerian people. For detailed equipment specifications, see 2-2-3 Equipment Plan.

2-2-2-2 Overall Plan

The scale and specifications of facilities and equipment in the Project shall be planned according to the following conditions.

(1) Climate and site conditions

Table 2-2-2.8 Climate and Site Conditions

(a) Altitude	541.0 m
(b) Ambient temperature (maximum) *1	43.1 ˚C
(c) Ambient temperature (minimum) *1	31.0 ˚C
(d) Relative humidity, Maximum *1	90 %
(e) Peak monthly rainfall *1	370.0 mm
(f) Maximum wind velocity	110 mile / hour
(g) Particulate	Take into consideration

[Source] Nigerian Meteorological Agency

(2) Electric system conditions

1) Distribution voltage: (medium voltage) 3 phase 3 wire, 33 kV
: (medium voltage) 3 phase 3 wire, 11 kV
: (low voltage) 3 phase 4 wire, 415/240 V
2) Frequency: 50 Hz
3) Maximum shour circuit capacity: 11 kV system, 12.5 kA (1 sec)
4) Grounding system: 11 kV system, direct grounding
5) Grounding resistance: 10 Ω or less, 3phase 3line, 33kV
6) Coloring: IEC standards (red, white, blue, black)

(3) Facilities planning conditions

The Project site is on the grounds of UMYU. As the site is expansive, gently undulating and has rainwater drainage channels running alongside the main road, almost the entire area is suitable for installing PV panels. When arranging the panels, safety measures shall be adopted regarding the upward force of winds in design of the mounting structure and foundations.

Since the Project site doesn’t contain an existing building for storing necessary electrical instruments such as the step-up transformer and power conditioner, a power conditioner room (single story, measuring around 5.0 m x 15.0 m) shall be newly constructed on the site.

Regarding the new power conditioner room, in order to ensure a structure that blocks out the heat created by the year-round high temperatures, chipboard shall be used for roofing materials, and ceilings shall be fitted indoors in order to minimize the impact of heat from the roof.

In addition, dust control must be taken into consideration to prevent dust from the Sahara from coming to the room.

The transformer for converting power to the 11 kV voltage used in UMYU shall be installed inside the new power conditioner room; 11 kV underground cable shall be laid in conduits to the 11 kV circuit breaker panel installed in the electricity room of the existing emergency generator house, and this shall be connected to the bus bar of the existing circuit breaker in order to supply power.

2-2-2-3 Equipment Plan

(1) Facilities plan conditions

The photovoltaic cells (850 kW) will be installed on approximately 16,500 m^2 of vacant land approximately 200 m (on the left side) from the UMYU main entrance. Since the land here is relatively flat, it will be relatively easy to execute the works. For the layout, see the outline design drawings in 2-3. The power conditioner and other equipment will be installed inside a building to be newly constructed adjacent to the photovoltaic modules. The high-voltage distribution line on the output side will be laid under the road and will lead to the power house some 460 m away. At nighttime, since the area becomes deserted and power interruptions are frequent, Photovoltaic Street lights will be installed around the panel site perimeter and steps will be taken to prevent theft.

(2) Outline specifications of equipment

The photovoltaic equipment to be procured and installed by the Japanese side under the Project shall be based on JIS and IEC standards and specifications. Also, when selecting the facilities and equipment for the photovoltaic grid-connected system, the minimum number of specification items shall be sought and standard design models shall be adopted in order to facilitate installation and shorten the installation period. The following table shows the outline of the basic plan, procurement quantity and the outline specifications of the main equipment. Since the system differs between makers, the numbers of junction boxes, collecting boxes and power conditioners are not yet decided.

Table 2-2-2.9 Outline of the Basic Plan

	Procurement and installation of the following photovoltaic equipment	Quantity
Equipment procurement and installation works	Solar power modules	1 set
	Solar power modules mounting structure	1 set
	Junction box *1)	1 set
	Collecting box *1)	1 set
	Combination operating panel	1
	Power conditioner *1)	5~10
	Control panel	1
	DC power supply	1
	Grid-connected transformer	1
	11kV switchgear	1
	Under voltage protective relay for 11kV receiving panel	1
	33kV supply meter panel	1
	33kV line protective ground-fault overvoltage protective relay	1
	Display system	1 set
	Instrumentation	1 set
	Wiring materials	1 set
	Grounding work materials	1 set
	Buried protective pipes	1 set
Equipment procurement plan	Solar power generating equipment replacement parts, maintenance tools, test devices and safety devices	1 set

Note *1) Quantity will vary depending on the maker.

Table 2-2-2.10 Solar Power Module Specifications

Equipment	Specifications	Required Specifications
1. Solar power modules	(1) Applicable standard	IEC and equivalent standards, protection class IP65 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature	+34.0℃
	(4) Installation method	Above ground installation
	(5) Type	Crystal silicon
	(6) Module efficiency	12% or higher
	(7) Module capacity	180W/1 or more

Table 2-2-2.11 Solar Power Module Mounting Structure Specifications

Equipment	Specifications	Required Specifications
2. Solar module mounting structure	(1) Support method	Steel frame
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Material	SS400 hot dip zinc finish or equivalent quality

Table 2-2-2.12 Junction Box Specifications

Equipment	Specifications	Required Specifications
3. Junction box	(1) Structure	Outdoor, wall hanging type, protection class IP44 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Maximum input voltage	String unit nominal open voltage (Voc) or more
	(5) Input circuits	Number of sub-array unit parallel lines or more
	(6) Input current	Module nominal shorting current (ISC) per circuit or higher
	(7) Output circuits	1 circuit
	(8) Output current	Module nominal shorting current (ISC) or higher
	(9) Internal devices	- Wiring circuit breaker: Number of circuits - Reverse flow prevention diode: Each string - Induced lightning protector: All input and output circuits, between wires, between earth

Table 2-2-2.13 Current Collection Box Specifications

Equipment	Specifications	Required Specifications
4. Current collection box	(1) Structure	Outdoor, wall hanging type, protection class IP44 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Maximum input voltage	String unit nominal open voltage (Voc) or more
	(5) Input circuits	Condensed number of junction boxes or more
	(6) Input current	Junction box output current or more
	(7) Output circuits	1 circuit
	(8) Output current	Sub-array nominal short circuit current x Number of input circuits or more
	(9) Internal devices	- Wiring circuit breaker: Number of circuits - Induced lightning protector: All input and output circuits, between wires, between earth

Table 2-2-2.14 Combination Operating Panel Specifications

Equipment	Specifications	Required Specifications
5. Combination operating panel	(1) Structure	Indoor, aboveground vertical standing type, protection class IP21 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Rated voltage	Set at DC400 V or the photovoltaic module voltage
	(5) Rated current	Set at DC400 A or the photovoltaic module current
	(6) Input circuits	10 circuits or more (including spare power conditioner)
	(7) Input current	Set at DC400 A or the photovoltaic module current
	(8) Output circuits	100 circuits (in case of 10 input circuits)
	(9) Output current	Set at DC400 A or the photovoltaic module current
	(10) Self-contained instruments	- Electromagnetic switch: 100 circuits (in case of 10 input circuits) - Induced lightning protector: All input and output circuits, between wires, between earth
	(11) Control power supply	DC100V
	(12) Operating conditions	- Direct manual operation by snap-in switch - Establishment of sequence circuit based on snap switch manual operation once per month - For the control procedure, see the single-line diagram.
	(13) Protective device	Thermal relay: 100 circuits (in case of 10 input circuits)

Table 2-2-2.15 Power Conditioner Specifications

Equipment	Specifications	Required Specifications
6. Power conditioner	(1) Structure	Indoor, aboveground vertical standing type, protection class IP21 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Main circuit system	Self-exciting voltage
	(5) Switching system	High frequency PWM
	(6) Insulation system	Commercial frequency insulation transformation
	(7) Cooling system	Forced air cooling
	(8) Rated input voltage	String maximum output voltage (Vpmax) or thereabouts
	(9) Input operation voltage range	The string maximum output voltage (Vpmax) and nominal open voltage (Voc) shall be within range.
	(10) Input circuits	The number of current collection boxes or more
	(11) Output electricity system	3φ3W or 3φ4W
	(12) Rated output voltage	AC415V or adjust to voltage on the transformer low voltage side
	(13) Rated frequency	50Hz
	(14) AC output current distortion factor	General current 5% or less, each sub-wave 3% or less
	(15) Power control system	Maximum output follow-up control
	(16) Rated power conversion efficiency	90% or more
	(17) Control functions	- Automatic start/stop, soft start - Automatic voltage adjustment - Input/output over-current adjustment - Output adjustment
	(18)Grid-connected protective functions	- Over voltage (OVR) - Under voltage (UVR) - Over frequency (OFR) - Under frequency (UFR) All permanent values, with timed variation
	(19) Islanding operation detection function	- Active type (at least 1 mode out of the following): ① Frequency shift system ② Active power fluctuation system ③ Reactive power fluctuation system ④ Load fluctuation system - Passive type (at least 1 mode out of the following): ① Detection method for power phase jump ② Detection method for sudden increase in third harmonic voltage ③ Detection method for frequency change rate

Table 2-2-2.16 Control Panel Specifications

Equipment	Specifications	Required Specifications
7. Control panel	(1) Structure	Indoor, aboveground vertical standing type, protection class IP21 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Rated voltage	AC600V or adjust to voltage on the transformer low voltage side
	(5) Number of phases	3φ4W
	(6) Rated current	AC2,000A or set at the transformer rated current and shorting current
	(7) Input circuits	Bus line lead-in or 10 circuits or more
	(8) Output circuits	1 circuit
	(9)Self-contained instruments	- Air-insulated circuit breaker (ACB): 1 (draw-out type) - Lightning conductors: 3 - Meter current transformers: 3 - Meter zero phase current transformers: 4 - Wiring circuit breakers (MCCB): 4 - Other auxiliary instruments: 1 set
	(10) Control power supply	DC100V
	(11) Operating conditions	- Direct manual operation of air-insulated circuit breaker by control switch
	(12) Measurement and protective devices	- Over-current relay: 1 (3 phase protection) - Ground-fault over-current relay: 1 - Ammeter: 1 (3 phase and zero phase measurement) - Wiring ground-fault over-current relays: 4

Table 2-2-2.17 DC Power Supply Specifications

Equipment	Specifications	Required Specifications
8. DC power supply	(1) Structure	Indoor, aboveground vertical standing type, protection class IP21 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Input AC rated voltage	AC415V or adjust to voltage on the transformer low voltage side
	(5) Input AC phases	3φ3W
	(6) Output DC rated voltage	DC100V
	(7) Output DC phases	2φ2W
	(8) Input AC rated current	AC20A or more
	(9) Output DC rated current	DC20A or more
	(10) Input AC peak capacity	5.6kVA or more
	(11) Output voltage accuracy	1.5% or less
	(12) Output efficiency	75% or more
	(13) Cooling method	Self-cooling
	(14) Output circuits	4 circuits or more
	(15) Storage battery	- Control valve type lead storage battery (MSE) or better - Cells: 54 - Storage battery unit voltage: DC2.23 V or higher - Output time factor: 50AH
	(16) Self-contained instruments	- AC transformer: 1 - Rectifier: 1 - AC circuit breaker: 1 - Wiring circuit breakers (MCCB): 6 or more - Other auxiliary instruments: 1 set
	(17) Control power supply	AC240V or DC100V
	(18) Operating conditions	- Thyristor constant voltage automatic control
	(19) Measurement and protective devices	- DC voltage protective device: 1 - Voltmeter: DC 1 - Ammeter: AC 1, DC 1 - AC voltage input display lamp: 1

Table 2-2-2.18 Transformer Specifications

Equipment	Specifications	Required Specifications
9. Grid-connection transformer	(1) Applicable standard, Structure	JIS, IEC Standards, Outdoors, vertical standing type
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Capacity	1,000kVA
	(5) Primary voltage	3φ4W AC415V or adjust to the power conditioner output voltage setting
	(6) Secondary voltage	3φ3W AC11kV
	(7) Frequency	50 Hz
	(8) Insulation class	Type B
	(9) Connection method	Ynd11 (415 V side: Y connection, 11 kV side:Δ connection)

Table 2-2-2.19 11 kV Switchgear Specifications

Equipment	Specifications	Required Specifications
10. 11kV switchgear (existing maker: MERLIN GREEN)	(1)Applicable standard, Structure	IEC or equivalent standards, Indoor, aboveground vertical standing type, protection class IP21 or higher
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Rated voltage	AC11kV or more
	(5) Number of phases	3φ3W
	(6) Rated current	630A or more
	(7) Bus wire shorting current	20kA or more
	(8) Input circuits	1 circuit
	(9) Connection method	Existing mold insulated bus line lead-in
	(10) Self-contained instruments	- Lightning conductors: 3 - Disconnecting switch: 1 - Grounded disconnecting switches: 2 - Vacuum circuit breaker: 1 (fixed) - Meter current transformers: 3 - Meter transformers: 3 - Other auxiliary instruments: 1 set
	(11) Control power supply	AC110V
	(12) Operating conditions	- Direct manual operation by mechanical or electrical interlock

Equipment	Specifications	Required Specifications
	(13) Measurement and protective devices	- Over-current relay: 1 (3 phase protection) - Ground-fault over-current relay: 1 - Reverse phase or current imbalance relay: 1 (3 phase protection) - Re-closing lockout relay: 1 - Power multi meter: 1

Table 2-2-2.20 11 kV Under-voltage Protective Relay for Receiving Panel Specifications

Equipment	Specifications	Required Specifications
11. Under voltage protective relay for 11kV receiving panel	(1) Applicable Standard, Structure	JIS or IEC standard, Indoor, wall hanging embedded type
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Input voltage	AC110V
	(5) Number of phases	3φ4W
	(6) Frequency	50Hz
	(7) Stabilization scope	60V ~ 100V equivalent
	(8) Operation time	0.2S ~ 5.0S equivalent
	(9) Power consumption	7.0VA or less
	(10) Control power supply	AC110V
	(11) Attached devices and equipment	- Voltmeter: 1 (3 phase measurement) - No-voltage contact: 2C (1a1b x 2) - Test terminal block: 1 set - Test plug: 1 set

Table 2-2-2.21 33 kV Supply Meter Panel Specifications

Equipment	Specifications	Required Specifications
12. 33 kV supply meter panel	(1) Structure	Indoor, aboveground vertical standing type, protection class IP23 or higher (take dust prevention steps and steps against horizontal water sprinkling)
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Rated voltage	AC33kV or more
	(5) Number of phases	3φ3W
	(6) Rated current	630A or more
	(7) Bus wire shorting current	20kA or more
	(8) Input circuits	1 circuit
	(9) Connection method	33kV cable lead-in
	(10) Self-contained instruments	- Meter current transformers (accuracy class: 0.5 class): 3 - Meter transformers (accuracy class: 0.5 class) : 3 - Other attached instruments: 1 set
	(11) Control power supply	AC110V

Equipment	Specifications	Required Specifications
	(11) Handling conditions	- Door lock and sealing
	(12) Measuring device	- Digital integral power consumption meter (with calibration) (accuracy class: 0.5 class): 1 (Existing electric energy meter: ER300P)

Table 2-2-2.22 33 kV Line Protection Ground Overvoltage Protective Relay Specifications

Equipment	Specifications	Required Specifications
13. 33 kV line protection ground overvoltage protective relay	(1) Applicable Standard, Structure	JIS or IEC standard, Indoor・wall hanging embedded type
	(2) Environment of use	Tropical, sandy area, no more than 1,000 m
	(3) Ambient temperature and humidity	+40℃ or less, 85% or less
	(4) Input voltage	AC110V
	(5) Number of phases	2W
	(6) Frequency	50Hz
	(7) Stabilization scope	10V ~ 50V equivalent
	(8) Operation time	0.1S ~ 30.0S equivalent
	(9) Power consumption	15.0VA or less
	(10) Control power supply	AC110V
	(11) Attached devices and equipment	- Zero phase voltmeter: 1 - No-voltage contact: 2C (1a1b x 2) - Test terminal block: 1 set - Test plug: 1 set

Table 2-2-2.23 Instrumentation Specifications

Equipment	Specifications	Required Specifications
14. Instrumentation	(1) Actinometer 1) Applicable standard 2) Sensitivity	 ISO9060 Second class or equivalent Ex. (6～8μV/(kW・m-2))
	(2) Thermometer 1) Type 2) Shape 3) Temperature range of use	 Measurement resistor Pt100Ω 4wire With basic shelter -40℃～＋60℃
	(3) Climate change box 1) Structure 2) Material 3) Input signals 4) Output signals 5) Power source 6) Housed equipment	 Outdoor wall hanging type SS400 hot dip zinc finish or equivalent quality Actinometer (0-10mV), thermometer (Pt100Ω) 4-20mA×2 AC240V Actinometer signal converter, thermometer signal converter, wiring circuit breaker, induced lightning protector

Equipment	Specifications	Required Specifications
	(4) Instrumentation monitoring device (site side) 1) Data measuring method - Measurement cycle - Data collection items 2) Used devices 3) Software specifications (server side)	 6 seconds Inclined plane solar intensity, temperature, generated electric energy Instrumentation monitoring device Serial signal converter (RS485→RS232C conversion) Uninterrupted power supply (to counter instantaneous stoppage) Instrumentation monitoring device box Instantaneous value display, graph and form display Power conditioner operating status, trouble information display Power conditioner protective device setting information storage
	(5) Remote monitoring system 1) Specifications - Site side data control - Data viewing - Data download 2) Data viewing rights	Transmission of site side data to the data logger and data storage Download of forms data, display and printing of forms and graphs

Table 2-2-2.24 Electric Wire Specifications

Equipment	Specifications	Required Specifications
15. Wiring materials		
Module ~ Junction box	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Ditto
Junction box ~ Current collection box	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Ditto
Current collection box ~ Combination operating panel ~ Power conditioner	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Cable ground, connecting terminal, bracket, frame

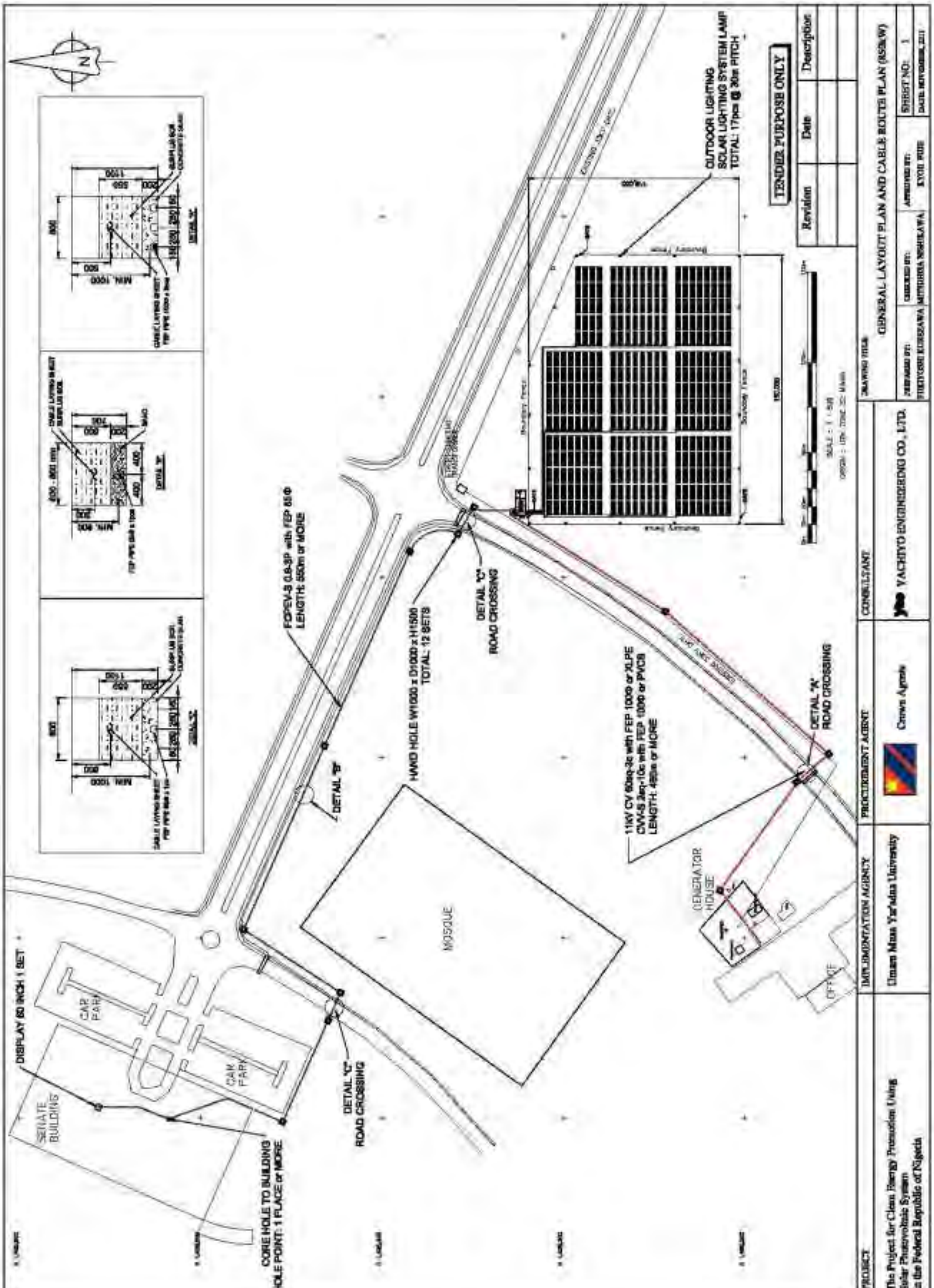
Equipment	Specifications	Required Specifications
Control panel ~ Transformer	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Existing panel dedicated termination material、bolt nuts, hexagonal terminal, transformation termination material, bracket, frame
Transformer ~ 11kV existing switchgear	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Existing panel dedicated termination material, bolt nuts, hexagonal terminal, bracket, frame
33kV existing supply meter panel ~ 33kV new supply meter panel	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Cable ground, connecting terminal
11kV existing switchgear ~control panel	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Cable ground, connecting terminal
Control panel ~ Display unit	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto RJ45 connector and equivalent items
Control panel ~ Data logger	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Cable ground, connecting terminal
Switch room ~ Climate change box (Communication cable)	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Ditto
Ground works materials	(1) Applicable standard (2) Model (3) Size (4) Other	IEC, JIS or an equivalent standard See 2-3 Outline Design Drawing Ditto Ground rod 14mm^2×1.5m

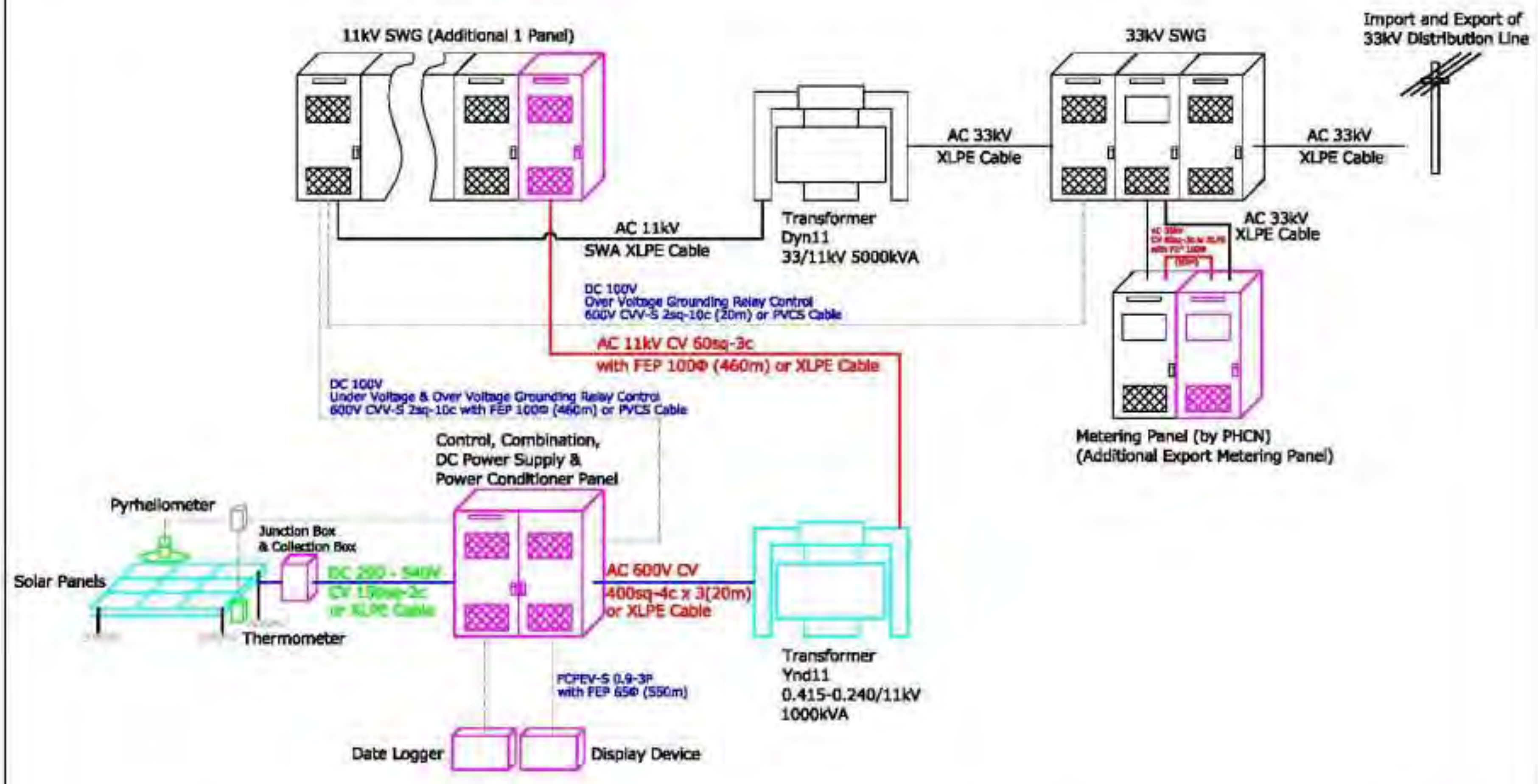
Table 2-2-2.25 Outline of Buried Protective Pipe

Equipment	Specifications	Required Specifications
16. Cable protection pipe	(1) Applicable Standard	IEC, JIS or an equivalent standard
	(2) Material	Steel pipe for cable protection, or cable flexible pipe, or undulating hard polyethylene pipe
	(3) Size	See 2-3

2-2-3 Outline Design Drawing

- General Layout Plan and Cable Route Plan
- System Flow Diagram
- Single Line Diagram for 33 kV and 11kV Line
- Single Line Diagram for Solar Farm
- Single Line Diagram for Combination Operating Panel
- Layout Plan for Power Conditioner Room
- Layout Plan for Existing Power House


DISPLAY 60 INCH 1 SET
SENATE BUILDING
CAR PARK
CAR PARK
CORE HOLE TO BUILDING
HOLE POINT: 1 PLACE or MORE
DETAIL "C"
ROAD CROSSING
MOSQUE
DETAIL "B"
FCPEV-S 0.9-3P with FEP 65Φ
LENGTH: 550m or MORE
HAND HOLE W1000 x D1000 x H1500
TOTAL: 12 SETS
DETAIL "C"
ROAD CROSSING
11kV CV 60sq-3c with FEP 100Φ or XLPE
CVV-S 2sq-10c with FEP 100Φ or PVC6
LENGTH: 450m or MORE
GENERATOR HOUSE
OFFICE
DETAIL "A"
ROAD CROSSING
OUTDOOR LIGHTING
SOLAR LIGHTING SYSTEM LAMP
TOTAL: 17pcs @ 30m PITCH
TENDER PURPOSE ONLY
Revision
Date
Description
PROJECT
The Project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria
IMPLEMENTATION AGENCY
Umaru Musa Yar'adua University
PROCUREMENT AGENT
Crown Agents
CONSULTANT
YACHIYO ENGINEERING CO., LTD.
DRAWING TITLE
GENERAL LAYOUT PLAN AND CABLE ROUTE PLAN
SHEET NO: 1



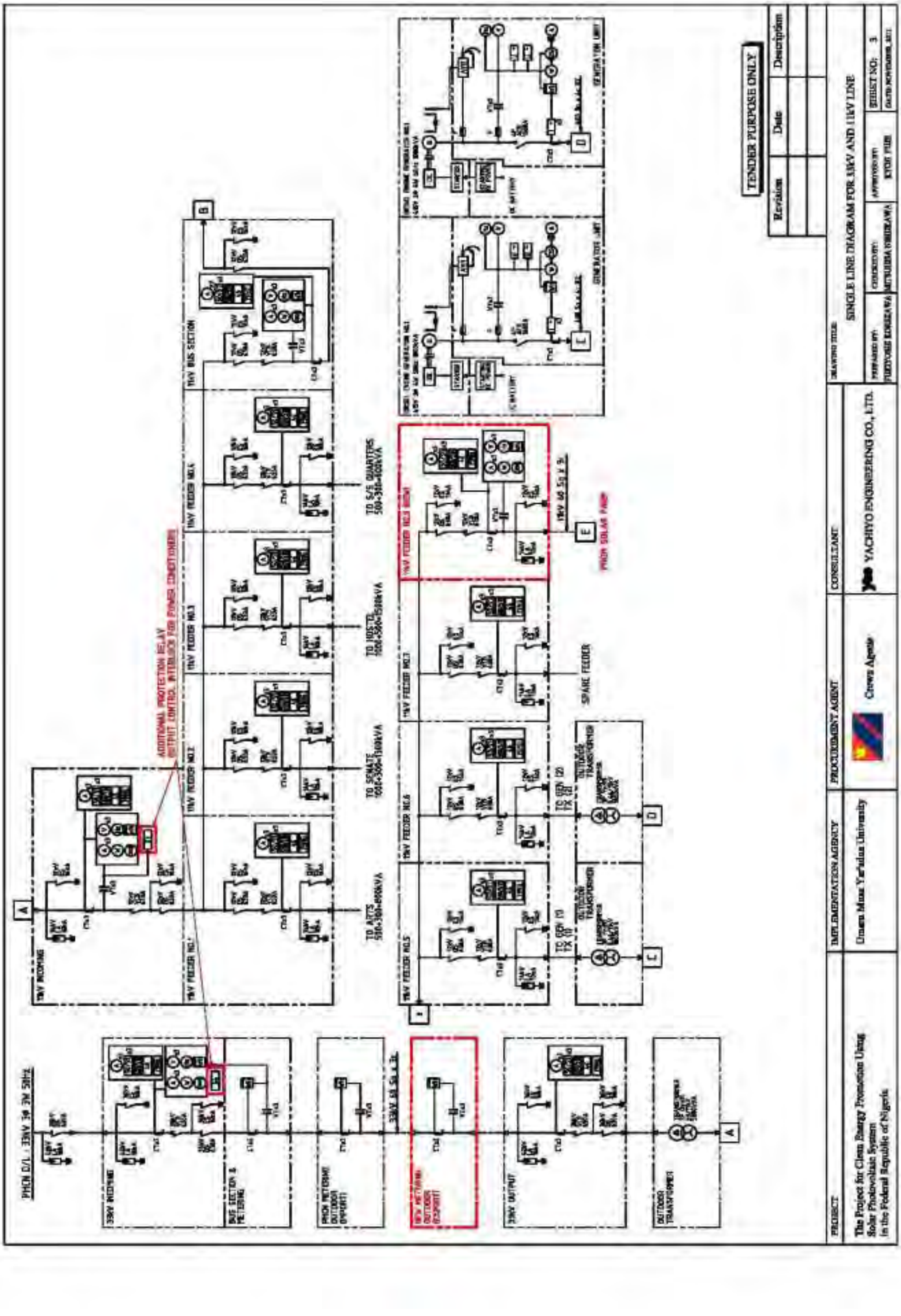
SYSTEM FLOW DIAGRAM for SOLAR POWER SYSTEM

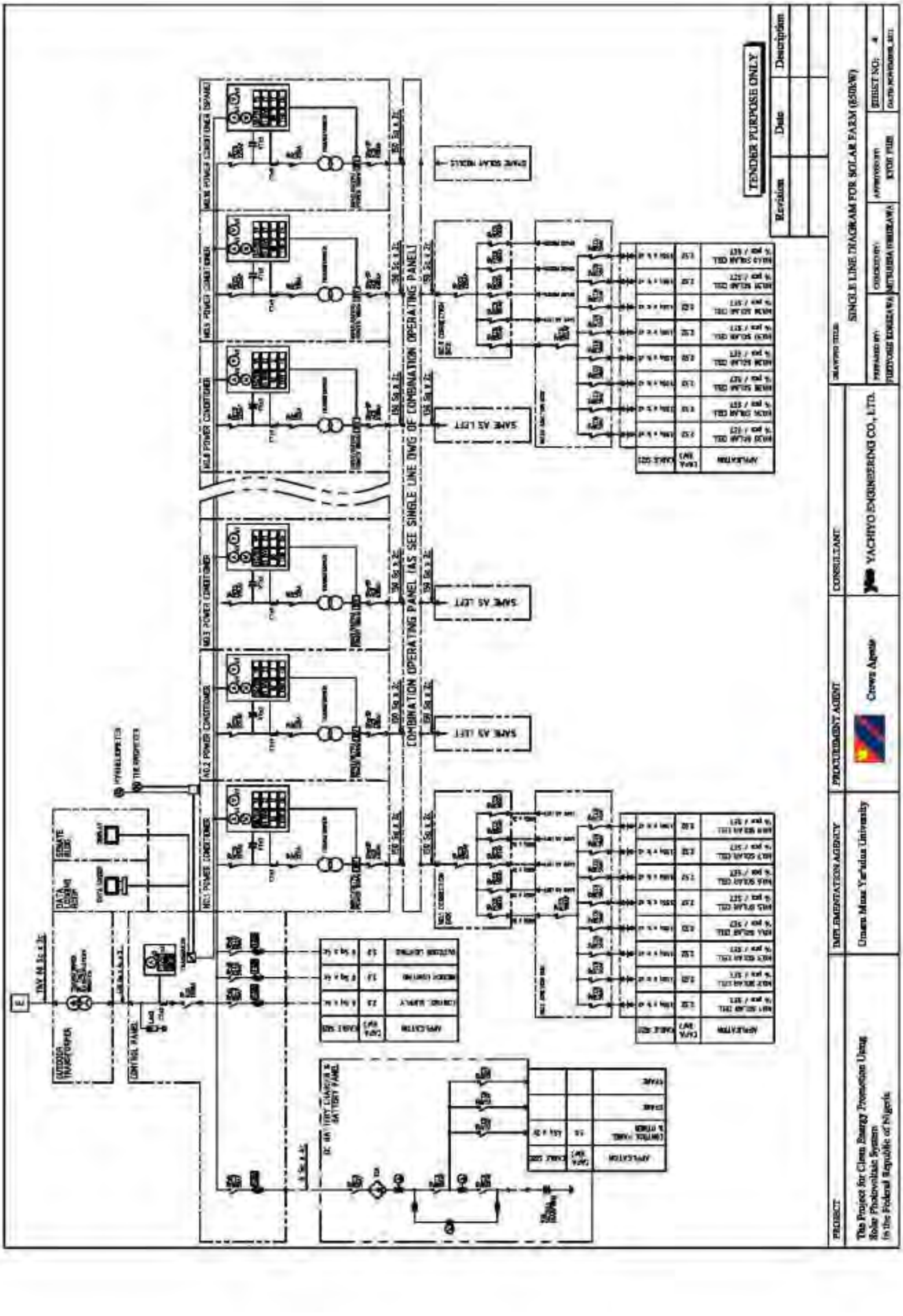
TENDER PURPOSE ONLY

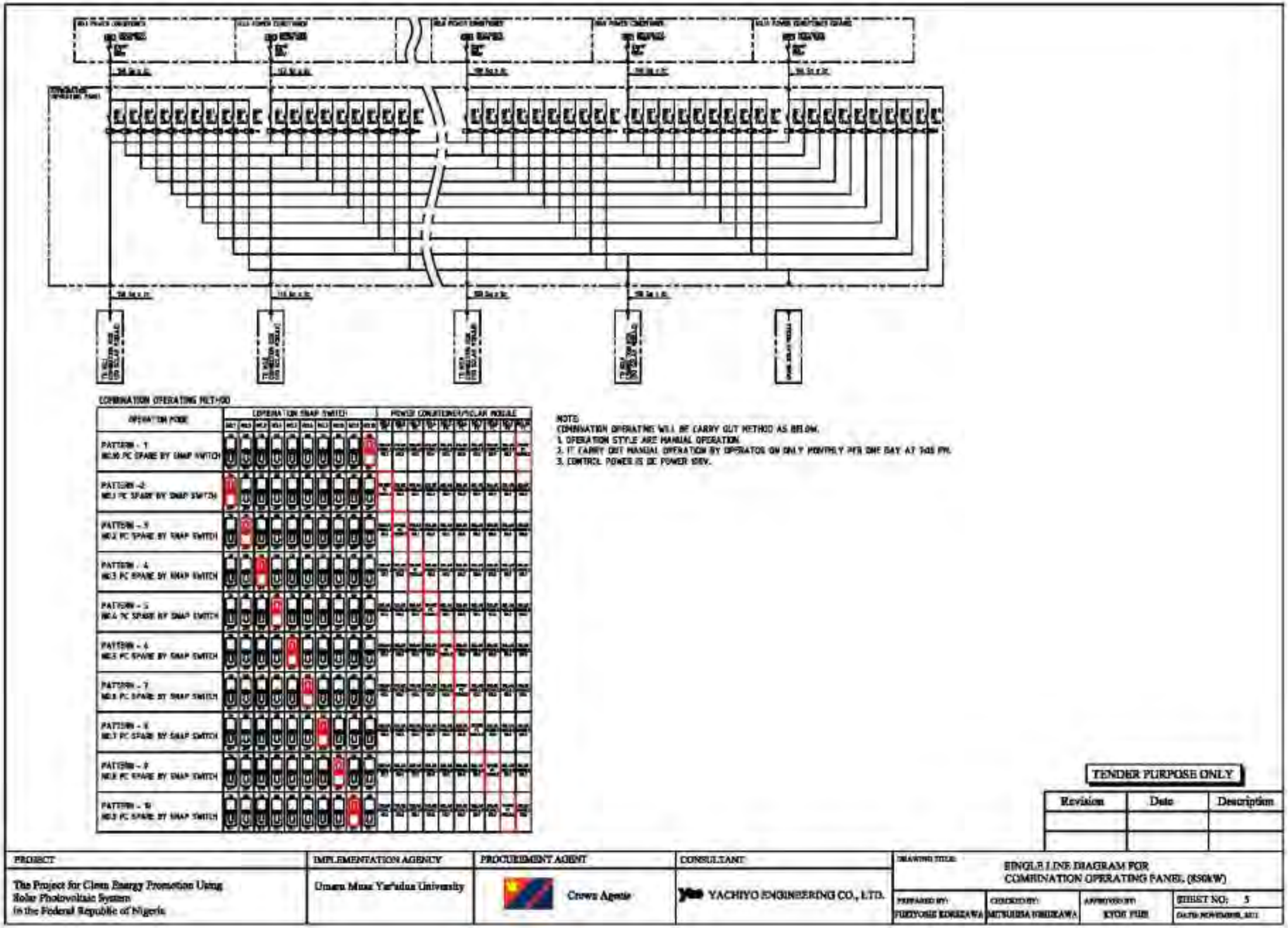
Revision	Date	Description

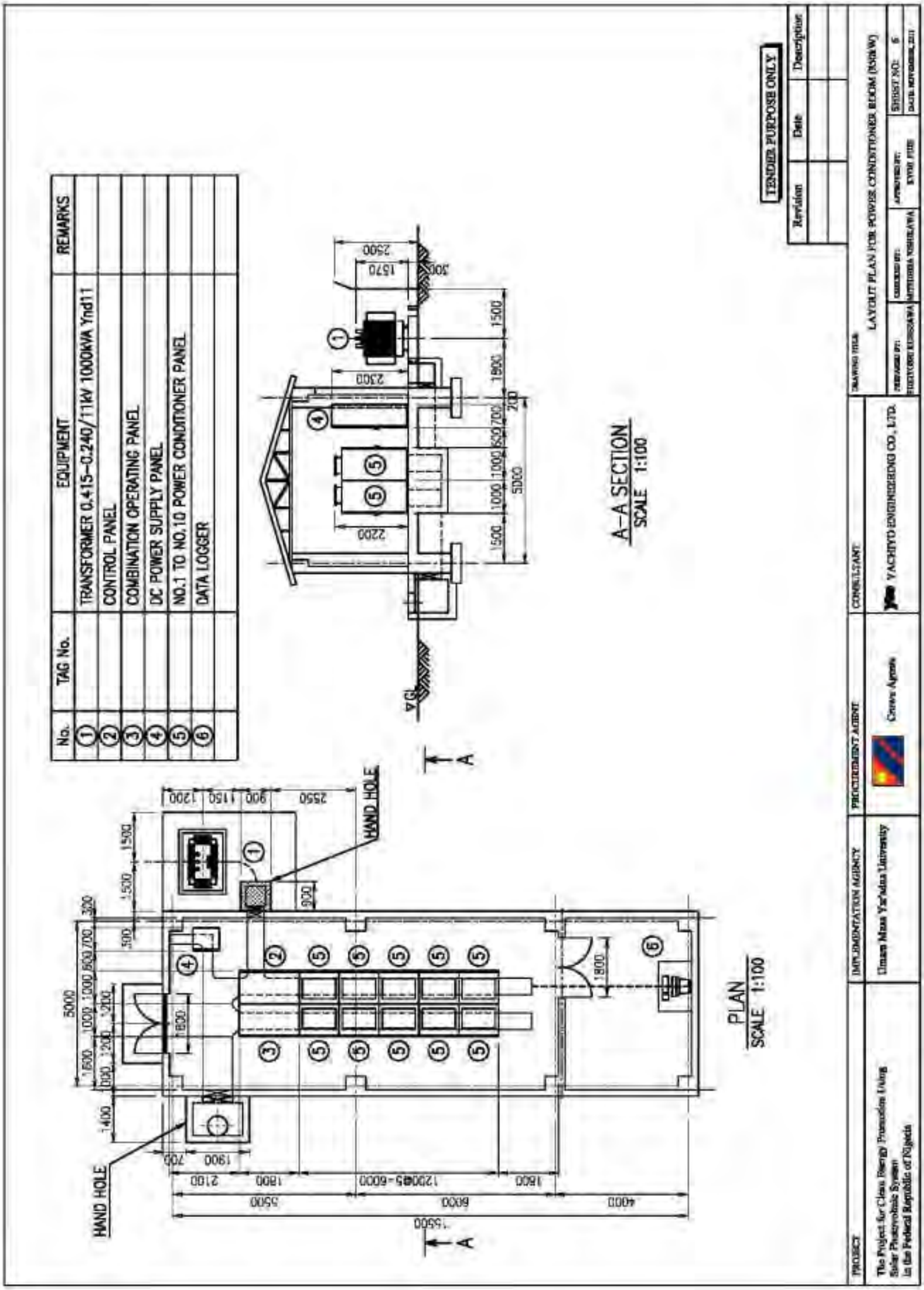
PROJECT	IMPLEMENTATION AGENCY	PROCUREMENT AGENT	CONSULTANT	DRAWING TITLE
The Project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria	Umaru Musa Yar'adua University	Crown Agents	YACHIYO ENGINEERING CO., LTD.	SYSTEM FLOW DIAGRAM

PREPARED BY:	CHECKED BY:	APPROVED BY:	SHEET NO: 2
FUKIYOSHI KOBIZAWA	MITSUHIRA NISHIKAWA	KYUJI FUJII	DATE: NOVEMBER, 2011

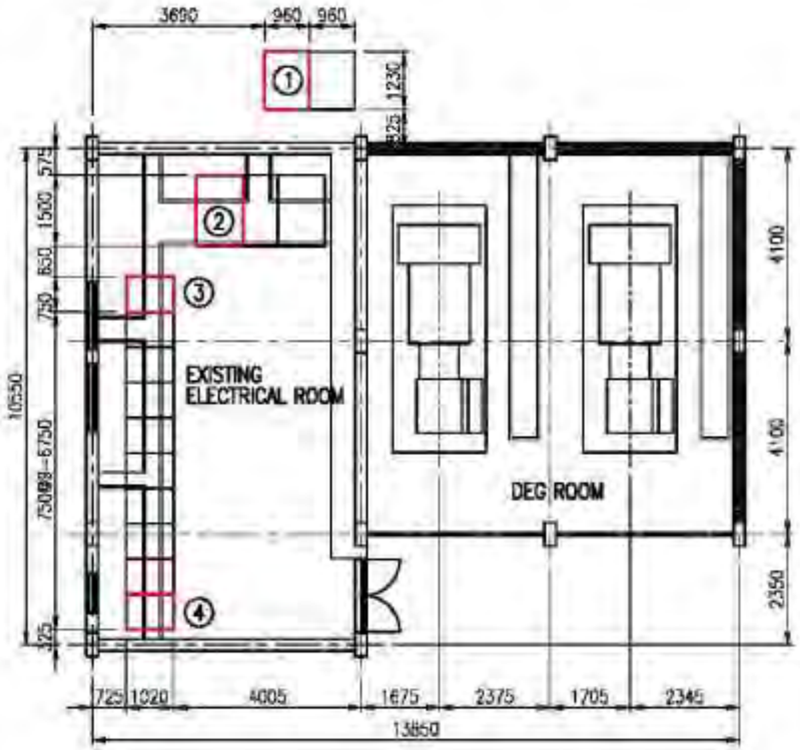

TENDER PURPOSE ONLY
Revision
Date
Description
PROJECT
The Project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria
IMPLEMENTATION AGENCY
Umaru Musa Yar'adua University
PROCUREMENT AGENT
Crown Agents
CONSULTANT
YACHIYO ENGINEERING CO., LTD.
DRAWING TITLE
SINGLE LINE DIAGRAM FOR 33KV AND 11KV LINE
SHEET NO.: 3
SPARE FEEDER
FROM SOLAR PARK


TENDER PURPOSE ONLY
Revision
Date
Description
COMBINATION OPERATING PANEL (AS SEE SINGLE LINE DWG OF COMBINATION OPERATING PANEL)
SAME AS LEFT
SAME AS LEFT
SAME AS LEFT
PROJECT
The Project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria
IMPLEMENTATION AGENCY
Umaru Musa Yar'adua University
PROCUREMENT AGENT
Crown Agents
CONSULTANT
YACHIYO ENGINEERING CO., LTD.
SINGLE LINE DIAGRAM FOR SOLAR FARM (850KW)


TENDER PURPOSE ONLY
Revision
Date
Description
PROJECT
The Project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria
IMPLEMENTATION AGENCY
Umaru Musa Yar'adua University
PROCUREMENT AGENT
Crown Agents
CONSULTANT
YACHIYO ENGINEERING CO., LTD.
DRAWING TITLE:
SINGLE LINE DIAGRAM FOR COMBINATION OPERATING PANEL (850kW)
SHEET NO: 5



No. | TAG No. | EQUIPMENT | REMARKS
1 TRANSFORMER 0.415-0.240/11kV 1000kVA Ynd11
2 CONTROL PANEL
3 COMBINATION OPERATING PANEL
4 DC POWER SUPPLY PANEL
5 NO.1 TO NO.10 POWER CONDITIONER PANEL
6 DATA LOGGER
HAND HOLE
HAND HOLE
PLAN
SCALE 1:100
A-A SECTION
SCALE 1:100
GL
TENDER PURPOSE ONLY
Revision
Date
Description
PROJECT
The Project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria
IMPLEMENTATION AGENCY
Umaru Musa Yar'adua University
PROCUREMENT AGENT
Crown Agents
CONSULTANT
YACHIYO ENGINEERING CO., LTD.
DRAWING TITLE
LAYOUT PLAN FOR POWER CONDITIONER ROOM (500kW)
SHEET NO. 6



No.	TAG No.	EQUIPMENT	REMARKS
①		33kV METERING PANEL (WITHIN CT & VT)	EXPORT
②		ADDITIONAL OF OVER VOLTAGE GROUNDING RELAY	33kV CB TRIP
③		11kV SWG FOR SOLAR FARM	INTERLOCK FOR PC
④		ADDITIONAL OF UNDER VOLTAGE RELAY	INTERLOCK FOR PC

TENDER PURPOSE ONLY

Revision	Date	Description

PROJECT	IMPLEMENTATION AGENCY	PROCUREMENT AGENT	CONSULTANT	DRAWING TITLE
The Project for Clean Energy Promotion Using Solar Photovoltaic System in the Federal Republic of Nigeria	Umaru Musa Yar'adua University	Crown Agents	YACHIYO ENGINEERING CO., LTD.	LAYOUT PLAN FOR EXISTING POWER HOUSE

SHEET NO: 7

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

The Project will be implemented based on the Government of Japan's Environment and Climate Change Program Grant Aid scheme. According to this, the Project will receive approval by the Government of Japan, the two countries' governments will sign the Exchange of Notes (E/N) and the Grant Agreement (G/A) before the Project progresses to the implementation stage. The procurement agent will be recommended to the Nigerian side by the Government of Japan, while Umaru Musa Yar'Adua University (UMYU) acting as the mandatory will be the implementing agency to ensure that the contract (tender and equipment procurement) is appropriately and smoothly executed.

(1) Implementation Setup

Following the conclusion of the Exchange of Notes (E/N) and Grant Agreement (G/A) concerning the Project, the Government of Nigeria will entrust selection and contracting of the works consultant and suppliers to the procurement agent. Also, the implementation design and works supervision consultant and suppliers will implement their respective duties upon binding contracts with the procurement agent.

(2) Responsible Government Agency

The responsible government agency will be the Federal Ministry of Power.

(3) Implementing Agency

The implementing agency for the Project is Umaru Musa Yar'Adua University (UMYU). The Project will be implemented as an Environment and Climate Change Program Grant Aid undertaking based on the procurement agency contract that is concluded between the Federal Ministry of Power (the responsible government agency on the Nigerian side) and the Japanese procurement agent.

Other related agencies on the Nigerian side are as indicated below, and it will be necessary to fully share information and coordinate with each agency in the implementation stage. When coordinating with each agency, it has been confirmed that the Center for Renewable Energy Reserch of Umaru Musa Yar'Adua University will act as the primary contact.

- National Planning Commission (NPC)
- Energy Commission of Nigeria (ECN)
- Federal Ministry of Science and Technology (FMST)

Also, the main agencies on the Nigerian side and the Government of Japan will establish an intergovernmental conference composed of representatives from each to discuss the items that require confirmation at government level. Furthermore, a working group will be established by

UMYU and the procurement agent, and this will confirm progress and discuss technical confirmation points and so on.

The Project implementation setup is indicated below.

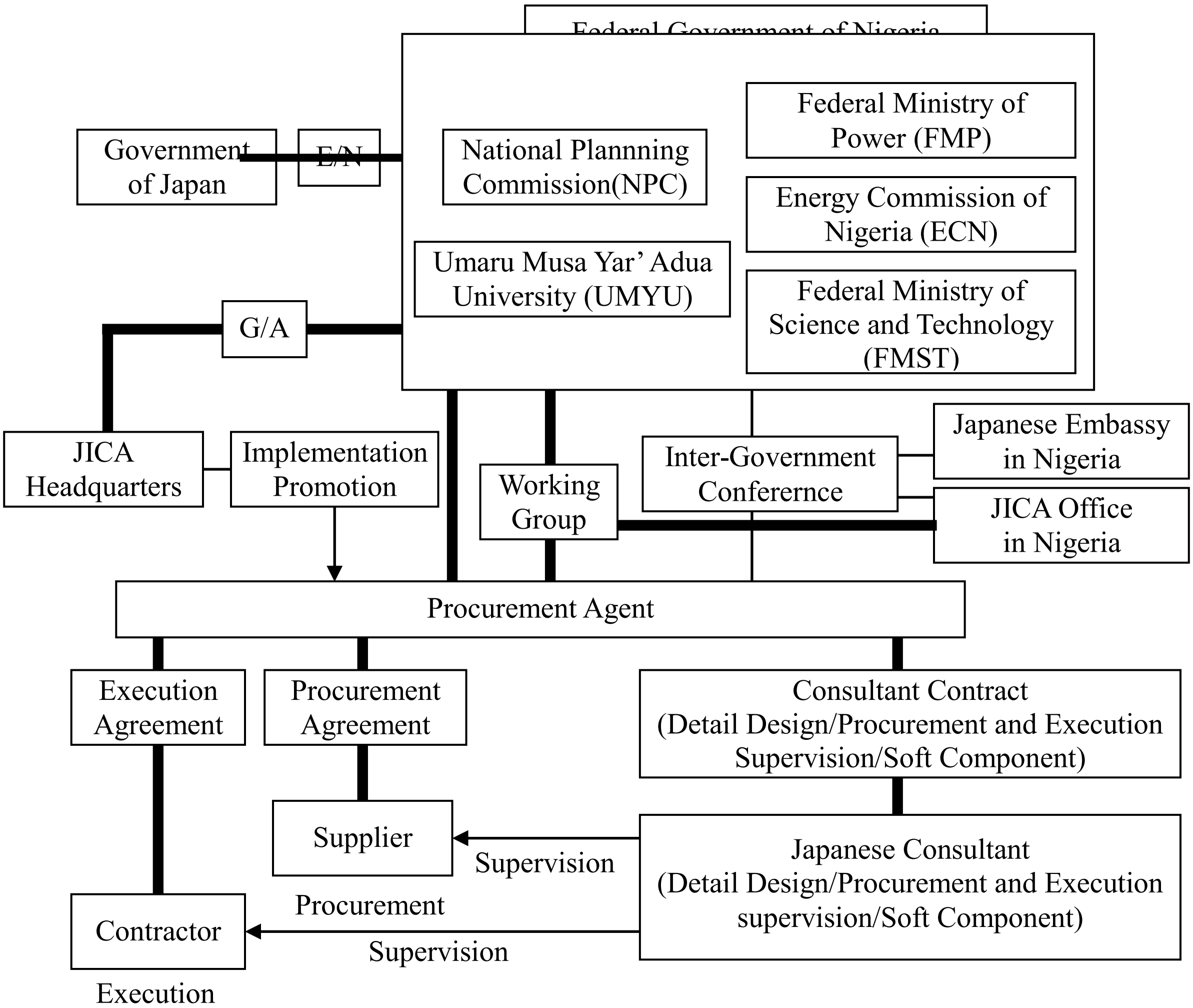


Figure 2-2-4.1 Implementation Setup

(4) Procurement Agent

1) Implementation Contents

The procurement agent will prepare the tender documents for equipment procurement, thereby initiating the tender management proceedings and procurement operations for the Project. The procurement agent, which will be recommended to the Nigerian side by the Government of Japan, will implement and execute general supervision to ensure that the Project components are appropriately and smoothly implemented in its capacity as the mandatory of the implementing agency.

Concerning tender work supervision, the procurement agent will prepare documents concerning the Agent Agreement, bank arrangements and contracts pertaining to tender, and it will distribute the tender documents and conduct duties pertaining to the tender, evaluation and contracting of suppliers.

In the area of works management, the supervisor dispatched by the Japanese procurement agent will conduct fund management including payments, expenditure planning in the event where excess funds arise, confirmation of implemented contents and reporting of progress to both governments, as well as maintain constant discussions, coordinate with and report to the Nigerian side.

2) Implementation Setup

① Tender work management period

The procurement agent will compile the tender documents, confirm equipment specifications and evaluate the tendering firms; however, since the international competitive tender for equipment procurement is likely to be complicated, the agent will recruit local auxiliary personnel. Moreover, since it will be necessary to receive and answer technical questions on the tender contents and appropriately evaluate the technical proposals of tenderers, the Japanese consultant will assist in the technical affairs.

② Works supervision period

The procurement agent will conduct general management during the works execution period, however, this will only comprise checking of key points and will be conducted under the works supervision of the Japanese consultant.

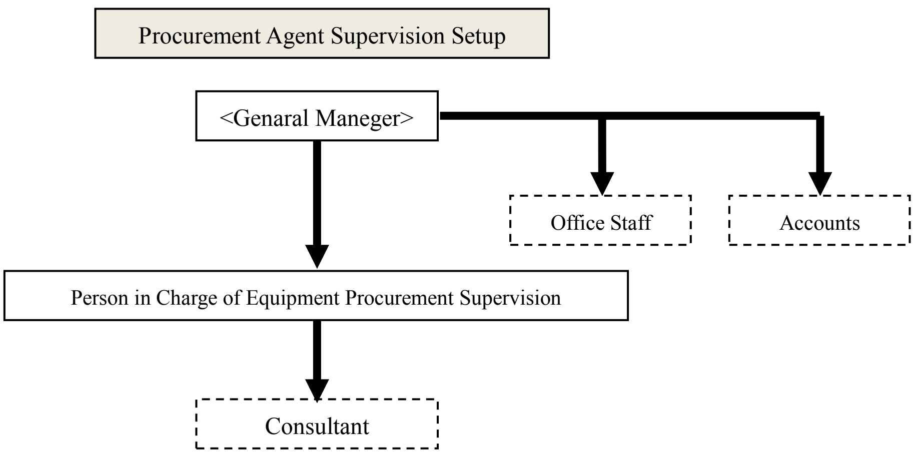


Figure 2-2-4.2 Procurement Agent Supervision Setup

(5) Construction Supervision and Procurement Supervision Consultant

The consultant that will be in charge of detailed design and work supervision will conduct detailed design and supervise the quality of work, schedule and safety, etc. of facilities construction, confirm quality, functions, performance and quantities in the equipment procurement, and check for exterior damage, etc. during the transportation of equipment after the consultant that implements preparately survey will be recommended by JICA and close a contract with procurement agency. If it discovers any problems, it will immediately prepare a report and discuss countermeasures with related officials. Moreover, the consultant in charge of construction supervision will assess the performance of contractor's works.

(6) Facilities Contractor and Equipment Supplier

The contractor and supplier that are selected by the procurement agent by tender must fully understand and promptly and certainly execute the contents of the contracts they bind with the Agent.

2-2-4-2 Implementation Conditions

(1) Construction Situation in Nigeria

It is possible to secure operators (workers) for construction works in Nigeria, however, skilled operators and technicians who possess expertise in the areas of schedule, quality and safety control, etc. are limited. Accordingly, it will be necessary for the Japanese contractor to dispatch engineers and skilled workers from Japan as the need arises.

Meanwhile, since Nigeria has no prior experience of photovoltaic system installation works on the scale of those proposed in the Project, and highly skilled technicians are required in order to install equipment and carry out adjustment and testing, etc. after installation, it will be difficult to utilize local personnel other than laborers. Accordingly, when implementing the installation work, it is desirable that the Japanese contractor procures local laborers and works equipment and dispatches engineers from Japan. Moreover, the Japanese engineers will conduct technology transfer in the shape of OJT for Nigerian engineers during the installation period.

(2) Implementation Planning Conditions

1) Rainy Season

In Nigeria, because there is frequent rainfall during the rainy season from July to October, it will be necessary to compile the implementation plan so that excavation and high voltage cable terminal processing work doesn't arise during this period.

2) Connection with Exsisting Facilities

When conducting connecting works with existing equipment, it will be necessary to compile the implementation plan so that power interruptions are kept to a minimum. Furthermore, if it is possible, it will be necessary to plan the works schedule so that connection works are carried out during university recess.

3) Exsisting Undergoround Facilities

When excavating for underground cables, it will be necessary to display ample care concerning existing power cable, sewers and telephone lines and to compile the schedule so that work doesn't coincide with underground cables expansion works, etc.

(3) Utilization of Local Equipment and Materials

The aggregate, cement and reinforcing bars, etc. required for building the foundations of the mounting structure for the PV modules can be procured in Nigeria, although it will be necessary to implement management and supervision of quality and deadlines. Accordingly, when compiling the implementation plan, locally procurable equipment and materials shall be utilized as far as possible for the foundation works.

(4) Safety Measures

Since the Project target site is UMYU in Katsina city, it has relatively few problems in terms of law and order, however, it will be necessary to display ample care for preventing theft of equipment and securing the safety of works personnel. Accordingly, not only is it essential that the Nigerian side take safety measures, but also the Japanese side will need to take steps such as assigning guards and so on.

(5) Tax Exemptions

In order to receive exemptions of customs duties and taxes on the Project equipment, the contractor will need to give advance notification to the Ministry of Finance via the Federal Ministry of Power. It is possible to receive exemptions on duties and domestic taxes, however, it has been confirmed that this is not an advance rebate system but rather a total exemption scheme whereby the implementing agency in Nigeria avoids any tax burden.

(6) Transportation

Equipment carried to Nigeria by sea is usually landed and undergoes customs clearance at the international port of Lagos. Customs clearance is carried out at the port; however, in Nigeria it is compulsory for incoming goods to undergo landing inspections by third party inspection companies. Since the customs clearance procedure including this inspection takes at least two weeks, the transportation plan will be compiled with this in mind. There are around six transport companies that transport goods from the port to inland locations and some of these have worked on grant aid projects in the past. Therefore, there shouldn't be a problem regarding inland transportation. Equipment transported from Japan will be packed in such a way that it can withstand the long sea voyage, landing at port, inland transportation to the Project site and storage.

2-2-4-3 Scope of Works

According to the Environment and Climate Change Program Grant Aid scheme, Table 2-2-4.1 shows the detailed scope of works on the Japanese and Nigerian sides.

Table 2-2-4.1 Scope of Works on the Japanese and Nigerian sides

No.	Item	Japan	Nigeria	Remarks
1	Securing of the equipment installation site		○	
2	Ground leveling and removal of obstructions on the equipment installation site		○	Including removal of anthill
3	Installation of fences and gates	○		
4	Facilities construction works and equipment installation	○		Including temporary installation works accompanying the facilities construction
5	Electrical works			
(1)	Electrical works			
	a) Indoor wiring works (lighting, sockets, etc.)	○		
	b) Site lighting works	○		
	c) Installation of power receiving panel	○		
(2)	Site drainage works (rainwater)	○		
(3)	Telephone and communications works			
	a) Main line works (to site)		○	
	b) Building internal line and pit works	○		
6	Commission for opening of bank account based on the B/A		○	
7	Handling of transport and customs clearance procedures and taxes			
(1)	Responsibility for ocean transport (air transport) of products related to procured equipment to the recipient country (Nigeria)	○		
(2)	Tax burden and customs clearance procedures at the port of unloading in Nigeria		○	
(3)	Transportation of procured equipment, etc. from the port of unloading to the inland site in Nigeria	○		
(4)	Exemption or bearing of domestic value added tax on procured construction materials and equipment in Nigeria		○	
8	OJT concerning operation and maintenance of facilities and procured equipment	○		The Nigerian side will select the personnel who will receive OJT
9	Operation and maintenance of facilities and procured equipment		○	
10	Other costs not covered by the grant aid		○	

Note: ○: Indicates the scope of responsibility regarding each item

2-2-4-4 Consultant Supervision

Based on the scheme of the Government of Japan's Environment and Climate Change Program, the consultant will organize a consistent Project Team to smoothly conduct the detailed design and construction supervision work according to the principles of the outline design. The consultant will permanently assign at least one engineer to the Project site during the construction supervision stage in order to conduct schedule control, quality control, performance control and safety control. Furthermore, an expert in Japan will attend factory inspections and pre-shipping inspections of equipment and materials manufactured in Japan with a view to ensuring that no troubles occur following delivery of materials and equipment to Nigeria.

(1) Basic Concept of Construction Supervision

The basic concept of construction supervision by the consultant will be as follows: to supervise the works progress to ensure they finish within the designated period, and to supervise and instruct the contractor to ensure that the quality, performance and delivery times specified in the contract are secured and that the site works are executed safely.

The important points to consider in consultant supervision are described below.

(2) Schedule Control

The consultant will compare progress with the implementation schedule decided in the contract every month or every week in order to adhere to the delivery deadline given in the contract. In cases where delays are predicted, the consultant will warn the contractor, to present a plan of countermeasures and offer guidance to ensure that the works and equipment delivery are completed within the contract period. The comparison of the planned schedule and actual progress will be carried out according to the following items.

a) Confirmation of works performance (manufacture of equipment and materials in plant and performance of civil engineering works on site)

b) Confirmation of equipment and materials delivery (switching equipment, distribution equipment and materials, and civil engineering works equipment and materials)

c) Confirmation of temporary installation works and construction machinery preparations

d) Confirmation of yield and actual numbers of engineers, skilled workers and laborers, etc.

(3) Quality and Performance Control

Supervision will be carried out based on the following items to determine whether the manufactured, delivered and installed equipment and materials and constructed facilities satisfy the required quality and performance stated in the contract documents. In cases where doubts arise over quality and performance, the consultant will immediately demand that the contractor make amendments, revisions or corrections.

a) Checking of shop drawings and specifications of equipment and materials

b) Attendance of plant inspections of equipment and materials and checking of plant inspection results

c) Checking of packing, transportation and on-site temporary storage methods

d) Checking of shop drawings and installation guidelines of equipment and materials

e) Checking of trial operation, adjustment, testing and inspection guidelines of equipment and materials

f) Supervision of equipment and materials site installation works and attendance of trial operations, adjustments, tests and inspections

g) Checking of equipment installation work drawings and shop drawings with site performance

(4) Safety Control

Discussions will be held and cooperation sought with responsible officers of the contractor and safety control will be exercised during the construction period in order to prevent industrial accidents and accidents affecting third parties. Important points to consider in safety control on the site are as follows:

a) Establishment of safety control regulations and appointment of manager

b) Prevention of accidents through implementation of periodic inspections of construction machinery

c) Planning of the works vehicles and construction machinery operating routes and thorough enforcement of slow driving

d) Encouragement of laborers to utilize welfare measures and vacations

e) Prevention of theft of equipment and assignmenent of guards

(5) Works Supervisor

The contractor will implement the procurement and installation of PV equipment and materials, and the distribution and communications equipment, cables, etc.. In order to implement these works, the contractor will employ a subcontractor(s) in Nigeria. Therefore, since the contractor will need to ensure that the subcontractor(s) complies with the works schedule, quality control, performance and safety measures prescribed in the contract, it will dispatch an engineer who has experience of similar projects in overseas countries to provide guidance and advice on the site.

2-2-4-5 Quality Control Plan

The consultant's construction supervisor will carry out supervision and checking based on the following items to ensure that the contractor secures the quality of Project equipment and materials and the execution and installation performance stipulated in the contract documents (technical specifications and implementation design drawings, etc.). In cases where doubts arise over quality and performance, the construction supervisor will immediately demand that the contractor make amendments, revisions or corrections.

a) Checking of shop drawings and specifications of equipment and materials

b) Attendance of plant inspections of equipment and materials and checking of plant inspection results

c) Checking of packing, transportation and on-site temporary storage methods

d) Checking of shop drawings and installation guidelines of equipment and materials

e) Checking of trial operation, adjustment, test and inspection guidelines of equipment and materials

f) Supervision of site installation works of equipment and materials and attendance of trial operations, adjustments, tests and inspections

g) Checking of facilities shop drawings against work performance on site

h) Checking of completion drawings

2-2-4-6 Procurement Plan

The main equipment such as photovoltaic modules and power conditioner to be procured and installed in the Project are not manufactured in Nigeria. However, although photovoltaic system retail agents do exist in Nigeria, it is difficult to acquire the necessary quality and quantities. The supplier of photovoltaic power equipment and main equipment in the Project shall be from Japan, based on the intent of the Japanese Environment and Cilmete Change Program Grant Aid Project. When Japanese product will be appointed, it will be necessary to take local conditions, ease of operation and maintenance by local engineers, and existence of the post-installation setup for procuring spare parts and responding to breakdowns, etc. into account.

As for the 11 kV circuit breaker panel scheduled for installation in the existing switch room of UMYU, since Japan doesn't have the 11 kV class, the product dimensions would be too large and too much time would be taken for manufacture if products were sought from Japan. Therefore, since the university currently uses circuit breaker panels from Europe, it will be necessary to consider the application of third country products from DAC affiliated nations.

In consideration of the above points, the origin of equipment and materials in the Project will be as follows.

a) Locally procured equipment and materials
Equipment and materials for the civil and building works such as cement, sand, concrete aggregate, reinforcing bars, timber, gasoline, diesel oil, works vehicles, cranes, trailers and other temporary installation equipment

b) Equipment and materials procured in Japan
Photovoltaic modules, power conditioner, grid-connection transformer, display unit, wiring materials, etc.

c) Equipment and materials procured from third countries
Circuit breaker panel, wiring materials, etc.

2-2-4-7 Operational Guidance Plan

Guidance on initial equipment controls and operation will basically be conducted by the Contractor as OJT (on the job training). In order to install and operate the grid-connected photovoltaic system (grid-connected PV system), the site electrical engineers of the Contractor must have ample knowledge on photovoltaic power generation. Figure 2-2-4.3 shows the proposed schedule for the grid-connected photovoltaic system installation works and initial equipment controls and operation guidance (OJT).

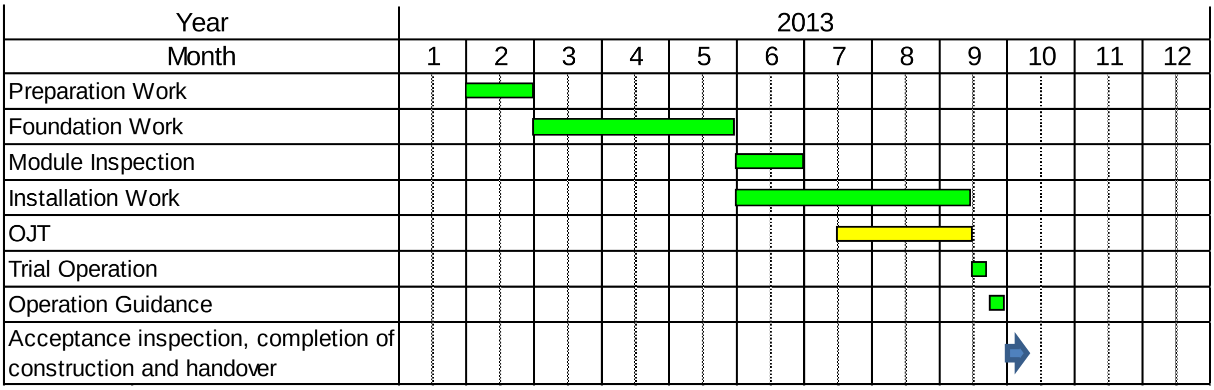


Figure 2-2-4.3 Initial Control Guidance Schedule

After contract with the contractor, it will take 6 months to prepare design drawing of equipment and to fabricate the equipment, and 3 months for transportation the equipment to the site. Installation works will take about 8 months from the start to the delivery including Trial operation and adjustment. 17 months will be needed in total.

It is scheduled to stage the soft component three times by the consulant during the installation works period of approximately 8 months. PV system operators must receive training under the soft component, as is described in detail in 2-4-8 (Soft Component Plan). In the soft component training, trainees will take part in classroom and practical training covering preparation of Operation and Maintenance (O/M) manuals, basics of photovoltaic systems and characteristics of grid-connected PV systems. Moreover, operators will use the grid-connected PV system to learn about methods and important points in installation via training during the installation works.

The operators will first learn basic know-how on photovoltaic power generation and then acquire practical operating technology from the Japanese engineers (installation engineers). It is currently scheduled for initial inspections and trial operation to begin 16.5 months after agreement.

(1) Initial operation guidance plan

The grid-connected PV system operators have already learned the basics of photovoltaic cells and grid-connected PV systems.

The operators will implement the following items together with the installation engineers

a) Inspections, checks and measurements on completion of the grid-connected PV system and at the start of operations

b) Trial operation methods

c) Routine inspections following the start of operation

1) Inspections, checks and measurement guidance before the start of operation

a) The inspection, check and measurement items to be implemented before operation are described in detail in 4-1 (Routine Inspection and Periodic Inspection Items). The results of inspections, checks and measurements will be recorded without fail.

b) Main inspection and check guidance
The installation engineers will conduct technology transfer of the following items to the operation managers.

① Solar power module and array inspections

In the construction stage, thoroughly check for any damage or breakage that may have occurred during transportation. Check for cracking, fractures and discoloration of the surface glass.

② Checking of wiring and cables

Since the service life of PV systems is long, damage or twisting of power lines and cables during installation can lead to decline of insulation resistance and dielectric breakdown. Keep records of the parts that cannot be checked after the installation works have been finished. In routine inspections and periodic inspections, check for signs of damage by visual inspection.

③ Confirmation of connecting terminals

Screws of power conditioners, etc. sometimes become loose during transportation. Temporary wiring is sometimes left unfinished, while cases that have been loosened for testing, etc. are sometimes forgotten about. Check for any loose screws on terminal sections before operation. Also, make sure there are no terminals with mistaken polarity (positive polarity is P or +, and negative polarity is N or -) or mistaken wiring between DC and AC circuits.

④ Inspection of other peripheral instruments

Also check other peripheral instruments by visual inspection.

2) Measurement guidance and safety measures guidance

The operation manager will check that the installed photovoltaic power modules are operating correctly and are maintaining performance levels before the start of operation. The operation managers and work assistants will receive guidance regarding safety measures on the handling of photovoltaic power arrays from the installation engineers before the start of actual work.

a) Safety measures
Before the start of work, it is important to observe the following points regarding safety measures (clothing and electrical shock countermeasures).

① Clothing
- Wear helmets, sneakers and hip bags.

② Shock prevention
- Detach one end of PV cell strings before the start of work
- Wear low voltage insulated gloves
- Use insulated tools
- Do not work when it is raining.

b) Solar power array inspection: Confirmation of voltage and polarity and measurement of short circuit currents
Confirm that the photovoltaic power modules have been correctly installed and that voltage is being generated as described in the specifications.

① Make sure that positive and negative polarities are not confused by checking each string with a voltmeter.
- Measurement of short circuit current

② Measure the photovoltaic power modules by ammeter to make sure that short circuit current flows as specified in the specifications.

c) Insulation resistance measurement
Insulation resistance testing will be implemented in order to confirm that it is OK to turn on power to the photovoltaic system. Insulation resistance will be measured following construction (before the start of operation), during periodic inspections and when identifying and repairing malfunctioning areas during accidents. Measured resistance values will be recorded. When the used voltage is 300 V or higher, insulation resistance should be at least 0.4 MΩ.

d) Ground resistance measurement
Grounding of electrical devices is important in order to protect human lives and property from accidents and fires caused by ground faults. Grounding works are divided into four types, i.e. A, B, C or D. Types A, C and D grounding works are implemented on uncharged areas such as the metal armor of electrical devices and cables. Type B installation works are implemented on the low voltage side cable ways of transformers for stepping down ultra-high and high voltage to low voltage. High voltage metal external boxes and low voltage exterior boxes exceeding 300 V are reduced to 10Ω or less, however, 500Ω or less is acceptable in cases where a device is installed for breaking current in cable ways within 0.5 seconds when ground faults occur.

e) Adjustment of permanent values and stabilization times of instruments before the start of operation
The operation manager and installation engineers will jointly adjust the permanent values and stabilization times of instruments in the grid-connected photovoltaic system.
The major permanent values and stabilization times will be as follows:
- Confirmation of permanent values of protective relays
- Confirmation of closing holdback time in cases of AC power restoration
- Confirmation of system stoppage time in cases of DC power loss
- Confirmation of system stoppage time in cases of AC power loss

After configuring the permanent values and stabilization times, implement careful checks to ensure the system is operating correctly. For details refer to 4-1 (Routine Inspection and Periodic Inspection Items).

f) Operation Guidance Plan
Once the grid-connected photovoltaic system goes into operation, unlike diesel engine generators, there is no need to conduct system controls. The grid-connected photovoltaic system automatically operates every day, however, if for some reason it is stopped, it will need to be switched on after checking. At the start of operation, since problems are apt to occur in the semiconductors and photovoltaic power modules, it will be necessary to conduct inspections every day. At the start of grid-connected photovoltaic system operation during

OJT term, the operation managers and installation engineers will patrol the installation site and learn the inspection areas and techniques.

① Creation of operation manual

The operation managers will create their own operation manual based on the technology they learn from the installation engineers.

② Creation and storage of routine inspection records

Routine inspection items are described in detail in 4-1 (Routine Inspection and Periodic Inspection Items). The operation manager will record routine inspection results in notebooks and archive them. Keeping records will make it possible to detect changes in the instruments.

③ Solar irradiation and generated electrical energy checks

The operation manager will check the amount of solar irradiation and generated electrical energy. Through doing this, it will be possible to detect changes when problems occur in the photovoltaic power modules and power conditioner, etc.

④ Panel cleaning

The operation manager will always monitor for dirt on panels during the routine inspections. It will be especially necessary to clean the panels every day when the Hamatan blows during the dry season.

2-2-4-8 Soft Component (Technical Assistance) Plan

(1) Back Gound of Soft Component Plan

In National Energy Plan plotted out in 2003, the Government of Nigeria pleced renewable energy as one of sustainable energ supply and is implementing introduction of renewable energy such as photovoltaic generation, wind generation, small hydro electric generation and biomass. However, plans are not progressing as scheduled due to insufficient condition of policies, regulation and institutional frame work for promotion of the introduction of renewrable energy and large fund procurement for initial investment.

UMYU is the intended site for installation of the photovoltaic generating facilityunder the Project. The operation of university facilities is managed by the Directorate of Physical Planning and Development Organization (DPPD), which is divided into the engineering services department and building department. The engineering services department is composed of the electricity, machine and civil engineering sections. These departments and sections implement all operation and maintenance work relating to electrical, mechanical and civil engineering affairs over the entire university. Personnel comprise 15 members in the electricity section, three in the machine section and five in the civil engineering section. The electricity section is in charge of operation and maintenance of the university's power receiving equipment, emergency generators and electrical equipment.

The Center for Renewable Energy Reserch (CeRER) is currently constructing a center building. The current CeRER is composed of the following four groups.

a) Photovoltaic power generation, solar thermal utilization and alternative fuel group (PV Group)

b) Biofuel group

c) Micro hydro and wind power generation group (MHP, Wind)

d) Energy saving group (Energy Efficiency)

Each group has a responsible person, who combines duties with work at the university. The CeRER currently has five staff members. The Director, Professor Zuru of Sotoko University, is currently on sabbatical (until March 2012) and is working on reforming the CeRER. Representatives from the university departments and the facilities department form a committee to discuss the direction for constructing the new CeRER. The new center building is scheduled to be completed in 2011. CeRER will be in charge of Operation and maintenance of photovoltaic system that is to be installed through the Project, in support of DPPD.

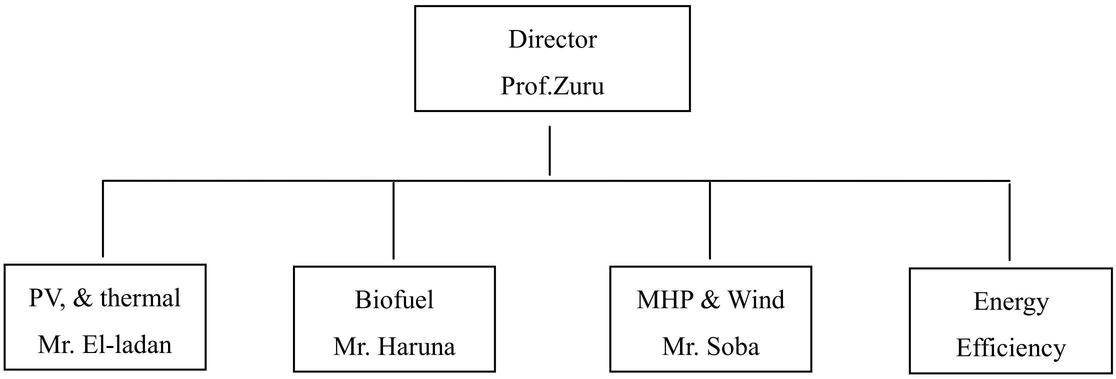


Figure 2-2-4.4 Renewable Energy Center Organization

(2) Photovoltaic cell experience of the university

The Information Communication Technology (ICT) department of UMYU has two photovoltaic systems, one for parabola antennas and one for computers, donated from overseas. The computer system is already out of use due to breakdown of the charge controller. The present PV group at the CeRER has no experience or staff concernitng plan, procurement, installation, operationof photovoltaic cells, but the CeRER plans to newly recruit staff members. The facilities department is in charge of photovoltaic streetlights, however, it has no experience of large-scale grid-connected systems such as the one proposed in the Project. This will be the first case of a large-scale grid-connected photovoltaic system in Nigeria and in order to ensure the success of the Project, it is desirable to have participation from as many related government agencies as possible.

(3) Current issues

Because of reasons item (2) above, the current issues of the CeRER (Center for Renewable Energy Research) of UMYU, which is the implementing agency, are as follows:

a) The maintenance setup regarding grid-connected photovoltaic systems is unclear.

b) Technical knowledge concerning the basics of photovoltaic power and systems is scant.

c) Technical know-how concerning photovoltaic systems is scant.

d) Technical knowledge concerning electricity in grid-connected photovoltaic systems is scant.

e) Maintenance concepts and knowledge on methods regarding grid-connected photovoltaic systems are scant.

f) Ability to respond to troubles in grid-connected photovoltaic systems is limited.

Improvements regarding above issues are as shown in Table 2-2-4.2.

Table 2-2-4.2 Current Issues and Proposed Improvements

Current Issue	Proposed Improvement	Guidance through Soft Component
The maintenance setup regarding grid-connected photovoltaic systems is unclear.	● CeRER takes the initiative in establishing a maintenance setup within CeRER.	● Make recommendations on the optimum maintenance setup and examine and discuss jointly with the related agencies.
Technical knowledge concerning the basics of photovoltaic power and systems is scant.	● Prepare a maintenance manual for the grid-connected photovoltaic system.	● Support manual preparation and implementation guidance.
Technical knowledge concerning electricity in grid-connected systems is scant.	● Prepare a maintenance manual on electricity technology for the grid-connected photovoltaic system.	● Support manual preparation and implementation guidance.
Maintenance concepts and knowledge on methods regarding grid-connected photovoltaic systems are	● Implement O&M technical training concerning the grid-connected photovoltaic system.	● Implement technical training on an appropriate grid-connected photovoltaic system.

scant.	● Implement training on monitoring methods, periodic inspection methods and other aspects of monitoring.	● Implement technical training on proper monitoring.
Ability to respond to troubles in grid-connected photovoltaic systems is limited.	● Include contents of troubleshooting in the maintenance manual. ● Conduct implementation guidance and enlightenment activities on the manual to ensure that maintenance is appropriately conducted.	● Support manual creation and implementation guidance. ● Ditto

(4) Soft component objective

The objective of the soft component is to facilitate the sustained and smooth operation and maintenance of the grid-connected photovoltaic system based on the maintenance manual with equipment owned by the implementing agency, i.e. CeRER.

(5) Method for confirming the degree of attainment of outputs

The implementation process will be divided into four stages as shown in Table 2-2-4.3 and categories 1~4 will be implemented in order. The outputs from each stage will be confirmed and evaluated as shown below.

Category 1: Evaluation and guidance on the maintenance manual
: Report preparation concerning confirmation of understanding on 1.3 in Table 2-2-4.3.
: Guidance on experimentation and measurement using photovoltaic modules

Category 2: Report preparation concerning confirmation of understanding on 2.1~2.3 in Table 2-2-4.3.
: Practical training for on-site inspection and installation works described in 2.4~2.5 in Table 2-2-4.3.

Category 3: Inspection and adjustment guidance as described in 3.1~3.2 in Table 2-2-4.3.
: Interview survey of operation manager and practical work assessment as described in 3.3~3.6 in Table 2-2-4.3.

Category 4: Interview survey of operation manager and practical work assessment as described in 4.1~4.4 in Table 2-2-4.3.

(6) Soft component activities (implementation plan)

The following activities will be implemented in order to ensure that the maintenance methods for the grid-connected photovoltaic power specifically understood and practiced.

1) Soft component implementation contents

Since a grid-connected photovoltaic system will be introduced for the first time to UMYU (the implementing agency), the host side has almost no know-how on how to operate and maintain the system. Accordingly, training will be implemented over a wide area from the basics of photovoltaic power generation to applied techniques of operation and maintenance. The specific contents are as shown in Table 2-2-4.3 and are broadly divided into Category 1 to Category 4. Each category will be implemented once.

Table 2-2-4.3 Training Contents

Category	Specific Implementation Contents
1. O&M setup building	1.1 Clarification of the responsibilities of O&M personnel 1.2 O&M manual creation in joint work with the Nigerian side 1.3 Solar technology 1.4 Principles and basic knowledge on photovoltaic systems 1.5 Basics of photovoltaic systems and electric technology 1.6 Outline of the introduced system
2. Technical training 1 Institutional Training	2.1 Features of the grid-connected photovoltaic system 2.2Issues for examination when introducing the grid-connected photovoltaic system 2.3 Technology for systems with and without reverse flows 2.4 Equipment inspections 2.5 Installation technology
3. Technical training 2 Institutional Training	3.1 System inspections 3.2 Trial operation and adjustment 3.3 Maintenance 3.4 Troubleshooting 3.5 O&M manual optimization 3.6 O&M setup evaluation
4. Monitoring	4.1 Optimization of monitoring methods 4.2 Routine inspections 4.3 Periodic inspections 4.4 Evaluation items 4.5 Reporting of monitoring results

2) Explanation to the Nigerian side

When implementing the soft component, it will be essential to have the participation of the CeRER (Renewable Energy Center) of UMYU, which is the implementing agency. The consultant shall stage a workshop in order to ensure that the local side thoroughly understands the objectives, implementation contents and activity schedule, etc. of the soft component. In addition to CeRER, the participants will include related officials of the UMYU facilities department (DPPD), FMP and PHCN. With respect to the officials from other than theDPPD, the technology transfer will aim to promote understanding of the operation and maintenance setup and responsibilities for the grid-connected photovoltaic system and to contribute to the promotion and dissemination of grid-connected photovoltaic systems in Nigeria in the future. The Project equipment will be newly installed and it will be necessary to build the operation and maintenance setup from scratch. Accordingly, the soft component will be commenced from before the start of the installation works and will proceed in order from the basics up.

3) Photovoltaic System Operating Committee (provisional name)

Following the start of the Project, the CeRER will promptly establish the Photovoltaic System Operating Committee (provisional title) with the objectives of securing the smooth implementation of the soft component and sustained operation after the soft component is finished. As the de facto receiving agency for the soft component, this committee will hold regular meetings during and after the Project to ensure that the Project equipment is operated and maintained smoothly and on a sustained basis. The committee will also provide a forum for monitoring progress, exchanging opinions and discussing issues regarding the soft component.

4) Operation and maintenance manual preparation

During Project implementation, the CeRER will prepare a manual of maintenance activities while holding discussions with the consultant. In order to draw out initiative from the Nigerian side, the CeRER will prepare the draft manual and complete it after receiving comments and guidance from the consultant. The manual will include a section on troubleshooting.

5) Procurement of Implementation Resources for the Soft Component

The Photovoltaic System Operating Committee (provisional title) will be established on the Nigerian side in order to effectively and efficiently implement the soft component. The committee will primarily conduct maintenance activities for the photovoltaic system while fully incorporating the opinions of the consultant. The committee will comprise around five members selected from the CeRER and DPPD (for example, actual maintenance personnel and managers), and the implementation setup will be as indicated below.

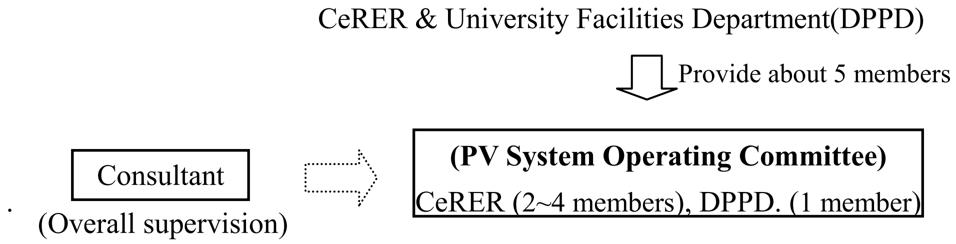


Figure 2-2-4.5 PV System Operating Committee Implementation Setup (proposal)

Table 2-2-4.4 PV System Operating Committee Implementation Setup (Proposed)

Work Area	Japanese Consultant	CeRER, Facilities Department
Project organization	2 members	Around 5 members (actual maintenance personnel and their managers)
Project operation method	Management of overall progress	Overall work management and actual maintenance
Orientation on the Project contents	Explanation	Hosting
Maintenance manual	Advice	Draft preparation
Maintenance follow-up	Management and guidance	Submission of results
Report destinations	Japanese Embassy in Nigeria and JICA	Japanese consultant

6) Soft Component Implementation Schedule

The soft component implementation schedule is as indicated in Figure 2-2-4.6 It will be implemented according to the categories shown in Table 2-2-4.3 The timing of each category will be as follows.

Category 1: Since supporting the construction of the maintenance setup and clarifying the setup before installation will arouse interest among the related parties; this will be implemented before the equipment is installed.

Category 2: Concerning the inspection and installation, etc., of equipment, since the actual equipment will be used, this will be implemented to coincide with the arrival of the equipment onsite.

Category 3: Concerning inspection and operation, etc., since the actual equipment will be used and it will be necessary to prepare the maintenance manual before the start of operation, this will be implemented between the middle of the installation works and the start of operation.

Since category 3 will be implemented with the emphasis on confirming that the Nigerian side can autonomously conduct maintenance, it will be implemented around one month after the completion of installation.

7) Soft component schedule (proposed)

The following figure shows the proposed schedules of soft component.

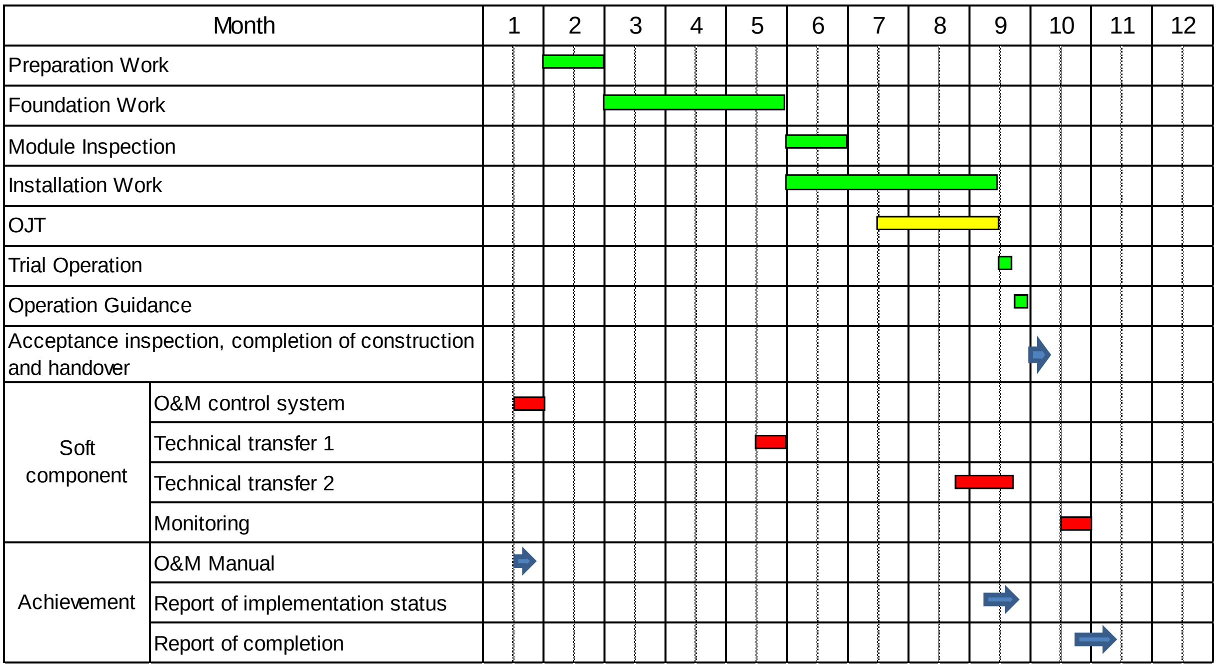


Figure 2-2-4.6 Soft Component Schedule

8) Responsibilities related to the soft component on the Nigerian side

The followings are responsibilities on the Nigerian side related to the soft component. CeRER will establish the PV System Operating Committee for cooperating with the soft component.

① CeRER will provide the conference rooms, etc. needed for implementing the soft component.

② CeRER will provide the human resources necessary for implementing the soft component.

③ The PV System Operating Committee will prepare the maintenance manual under the consultations conducted by the consultant.

④ CeRER will appropriately operate and maintain the grid-connected photovoltaic system based on the maintenance manual.

⑤ CeRER will submit performance reports to the Japanese consultant for a certain period based on the operation and maintenance manual

2-2-4-9 Implementation Schedule

The Project implementation schedule was compiled as follows based on the scheme of the Government of Japan’s Environment and Climate Change Program Grant Aid.

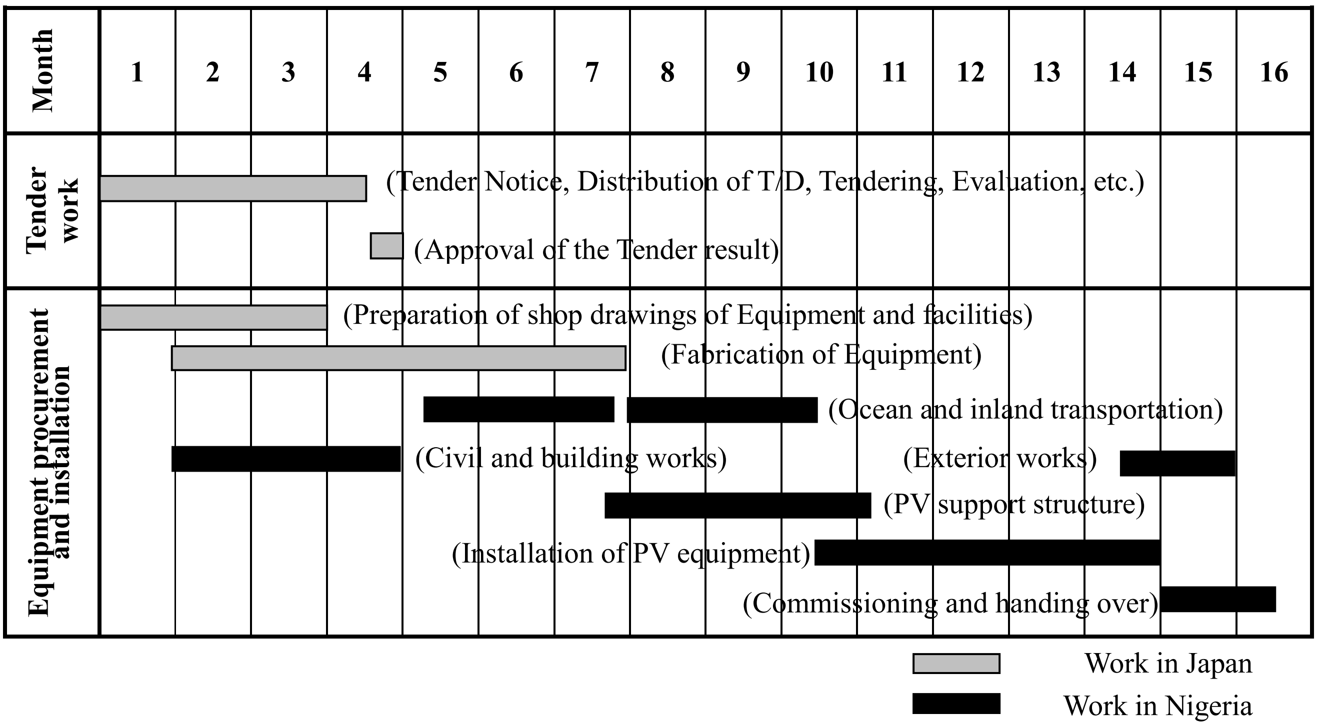


Figure 2-2-4.7 Project Implementation Schedule Sheet

2-3 Obligations of Recipient Country

2-3-1 Obligations of Recipient Country

When it comes to implementing the Project, in addition to the scope of works on the Nigerian side indicated in 2-2-4-3 Scope of Works, items to be implemented or borne by the Nigerian side are as follows.

① To provide information and materials necessary for the Project

② To secure tax exemption and customs clearance and the speedy unloading of products for the Project at the port of unloading in Nigeria

③ To grant permission for Japanese nationals to enter and stay in Nigeria in relation to the products and services provided based on the authorized contract

④ To exempt Japanese nationals from taxes and tariffs, etc. that are ordinarily levied in Nigeria on products and services supplied based on authorized contracts.

⑤ To pay commission fees to the Japanese bank in relation to opening of the bank account for the Project

⑥ To bear all items not covered under Japan's Program Grant Aid for Environment and Climate Change when implementing the Project

⑦ To attend equipment and materials inspections on site and to appoint an engineer and skilled workers as counterparts for the transfer of operation and maintenance technology

⑧ To properly and effectively use and maintain the equipment and materials procured under Japan's grant aid

⑨ To secure a disposal site for excavated earth, sewage, waste oil and recovered equipment and materials during the works period (if necessary)

⑩ To secure the safety and provide guidance and education to local residents, university employees and students, etc. during the works period

⑪ To take the minimum required power interruption countermeasures when connecting the Project equipment and existing equipment

⑫ To build a temporary road and equipment and materials storage area, etc. during the works

2-3-2 Important Points to Consider when Implementing the Project

Important points to consider that will have a direct impact on the Project implementation are thought to be as follows.

① Coinciding with the procurement and installation of the photovoltaic power equipment and 11 kV distribution lines by the Japanese side in the Project, the Nigerian side will need to form a construction team to remove trees from the works site, implement site development works and prepare sites for temporary installations (equipment storage yards and site offices, etc.).

② The Nigerian side will need to cooperate with the Japanese consultant and works personnel with a view to advancing procedures with the Federal Ministry of Environment and Nigerian Electricity Regulatory Commission and taking steps for customs clearance. It will also need to compile the necessary personnel plan and equipment and materials purchasing plan, etc. with a view to smoothly advancing the works.

③ In order to advance operation and maintenance of the grid-connected photovoltaic system, the Nigerian side will need to organize a Consultative Committee. This committee will comprise representatives from the responsible government offices and implementing agencies based mainly in Abuja.

④ The Project photovoltaic system will be connected to the university distribution system and will be the first of its kind in Nigeria. The records and data obtained in operation of the system will be shared in the Consultative Committee for the furtherance of photovoltaic power technology in Nigeria. Similarly, data obtained from measuring and inspection instruments installed in the Project will be the common property of the Consultative Committee participants.

⑤ The Nigerian side will need to promptly appoint the technicians and engineers who will take part in the OJT and soft component of the Project via the Consultative Committee. It will be necessary to ensure that these members participate in field training and secure the horizontal extension of technology to other engineers and technicians who don't participate in the training.

⑥ The personnel who take part in the Consultative Committee shall strive for the diffusion of photovoltaic power and grid-connected photovoltaic systems geared to preventing global warming, based on the information and records that are obtained via operation and maintenance of the Project system.

2-4 Project Operation Plan

2-4-1 Routine Inspection and Periodic Inspection Items

Routine maintenance and inspections will be essential in order to ensure the sustainable operation of the grid-connected photovoltaic system. Operation managers will basically implement the following three types of inspections:

- Inspections and checking on completion of the grid-connected PV system and before the start of operation
- Routine inspections following the start of operation
- Periodic inspections after operation or after passage of a set period

(1) Inspection items on system completion and in periodic inspections

The items inspected on completion of the system and in periodic inspections are almost the same. Table 2-4-1.1 shows the inspection items and measurement items. For details on the system completion inspection and checking, see 2-4-7 (Operational Guidance Plan).

(2) Routine inspections

Unlike other generating facilities, the grid-connected photovoltaic system requires no special controls following the start of operation such as start up and turns off.

The grid-connected photovoltaic system automatically starts operating every day once the sun rises to a certain point. If the grid-connected photovoltaic system stops for some reason, it is necessary to investigate the cause and restart it by manually pushing the start switch. In the initial stages of operation, since troubles sometimes occur in the semiconductors and photovoltaic power modules, it is necessary to implement inspections of operational status every day. In the initial stage, during OJT term, the operation managers shall patrol the photovoltaic power installation site with the Japanese engineers, installation engineers to learn the inspection areas and techniques.

The photovoltaic equipment can be automatically operated without any operating personnel, although performing routine inspections makes it possible to quickly discover system abnormalities.

Routine inspections will be implemented as visual checks every day for the first month after the start of operation. After that they can be implemented around once per week, however, it will be necessary to check and wipe away dust from panels every day during the dry season. Table 2-4-1.1 shows the inspection items.

Table 2-4-1.1 Routine Inspection Items

Inspection target	Inspection Item
Solar cell array	- Surface dirt, damage - Mounting structure corrosion, rust - External wiring damage
Junction box	- External box corrosion, rust - External wiring damage
Power conditioner	- External box corrosion, rust - External wiring damage - Noise, odor during operation - Blockage of the ventilation outlet filter - Installed environment (humidity, temperature, etc.)
Grounding	- Wiring damage
Power generation situation	- Confirmation of normal operation and records of generated electrical energy and amount of solar irradiation - Checking of instrumentation and displays

The operation manager shall strictly observe the following three points when implementing routine inspections.

1) Preparation and archiving of routine inspection records

The routine inspection items are indicated in Table 2-4-1.1 (Routine Inspections). After checking the items indicated in the table, the operation manager will record the results and archive them. Through keeping records in this way, it will be possible to detect changes in the equipment.

2) Solar irradiation and generated electrical energy check

The operation manager shall constantly check the amount of solar irradiation and generated electrical energy. By doing so, the operation manager will be able to detect any changes when troubles arise in the photovoltaic modules and power conditioners.

3) Panel cleaning

The operation manager will constantly monitor the panels for dirtiness in the routine inspections. In particular, the panels shall be cleaned every day during the Hamatan season in the dry season.

(3) Periodic inspections

Table 2-4-1.2 shows the general periodic inspection items and measurement items. Periodic inspection entails stopping the system after a certain period in order to inspect the instruments and measure the items shown in the table. The first periodic inspection will be implemented five years after the start of operation.

Table 2-4-1.2 Periodic Inspection Items

Inspection Target	Inspection Item	Measurement/Test
Solar cell array	- Surface dirt, damage - External wiring damage - Mounting structure corrosion, rust - Grounding wire damage, ground wire looseness	-Insulation resistance measurement -Open voltage measurement (when needed)
Junction box, collecting box	- External box corrosion, rust - External wiring damage, connecting terminal looseness - Grounding wire damage, ground wire looseness	- Insulation resistance measurement
Power conditioner	- External box corrosion, rust - External wiring damage, connecting terminal looseness - Grounding wire damage, grounding wire looseness - Noise, odor during operation - Blockage of the ventilation outlet filter - Installed environment (humidity, temperature, etc.)	- Insulation resistance measurement - Surface operation check - Protective function test
Grounding	- Wiring damage	Grounding resistance measurement

[Source] Design and Installation of Photovoltaic Power Generating Systems

1) Periodic Inspection Contents

① Always record and archive the results of conducting the inspections and checks shown in Table 2-4-1.2

② Major inspection and check items

- Solar cell module and array inspection

  Thoroughly check for no broken or damaged panels. Check for cracking, fractures and discoloration of the surface glass.

- Checking of wiring and cables

  Check for any damage or twisting of power lines and cables.

- Confirmation of connecting terminals

  Check for any loose screws on terminal sections, and also check the polarity of screws.

- Inspection of other peripheral instruments

  Check for abnormalities in other peripheral instruments by visual inspection.

2) Measurement and safety measures

The operation manager will check that the installed photovoltaic modules are operating correctly and are maintaining performance levels before the start of operation. The operation managers and work assistants will receive guidance regarding safety measures on the handling of photovoltaic arrays from the installation engineers before the start of actual work, and safety measures will be implemented for the work assistants.

① Safety measures

Before the start of work, it is important for operators to observe the following points regarding safety measures (clothing and electrical shock countermeasures).

- Clothing
  - Wear helmets, sneakers and hip bags.
- Shock prevention
  - Detach one end of PV cell strings before the start of work
  - Wear low voltage insulated gloves
  - Use insulated tools
  - Do not work when it is raining.

② Solar array inspection: Confirmation of voltage and polarity and measurement of short circuit currents

- Confirm that the photovoltaic modules have been correctly installed and that voltage is being generated as described in the specifications.
  - Make sure that positive and negative polarities are not confused by checking each string with a voltmeter.
- Measurement of short circuit current
  - Measure the photovoltaic modules by ammeter to make sure that short circuit current flows as stipulated in the specifications.

③ Ground resistance measurement

Grounding of electrical devices is important in order to protect human lives and property from accidents and fires caused by ground faults. According to Japanese standards, grounding works are divided into four types, i.e. A, B, C or D. Types A, C and D grounding works are implemented on uncharged areas such as the metal armor of electrical devices and cables. Type B installation works are implemented on the low voltage side cable ways of transformers for stepping down ultra-high and high voltage to low voltage. High voltage metal external boxes and low voltage exterior boxes exceeding 300 V are reduced to 10Ω or less, however, 500Ω or less is acceptable in cases where a device for breaking current in cable ways in 0.5 seconds or less when ground faults occur is installed. Since voltage of the photovoltaic array in the Project is 300 V or more, it will be necessary to keep the grounding resistance to 10Ω or less.

④ Insulation resistance measurement

Insulation resistance testing will be implemented in order to confirm that it is OK to turn on power to the PV system. Insulation resistance will be measured following construction (before the start of operation), during periodic inspections and when identifying and repairing malfunctioning areas during accidents. Measured resistance values will be recorded. When the used voltage is 300 V or higher, insulation resistance should be at least 0.4 MΩ.

3) Grid-connected photovoltaic system inspection sheet

The grid-connected photovoltaic system at the Project will be a high-voltage grid-connected system. As such, in addition to the inspections described in Table 2-4-1.2 inspections will also be conducted while referring to the following high voltage grid-connected inspection items and judgment criteria. Care is needed because standard values differ according to the maker. Inspection records should be archived.

Table 2-4-1.3 Inspection Items and Judgment Criteria for the High Voltage Grid-Connected Photovoltaic System (Inspection date: Inspector:)

Instrument, etc.	Inspection Item		Judgment Criteria	Remarks	Inspector
PV cells	Dirt on glass		Glass should not be dirty		
	Frame damage, deformation		The frame should not be damaged or deformed.		
	External wiring, dirt, damage		External wiring should not be dirty or broken.		
Mounting structure	Rust, scratching		There should be no rust or scratching.		
	Mounting structure fixing		There should be no loose bolts.		
	Fixing of photovoltaic cells and mounting structure		There should be no loose bolts.		
	Grounding of mounting structure		The mounting structure should be grounded.		
	Attachment of structures		Structures should be attached tightly.		
Operation/Stop	Power conditioner	Grid-connected operation	Operation should be conducted with the ‘Operate’ switch.		
		Operation/Stop	Operation should be stopped with the ‘Stop’ switch.		
Operation/Stop	Commercial power supply	Power interruption	The power conditioner should stop instantaneously.		

<table>
<tr><th>Instrument, etc.</th><th colspan="2">Inspection Item</th><th>Judgment Criteria</th><th>Remarks</th><th>Inspector</th></tr>
<tr><td rowspan="2"></td><td></td><td>Power resumption</td><td>The power conditioner should resume operation automatically after ( ) seconds on the resumption timer.</td><td></td><td></td></tr>
<tr><td>OVGR</td><td>OVGR Operation</td><td>The power conditioner should stop when OVGR is operated.</td><td></td><td></td></tr>
<tr><td rowspan="8">Junction box</td><td colspan="2">Terminal box loose screws</td><td>There should be no loose screws.</td><td>Junction box</td><td></td></tr>
<tr><td colspan="2">Wiring connections (polarity)</td><td>There should be no confusion between + (plus) and – (minus) in wiring.</td><td></td><td></td></tr>
<tr><td colspan="2">Grounding works</td><td>Equipment should be certainly grounded.</td><td></td><td></td></tr>
<tr><td colspan="2">Rust, dirt</td><td>There should be no rust or dirt.</td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="2">Insulation resistance measurement
Voltage DC1000V</td><td>Insulation resistance between the photovoltaic cells + (plus) and ground should be at least 1MΩ.</td><td></td><td rowspan="2"></td></tr>
<tr><td>Insulation resistance between the PV cells – (minus) and ground should be at least 1MΩ.</td><td></td></tr>
<tr><td rowspan="2">Solar cell open voltage measurement</td><td>Open voltage in case of ( ) series</td><td>Voltage should be less than DC (-)V</td><td>PV1
PV2
PV3
PV4</td><td></td></tr>
<tr><td>Voltage fluctuation</td><td>Fluctuation should be less than ( )V (determined by the system)</td><td>V</td><td></td></tr>
<tr><td rowspan="9">Power conditioner</td><td colspan="2">Terminal box loose screws</td><td>There should be no loose screws.</td><td></td><td></td></tr>
<tr><td colspan="2" rowspan="2">Wiring connections (polarity)</td><td>There should be no confusion between + (plus) and – (minus) in wiring.</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>The AC output RST should be correctly wired.</td></tr>
<tr><td colspan="2">Terminal box loose screws</td><td>Equipment should be certainly grounded.</td><td></td><td></td></tr>
<tr><td colspan="2">Protective relay configuration</td><td>Confirm that configuration is as designed.</td><td></td><td></td></tr>
<tr><td colspan="2">Noise</td><td>Separate TVs and radios by at least 3 m.</td><td></td><td></td></tr>
<tr><td colspan="2">Ventilation</td><td>Are the ventilation ducts open?</td><td></td><td></td></tr>
<tr><td colspan="2">Combustible objects in the vicinity</td><td>Are there no flammable objects nearby?</td><td></td><td></td></tr>
<tr><td colspan="2">Grid voltage measurement</td><td>Voltage between RTs should be no more than AC( )V ± ( )V.</td><td>Between RS
Between ST
Between TR</td><td></td></tr>
</table>

4) Adjustment of permanent values and stabilization times of instruments before the start of operation

The operation manager will configure the following instruments and check that the instruments operate as configured before resuming operation.

The operation manager will adjust the permanent values and stabilization times of instruments in the grid-connected photovoltaic system. The main permanent values and stabilization times are as follows.

① Confirmation of permanent values of protective relays

Confirm the permanent value and stabilization time of the installed power conditioner.

② Confirmation of closing holdback time in cases of AC power restoration

After confirming the power conditioner, close the breaker on the DC side. If there is no problem with the display, close the breaker on the AC side and measure the time until grid-connected operation starts.

③ Confirmation of system stoppage time in cases of DC power loss

Turn the breaker on the DC side off during power conditioner operation and make sure that the power conditioner stops safely.

④ Confirmation of system stoppage time in cases of AC power loss

After performing item ③ turn the DC side breaker on and turn the AC side breaker off while in the operating state, and make sure that the power conditioner completely stops.(Note: Since there are differences between makers, refer to the maker specifications).

2-4-2 Spare Parts Purchasing Plan

Since the photovoltaic system contains no internal operating parts, it is basically a maintenance-free system. It experiences no breakdowns as a result of abrasion and friction, etc., however, because it uses an inverter, there is a possibility that failure will occur in the semiconductors. Since semiconductor faults appear during initial operation, it is considered to be normally operating if no initial troubles arise. However, this does not mean that failures can’t be caused by natural disasters and fires or that there will be no degradation or wear caused by long-term use. It is necessary to keep spare items on hand for the power conditioner, which is the heart of the system, and a number of other instruments.

2-4-2-1 Equipment replacement intervals and inspection contents

Equipment becomes worn down and eventually loses its functions over time. The state of degradation in photovoltaic power modules can be judged to an extent through measuring output characteristics, however, it is difficult to discern degradation in many other instruments. According to the preventive maintenance philosophy for preserving system reliability, parts are changed before they break down. Table 2-4-2.1 shows the recommended replacement intervals and inspection contents of major instruments for reference. Depending on the system, there is concern that costs will become higher, however, spare parts will be supplied in the Project.

Table 2-4-2.1 Replacement Intervals and Inspection Contents of Major Equipment (Recommended cases)

Part Type	Recommended Replacement Interval	Inspection Contents
Photovoltaic modules	20~30 years	External appearance and voltage measurement
Junction box	20 years	Malfunction
Circuit breaker	10～15 years	Malfunction
Collecting box	10～15 years	Malfunction
Power conditioner	10～15 years	Malfunction
Combination panel	10～15 years	Malfunction
Low voltage panels	10～15 years	Malfunction
DC power supply	7~15 years	Malfunction
11kV switchgear	10～15 years	Malfunction
33kVsupply meter panel	10～15 years	Malfunction
Protective relays	20 years	Malfunction
Transformer	20 years or more	Temperature increase
Cooling fan	10 years or more	Change in air flow or turning sound
Fuse	7 years or 50,000 hours	Meltdown
Cooler	10～15 years	Malfunction, reduced performance

2-4-2-2 Spare parts storage

Breakages and failures of main items of equipment in photovoltaic systems frequently lead to suspension of system functions. When troubles occur, it is desirable to promptly conduct repairs or replace the problem equipment, and the system can be quickly restored if replacement equipment is kept on hand. However, since it is expensive to keep stores of expensive parts or large quantities of parts, it is necessary to determine the types and quantities of spare parts upon considering the equipment characteristics, economy and time required for system recovery, etc. Table 2-4-2.2 shows the types and quantities of spare parts that are recommended for storage in the Project.

Table 2-4-2.2 Spare Parts Storage

Storage Location	Equipment (recommended)	Quantity (recommended)
Power conditioner room Store	Photovoltaic modules	3% of the total number of modules
	Junction box	2
	Collecting box	1
	Air-insulated circuit breaker (ACB) 600V,2000A	1
	Electromagnetic contactor 500V *1)	Each 1 of all types
	For AC Wiring circuit breaker 600V *1)	Each 1 of all types
	For DC Wiring circuit breaker 500V *1)	Each 1 of all types
	Fuse	100% of the total
	Auxiliary relay	Each 1 of all types
	Wiring	3% of all types

Note *1): Voltage may differ depending on the maker and system.

2-4-2-3 Spare parts procurement plan

The recommended replacement intervals of the major items of equipment in the grid-connected photovoltaic system are as indicated below. Costs arise when major items of equipment are replaced, and it is necessary to budget for these every year. However, in the Project, spare units will be procured for all the main instruments that comprise the photovoltaic system. The service life of the cooler in the power conditioner room is 10~15 years and, since no spare cooler will be procured in the Project, it will be necessary to budget for replacement of this in the 10th year after start of operation. Coolers and other items can be purchased in Abuja.

Table 2-4-2.3 Replacement Intervals and Costs of Replacement Parts

Part	Replacement Interval	Quantity	Cost
Air conditioner	10~15 years	1	700,000 Naira

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Costs to be borne by the Nigerian side: US$ 28,600- (approximately 2.37 million yen)

The contents and costs to be borne by the Nigerian side are as follows:

1) Land preparation of the project site: US$ 16,900 (approximately 1.40 million yen)

2) Payment of commission for the bank: US$ 11,700 (approximately 0.97 million yen)

(2) Estimation criteria

1) Estimation point: July 2011

2) Exchange rate: US$1 = 83.00 yen
(TTS mean value from January 2011 to June 2011)

3) Works and procurement period: The detailed design and equipment procurement and installation period is as shown in the implementation schedule.

4) Other points: The Project will be implemented according to the Grant Aid Scheme of the Government of Japan.

2-5-2 Operation and Maintenance Cost

Main equipment of the photovoltaic system procured in the Project is composed of Japanese product and this is especially true in the grid-connected system here since it doesn't use batteries. However, since the system here will be installed overseas, it will not be possible to respond to any problems as quickly as compared to the case of installation in Japan. Implementation of routine inspections and periodic inspections needed for operation and maintenance helps in quickly discovering system failures and troubles and is useful for improving operation methods. Also, keeping manuals and operating records on hand is an effective means of enhancing system maintenance. Moreover, establishing a setup for storing and supplying replacement parts and so on enhances the system reliability. Maintenance is important for ensuring the long-term operation of grid-connected photovoltaic systems. Key points in maintenance are the replenishment of instruments at times of failure and implementation of routine inspections. The special condition in Katsina, Nigeria is the fine sand that is carried by Hamatan winds during the dry season. When the Hamatan is blowing strongly, the back window of a sedan car can become so covered in dust that it can no longer transmit light. During the dry season, it will be important to clean photovoltaic panels on a daily basis. The important points in maintaining the grid-connected photovoltaic system are indicated below.

(1) Important maintenance points

1) Implementation of periodic inspections and maintenance

Periodic inspections and maintenance are the basic requirement for ensuring the stable and long-term operation of photovoltaic systems. Early detection of system failures and troubles is important for improving operation methods and conducting preventive maintenance.

2) Preparation of manuals

Compiling the contents of maintenance work into manuals is effective for limiting disparities in capability between engineers and improving the efficiency of system maintenance.

3) Maintenance of operating records

Operation managers keep records of photovoltaic system inspection and maintenance conditions and any failures, troubles or problems in the system. Such records prove useful in identifying failure-prone points, preventing reoccurrence of problems and preventing problems. Furthermore, records are fed back to manuals and education of engineers and can be used for improving the content and efficiency of maintenance technology.

4) Equipment replenishment

It is desirable to use locally procurable equipment and materials in the system as much as possible. However, if imported products or products that are locally hard to procure have to be used from the viewpoints of reliability and cost, it is necessary to establish a system for promptly supplying them when needed.

5) CeRER staff education

Since the CeRER staff will be directly or indirectly involved in maintenance of the photovoltaic system, they will need to be educated. It will be possible to operate the photovoltaic system more effectively if all CeRER staff members understand the system. Operation managers must carry out this education for CeRER staff.

(2) Equipment replenishment

Photovoltaic cell modules are said to have a service life of 20 years or more, while the other component equipment and materials have shorter life. The long-term and stable operation of the system depends on the rapid replacement of such equipment and materials. Description of the replacement intervals, inspection contents and spare parts storage methods, etc. is given in Section 2-4-2-3 (Spare Parts Purchasing Plan).

(3) Operation and maintenance cost

In addition to the equipment described above, personnel expenses are also required in order to maintain the grid-connected photovoltaic system. Regarding personnel costs, CeRER staff members will conduct operation and maintenance of the system in addition to the regular duties. As for panel cleaning, it will be necessary to seasonally recruit cleaners.

1) Personnel expenses

Panel cleaners will be employed (seasonally on a part-time basis). The cleaners will clean panels every day during the dry season.

Table 2-5-2.1 Seasonal Employment Costs

Employed number	Employed period	Employed months	Rate / month	Employment cost (month)	Employment cost (year)
2 people	October ~April	7 months	30,000N	60,000N	420,000N

2) Equipment replenishment costs

Table 2-4-2.1 shows the necessary equipment and estimated service lives for operating the grid-connected photovoltaic system over the long term. These instruments are expensive, however, replacement parts will be supplied when installing the system. The university side will need to bear the cost of replacing the cooler in the power conditioner room.

(4) Operation and maintenance cost

Table 2-5-2.2 shows the operation and maintenance costs of the grid-connected photovoltaic system. The annual cost of the grid-connected photovoltaic system is approximately 586,044N (US$3,992)

Table 2-5-2.2 Operation and Maintenance Cost

	Annual cost (N/year)	Remarks
Employment cost	420,000N	Panel cleaners: 2 people (7 months)
Equipment cost	70,000N	Cooler (1 year)
Electricity charge (*1)	42,744N	Power conditioner room electricity Display units
Others (contingencies)	53,300N	10%
Total	586,044N	

Note: Electricity charge calculation

- Power conditioner room ventilation fan, etc. is estimated as 2.5 kW/hour (assuming room temperature of 27~35℃).
- Electricity usage: 365 x 9 x 0.5 x 2.5 ＝ 4380kWh / year (assuming 50% conduction rate), 9 hours per day, conduction rate 50%

- Electricity charge: Categorized in Industrial rate.

Table 2-5-2.3 Electricity Charge

Tariff system (industrial)	5kVA or less	Annual electricity charge
Minimum tariff	136N / M	1,632N
Fixed charge	136N /M	1,632N
Meter repairs	151N / M	1,812N
Energy cost	8.6 kWh	37,668N
Total Cost		42,744N

CHAPTER 3 PROJECT EVALUATION

Chapter 3 **Project Evaluation**

3-1 Preconditions

3-1-1 Preconditions for Project Implementation

Project implementation requires the acquisition of permission to use the photovoltaic panel installation site and the granting of the environmental authorization. Concerning use of land, permission has been secured from Umaru Musa Yar'Adua University (UMYU), which is the Project implementing agency; moreover, there shouldn't be any trouble securing the environmental authorization because the Project will contribute to the mitigation of global warming.

3-1-2 Preconditions and External Conditions for Achievement of the Overall Project Plan

The issues that need to be tackled by the Government of Nigeria in order to realize and sustain the Project effects are as follows.

① It will be necessary to appropriately conduct routine maintenance to ensure that the PV system equipment procured and installed by the Japanese side is utilized to the full.

② It will be necessary for related agencies to participate in equipment installation and technical guidance in the Project, in order to acquire photovoltaic system technology and utilize it in future enlightenment and dissemination.

③ It will be necessary to build a framework for saving the tariff reductions enabled by photovoltaic power generation as a maintenance fund and to utilize this saved money for renewing and maintaining equipment.

④ It will be necessary to secure, educate and training personnel for maintaining the photovoltaic system equipment.

⑤ It will be necessary to share data on solar irradiation and generated electric energy, etc. with related agencies and utilize it in future plans.

3-2 Project Evaluation

3-2-1 Validity

As is indicated below, since the Project will contribute to the realization of Nigeria's development plans and energy policy as well as benefit the general population, it is deemed to have high validity as a grant aid undertaking.

① Benefitting population

Project implementation will enable employees (approximately 690) of UMYU receive power supply from photovoltaic power generation. Moreover, the reduction in emissions of greenhouse gases enabled by photovoltaic power generation will benefit all the people of Nigeria.

② Contribution to stable operation of public welfare facilities

In addition to contributing to power supply for the university (a public welfare facility), the Project will aid in the dissemination and public education of renewable energy because the Center for Renewable Energy Research inside UMYU will be able to collect data, conduct research and publish findings based on utilizing the Project photovoltaic system.

③ Operation and maintenance capacity

Since the equipment and materials to be procured in the Project can be comfortably operated and maintained under the present technical capacity in Nigeria, they will present no particular problems regarding implementation of the Project.

④ Contribution to development plans in Nigeria

The project will contribute to the national energy policy and renewable energy plans being implemented by the Government of Nigeria.

⑤ Government of Japan's Grant Aid Scheme

The Government of Japan's Grant Aid Scheme will not hinder implementation of the Project. Moreover, since the Project contents and schedule are feasible for implementation under the Grant Aid Scheme, the Project can be implemented without any major difficulty.

⑥ Necessity and superiority of Japanese technology

In the Project it will be possible to utilize Japanese advanced technology in the field of clean energy including renewable energy. In particular, it will be possible to utilize extremely superior Japanese technology in the field of photovoltaic power generation.

3-2-2 Efficiency

The anticipated effects of Project implementation are as indicated below.

① Quantitative effects

Indicator	Reference value (2010)	Target value (2016)

Net electric energy (MWh/year)*	0	330
CO_2 reduction (t/year)*	0	232

*: Arising out of the Project

② Qualitative effects

Current conditions and problems	Project countermeasures (grant aid project)	Degree of Project effects and improvement
1. Although the Government of Nigeria regards promotion of the introduction of renewable energy as a policy goal, a lack of enlightenment and dissemination activities is hindering progress.	Introduce and installation of a 850 kWp grid connected photovoltaic system at UMYU.	Through installing a photovoltaic system at UMYU, which has approximately 4,300 students, an enlightenment effect can be expected with respect to the teachers and students of the university and visitors.
2. Although the Government of Nigeria is aiming to introduce grid-connected renewable energy based on the Renewable Energy Master Plan, the country has no experience of similar systems.	Ditto	Because personnel on the Nigerian side will be involved in the planning, installation and maintenance of grid-connected photovoltaic system equipment, they will acquire knowledge and experience on photovoltaic power equipment, and this will contribute to future dissemination.

3-2-3 Conclusion

As was indicated above, since the Project can be expected to impart major effects and to contribute to realizing the energy policy of Nigeria, it will be highly valid and effective to implement the Government of Japan’s Grant Aid Scheme for part of the Project activity. Moreover, the Nigerian side is deemed to possess adequate personnel and budget capability to host the Project and handle the operation and maintenance of equipment after its completion.

Appendices

[Appendices]

1. Member List of the Study Team
2. Study Schedule
3. List of Parties Concerned in the Recipient Country
4. Minutes of Discussions
5. Beneficial Effects of the Project
6. Soft Component (Technical Assistance) Plan

Appendix 1 Member List of the Study Team

1. Member List of the Study Team

(1) First Field Survey (Nigeria/Ghana)

Name	Responsible Work Area	Current Position
Kyojin MIMA	Leader	Chief Representative, Nigeria Office, Japan International Cooperation Agency (JICA)
Katsuhiko SHINO	Planning Management	Japan International Cooperation Agency (JICA)
Minoru YAMAGUCHI	Procurement Planning & Management	Crown Agents (CA)
Kyoji FUJII	Chief Consultant / Distribution System Operation / Operation and Maintenance Planning	Yachiyo Engineering Co., Ltd.
Mitsuhisa NISHIKAWA	Deputy Chief Consultant / Grid-Connected PV System	Yachiyo Engineering Co., Ltd.
Katsuo URANO	Solar Power System	Yachiyo Engineering Co., Ltd.
Takayuki MIYAMOTO	Procurement Planning / Estimation 1	Yachiyo Engineering Co., Ltd.
Kazunari NOGAMI	Related Institutional Framework and Standard / Environmental and Social Considerations	Yachiyo Engineering Co., Ltd.
Testuo YATSU	Architectural Design 1	Yachiyo Engineering Co., Ltd.

(2) Second Field Survey (Nigeria/Ghana)

Name	Responsible Work Area	Current Position
Kyoji FUJII	Chief Consultant / Distribution System Operation / Operation and Maintenance Planning	Yachiyo Engineering Co., Ltd.
Mitsuhisa NISHIKAWA	Deputy Chief Consultant / Grid-Connected PV System	Yachiyo Engineering Co., Ltd.
Katsuo URANO	Solar Power System	Yachiyo Engineering Co., Ltd.
Masayuki TAMAI	Equipment and Facility Planning	Yachiyo Engineering Co., Ltd.
Takayuki MIYAMOTO	Procurement Planning 1 / Cost Estimation 1	Yachiyo Engineering Co., Ltd.
Kazunari NOGAMI	Related Institutional Framework and Standard / Environmental and Social Considerations	Yachiyo Engineering Co., Ltd.
Yosuke TSURUOKA	Architectural Design 2	Yachiyo Engineering Co., Ltd.
Daisuke AKATSUKA	Coordinator	Yachiyo Engineering Co., Ltd.

(3) Fourth Field Survey (Nigeria)

Name	Responsible Work Area	Current Position
Yoshitaka SUMI	Leader	Chief Representative, JICA Nigeria Office
Kyoji FUJII	Chief Consultant / Operation and Maintenance Planning Environment & Social Consideration	Yachiyo Engineering Co., Ltd.
Mitsuhisa NISHIKAWA	Deputy Chief Consultant / Grid-Connected PV System	Yachiyo Engineering Co., Ltd.
Katsuo URANO	Solar Power System	Yachiyo Engineering Co., Ltd.
Fukiyoshi KOREZAWA	Equipment and facility planning	Yachiyo Engineering Co., Ltd.
Toru FUJII	Procurement & Cost Estimation	Yachiyo Engineering Co., Ltd.
Yosuke TSURUOKA	Civil & Architectural Design	Yachiyo Engineering Co., Ltd.
Kazuaki KONDO	Coordinator	Yachiyo Engineering Co., Ltd.

(4) Fifth Field Survey (Nigeria)

Name	Responsible Work Area	Current Position
Yoshitaka SUMI	Leader	Chief Representative, JICA Nigeria Office
Tomoyuki Uda	Planning Management	Japan International Cooperation Agency (JICA)
Kyoji FUJII	Chief Consultant / Operation and Maintenance Planning Environment & Social Consideration	Yachiyo Engineering Co., Ltd.
Mitsuhisa NISHIKAWA	Deputy Chief Consultant / Grid-Connected PV System	Yachiyo Engineering Co., Ltd.
Katsuo URANO	Solar Power System	Yachiyo Engineering Co., Ltd.
Fukiyoshi KOREZAWA	Equipment and facility planning	Yachiyo Engineering Co., Ltd.

Appendix 2 Study Schedule

2.Study Schedule

(1) First Field Survey

<table>
<tr><th rowspan="3">No.</th><th rowspan="3">Date</th><th rowspan="3">Day</th><th colspan="2">Survey Contents</th><th rowspan="3">Overnight</th></tr>
<tr><th>Official members</th><th>Consultant Team members (Yachiyo Engineering Co., Ltd.)</th></tr>
<tr><th>JICA
(Mr. Kyojin MIMA,
Mr. Shino, Mr. Yamaguchi)</th><th>Fujii, Nishikawa, Urano, Miyamoto, Nogami, Yatsu</th></tr>
<tr><td>1</td><td>Dec 12, 2009</td><td>Sat</td><td colspan="2">• Transfer Accra 08:10 → Lagos 10:15 by VK810, Lagos 14:20 → Abuja 15:35 by W3157｝</td><td>Abuja</td></tr>
<tr><td>2</td><td>Dec 13, 2009</td><td>Sun</td><td>• Arrive in Abuja
• Team discussions</td><td>• Arrangement of materials
• Team discussions</td><td>Abuja</td></tr>
<tr><td>3</td><td>Dec 14, 2009</td><td>Mon</td><td colspan="2">• Discussions with Abuja National Hospital
• Discussions with the Energy Commission of Nigeria and the National Planning Commission
• Site survey</td><td>Abuja</td></tr>
<tr><td>4</td><td>Dec 15, 2009</td><td>Tue</td><td colspan="2">• Discussions with the Federal Ministry of Power
• Site survey</td><td>Abuja</td></tr>
<tr><td>5</td><td>Dec 16, 2009</td><td>Wed</td><td colspan="2">• Discussion of the minutes
• Site survey</td><td>Abuja</td></tr>
<tr><td>6</td><td>Dec 17, 2009</td><td>Thu</td><td colspan="2">• Signing of minutes, discussions with Abuja Power Distribution Company
• Site survey</td><td>Abuja</td></tr>
<tr><td>7</td><td>Dec 18, 2009</td><td>Fri</td><td colspan="2">• Report to Embassy of Japan, JICA Nigeria Office
• Arrangement of materials
• Leave Abuja (consultant team members)</td><td>Abuja</td></tr>
<tr><td>8</td><td>Dec 19, 2009</td><td>Sat</td><td colspan="2">• Leave Abuja</td><td></td></tr>
</table>

(2) Second Field Survey

No.	Date	Day	Survey Contents Consultant Team members (Yachiyo Engineering Co., Ltd.) Fujii, Nishikawa, Urano, Tamai, Miyamoto, Nogami, Tsuruoka, Akatsuka	Overnight
1	Feb 21, 2010	Sun	• Transfer {Tokyo 11:30 → Amsterdam 15:45 by JL411}	Amsterdam
2	Feb 22, 2010	Mon	• Transfer {Amsterdam 13:50 →Abuja 20:15 by KL577}	Abuja
3	Feb 23, 2010	Tue	• ① Courtesy call: JICA Nigeria Office, Abuja National Hospital	Abuja
4	Feb 24, 2010	Wed	• ① Technical discussions (Abuja National Hospital) and field survey • ② Courtesy call: ECN • ③ Survey of local procurement and construction conditions	Abuja
5	Feb 25, 2010	Thu	• ① Site survey and technical discussions (Abuja National Hospital, PHCN, Federal Ministry of Power), ② Survey of local procurement and construction conditions	Abuja
6	Feb26, 2010	Fri	• ①Site survey, ② Survey of local procurement and construction conditions	Abuja
7	Feb27, 2010	Sat	• ①Site survey, ②Arrangement of materials and Team discussions, ③Survey of local procurement and construction conditions	Abuja
8	Feb28, 2010	Sun	• ①Arrangement of materials and Team discussions • Transfer {Tokyo 13:30 → Frankfurt 17:45 by JL407} (Tamai)	Abuja Tamai: Frankfurt
9	Mar 1, 2010	Mon	• ①Site survey and technical discussions (Abuja National Hospital), ② Survey of local procurement and construction conditions • Transfer {Frankfurt 11:35 →Abuja 17:35 by LH568} (Tamai)	Abuja
10	Mar 2, 2010	Tue	• ① Site survey and technical discussions (Abuja National Hospital) • ② Survey of local procurement and construction conditions	Abuja
11	Mar 3, 2010	Wed	• ①Site survey and technical discussions (Abuja National Hospital), ② Discussions on environmental and social consideration (Federal Ministry of Environment) • ③ Survey of local procurement and construction conditions	Abuja
12	Mar 4, 2010	Thu	• ①Site survey and technical discussions (Abuja National Hospital), ②Discussions on environmental and social consideration (Abuja National Hospital) • ③ Climate data collection (Nigeria Meteorological Office)	Abuja
13	Mar 5, 2010	Fri	• ① Technical discussions (Ministry of Science and Technology, Federal Ministry of Power), ② Survey of local procurement and construction conditions	Abuja
14	Mar 6, 2010	Sat	• ① Team discussions, ② Preparation of the Field Report (draft), ③ Preparation of the Field Survey Results Summary (Draft)	Abuja
15	Mar 7, 2010	Sun	• ① Preparation of the Field Report (draft), ② Preparation of the Field Survey Results Summary (Draft)	Abuja
16	Mar 8, 2010	Mon	• ①Submission and discussion of the Technical Memorandum(draft) (Abuja National Hospital),② Modification of the Technical Memorandum(draft) • ③ Preparation of the Field Survey Results Summary (Draft)	Abuja
17	Mar 9, 2010	Tue	• ① Site survey and technical discussions (Abuja National Hospital), ② Site survey of photovoltaic project (Kaduna) • ③ Preparation of the Field Survey Results Summary (Draft)	Abuja
18	Mar10, 2010	Wed	• ① Discussion and signing of the Technical Memorandum(draft) (Abuja National Hospital), ② Preparation of the Field Survey Results Summary (Draft)	Abuja
19	Mar11, 2010	Thu	• ① Courtesy calls and reporting (JICA Nigeria Office, Japanese Embassy), ② Supplementary survey	Abuja
20	Mar12, 2010	Fri	• ① Supplementary survey, ② Transfer {Abuja 19:45 →Accra 20:35 by W3061}	

(3)Fourth Field Survey

No.	Date	Day	Survey Contents: Official: JICA (Team Leader: Yoshitaka SUMI)	Survey Contents: Consultant Team members (Yachiyo Engineering Co., Ltd.): Kyoji Fujii	Urano, Korezawa, Toru Fujii, Tsuruoka, Kondo	Nishikawa	Overnight
1	June 12, 2011	Sun		• Transfer {Narita 11:45 → London 16:20 by JL401} • Transfer {London 22:15 → Abuja 04:35+1 by BA0083}			Onboard plane
2	June 13, 2011	Mon	• ① Courtesy call: JICA (Office), Japanese Embassy	• Transfer { → Abuja 04:35 by BA0083}			Abuja
3	June 14, 2011	Tue	• ① Courtesy call: Energy Commission of Nigeria (ECN), Nigerian Energy Regulatory Commission (NERC), National Planning Commission (NPC), Federal Ministry of Power (FMP)				Abuja
4	June 15, 2011	Wed	• Transfer {Abuja→Katsina by Car}				Katsina
5	June 16, 2011	Thu	• ① Courtesy call, site survey and discussions on the minutes (Umaru Musa Yar'Adua University), ② Survey of the power distribution company (PHCN)				Katsina
6	June 17, 2011	Fri	• Transfer {Katsina→Abuja by Car}	• ① Site surveys and discussions on the minutes (Umaru Musa Yar'Adua University)			Katsina
7	June 18, 2011	Sat		• ① Arrangement of materials and Team discussions, ② Survey of local procurement and construction conditions)			Katsina
8	June 19, 2011	Sun		• Transfer {Katsina→Abuja by Car}	• ①Arrangement of materials and Team discussions	• Transfer {Narita 11:45 → London 16:20 by JL401} • Transfer {London 22:15 → Abuja 04:35+1 by BA0083}	Abuja/ Katsina
9	June 20, 2011	Mon	• ① Discussions on the minutes (Federal Ministry of Power: FMP)		• ① Site survey and technical discussions (Umaru Musa Yar'Adua University)	• ① Discussions on the minutes (Federal Ministry of Power: FMP)	Abuja/ Katsina
10	June 21, 2011	Tue	• ① Discussions on the minutes (Federal Ministry of Power: FMP)		• ① Site survey and technical discussions(Umaru Musa Yar'Adua University)	• ① Discussions on the minutes (Federal Ministry of Power: FMP)	Abuja/ Katsina
11	June 22, 2011	Wed		• Transfer {Abuja→Katsina by Car}	• ① Site survey and technical discussions (Umaru Musa Yar'Adua University)	• Transfer {Abuja→Katsina by Car}	Katsina
12	June 23, 2011	Thu		• ① Site survey and technical discussions(Umaru Musa Yar'Adua University)			Katsina
13	June 24, 2011	Fri		• ① Site survey and technical discussions(Umaru Musa Yar'Adua University), ②Preparation of the Field Report (draft), ③ Preparation of the Field Survey Results Summary (Draft)			Katsina
14	June 25, 2011	Sat		• ① Preparation of the Field Report (draft), ② Preparation of the Field Survey Results Summary (Draft)			Katsina
15	June 26, 2011	Sun		• ① Preparation of the Field Report (draft), ② Preparation of the Field Survey Results Summary (Draft)			Katsina
16	June 27, 2011	Mon		• ① Submission and discussion of the Field Report (draft), (Umaru Musa Yar'Adua University), ② Modification of the Field Report, ③ Preparation of the Field Survey Results Summary (Draft)			Katsina
17	June 28, 2011	Tue		• Transfer{Katsina→Abuja by Car}			Abuja

No.	Date	Day	Survey Contents: Official: JICA (Team Leader: Yoshitaka SUMI)	Consultant Team members (Yachiyo Engineering Co., Ltd.): Kyoji Fujii	Urano, Korezawa, Toru Fujii, Tsuruoka, Kondo	Nishikawa	Overnight
18	June 29, 2011	Wed		• ① Submission and discussion of the Field Report (Federal Ministry of Power), ② Preparation of the Field Survey Results Summary (Draft)			Abuja
19	June 30, 2011	Thu		• ① Submission and discussion of the Field Report (Federal Ministry of Power), ② Preparation of the Field Survey Results Summary (Draft) • Transfer {Abuja 08:45 → London 15:05 by BA0082} • Transfer {London 19:15 → Narita 15:00+1 by JL402}		• Transfer {Abuja 07:15 → Lagos 08:30 by W3162} • Survey of a steel manufacturing company	Abuja/ Lagos
20	July 1, 2011	Fri		• ① Submission and discussion of the Field Report (Federal Ministry of Power), ② Preparation of the Field Survey Results Summary (Draft) • Arrive in Narita 15:00		• Transfer {Lagos 13:15 → Abuja 15:00 by W3157}	Abuja
21	July 2, 2011	Sat		• ① Arrangement of materials and Team discussions, ② Survey of local procurement and construction conditions			Abuja
22	July 3, 2011	Sun		• ① Arrangement of materials and Team discussions			Abuja
23	July 4, 2011	Mon	• ① Courtesy calls and reporting (JICA (office), Japanese Embassy)				Onboard plane
				• Transfer {Abuja 22:25 → Frankfurt 05:25+1 by LH569}			
24	July 5, 2011	Tue		• Transfer {Frankfurt 21:05 → Narita 15:25+1 by JL408}			Onboard plane
25	July 6, 2011	Wed		• Arrive in Narita 15:25			

(4) Fifth Field Survey

No.	Date	Day	Contents of Field Survey: JICA Official (Mr. Sumi)	JICA Official (Mr. Uda)	Consultant (Mr. K.Fujii)	Consultant (Mr. Nishikawa, Mr. Urano, Mr. Korezawa)	Stay at
1	Dec 11, 2011	Sun		Trip {Narita 11:45 → London 15:25 by JL401} Trip {London 22:15 → Abuja 05:35+1 by BA083}			On board
2	Dec 12, 2011	Mon		Trip { → Abuja 04:35 by BA0083}			Abuja
			Courtesy call : JICA Nigeria Office, Embassy of Japan, Federal Ministry of Power (FMP), National Planning Commission (NPC)				
3	Dec 13, 2011	Tue	Trip { Abuja → Katsina by Car}				Katsina
4	Dec 14, 2011	Wed	① Discussion on the contents of Minutes of Discussions and explanation of draft report (Umaru Musa Yar'adua University)				Katsina
5	Dec 15, 2011	Thu	Trip {Katsina → Abuja by Car}				Abuja
6	Dec 16, 2011	Fri	Signing of Minutes of Discussions (FMP)				Abuja
7	Dec 17, 2011	Sat		Trip {Abuja 10:05 → London 15:30 by BA082} Trip {London 19:00 → Narita 16:00+1 by JL402}			On board
8	Dec 18, 2011	Sun		Arrival at Narita 16:00			

Appendix 3 List of Parties Concerned in the Recipient Country

3. List of Parties Concerned in the Recipient Country

Affiliation and Name	Position
Umaru Musa Yar'Adua University	
Dr. Ibrahim Sada	Deputy Vice-Chancellor
Mr. Abdul Halliru Abdullahi	Registrar
Mr. Abdul Fatah Muhammad	Director, Planning and Development
Engr. Ibrahim Haruna Soba	Representative Chairman of Centre for Renewable Energy
Engr. Sahal Hassan	Electrical Engineer
Mr. Lawal Salisu	Mechanical Engineer
Mr. Abdulkaim H. El-ladan	Research Fellow
Mr. Salisu Aminu Batagarawa	Bursar
Energy Commission of Nigeria	
Chief. I. J. Dioha	Deputy Director
Dr. Paulinus Ugwuoke	Assistant Director
Engr. Abaka Umar	Engineer
Engr. M. M. Gaji	Engineer
Nigerian Electricity Regulatory Commission	
Mr. Mohammed Lawal Bello	Vice Chairman
Mr. Patrick Okey Umeh	Commissioner/Finance & management Services
Dr. Usman Abba Arabi	Assisting General Manager, Govt., External & Industry Relations

National Planning Commission

Mr. Faniran Sanjo O.	Chief planning officer, Bilateral Economic Cooperation (Asia Pacific)

Federal Ministry of Power

Mr. Sanusi Garba	Director (Power)
Engr. E. O. Ajayi	Deputy Director (Power)
Mr. Adamu David E.	Electrical Engineer
Mr. Eneh Kingsley	Principal Engineer
Mr. Eugene Ejeregbe	Senior Mechanical Engineer

Power Holding Company of Nigeria

Mr. S. M. Audu	Business Manager
Engr. R. Obajemini	Engineer
Mr. Haruna I. Shinkafi	Operational Mechanical Engineer
Mr. Aliyu Musa	Human Resource Supervisor

Federal Ministry of Environment

Mr. Omotade O. O	Head, Impact monitoring branch

JICA Nigeria Office

Office Manager

Staff member

Staff member

Consultant

Embassy of Japan in Nigeria

First Secretary

First Secretary (in charge of Economic Cooperation)

Appendix 4 Minutes of Discussions

4. Minutes of Discussions

Minutes of Discussions
on the Preparatory Survey
on the Project for Clean Energy Promotion Using Solar Photovoltaic System
in the Federal Republic of Nigeria

The Government of Japan (hereinafter referred to as "GoJ") has established Cool Earth Partnership as a new financial mechanism. Through this, GoJ is cooperating actively with developing countries' efforts to reduce greenhouse gasses emissions, such as efforts to promote clean energy. A new scheme of grant aid, "Program Grant Aid for Environment and Climate Change", was also created by GoJ as a component of this financial mechanism. According to the initiative of Cool Earth Partnership, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), in consultation with GoJ, decided to conduct a Preparatory Survey (hereinafter referred to as "the Survey") on the Project for Clean Energy Promotion Using Solar Photovoltaic System(hereinafter referred to as "the Project").

JICA sent to the Federal Republic of Nigeria (hereinafter referred to as "Nigeria") the Preparatory Survey Team (hereinafter referred to as "the Team"), headed by Mr. Yoshitaka Sumi, Chief Representative, JICA Nigeria Office, and is scheduled to stay in Nigeria from June 13th to July 4th 2011.

The Team held discussions with the concerned officials of the Government of Nigeria and conducted a field survey.

In the course of discussions and field survey, both sides confirmed the main items described in the attached sheets.

Abuja
June 20, 2011

Mr. Yoshitaka Sumi
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Sanusi Garba
Director, (Power)
Federal Ministry of Power

B. O. Akpanyung
Director
International Cooperation Department,
National Planning Commission

ATTACHMENT

1. Current Situation

The Government of Nigeria recognizes the renewable energy could play a more important role in terms of enabling to meet their energy requirement. In the National Energy Policy, established in 2003, it states that the Solar Photovoltaic (PV) is one of the alternative technologies with high potential for promotion of the use of renewable energy, diversification of energy source and saving the utilization of natural resources in Nigeria

In this situation, both sides confirm that the Project, which introduces PV power generation systems connected with the national power grid, is one of the pilot systems to enhance the possibility of applying renewable energy.

2. Objective of the Project

The objective of the Project is to promote clean energy utilization and achieve emissions reductions by installing the PV system to be connected to the national grid.

3. Responsible Organization and Implementing Organization

The responsible organization is the Federal Ministry of Power and implementing organization is the Umaru Musa Yar'adua University. (The organization charts of the ministry and university are shown in Annex-1.)

4. Items Requested by Nigerian Side

4-1. After discussions with the Team, the installation of the on-grid power generating system using PV including following equipment was requested by the Nigerian side.

Table 1 Projects requested by Nigerian Government

	Description
Location	Umaru Musa Yar'adua University, Katsina State
Outline	The power produced is used for the Umaru Musa Yar'adua University
Requested equipment	(1) Solar module (total capacity might be approx. 500～1,000 kWp) (2) Junction box (3) Power conditioner (4) Circuit breaker (5) Cables for electric distribution (6) Data collecting and display device (7) Other relevant component to complete PV system such as Transformer, Control panel and Operation display (8) Training for operation and maintenance of PV system (eight numbers of counter part personnel)

4-2. The project site is as shown in Annex-2.

4-3. The Nigerian side explained that there is no duplication between requested contents of the Project and any other plans implemented by the other donors or the Nigerian side.

4-4. The Team will report the findings and items requested by the Nigerian side to JICA Headquarters and the Government of Japan.

5. Japan's Program Grant Aid for Environment and Climate Change

The Nigerian side understood the Japan's Program Grant Aid for Environment and Climate Change scheme explained by the Team as described in Annex-3, 4, 5, 6 and 7.

6. Schedule of the Study

6-1. The Team will proceed to further survey in Nigeria until July 4th 2011 as the Preparatory Survey.

6-2. After the completion of the Preparatory Survey, the Team will report the results to Nigerian side, JICA Headquarters and GoJ.

6-3. JICA will prepare the draft report and reference document in English and dispatch a mission to Nigeria in order to explain their contents around the end of October, 2011.

6-4. When the contents of the draft report and reference document are accepted in principle by the Government of Nigeria, JICA will complete the final report and reference document, and submit them to the Government of Nigeria and to the Procurement Agent by the end of December, 2011.

7. Other Relevant Issues

7-1. Permission of Land Acquisition / Usage

The Umaru Musa Yar'adua University owns the land mentioned below.

Also, Umaru Musa Yar'adua University agreed to permit the usage of necessary land or facilities for installation of the equipment.

(a) Securing necessary land or facilities
- for PV Modules
(- including underground cables between PV Modules and Power Conditioners)
- for Power Conditioners and transformer(s)

(b) Temporary office, stockyard, workshop, etc., during facility construction and installation of the equipment and materials
- Approximately 1,000 m^2 areas within the site.

7-2.Procurement of Equipment

The Team explained that, in accordance with the policy of Government of Japan, products of Japan shall be procured for major equipment in the Project. The Nigerian side agreed with the policy of Government of Japan and requested that the major Equipment and Materials shall be made in Japan.

7-3. Coordination with Relevant Organizations

The responsible Organization for the Project shall be the focal point for the Team, and responsible for the coordination with relevant organizations. The Nigerian side agreed to establish a consultative committee in order to coordinate with the Japanese side which consists of the Embassy of Japan, the JICA office and the Procurement Agent. Terms of Reference of the Consultative Committee is referred to Annex-8.

7-4. Environmental and Social Considerations

The Team explained the outline of JICA Environmental and Social Considerations Guideline (hereinafter referred to as "the JICA Guideline") to the Nigerian side. The Nigerian side agreed to take the JICA Guideline into consideration, and shall complete the necessary procedures

7-5. Operation and Maintenance

The Responsible Organization agreed to secure and allocate the necessary budget and personnel for the operation and maintenance of grid-connected PV system procured and installed under the Project.

7-6. Customs and Tax exemption

The Nigerian side agreed that the Nigerian side shall be responsible for the exemption and/or reimbursement (payment/assumption) of all customs, tax, levies and duties incurred in Nigeria for implementation of the Project.

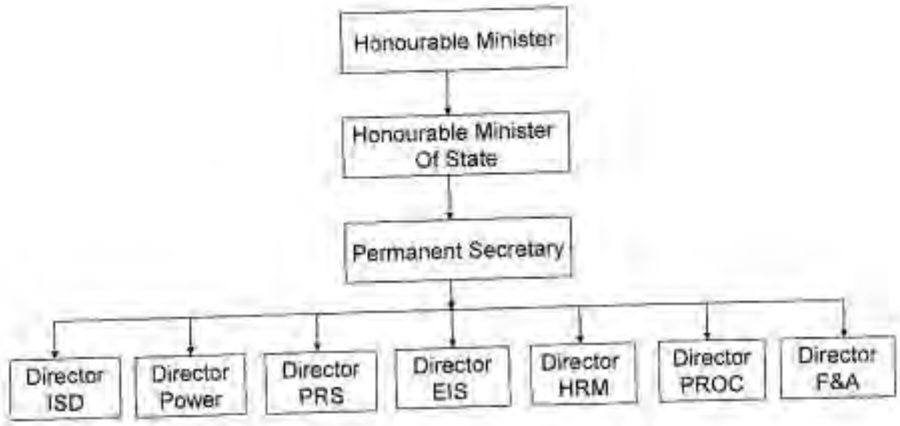
7-7. The Nigerian side shall ensure the security of all concerned Japanese nationals working for the Project, if deemed necessary.

7-8. The Nigerian side shall provide necessary numbers of counterpart personnel to the Team during the period of their studies in Nigeria

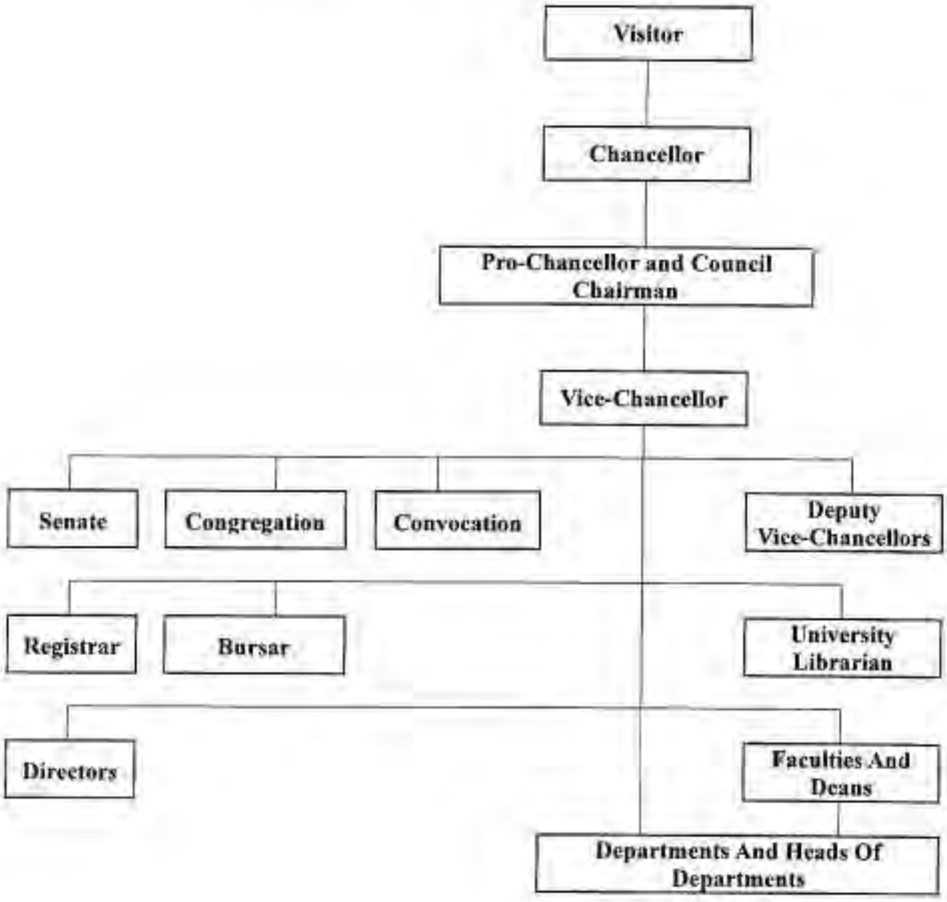
7-9. The Nigerian side shall submit all the answers to the Questionnaire, which the Team handed to the Nigerian side, by 30th June 2011.

<List of Annex>

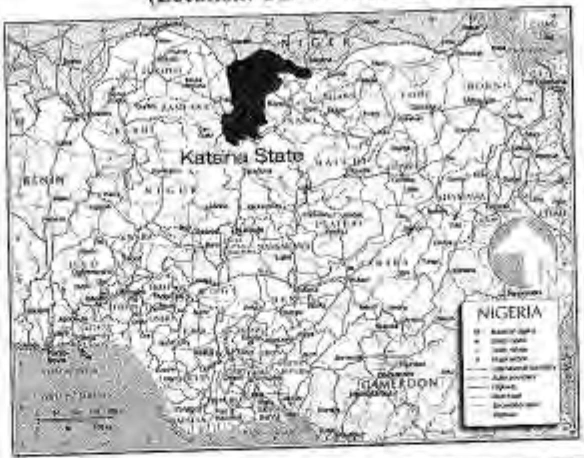
Organization Chart of Responsible Organization
(Federal Ministry of Power)



Organization Chart of Implementing Organization
(Umaru Musa Yar'adua University)



Candidate Site for PV System installed by the Project
(Location: Umaru Musa Yar'adua University, Katsina State)



■ African Continent

■ Federal Republic of Nigeria

Site Location Map (Katsina State)

Program Grant Aid for Environment and Climate Change of the Government of Japan
(Provisional)

The Grant Aid provides a recipient country (hereafter referred to as "the Recipient") with non-reimbursable funds to procure the facilities, equipment, and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

Based on "Cool Earth Partnership" initiative of the Government of Japan, the Program Grant Aid for Environment and Climate Change (hereafter referred to as "GAEC") aims to mitigate effects of global warming by reducing GHGs emission (mitigation; e.g. improvement of energy efficiency) and to take adaptive measures (adaptation; e.g. measures against disasters related to climate change, including disaster prevention such as enhancing disaster risk management).GAEC may contain multiple components that can be combined to effectively meet these needs.

1. Procedures for GAEC

GAEC is executed through the following procedures.

Preparatory Survey 1	Preparatory Survey for project identification conducted by Japan International Cooperation Agency (JICA)
Application	Request made by a recipient country
Appraisal & Approval	Appraisal by the Government of Japan and Approval by the Cabinet
Determination of Implementation	The Notes exchanged between the Government of Japan and the Recipient Country
Grant Agreement (hereinafter referred to as the "G/A")	Agreement concluded between JICA and the Recipient
Preparatory Survey 2	Preparatory Survey for design conducted by JICA
Implementation	Procurement through the Procurement Agency by the Recipient

Firstly, if the candidate project for a GAEC is identified by the Recipient and the Government of Japan, the Government of Japan (the Ministry of Foreign Affairs) examines it whether it is eligible for GAEC. When the request is deemed appropriate, JICA, in consultation with the Government of Japan, conducts the Preparatory Survey (hereafter referred to as "the Survey") on the candidate project as Phase 1 of the Survey with Japanese consulting firms.

Secondly, the Recipient submits the official request to the Government of Japan, while the appropriateness, necessity and the basic components of the project are examined in the course of Phase 1 of the Survey.

Thirdly, the Government of Japan appraises the project to see whether it is suitable for Japan's GAEC, based on the Survey report prepared by JICA, and the results are then submitted to the Cabinet for approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (E/N) signed by the Governments of Japan and the Recipient.

Fifthly, JICA engages Grant Agreement (G/A) with the Recipient and executes the Grant by making payments of the amount agreed in the E/N and strictly monitors that the funds of the Grant are properly and effectively used.

Procurement Management Agent is designated to conduct the procurement services of products and services (including fund management, preparing tenders, contracts) for GAEC on behalf of the Recipient. The Agent is an impartial and specialized organization that will render services according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the Agreed Minutes ("A/M").

2. Preparatory Survey

1) Contents of the Survey

The purpose of the Preparatory Survey (hereafter referred to as "the Survey"), conducted by JICA on a requested project (hereafter referred to as "the Project"), is to provide the basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Survey are as follows:

- Confirmation of background, objectives, and benefits of the Project and institutional capacity of agencies and communities concerned of the Recipient necessary for project implementation.
- Evaluation of relevance of the Project to be implemented under the Grant Aid Scheme for Environment and Climate Change from a technical, social, and economic point of view.
- Confirmation of items agreed upon by both parties concerning the basic concept of the Project.
- Preparation of the design of the Project and reference document for tender.
- Estimation of cost for the Project.

The contents of the original request will be modified, as found necessary, in the design of the Project according to the guidelines of Japan's Grant Aid scheme.

The Government of Japan requests the Government of the Recipient to take whatever measures necessary to ensure its responsibility in implementing the Project. Such measures must be guaranteed even if they may fall outside the jurisdiction of the implementing organization of the Recipient. This has been confirmed by all relevant organizations of the Recipient through the Minutes of Discussions.

2) Selection of consulting firms

For the smooth implementation of the Survey, JICA will conduct the Survey with registered consulting firms. JICA selects the firms based on proposals submitted by firms with interest in implementing the Survey. The firms selected will carry out the Preparatory Survey and prepare a report, based on the terms of reference set by JICA.

3. Implementation of GAEC after the E/N

1) Exchange of Notes (E/N)

The content of GAEC will be determined in accordance with the Notes exchanged by the two Governments concerned, in which items including, objectives of the project, period of execution, conditions and amount of the Grant Aid are confirmed.

2) Details of Procedures
Details of procedures on procurement and services under GAEC will be agreed between the authorities of the two governments concerned at the time of the signing of the G/A.

Essential points to be agreed are outlined as follows:
a) JICA will supervise the implementation of the Project.
b) Products and services will be procured and provided in accordance with JICA's "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change."
c) The Recipient will conclude a contract with the Agent.
d) The Agent is the representative acting in the name of the Recipient concerning all transfers of funds to the Agent.

3) Focal points of "Procurement Guidelines for the Program Grant Aid for Environment and Climate Change"
a) The Agent
The Agent is the organization, which provides procurement of products and services on behalf of the Recipient according to the Agent Agreement with the Recipient. The Agent is recommended to the Recipient by the Government of Japan and agreed between the two Governments in the A/M.

b) Agent Agreement
The Recipient will conclude the Agent Agreement, in principle, within two months after the signing of the G/A, in accordance with the A/M. The scope of the Agent's services will be clearly specified in the Agent Agreement.

c) Approval of the Agent Agreement
The Agent Agreement is prepared as two identical documents and the copy of the Agent Agreement will be submitted to JICA by the Recipient through the Agent. JICA confirms whether the Agent Agreement is concluded in conformity with the E/N, A/M, and G/A and the Procurement Guidelines for the Program Grant Aid for Environment and Climate Change then approves the Agent Agreement.

The Agent Agreement concluded between the Recipient and the Agent will become effective after the approval by JICA in a written form.

d) Payment Methods
The Agent Agreement will stipulate that "Regarding all transfers of the fund to the Agent, the Recipient will designate the Agent to act on behalf of the Recipient and issue a Blanket Disbursement Authorization ("the BDA")to conduct the transfer of the fund (hereinafter referred to as "the Advances") to the Procurement Account from the Recipient Account.

The Agent Agreement will clearly state that the payment to the Agent will be made in Japanese yen from the Advances and that the final payment to the Agent will be made when the total remaining amount become less than three percent (3%) of the Grant and its accrued interests excluding the Agent's fees.

e) Products and Services Eligible for Procurement
Products and services to be procured will be selected from those defined in the G/A.

f) Firm and Consultant
The firm and consultant who would contract with the Agent shall be Japanese Nationals.

The consultants that will be employed to do detail design and supervise the work for the Project, however will be in principle, Japanese nationals recommended by JICA for the purpose of maintaining technical consistency with the Study.

g) Method of Procurement
When conducting the procurement, sufficient attention will be paid to transparency in selecting the firms and for this purpose, competitive tendering will be employed in principle.

h) Tender Documents
The tender documents should contain all information necessary to enable tenderers to prepare valid offers for the products and services to be procured by GAEC.

The rights and obligations of the Recipient, the Agent and the firms supplying products and services should be stipulated in the tender documents to be prepared by the Agent. Aside from this, the tender documents will be prepared in consultation with the Recipient.

i) Pre-qualification Examination of Tenderers
The Agent may conduct a pre-qualification examination of tenderers in advance of the tender so that the invitation to the tender can be extended only to eligible firms. The pre-qualification examination should be performed only with respect to whether the prospective tenderers have the capability of concluding the contracts.

For this, the following points should be taken into consideration:
(1) Experience and past performance in contracts of similar kind
(2) Financial credibility (including assets such as real estate)
(3) Existence of offices and other items to be specified in the tender documents.
(4) Their potentialities to use necessary personnel and facilities.

j) Tender Evaluation
The tender evaluation should be implemented on the basis of the conditions specified in the tender documents.

Those tenderers which substantially conform to the technical specifications and other stipulations of the tender documents, will be judged in principle on the basis of the submitted price, and the tenderer who offers the lowest price will be designated as the successful tenderer.

The Agent will submit a detailed evaluation report of tenders to JICA for its information, while the notification of the results to the tenderers will not be premised on the confirmation by JICA.

k) Additional procurement
If there is any remaining balance after the competitive and/or selective tendering and/or direct negotiation for a contract, and if the Recipient would like to procure additional items, the Agent is allowed to conduct this additional procurement, following the points mentioned below:
(1) Procurement of same products and services
When the products and services to be additionally procured are identical with the initial tender and a competitive tendering is judged not efficient, additional procurement can be conducted by a negotiated contract with the successful tenderer of the initial tender.
(2) Other procurements
When products and services other than those mentioned above in (1) are to be procured, the procurement should be conducted through competitive tendering. In this case, the

products and services for additional procurement will be selected from among those in accordance with the G/A.

l) Conclusion of the Contracts

In order to procure products and services in accordance with the guideline, the Agent will conclude contracts with firms selected by tendering or other methods.

m) Terms of Payment

The contract will clearly state the terms of payment. The Agent will make payment from the "advances," against the submission of the necessary documents from the firm on the basis of the conditions specified in the contract. When the services are the object of procurement, the Agent may pay certain portion of the contract amount in advance to the firms on the conditions that such firms submit the advance payment guarantee worth the amount of the advance payment to the Agent.

4) Undertakings required by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the Recipient is required to undertake necessary measures as the following:

a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the Project.
b) To provide facilities for distributing electricity, water supply and drainage and other incidental facilities in and around the sites.
c) To ensure all the expense and prompt execution for unloading, customs clearing at the port of disembarkation and domestic transportation of products purchased under the Grant Aid,
d) To ensure that customs duty, internal taxes and other fiscal levies that may be imposed in the Recipient with respect to the purchase of the Components and the Agent's services will be exempted by the Government of the Recipient.
e) To accord all the concerned parties, whose services may be required in connection with supply of the products and services under the contracts, such facilities as may be necessary for their entry into the Recipient and stay therein for the performance of their work.

5) "Proper use of funds"

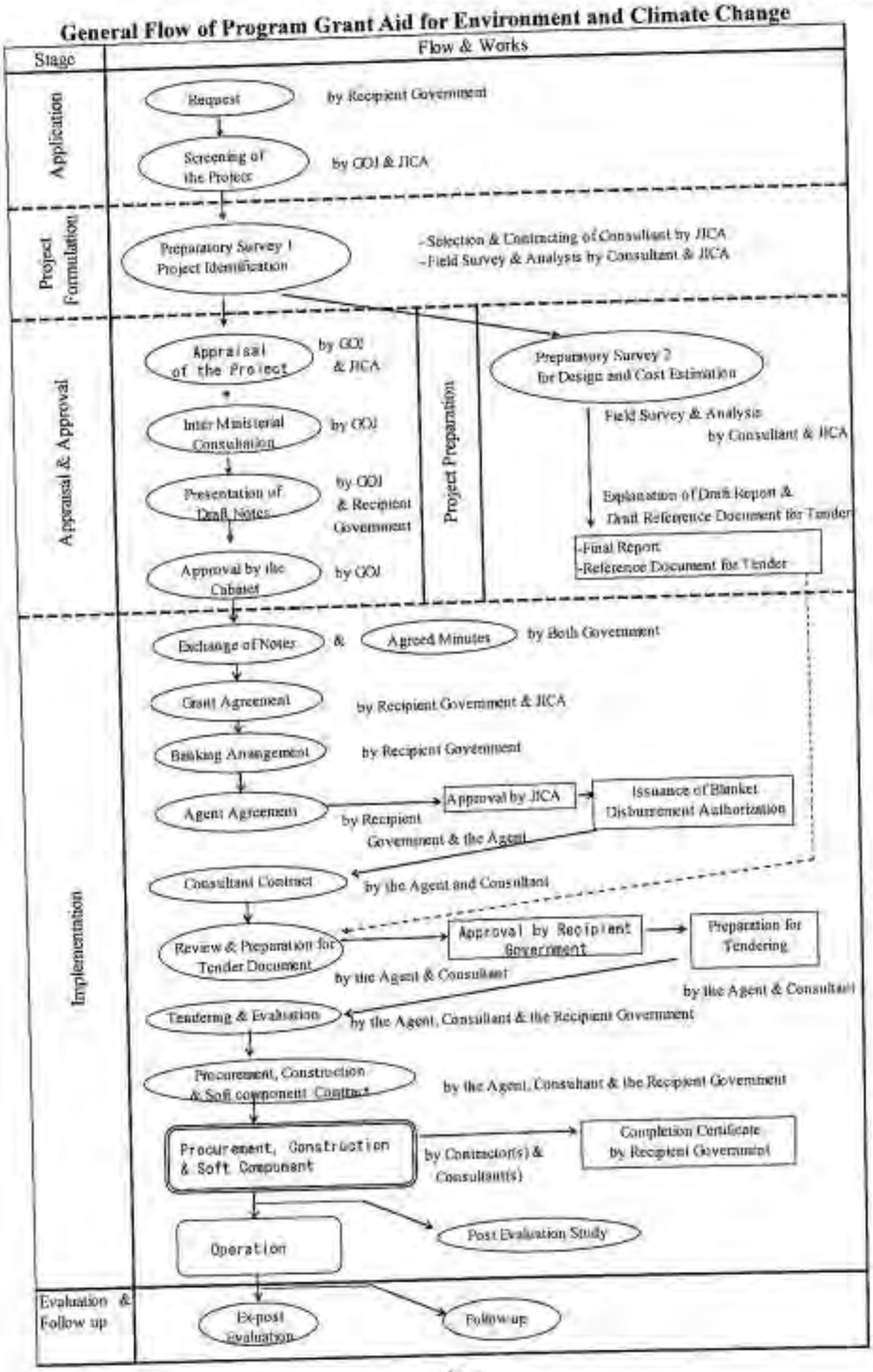
The Recipient is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign personnel necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

6) "Export and Re-export" of products

The products purchased under the Grant and its accrued interest will not be exported or re-exported from the Recipient.

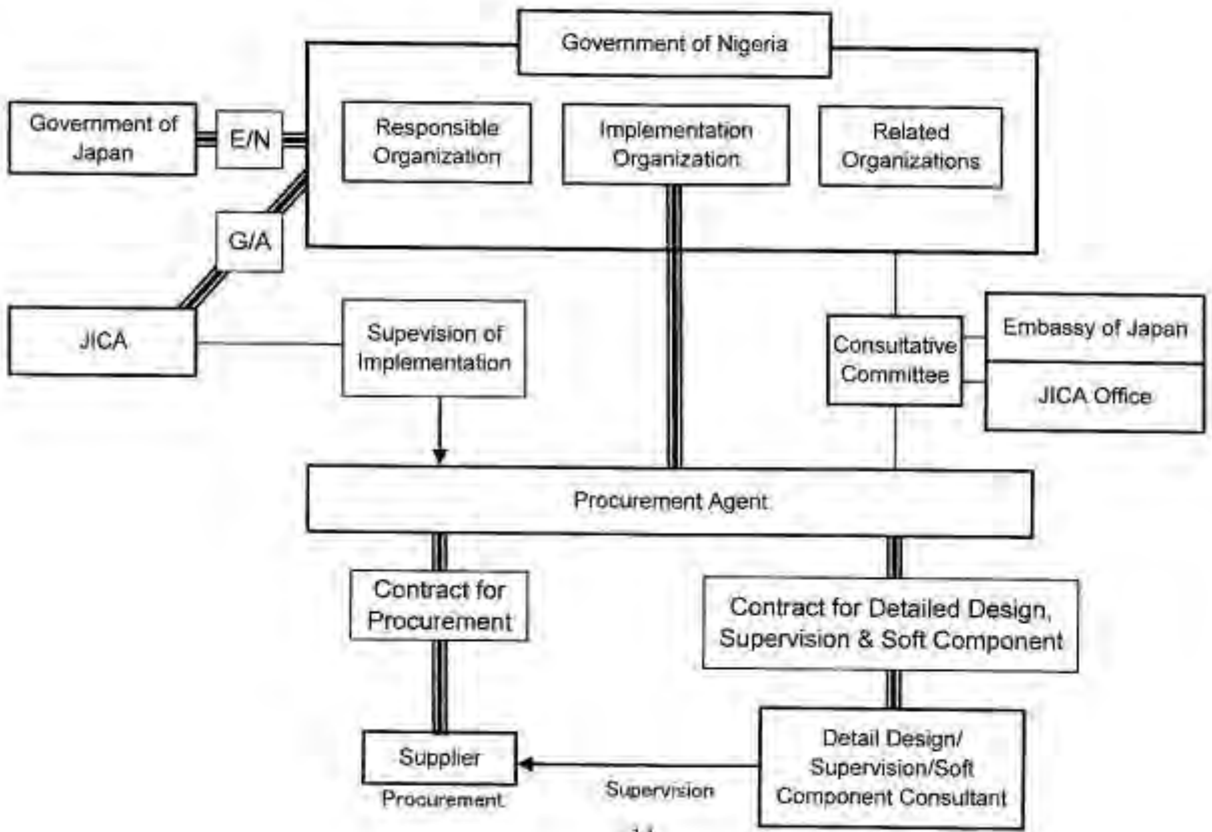
Annex-4

General Flow of Program Grant Aid for Environment and Climate Change

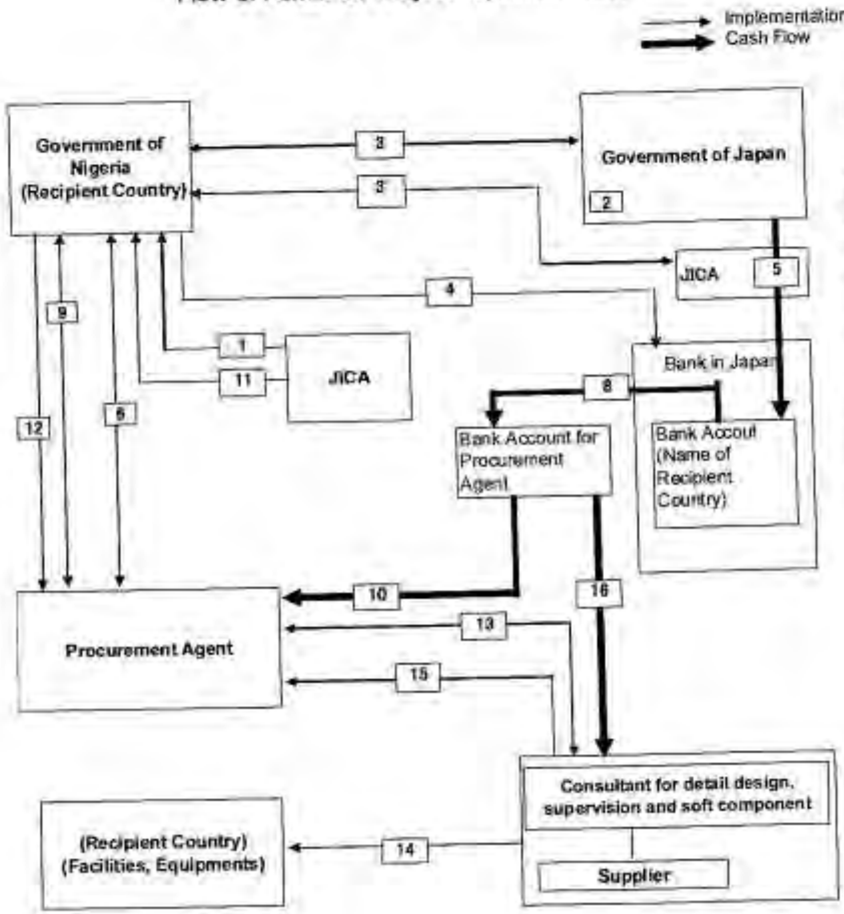


- 13 -

Project Implementation System



Flow of Funds for Project Implementation



1 Preparatory Survey / Reference Document for Tender

2 Approval of Cabinet

3 Signing of Exchange of Notes (E/N)

3' Signing of Grant Agreement (G/A)

4 Banking Arrangement (B/A)

5 Disbursement of Funds from the Government of Japan

6 Signing of Agent Agreement (A/A)' + BD

7 N/A

8 Transfer of Funds

9 Decision of Project Components

10 Payment of Remuneration for Agent

11 Recommendation of Consultant for Detail Design/Supervision (JICA→Recipient Country)

12 Recommendation of Consultant for Detail Design / Supervision (Recipient Country→Procurement Agent)

13 Conclusion of Contract

14 Construction and Procurement

15 Application for Payment

16 Payment

Major undertakings to be taken by each Government

No	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed urgently		●
3	To construct gates and fences in and around the site		●
4	To construct a parking lot if necessary		●
5	To construct roads		
	1) Within the site	●	
	2) Outside the site and Access road		●
6	To construct the facility and install the equipment	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities if necessary		
	1)Electricity		
	a. The power distribution line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer for the site	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for conveying storm water, sewage, etc. from the site)		●
	b. The drainage system within the site (for sewage, ordinary waste, storm water, etc.)	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A):		
	1) Payment of bank commission		●
9	To ensure all the expense and prompt execution of unloading and customs clearance at the port of disembarkation in the recipient country		
	1) Marine or air transportation of the products from Japan or third countries to the recipient	●	
	2) To ensure all the expense and prompt execution of unloading, tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
10	To accord Japanese nationals and / or nationals of third countries, including persons employed by the agent whose services may be required in connection with the Components such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work		●
11	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of the Agent will be exempted by the Government of recipient country		●
12	To maintain and use properly and effectively the facilities that are constructed and the equipment that is provided under the Grant.		●
13	To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the purchase of the Components as well as for the agent's fees		●
14	To ensure environmental and social consideration for the Programme.		●

Terms of Reference of the Consultative Committee (Provisional)

1. To confirm an implementation schedule of the Program for the speedy and effective utilization of the Grant and its accrued interest.

2. To discuss the modifications of the Program, including modification of the design of the facility.

3. To exchange views on allocations of the Grant and its accrued interest as well as on potential end-users.

4. To identify problems which may delay the utilization of the Grant and its accrued interest, and to explore solutions to such problems.

5. To exchange views on publicity related to the utilization of the Grant and its accrued interest.

6. To discuss any other matters that may arise from or in connection with the G/A.

Minutes of Discussions
on
the Preparatory Survey (Outline Design)
on
The Project for Introduction of Clean Energy by Solar Electricity Generation System
in
the Federal Republic of Nigeria

(Explanation on Draft Final Report)

In June 2011, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched to Nigeria a Preparatory Survey Team on the Project for the Introduction of Clean Energy by Solar Electricity Generation System (hereinafter referred to as "the Project"), to hold discussions with relevant officials of the Government of the Federal Republic of Nigeria to conduct field surveys and to make technical evaluations. After discussing results of the Preparatory Survey in Japan, JICA prepared a Draft Final Report of the Outline Design.

In order to explain and to consult with the concerned officials of the Nigerian side on the components of the Draft Final Report, JICA dispatched to Nigeria a Preparatory Survey Team for Draft Final Report Explanation (hereinafter referred to as "the Team"), which is headed by Mr. Yoshitaka SUMI, Chief Representative of JICA Nigeria Office, from December 12th to 17th, 2011.

As a result of the discussions held between JICA and concerned officials of the Federal Government of Nigeria, the main items described on the attached sheets are confirmed.

Abuja, December 14, 2011

Mr. Yoshitaka SUMI
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Engr. Sanusi Garba
Director, (Power)
Federal Ministry of Power

Prof. Muuta Ibrahim
Vice Chancellor
Umaru Musa Yar'adua University

Mr. B. O. Akpanyung
Director
International Cooperation Department,
National Planning Commission

ATTACHMENT

1. Components of the Draft Final Report

The Federal Ministry of Power (hereinafter referred to as "FMP") and Umaru Musa Yar'adua University (hereinafter referred to as "UMYU") accepted in principle the components of the Draft Final Report explained by the Team.

2. Program Grant Aid for Environment and Climate Change of the Government of Japan

The Nigerian side understood the contents of the Minutes of Discussions signed by JICA and the Nigerian side on 20th June, 2011 (hereinafter referred to as "the previous M/D"), and agreed to take the necessary measures confirmed on the previous M/D for smooth implementation of the Project following procedures of the Program Grant Aid for Environment and Climate Change of the Government of Japan as shown in **Annex-1**.

3. Confirmation of progress made after the previous M/D

3.1. Project site and capacity of PV system

JICA and The Nigerian side confirmed that project site is UMYU, Katsina State. The Team explained that the capacity of solar photovoltaic system (hereinafter referred to as "PV system") was fixed at 850 kWp instead of "the total capacity might be approx. 500~1,000 kWp" in the previous M/D based on the result of outline design and cost estimation. The Nigerian side accepted the change of PV capacity.

3.2. Responsible and Implementing Agencies for the Project

JICA and The Nigerian side confirmed that the responsible agency for the Project is FMP and the implementing agency for the Project is UMYU.

4. Equipment to be procured

The Team explained that the list of equipment to be procured is as shown in **Annex-2** based on the result of the Preparatory Survey conducted in June 2011 and the Study in Japan. After discussions, JICA and the Nigerian side agreed to procure the major equipment such as PV module, Power Conditioner and Transformer from Japan, while third country products are acceptable for other type of equipment and accessories.

5. Procurement Process for the Project

JICA and the Nigerian side reconfirmed that procurement process will be supervised by the Procurement Agent (hereinafter referred to as "the Agent") who is recommended by the government of Japan through necessary consultations with the Consultative Committee (hereinafter referred to as "the Committee"). JICA and the Nigerian side also reconfirmed the roles of the Agent as follows:

(1) The Agent will render the services stipulated in the provisions of the G/A (Grant Agreement) as well as the E/N (Exchange of Notes) for the Project;

(2) The Agent will implement the procurement procedures necessary for the Project according to the provisions of the G/A and E/N and any other relevant guidelines

(3) JICA will provide a Final Report to the Agent; and

(4) The Agent will undertake the procurement according to the contents of the Final Report of the Outline Design.

The Team explained that if tender price exceeds the amount agreed on G/A and E/N, quantity or/and items of the equipment would be reduced until the cost for the Project comes down to the amount agreed on G/A and E/N.

The Nigerian side agreed that if there is a remaining amount of the cost for the Project after tenders, additional items of equipment would be procured based on priorities which will be set by the Committee.

The Nigerian side also understood that decision on addition or reduction of the equipment to be procured would be made through necessary consultations with members of the Committee.

6. Project Cost

The Nigerian side agreed that the cost for the Project should not exceed the upper limit of amount agreed on in E/N. JICA and The Nigerian side also agreed that the cost for the Project contains procurement cost of equipment, the cost for transportation up to the site for the Project, installation cost, the Consultant fee, the Agent fee, and the cost for soft component for the technical support of operation and maintenance of equipment.

7. Confidentiality of the Project

(1) Detailed specifications of the Facilities and Equipment

The Nigerian side agreed that all the information related to the Project including detailed drawings and specifications of the facilities and equipment and other technical information shall not be disclosed to any outside parties (i.e. outside of JICA, The Nigerian side and the Agent) before the conclusion of all the contract(s) for the Project.

(2) Confidentiality of the Cost Estimation

The Team explained the estimated the cost of the Project as described in **Annex-3**. The Nigerian side agreed that the estimated cost for the Project should never be duplicated or disclosed to any outside parties (i.e. outside of JICA, The Nigerian side and the Agent) before tender for the Project. The Nigerian side understood that the estimated cost for the Project attached as Annex-3 is not final and is subject to change as a result of examination through revision of the Outline Design Study.

The Consultative Committee

The Nigerian side agreed that FMP will chair the Committee in order to facilitate ... tation and procurement process. The Terms of Reference of the Committee are outlined in A... of the previous M/D.

The me... s of the Committee are as follows:

(1) Represe... ive(s) of FMP (Chair)
(2) Represen... s) of UMYU,
(3) Representat... National Planning Commission (NPC)
(4) Representative(s) ... ergy Commission of Nigeria (ECN)
(5) Representative(s) of the Federal Ministry of Science and Technology (FMST)
(6) Representative(s) of the Embassy of Japan (EOJ)
(7) Representative(s) of JICA Nigeria Office

The ... ing of the Committee shall be held after the signing of the consulting services ... between the Agent and the Consultant. Further meetings shall be held upon the request of either the Nigerian side or the Japanese side. The Procurement Agent may advise JICA and the Nigerian side on the necessity to call for a meeting of the Committee.

9. Other Relevant Issues

9.1 Undertakings to be taken by the Nigerian side

The Team requested the Nigerian side to abide by the following undertakings by the Nigerian side in addition to major undertakings described in the previous M/D and in Annex-4 of this M/D. The Nigerian side agreed to do so.

(1) Land usage for PV system

The owner of the land to be used for the Project is UMYU. The Nigerian side has reconfirmed that there is no objection to use the land for the Project.

(2) Environmental and Social Considerations

The Team explained the outline of JICA Environmental and Social Considerations Guideline (hereinafter referred to as "the JICA Guideline") to the Nigerian side. The Nigerian side agreed to take the JICA Guideline into consideration, and shall complete the necessary procedures.

The Nigerian side shall obtain an official statement from the Federal Ministry of Environment that EIA and IEE are not required for the Project.

(3) Application of the Related Laws and Regulations

1) The Nigerian side agreed that structural design for frames to mount PV panels and power conditioner house shall comply with the Architectural Codes and Standards in Japan in consideration of relevant laws and regulations as well as natural conditions in Nigeria.
2) Electrical design for Grid-connected PV system should be conducted in accordance with JIS/IEC.

(4) Customs and Tax Exemption

The Nigerian side agreed that FMP shall be responsible for the exemption of all customs, tax, levies and duties incurred in Nigeria for the implementation of the Project.

(5) Assignment of Counterpart Personnel

1) Overall project management

The Nigerian side assigned following personnel for overall project management and coordination in each organization.

FMP : Engr. Sanusi Garba (Director of Power)
UMYU: Prof. Mauta Ibrahim (Vice Chancellor)

2) Soft Component

The Nigerian side agreed to assign necessary personnel in accordance with the soft component plan proposed by the Team.

FMP and UMYU will assign the focal Counterpart Personnel for the soft component.

Other personnel will be assigned from other organizations as required at the time of project implementation.

9.2. Ownership and Operation and Maintenance (O&M) Responsibilities of Equipment

The Nigerian side has reconfirmed that the FMP is the final owner of Equipment and UMYU is responsible for securing necessary budget and personnel for Operation and Maintenance (O&M) of Grid-connected PV system procured and installed under the Project. The Nigerian side confirmed that the Equipment procured under the Project shall be fully operated and maintained by UMYU.

<List of Annex>

Annex-1 Program Grant Aid for Environment and Climate Change of the Government of Japan
Annex-2 List of Equipment
Annex-3 Estimated Project Cost (Confidential)
Annex-4 Major Undertakings to be taken by each Government

Program Grant Aid for Environment and Climate Change
of the Government of Japan
(Provisional)

The Grant Aid provides a recipient country (hereafter referred to as "the Recipient") with non-reimbursable funds to procure the facilities, equipment, and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

Based on "Cool Earth Partnership" initiative of the Government of Japan, the Program Grant Aid for Environment and Climate Change (hereafter referred to as "GAEC") aims to mitigate effects of global warming by reducing GHGs emission (mitigation; e.g. improvement of energy efficiency) and to take adaptive measures (adaptation; e.g. measures against disasters related to climate change, including disaster prevention such as enhancing disaster risk management).GAEC may contain multiple components that can be combined to effectively meet these needs.

I. Procedures for GAEC

GAEC is executed through the following procedures.

Preparatory Survey 1	Preparatory Survey for project identification conducted by Japan International Cooperation Agency (JICA)
Application	Request made by a recipient country
Appraisal & Approval	Appraisal by the Government of Japan and Approval by the Cabinet
Determination of Implementation	The Notes exchanged between the Government of Japan and the Recipient Country
Grant Agreement (hereinafter referred to as the "G/A")	Agreement concluded between JICA and the Recipient
Preparatory Survey 2	Preparatory Survey for design conducted by JICA
Implementation	Procurement through the Procurement Agency by the Recipient

Firstly, if the candidate project for a GAEC is identified by the Recipient and the Government of Japan, the Government of Japan (the Ministry of Foreign Affairs) examines it whether it is eligible for GAEC. When the request is deemed appropriate, JICA, in consultation with the Government of Japan, conducts the Preparatory Survey (hereafter referred to as "the Survey") on the candidate project as Phase I of the Survey with Japanese consulting firms.

Secondly, the Recipient submits the official request to the Government of Japan, while the appropriateness, necessity and the basic components of the Program are examined in the course of Phase I of the Survey.

Thirdly, the Government of Japan appraises the Program to see whether it is suitable for Japan's GAEC, based on the Survey report prepared by JICA, and the results are then submitted to the Cabinet for approval.

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3. Implementation of GAEC after the E/N

1) Exchange of Notes (E/N)

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Essential points to be agreed are outlined as follows:

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The Agent Agreement is prepared as two identical documents and the copy of the Agent Agreement will be submitted to JICA by the Recipient through the Agent. JICA confirms whether the Agent Agreement is concluded in conformity with the E/N, A/M, and G/A and the Procurement Guidelines for the Program Grant Aid for Environment and Climate Change then approves the Agent Agreement.

The Agent Agreement concluded between the Recipient and the Agent will become effective after the approval by JICA in a written form.

d) Payment Methods

The Agent Agreement will stipulate that "Regarding all transfers of the fund to the Agent, the Recipient will designate the Agent to act on behalf of the Recipient and issue a Blanket Disbursement Authorization ("the BDA")to conduct the transfer of the fund (hereinafter referred to as "the Advances") to the Procurement Account from the Recipient Account.

The Agent Agreement will clearly state that the payment to the Agent will be made in Japanese yen from the Advances and that the final payment to the Agent will be made when the total remaining amount become less than three percent (3%) of the Grant and its accrued interests excluding the Agent's fees.

e) Products and Services Eligible for Procurement
Products and services to be procured will be selected from those defined in the G/A.

f) Firm and Consultant
The firm and consultant who would contract with the Agent shall be Japanese Nationals.

The consultants that will be employed to do detail design and supervise the work for the Project, will, however, be in principle, Japanese nationals recommended by JICA for the purpose of maintaining technical consistency with the Study.

g) Method of Procurement
When conducting the procurement, sufficient attention will be paid to transparency in selecting the firms and for this purpose, competitive tendering will be employed in principle.

h) Tender Documents
The tender documents should contain all information necessary to enable tenderers to prepare valid offers for the products and services to be procured by GAEC.

The rights and obligations of the Recipient, the Agent and the firms supplying products and services should be stipulated in the tender documents to be prepared by the Agent. Aside from this, the tender documents will be prepared in consultation with the Recipient.

i) Pre-qualification Examination of Tenderers
The Agent may conduct a pre-qualification examination of tenderers in advance of the tender so that the invitation to the tender can be extended only to eligible firms. The pre-qualification examination should be performed only with respect to whether the prospective tenderers have the capability of concluding the contracts.

For this, the following points should be taken into consideration:
(1) Experience and past performance in contracts of similar kind
(2) Financial credibility (including assets such as real estate)
(3) Existence of offices and other items to be specified in the tender documents.
(4) Their potentialities to use necessary personnel and facilities.

j) Tender Evaluation
The tender evaluation should be implemented on the basis of the conditions specified in the tender documents.

Those tenderers which substantially conform to the technical specifications and other stipulations of the tender documents will be judged in principle on the basis of the submitted price, and the tenderer who offers the lowest price will be designated as the successful tenderer.

The Agent will submit a detailed evaluation report of tenders to JICA for its information.

while the notification of the results to the tenderers will not be premised on the confirmation by JICA.

k) Additional procurement
If there is any remaining balance after the competitive and/or selective tendering and/or direct negotiation for a contract, and if the Recipient would like to procure additional items, the Agent is allowed to conduct this additional procurement, following the points mentioned below:
(1) Procurement of same products and services
When the products and services to be additionally procured are identical with the initial tender and a competitive tendering is judged not efficient, additional procurement can be conducted by a negotiated contract with the successful tenderer of the initial tender.
(2) Other procurements
When products and services other than those mentioned above in (1) are to be procured, the procurement should be conducted through competitive tendering. In this case, the products and services for additional procurement will be selected from among those in accordance with the G/A.

l) Conclusion of the Contracts
In order to procure products and services in accordance with the guideline, the Agent will conclude contracts with firms selected by tendering or other methods.

m) Terms of Payment
The contract will clearly state the terms of payment. The Agent will make payment from the "advances," against the submission of the necessary documents from the firm on the basis of the conditions specified in the contract. When the services are the object of procurement, the Agent may pay certain portion of the contract amount in advance to the firms on the conditions that such firms submit the advance payment guarantee worth the amount of the advance payment to the Agent.

4) Undertakings required by the Government of the Recipient Country
In the implementation of the Grant Aid Project, the Recipient is required to undertake necessary measures as the following:
a) To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the Project.
b) To provide facilities for distributing electricity, water supply and drainage and other incidental facilities in and around the sites.
c) To ensure all the expense and prompt execution for unloading, customs clearing at the port of disembarkation and domestic transportation of products purchased under the Grant Aid.
d) To ensure that customs duty, internal taxes and other fiscal levies that may be imposed in the Recipient with respect to the purchase of the Components and the Agent's services will be exempted by the Government of the Recipient.
e) To accord all the concerned parties, whose services may be required in connection with supply of the products and services under the contracts, such facilities as may be necessary for their entry into the Recipient and stay therein for the performance of their work.

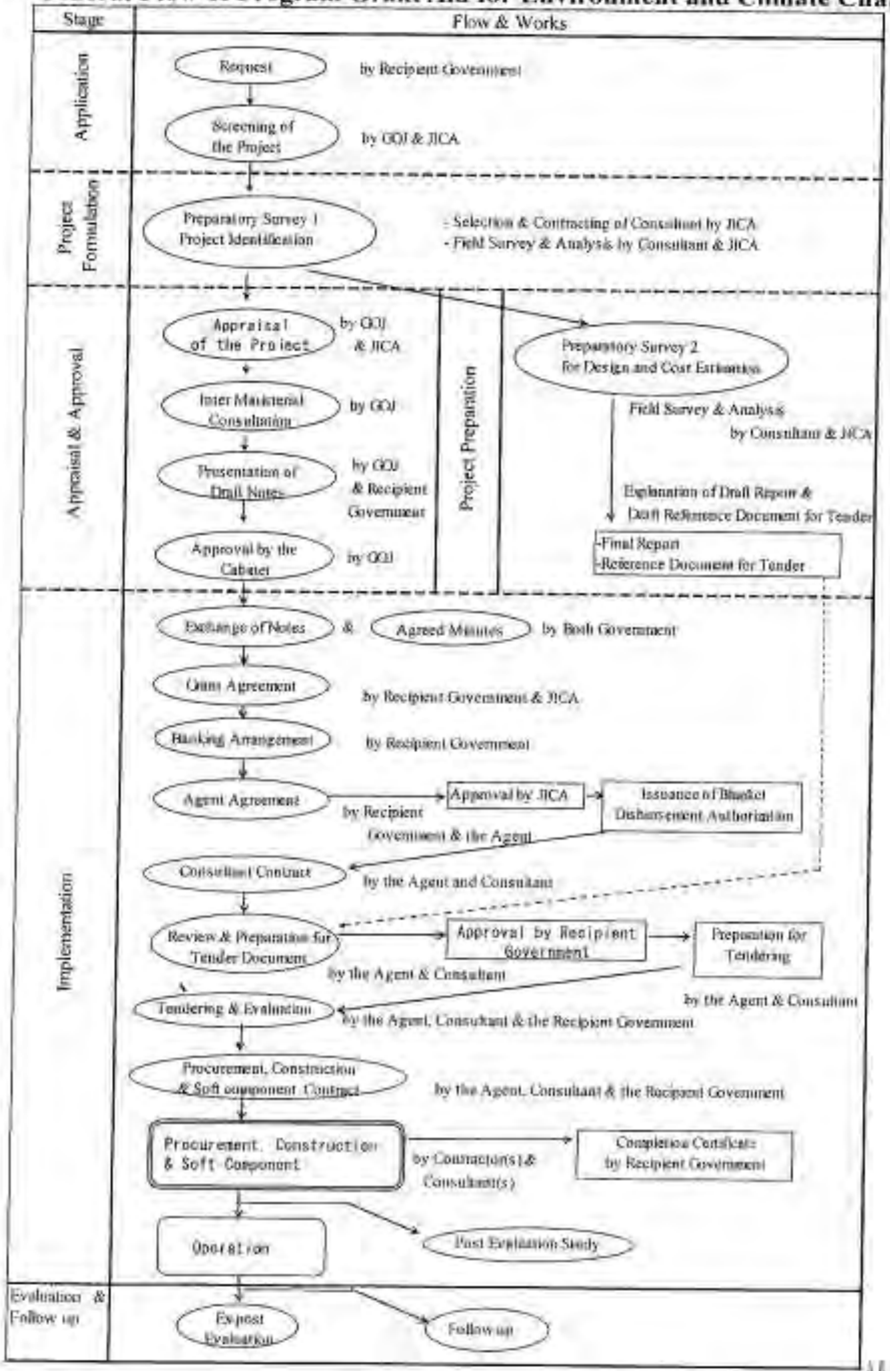
5) "Proper use of funds"
The Recipient is required to operate and maintain the facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign personnel necessary for

this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

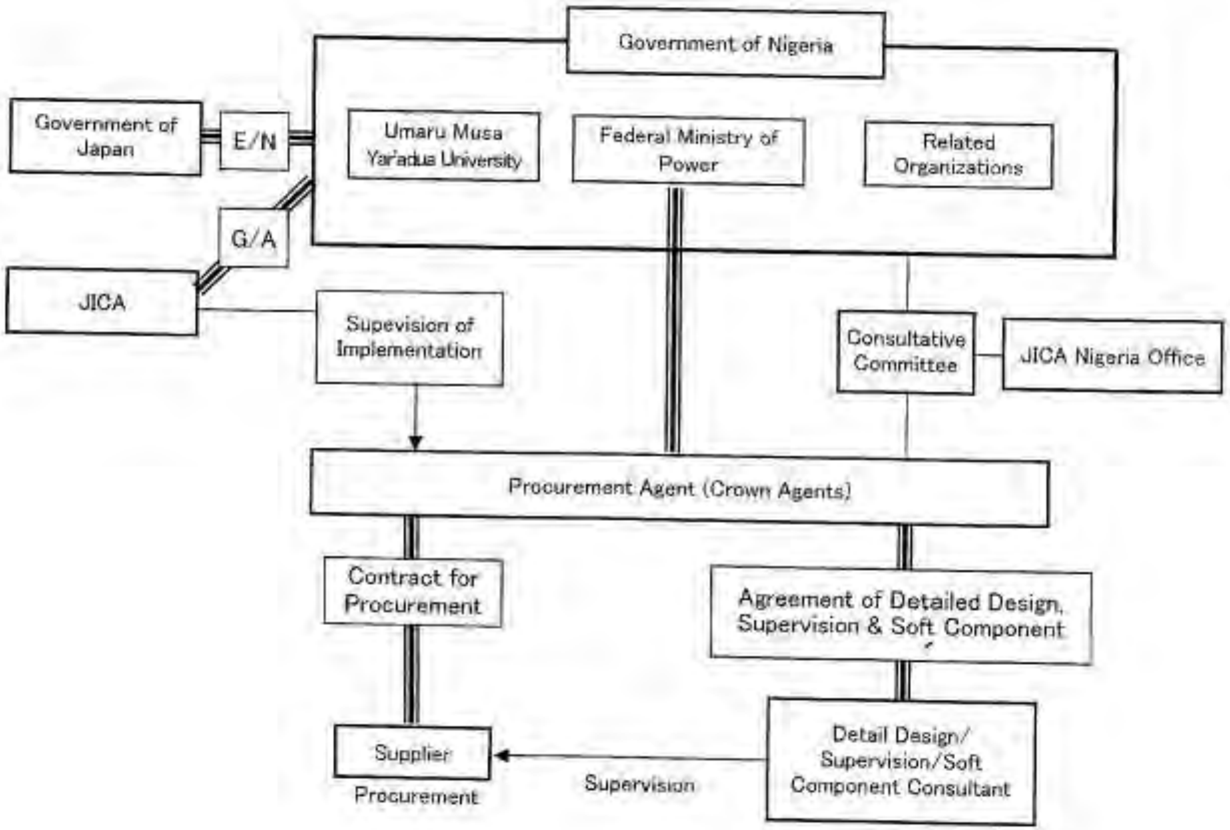
6) "Export and Re-export" of products

The products purchased under the Grant and its accrued interest will not be exported or re-exported from the Recipient.

General Flow of Program Grant Aid for Environment and Climate Change



Project Implementation System



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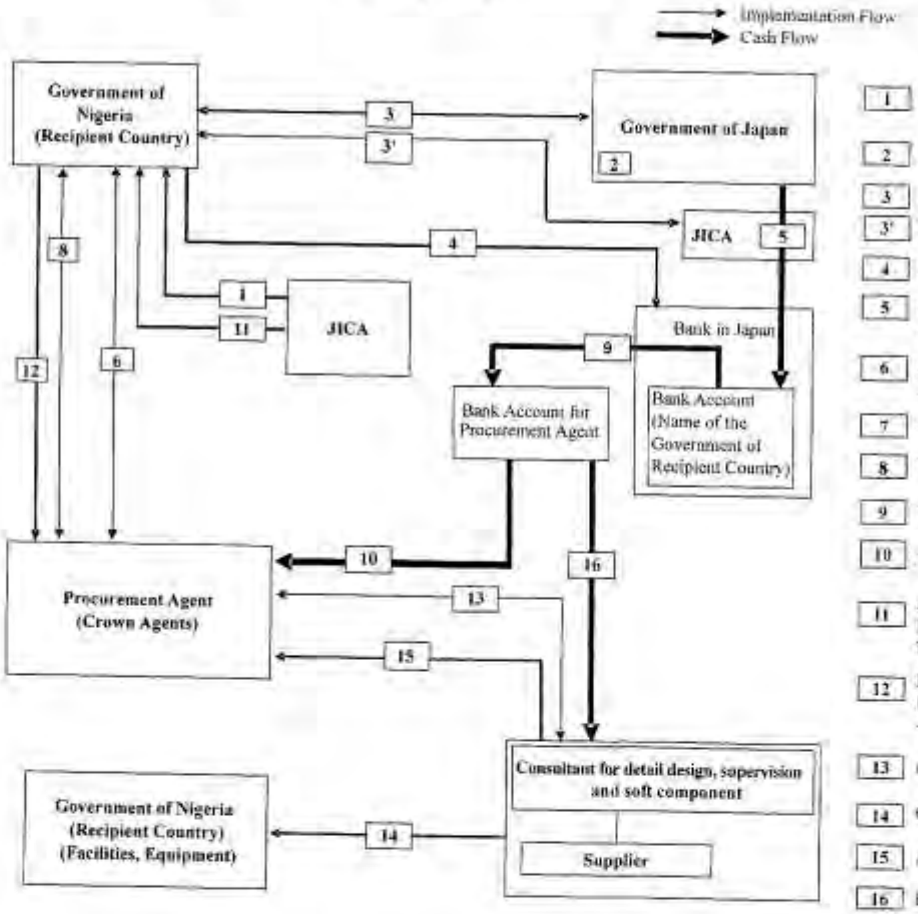
Flow of Funds for Project Implementation



- 1 Preparatory Survey / Reference Document for Tender
- 2 Approval of Cabinet
- 3 Signing of Exchange of Notes (E/N)
- 3' Signing of Grant Agreement (G/A)
- 4 Banking Arrangement (B/A)
- 5 Disbursement of Funds from the Government of Japan
- 6 Signing of Agent Agreement (A/A) + BDA
- 7 N/A
- 8 Decision of Project Components
- 9 Transfer of Funds
- 10 Payment of Remuneration for Agent
- 11 Recommendation of Consultant for Detail Design/Supervision (JICA -> Government of Nigeria)
- 12 Recommendation of Consultant for Detail Design / Supervision (Government of Nigeria -> Procurement Agent)
- 13 Conclusion of Contract
- 14 Construction and Procurement
- 15 Application for Payment
- 16 Payment

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List of Major Equipment

The following table shows a list of equipment procured under the Program.

	Procurement and installation of the following photovoltaic equipment	Quantity
Equipment procurement and installation works	1. Solar power modules (850 kWp or more)	1 Lot
	2. Solar power modules mounting structure	1 Lot
	3. Junction box *1)	1 Lot
	4. Collecting box *1)	1 Lot
	5. Combination operating panel	1 set
	6. Power conditioner (100 kW)	10 sets
	7. Control panel	1 set
	8. DC power supply	1 set
	9. Grid-connected transformer (1,000 kVA)	1 set
	10. 11kV switchgear	1 set
	11. Under voltage protective relay for 11kV receiving panel	1 set
	12. 33kV supply meter panel	1 set
	13. 33kV line protective ground-fault overvoltage protective relay	1 set
	14. Display system	1 Lot
	15. Instrumentation	1 Lot
	16. Wiring materials	1 Lot
	17. Grounding work materials	1 Lot
	18. Buried protective pipes	1 Lot
Equipment procurement Works	Solar power generating equipment replacement parts, maintenance tools, test devices and safety devices	1 set

Note *1) Quantity will vary depending on the maker.
Source: JICA Study Team

Project Cost Estimation (Confidential)

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Major undertakings to be taken by each Goverment

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed urgently		●
3	To construct gates and fences in and around the site	●	
4	To construct a parking lot if necessary		●
5	To construct roads		
	1) Within the site	●	
	2) Outside the site and Access road		●
6	To construct the facility and install the equipment	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities if necessary:		
	1)Electricity		
	a. The power distribution line to the site		●
	b. The drop wiring and internal wiring within the site	●	
	c. The main circuit breaker and transformer for the site	●	
	2) Water Supply		
	a. The city water distribution main to the site		●
	b. The supply system within the site (receiving and elevated tanks)	●	
	3) Drainage		
	a. The city drainage main (for conveying storm water, sewage, etc. from the site)		●
	b. The drainage system within the site (for sewage, ordinary waste, storm water, etc.)	●	
	4) Gas Supply		
	a. The city gas main to the site		●
	b. The gas supply system within the site	●	
	5) Telephone System		
	a. The telephone trunk line to the main distribution frame/panel (MDF) of the building		●
	b. The MDF and the extension after the frame/panel	●	
	6) Furniture and Equipment		
	a. General furniture		●
	b. Project equipment	●	
8	To bear the following commissions applied by the bank in Japan for banking services based upon the Bank Arrangement (B/A):		
	1) Payment of bank commission		●
9	To ensure all the expense and prompt execution of unloading and customs clearance at the port of disembarkation in the recipient country		
	1) Marine or air transportation of the products from Japan or third countries to the recipient	●	
	2) To ensure all the expense and prompt execution of unloading, tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	●	
10	To accord Japanese nationals and / or nationals of third countries, including persons employed by the agent whose services may be required in connection with the Components such facilities as may be necessary for their entry into recipient country and stay therein for the performance of their work.		●
11	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the purchase of the Components and to the employment of the Agent will be exempted by the Government of recipient country		●
12	To maintain and use properly and effectively the facilities that are constructed and the equipment that is provided under the Grant.		●
13	To bear all the expenses, other than those covered by the Grant and its accrued interest, necessary for the purchase of the Components as well as for the agent's fees.		●
14	To ensure environmental and social consideration for the Programme.		●

Minutes of Discussions
on
the Preparatory Survey (Outline Design)
on
The Project for Introduction of Clean Energy by Solar Electricity Generation System
in
the Federal Republic of Nigeria

(Amendment of Annex 3 of M/D on December 14, 2011)

In June 2011, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched to Nigeria a Preparatory Survey Team on the Project for the Introduction of Clean Energy by Solar Electricity Generation System (hereinafter referred to as "the Project"), to hold discussions with relevant officials of the Government of the Federal Republic of Nigeria to conduct field surveys and to make technical evaluations. After discussing results of the Preparatory Survey in Japan, JICA prepared a Draft Final Report of the Outline Design, which was explained and consulted with the concerned officials of the Nigerian side from December 12th to 17th, 2011. The result of the discussions held between JICA and concerned officials of the Federal Government of Nigeria were confirmed as the Minutes of Discussions (M/D) signed on December 14th, 2011.

On the stage of preparing Final Report of the Outline Design, the Project Cost were re-estimated and all the related stakeholders confirmed the necessity to replace the Annex 3 of the M/D.

Abuja, March 6, 2012

Mr. Yoshitaka SUMI
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Engr. Sanusi Garba
Director, (Power)
Federal Ministry of Power

Prof. Muuta Ibrahim
Vice Chancellor
Umaru Musa Yar'adua University

Mr. B. O. Akpanyung
Director
International Cooperation Department,
National Planning Commission

Project Cost Estimation (Confidential)

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3

Appendix 5 Soft Component (Technical Assistance) Plan

5. Soft Component (Technical Assistance) Plan

Preparatory Survey

on

The Project for Clean Energy Promotion Using

Solar Photovoltaic System

in

The Federal Republic of Nigeria

Soft Component Plan

March 2012

YACHIYO ENGINEERING CO., LTD.

Contents

1. Background to Planning the Soft Component

The Project for Clean Energy Promotion Using Solar Photovoltaic System intends to procure and install a grid-connected photovoltaic system (output 850 kWp) as well as associated transformer and station distribution equipment at Umaru Musa Yar'Adua University (UMYU), Katsina State in the Federal Republic of Nigeria (hereafter referred to as Nigeria).

In the National Energy Plan that was compiled in 2003, renewable energy was identified as a pillar of sustainable energy supply, and renewable energies such as photovoltaic power, wind power, micro hydropower and biomass energy, etc. came to be introduced under the Renewable Energy Master Plan of 2005. However, renewable energy introduction is not progressing as desired because there are no policies, regulations or institutional framework geared to promoting the introduction of renewable energy, it is difficult to raise the funds required to pay for the massive initial investment and other factors. This grant aid Project aims to make a contribution to the goal of introducing renewable energy in Nigeria and, through conducting photovoltaic power generation, reducing the used amount of thermal power generation fuel and limiting greenhouse gas emissions, which is compatible with the Government of Nigeria's policy for addressing climate change (mitigation measures).

The Energy Commission of Nigeria (ECN) and aid agencies take the initiative in introducing photovoltaic generating equipment in Nigeria, primarily introducing SHS (solar home systems), vaccine storage PV[2] refrigerators, solar pumps and PV streetlights, etc. in regional areas that are not yet electrified, however, so far a grid-connected photovoltaic system (grid-connected PV system) has not been introduced in Nigeria. Therefore, although efforts to introduce photovoltaic generating equipment are being advanced in Nigeria, the local side doesn't possess adequate know-how and experience regarding the operation and maintenance of a grid-connected PV system.

The operation of power equipment and facilities on the campus of UMYU is managed by the electricity section of the Directorate of Physical Planning and Development Organization (DPPD). This section is in charge of operation and maintenance of the university's power receiving equipment, emergency generators and electrical equipment. The Center for Renewable Energy Research (CeRER), also located inside UMYU, conducts research into renewable energies including photovoltaic energy. However, photovoltaic equipment currently installed in UMYU is limited to PV streetlights and DC independent power sources, and it will be difficult for the local personnel to acquire the necessary knowledge and technology to operate and maintain a grid-connected PV system via their everyday work. Moreover, since the PHCN (Power Holding Company of Nigeria), which is the operator of the power distribution network, has little experience of connecting grid-connected private generating systems to the grid or operating such systems, it doesn't possess sufficient know-how of important points or troubleshooting for grid-connected PV systems. Furthermore, no regulations or technical standards have been established regarding the grid connection of renewable energy systems that entail the purchase and sale of electricity.

[2]PV: Acronym for Photovoltaic, meaning solar cell

The objectives of the soft component are to support the smooth launch of the Project and to conduct technology transfer for the implementing agencies in charge of operation and maintenance at UMYU (CeRER and DPPD) with a view to facilitating the sustainable operation and maintenance of the grid-connected PV system. In addition, as it is necessary for the agencies responsible for operation and maintenance of the distribution grid to which the PV system will be connected to grasp grid-connected PV system characteristics, the necessary technology transfer regarding outline of the grid-connected PV system, important consideration points in system operation and technical requirements concerning grid connection will be conducted for the PHCN, which operates the distribution grid, and the Federal Ministry of Power (FMP), which is the regulatory agency for the power utility.

2. Soft Component Goals

The goals of the soft component are as indicated Table 3-1. It is anticipated that attaining these goals will help sustain the effects of the grant aid project.

(1) Following completion of the Project construction, operation and maintenance of the grid-connected PV system is commenced smoothly by the Nigerian side.
(2) Operation and maintenance of the grid-connected PV system is implemented on a sustained basis.
(3) The distribution grid to which the system is connected is operated in a stable manner.

3. Outputs of the Soft Component

The outputs that need to be achieved in the soft component are as follows.

Table 3-1 Outputs of the Soft Component

Goal	Outputs of the Soft Component	Targets
1. Following completion of the Project works, operation and maintenance of the grid connected PV system is commenced smoothly by the Nigerian side.	1-1 The operation and maintenance organization for the grid-connected PV system is established. 1-2 Operation and maintenance personnel acquire the technologies to operate and maintain the grid-connected PV system.	CeRER DPPD
2. Operation and maintenance of the grid-connected PV system is implemented on a sustained basis.	1-3 An operation and maintenance manual that includes troubleshooting is created for the grid-connected PV system.	CeRER DPPD
	1-4 The outline and characteristics of the grid-connected PV system are understood. 1-5 Troubleshooting methods for the grid-connected PV system are established (targeting the distribution system	CeRER DPPD

		within the university).	
3. The distribution grid to which the system is connected is operated in a stable manner.	1-6	The outline and characteristics of the grid-connected PV system are understood.	PHCN FMP
	1-7	Troubleshooting methods for the grid-connected PV system are established (targeting the distribution system of the PHCN).	PHCN

4. Method for Confirming the Degree of Attainment of Outputs

The outputs of the soft component will be gauged through confirming the created operation and maintenance manual and reports of the participants. Table 4-1 shows the method for confirming outputs according to each activity and contents. In the manual, it will be confirmed that all necessary items concerning operation and maintenance organization and roles, daily operation, periodic inspections and troubleshooting, etc. are covered, and the technical contents are stated without error, while advice and guidance will be offered where needed. In reports, trainees will be asked to state the contents of technology transfer as they understand them according to each theme, and their level of understanding of the lecture contents will be evaluated. Moreover, concerning items for which understanding is inadequate, supplementary lectures will be given.

Table 4-1 Method for Confirming the Soft Component Outputs

Targets	Outputs of the Soft Component	Method for Confirming the Degree of Attainment
CeRER DPPD	• The operation and maintenance organization for the grid-connected PV system is established. • Operation and maintenance personnel acquire the technologies to operate and maintain the grid-connected PV system. • An operation and maintenance manual that includes troubleshooting is created for the grid-connected PV system.	• Manual • Report • Manual
CeRER DPPD	• The outline and characteristics of the grid-connected PV system are understood. • Troubleshooting methods for the grid-connected PV system are established (targeting the distribution system within the university).	• Report • Manual
PHCN	• The outline and characteristics (including reverse power flows) of the grid-connected PV system are understood. • Troubleshooting methods for the grid-connected PV system are established (targeting the distribution system of the PHCN).	• Report • Manual
FMOP	• The outline and characteristics (including reverse power flows) of the grid-connected PV system are understood.	• Report
ECN	• The outline and characteristics (including reverse power flows) of the grid-connected PV system are understood.	• Report

5. Soft Component Activities (Input Implementation Plan)

5-1 Contents and Activities of the Soft Component

As is shown in Table 5-1, the activities of the soft component extend from the basics of solar cells to operation, maintenance and monitoring. The techniques used for transferring technology will be classroom lecture, drill (manual preparation by trainees) and practical training using equipment. The solar cell modules, measuring instruments and tools scheduled for introduction to UMYU will be used in the practical training. Incidentally, reverse power flows to the distribution grid will arise in the grid-connected PV system to be introduced to UMYU under the grant aid. Assuming that grid-connected PV systems that entail reverse power flows will come to be introduced to Nigeria in the future, technology both with and without reverse power flows will be included.

Table 5-1 Contents of Soft Component Activities and Method of Technology Transfer

Goal	Soft Component Output	Contents of Activities	Technology Transfer Method	Targets
1. Following completion of the Project works, operation and maintenance of the grid connected PV system is commenced smoothly by the Nigerian side.	1-1 The operation and maintenance organization for the grid-connected PV system is established.	• Outline of the introduced system • Clarification of the responsibilities of operation and maintenance personnel • Evaluation of the operation and maintenance setup	• Classroom lecture • Classroom lecture • Classroom lecture, group drill	CeRER DPPD
	1-2 Operation and maintenance personnel acquire the technologies to operate and maintain the grid-connected PV system.	• Transfer of the principles and basic knowledge of the PV system • Lecture on the features and protective functions (including reverse power flows) of the grid-connected PV system • Equipment inspection technology and installation technology • Transfer of operation technology • Transfer of maintenance technology • Technology transfer of periodic inspection techniques • Monitoring	• Classroom lecture • Classroom lecture • Practical training (operation controls using actual equipment) • Practical training • Practical training (preparation of inspection list, inspection and repair) • Practical training (including insulation resistance and open voltage measurement) • Practical training (recording and evaluation of operating data, status monitoring of equipment)	CeRER DPPD

Goal	Soft Component Output	Contents of Activities	Technology Transfer Method	Targets
2. Operation and maintenance of the grid-connected PV system is implemented on a sustained basis.	1-3 An operation and maintenance manual that includes troubleshooting is created for the grid-connected PV system.	• Creation of the operation and maintenance manual in joint work with the Nigerian side • Optimization of the troubleshooting and operation and maintenance manual	• Classroom lecture, drill (manual preparation) • Practical training (operation controls based on the manual, and trouble simulation training)	CeRER DPPD
	1-4 The outline and characteristics of the grid-connected PV system are understood. 1-5 Troubleshooting methods for the grid-connected PV system are established (targeting the distribution system within the university).	• Lecture on the features and protective functions (including reverse power flows) of the grid-connected PV system • Optimization of the troubleshooting (including reverse power flows) and operation and maintenance manual	• Classroom lecture • Practical training (operation controls based on the manual, and trouble simulation training)	CeRER DPPD
3. The distribution grid to which the system is connected is operated in a stable manner.	1-6 The outline and characteristics (including reverse power flows) of the grid-connected PV system are understood.	• Lecture on the features and protective functions (including reverse power flows) of the grid-connected PV system • Examination items when introducing the grid-connected PV system (including reverse power flows)	• Classroom lecture • Classroom lecture	CeRER DPPD PHCN FMP

	1-7 Troubleshooting methods for the grid-connected PV system are established (targeting the distribution system of the PHCN).	• Optimization of the troubleshooting (including reverse power flows) and operation and maintenance manual	• Practical training (operation controls based on the manual, and trouble simulation training)	PHCN

5-2 Input Implementation Plan

(1) Input Implementation Plan on the Japanese Side

Through implementing the activities shown in Table 5-1 above, the necessary technology will be transferred to enable CeRER of UMYU (the implementing agency) to concretely understand and practice operation and maintenance of the grid-connected PV system. Moreover, technology transfer concerning outline of the grid-connected PV system and important points to consider in operation will be carried out with respect to the DPPD (operator of power distribution equipment on the university premises), the PHCN (operator of the power distribution network), and the FMP (monitoring and regulatory agency for the power system). The contracted consultant will dispatch two engineers (one in charge of the PV system and one in charge of grid connection) to Nigeria to carry out the technology transfer (Soft Component) over the period indicated in Table 5-2.

Table 5-2 Input Plan concerning the Soft Component

Name	Rank	Dispatch Period	Number of Trips	Work Contents
1. Construction of the operation and maintenance setup				
Instructing engineer 1 (PV system)	3	0.5months	1	Construction of the operation and maintenance setup of the implementing agency in UMYU, and outline of the introduced system
Instructing engineer 2 (Grid connection)	3	0.5months	1	Construction of a mutual cooperation setup with the power operator (PHCN), and outline of the introduced system
2. Technical training (1)				
Instructing engineer 1 (PV system)	3	0.5 month	1	Transfer of PV system installation, inspection, technology
Instructing engineer 2 (Grid connection)	3	0.5 month	1	Technology transfer concerning grid connection equipment, inspection technology and installation technology
3. Technical training (2)				
Instructing engineer 1 (PV system)	3	1.0 month	1	Transfer of PV system operation and maintenance technology
Instructing engineer 2 (Grid connection)	3	1.0 month	1	Technology transfer concerning grid connection operation technology
4. Monitoring				
Instructing engineer 1 (PV system)	3	0.5months	1	Evaluation of learning of technology pertaining to the PV system
Instructing engineer 2 (Grid connection)	3	0.5months	1	Evaluation of learning of technology pertaining to grid connection

(2) Input Implementation Plan on the Nigerian Side

Inputs on the Nigerian side include the appointment and dispatch of trainees to take part in the soft component, launch of the operation and maintenance organization, establishment of the operating organization for ensuring the smooth implementation of the soft component, and so on. Specific contents are as described below.

1) PV System Operating Committee (provisional name)

Following the start of the Project, the CeRER will promptly establish the PV System Operating Committee (provisional title) with the objectives of securing the smooth implementation of the soft component and sustained operation after the soft component is finished. As the de facto receiving agency for the soft component, as well as the forum for gauging achievement of the soft component, exchanging opinions and discussing issues, this committee will hold regular meetings during the soft component. Following completion of the soft component, the PV System Operating Committee will guide the PV Working Group to ensure that the Project equipment is operated and maintained smoothly and on a sustained basis. The PV Working Group will report on the operation and maintenance conditions of the PV system to the committee and receive guidance and advise when needed.

The PV System Operating Committee will have its secretariat inside the CeRER and will also comprise representatives from the FMP, ECN, PHCN and DPPD. Each agency will contribute one or two members from relevant departments. Figure 5-1 shows the organization chart of the PV System Operating Committee.

The PV System Operating Committee will be operated according to the implementation setup indicated in Figure 5-3 and will discuss the following matters in readiness for the dissemination of the grid-connected PV system.

- Issues concerning operation and maintenance of the grid-connected PV system
- Impact of the grid-connected PV system on operation of the power company’s distribution system and the quality of electricity
- Impediments to disseminating the grid-connected PV system in Nigeria
- Legal controls for disseminating the grid-connected PV system in Nigeria
- Technical standards for disseminating the grid-connected PV system in Nigeria

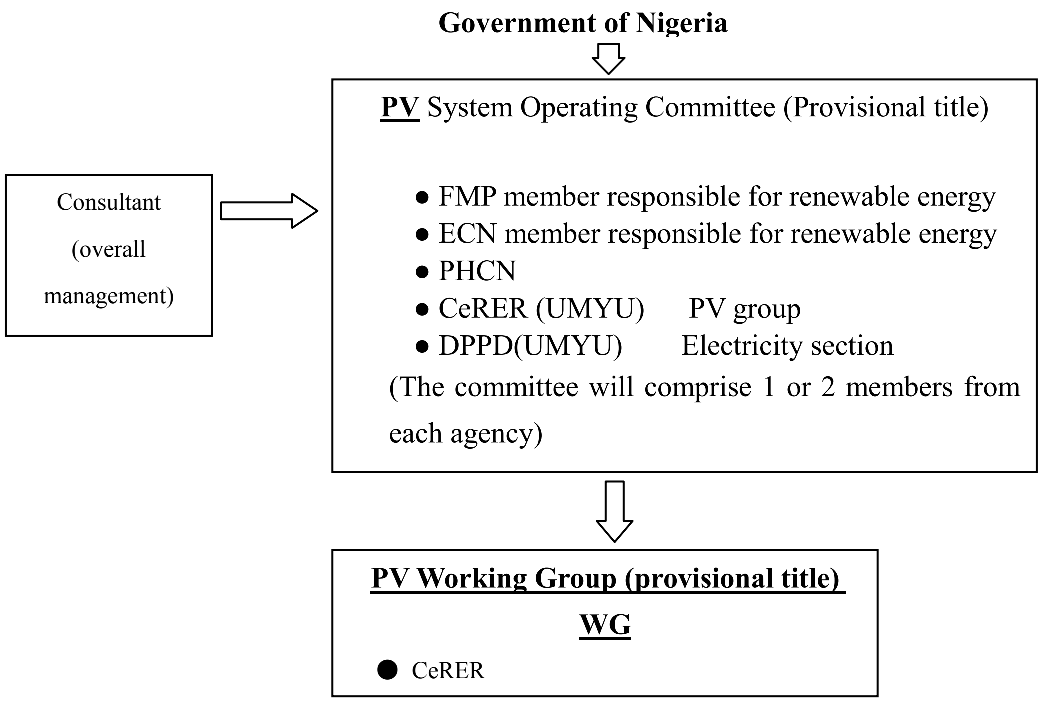


Figure 5-1 PV System Operating Committee Implementation Setup (Plan)

2) PV Working Group Plan

Established as a subordinate organization to the PV System Operating Committee, the PV Working Group will implement the operation and maintenance of the grid-connected PV system under the Committee's guidance and supervision.

Table 5-3 shows the implementation setup of the PV System Operating Committee and PV Working Group.

Table 5-3 Implementation Setup of the PV System Operating Committee (Plan)

	Japanese Consultant	PV System Operating Committee	PV Working Group
Number of members	2	5－10	3－5
Role	Overall progress management	Overall work management	System maintenance
Role in the soft component	Explanation	Hosting	Hosting and participation
Maintenance manual	Advice	Draft check	Draft preparation
Operation control and analysis	Advice	Data analysis and examination	Operation control and data analysis
Maintenance follow-up	Management guidance	Maintenance reporting	Maintenance reporting
Report destinations	Japanese Embassy	JICA Nigeria Office	PV System Operating

	JICA Nigeria Office		Committee

6. Procurement of Implementation Resources for the Soft Component

The supplier of photovoltaic power equipment and main equipment in the Project shall be from Japan, based on the intent of the Japanese Environment and Climate Change Program Grant Aid Project. Therefore it will be necessary for the engineers dispatched in the soft component to be well-versed in Japanese products and systems. There are engineers that carry out PV system installation in Nigeria, however, they have only ever handled European and Chinese products and do not possess ample experience concerning grid-connected systems. Therefore, regarding the implementation resources for the soft component, a scheme of direct support by a consultant that is well-versed in Japanese PV systems and grid-connected systems will be adopted.

7. Soft Component Implementation Schedule

Table 7-1 shows the soft component implementation schedule.

The engineers dispatched from Japan will implement the soft component according to the categories indicated in that table. The timing of each category will be as follows.

1) **Construction of the operation and maintenance setup:**

This will be implemented to support construction of the maintenance setup. As clarifying the maintenance setup before installing the equipment will stimulate the awareness of concerned parties during installation, this will be implemented in advance.

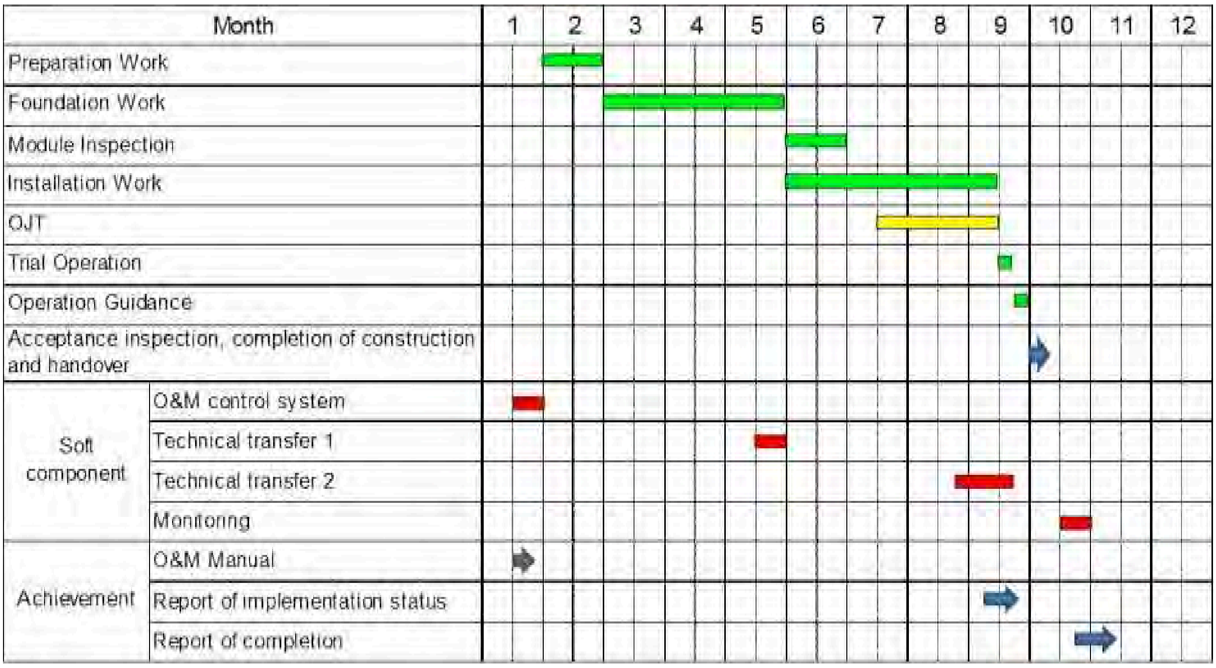
2) **Technical training**

Training on installation, inspection and operation, etc. will be conducted using actual equipment. In order to prepare the maintenance manual required before the start of equipment operation, the training will be conducted in the first part of the installation works and before the start of operation.

3) **Monitoring:**

As this will be implemented with the emphasis on confirming that the Nigerian side is autonomously conducting maintenance, it will be implemented approximately one month after completion of the installation.

Table 7-1 Soft Component Implementation Schedule



8. Outputs

As is stated in Table 7-1, the outputs of the soft component will consist of the operation and maintenance manual (including troubleshooting), implementation status report (English language progress report for the client), completion report (English language final report for the client) and the teaching materials used in the technology transfer.

9. Soft Component Cost Estimation

The estimated cost of the soft component is 18,413,000 yen, and Table 9-1 shows the breakdown of this.

Table 9-1 Soft Component Cost Estimation

Item	Cost (Unit: 1000 yen)
Personnel expenses	3,890
Direct costs	9,544
Indirect costs	4,979
Total	18,413

10. Obligations of the Implementing Agencies in Nigeria

1) The CeRER in UMYU will establish the PV System Operating Committee to cooperate with implementation of the soft component.

2) The CeRER will prepare conference rooms, etc. needed for implementation of the soft component.

3) The CeRER will provide the personnel required in the soft component.

4) The PV System Operating Committee will autonomously prepare the operation and maintenance manual while consulting with the consultant. Moreover, following the start of system operation, it will revise and update the manual according to conditions on the ground.

5) The CeRER will maintain the grid-connected PV system based on the operation and maintenance manual. In cases where PV system operation managers are transferred, technology will be transferred to successors utilizing the outputs of the soft component.

6) The PV System Operating Committee will submit inspection results reports based on the operation and maintenance manual to the JICA Nigeria Office.

Appendix 6 Project Benefits

6. Beneficial Effects of the Project

6.1 Estimated generated electrical energy

The rated output of the grid-connected photovoltaic system to be installed in the Project is 850 kWp. The following formula is used for calculating the estimated generated electrical energy, and the solar irradiation amount on an inclined surface shown in Table 2-2 is used as the mean monthly solar irradiation.

$Ep = \Sigma (H_A / Gs) * K * P$

(Σ indicates the cumulative estimated generated electrical energy for each month).

Where,

- Ep = Estimated annual generated electrical energy (kWh/year)
- H_A = Mean monthly solar irradiation on installed surfaces (kWh/m^2/day)
- Gs = Standard solar intensity (1kW/m^2)
- P = PV cell capacity
- K = Loss coefficient = Kd * Kt * η_{INV}

DC correction coefficient Kd: This has been set at 0.8 and includes correction for loss caused by dirt on the surface of photovoltaic cells and fluctuations in solar intensity, and correction for disparities in photovoltaic cell characteristics.

* Temperature correction coefficient Kt: Correction coefficient for fluctuations in conversion efficiency due to rises in the temperature of photovoltaic cells caused by sunlight.

  $Kt = 1 + \alpha (Tm - 25) / 100$

  Where, α: Maximum output temperature coefficient (% · ℃$^{-1}$) = - 0.5 (% · ℃$^{-1}$) [Crystal]

  Tm: Module temperature (℃) = Tav + ΔT

  Tav: Mean monthly temperature (℃)

  ΔT: Module temperature increase (℃)

Rear open type	18.4
Roof type	21.5

  ΔT : 18.4 ℃

* Inverter efficiency ηINV: Inverter AC-DC conversion efficiency. This is assumed to be 0.94 here.

In the case where the photovoltaic system in the Project operates without any stoppages, generated electrical energy of 1,122,390 kWh per year can be anticipated.

Table 1 Generated Electrical Energy Estimation

Item	Unit/Formula	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Amount of solar irradiation (horizontal surface)	kWh/m^2	5.14	5.9	6.14	6.36	5.58	5.05	4.93	4.63	4.91	5.26	5.31	5.16	
Amount of solar irradiation (inclined surface)	kWh/m^2	5.74	6.33	6.26	6.14	5.53	5.06	4.90	4.52	4.88	5.52	5.88	5.83	
Days in month	Days	31	28	31	30	31	30	31	31	30	31	30	31	
Monthly solar irradiation	$kWh/m^2/day$	177.94	177.24	194.06	184.20	171.43	151.80	151.90	140.12	146.40	171.12	176.40	180.73	2,023.34
Temperature	℃	26.7	31.9	34.5	37.5	38.7	35.7	32.6	30.4	32	34.6	32.1	29.3	
Module temperature (Tm)	℃	45.1	50.3	52.9	55.9	57.1	54.1	51	48.8	50.4	53	50.5	47.7	
Deviation coeffcient from standard temperature	$\alpha(Tm-25)$	0.10	0.13	0.14	0.15	0.16	0.15	0.13	0.12	0.13	0.14	0.13	0.11	
Temperature correction coefficient (Kt)	$1+\alpha(Tm-25)/100$	0.90	0.87	0.86	0.85	0.84	0.85	0.87	0.88	0.87	0.86	0.87	0.89	
Loss factor (K)	$Kd*\varepsilon*Kt$	0.68	0.66	0.65	0.64	0.63	0.64	0.65	0.66	0.66	0.65	0.66	0.67	
Generated electrical energy	kWh	102,308	98,960	106,739	99,550	91,991	82,913	84,472	78,907	81,694	94,067	98,379	102,411	1,122,390

[Note] Data on the amount of solar irradiation and temperature obtained from the Nigeria Meteorological Agency (NIMET)

Figure 1 shows the pattern of generated electrical energy in each month.

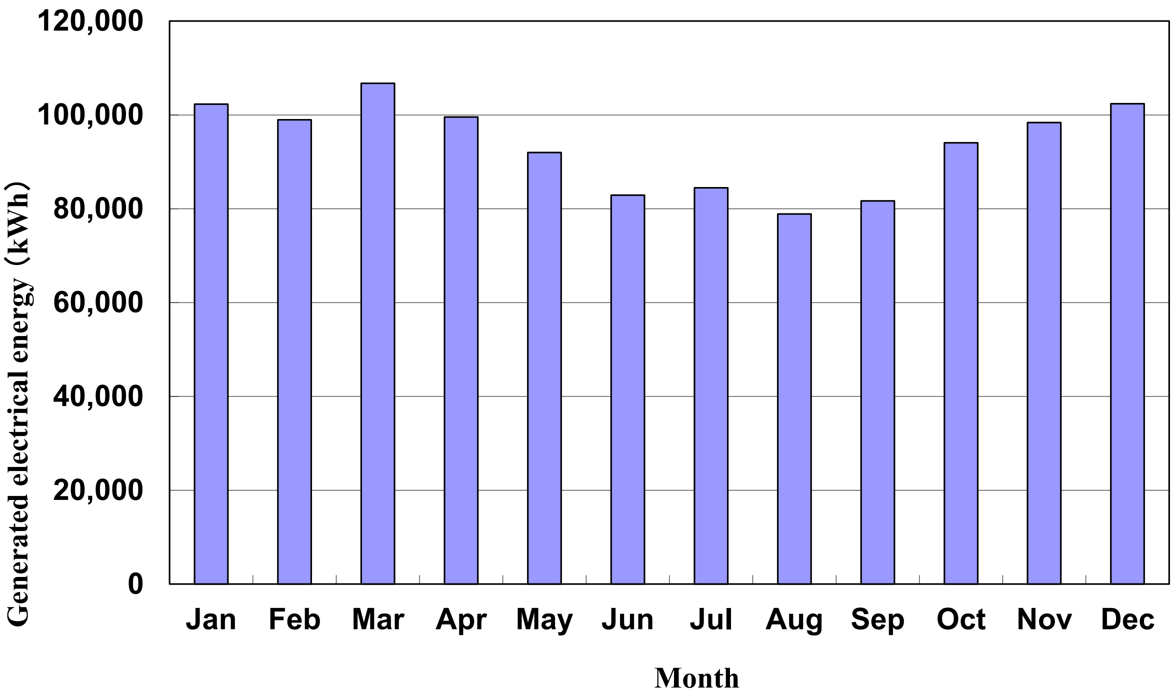


Figure 1 Generated Electrical Energy Estimation

6.2 Power consumption reduction effect

The electric power supplied by PHCN to Umaru Musa Yar'Adua University between October 2010 and June 2011 amounted to 514,000 kWh, and this worked out as 685,333 kWh/year. However, between March and June 2011, the ratio of power supply time between 09:00 and 16:00 was only around 50 percent. In the event where the current power supply situation is continued, the operating rate of the photovoltaic system will be approximately 50 percent and the estimated reduction in purchased power will be 561,195kWh/year. Therefore, Umaru Musa Yar'Adua University will be able to reduce the amount of power it purchases from PHCN by 81.9 percent.

［Formula］ 561,195 kWh/year ÷ 685,333 kWh/year ＝0.8189 → 82% reduction

6.3 Power tariff saving

The power tariffs paid by Umaru Musa Yar'Adua University between October 2010 and June 2011 amounted to 4,423,758 Naira. Since the rate following hike is applied to the specific tariff from January 2011 onwards, the average power tariff rate can be calculated as follows from the amount of electricity used and tariffs paid between January and June 2011.

［Formula］3,360,296 Naira ÷ 369,100 kWh＝9.104 Naira/kWh

Since the Project photovoltaic system will enable power consumption to be reduced by 561,195kWh /year, Umaru Musa Yar'Adua University can make a saving of 5,109,119 Naira per year on electricity tariffs.

［Formula］9.104 Naira/kWh ×561,195 kWh/year ＝ 5,109,119 Naira/year

6.4 CO_2 emissions reduction effect

According to statistics of the International Energy Agency (IEA), the base unit of CO_2 emissions in power generation in Nigeria in 2007 was 0.413 tCO_2/MWh. As a result of the photovoltaic power generation in the Project, it will be possible to reduce CO_2 emissions by 231.8 tons per year.

[Formula] 0.413 tCO_2/MWh ×561,195 kWh/year ÷ 1,000 ＝231.8 tCO_2/year

According to statistics of the International Energy Agency (IEA), total CO_2 emissions in Nigeria in 2007 were 51,380,000 tons. The amount of CO_2 emission reductions enabled by photovoltaic power generation in the Project will be equivalent to 4.51×10^{-4}% of the total CO_2 emissions in 2007.

[Formula] $231.8t \div (51.38\times10^{6}\,t) = 4.51\times10^{-6} \rightarrow 4.51\times10^{-4}\,\%$