ORIENTAL REPUBLIC OF URUGUAY
Ministry of Industrial, Energy and Mining
National Administration of Electric Power Generation and Transmission

THE PREPARATORY SURVEY ON THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE ORIENTAL REPUBLIC OF URUGUAY

Preparatory Survey Report

October 2010

Japan International Cooperation Agency

NIPPON KOEI CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) conducted the Project for Introduction of Clean Energy by Solar Electricity Generation System in Uruguay.

JICA sent to Uruguay a survey team from July 12^{th} to July 25^{th}, 2009 and November 2^{nd} to November22^{nd}, 2009.

The team held discussions with the officials concerned of the Government of Uruguay, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Uruguay from March 14^{th} to March 20^{th}, 2010 in order to discuss a draft outline design, and as this result, 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.

I wish to express my sincere appreciation to the officials concerned of the Government of Uruguay for their close cooperation extended to the teams.

October 2010

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

Summary

Summary（Uruguay）

1. Country Overview

The Oriental Republic of Uruguay (Uruguay) is situated in the temperate zone of South America. It borders Argentina to the west, Brazil to the north and northeast, the River Plate to the south and Atlantic Ocean to the east. The Uruguayan coast spans over 680 km. Approximately 70% of the total population of 3,380,177 live in the coastal zone. The rate of population growth (0.6%) has been among the lowest in the American continent since the 1960s. The territory is 175,016 km^2 with approximately 140,000 km^2 of territorial sea, islands and jurisdictional waters of bordering rivers and lagoons.

Even though the largest part of the territory is engaged in agriculture and cattle breeding, 91% of the population live in urban areas. The topography is undulated, with little variation in altitude with respect to the mean sea level. Uruguayans share a Spanish linguistic and cultural background with its neighbor country, Argentina. Most Uruguayans descended from the colonial era settlers and immigrants from Europe with almost 88% of the population being of European descent.

Uruguay's economy is characterized by an export-oriented agricultural sector, a well-educated work force, and high levels of social spending. After reaching an average growth rate of 5% annually during 1996-98, its economy suffered a major downturn in 1999-2002, stemming largely from the spillover effects of the economic problems of its large neighbors, Argentina and Brazil. During the period 2004-08, economic growth of Uruguay resumed and averaged 8% annually before falling to 1.7% in 2009.

2. Background of the Project and Outline

The Program Grant Aid for Environment and Climate Change of the Government of Japan (GoJ) is introduced as assistance to developing countries that are aiming to achieve both economic growth and reduction of greenhouse gasses emissions, and are working to contribute in achieving climate stability. As one measure, Japan established a new financial mechanism. Through this, Japan decided to cooperate actively with developing countries' efforts to reduce emissions and promote clean energy. At the same time, Japan extended the hand of assistance to developing countries suffering severely from adverse impacts caused by climate change. According to the initiative of this mechanism, the Japan International Cooperation Agency (JICA), in consultation with GoJ, decided to conduct a Preparatory Survey on the Project for Introduction of Clean Energy by Solar Electricity Generation System in Uruguay.

In Uruguay, national power generation depends heavily on hydraulic power. In the past, operation of power generation had large impacts such as drought, due to climate change effects. These past years, agreements are being made with neighboring countries regarding power and natural gas in order to stabilize power supply and avoid influence of the fluctuation of international oil prices. In its energy policy, the importance of reducing dependency on fossil fuel and stabilizing power supply by adopting diverse energy resources are mentioned. As described above, it considered that the installation of renewable power generation is one of the best options for climate change mitigation.

Under the above background, wind and biomass power generation systems are being promoted through the aggressive participation of the private sector. However, introduction of solar home systems (SHS) for rural electrification is also limited due to the high electrification rate in Uruguay.

It is estimated that the number of un-electrified household is only around 6,000. Of these, 2,000 households are located in areas where grid extension is economically not feasible. The remaining number of households can be considered as the latent demand for SHS in remote areas.

In the agreement requested by the Government of Uruguay (GoU), necessary equipment for grid-connected solar PV system will be introduced in the project. The Ministry of Industry, Energy and Mining (MIEM) is the responsible organization while the National Electric Power Generation and Transmissions (UTE) is the implementing organization for the project. Meanwhile, the Mixed Technical Commission for Salto Grande Hydropower Station (DU CTM) provides the construction site for this project in the premises of Salto Grande Hydraulic Power Station. The equipment should be procured according to necessity, adequacy and sustainability of climate change mitigation. The plan consists of scheduled equipment procurement and soft component (technical assistance).

3. Outline of Preparatory Survey and Project Contents

JICA, in consultation with GoJ, decided to conduct a Preparatory Survey on the Project for Introduction of Clean Energy by Solar Electricity Generation System in Uruguay (the Project).

JICA sent the Preparatory Survey Team (the Team) to Uruguay, and stayed in the country from 12 July 2009 to 24 July 2009. The Team held discussions with concerned officials of GoU and conducted the first field survey. The first survey report was subsequently submitted to JICA. The second survey was carried out from 1 November 2009 to 21 November 2009. Then, the Draft Outline Design Report was prepared in Japan based on discussions, field survey and technical examination of the second survey result. In order to explain and consult with the concerned officials of the GoU regarding the component of the Draft Final Report, JICA dispatched the Team from 14 March 2010 to 19 March 2010.

Based on the discussions between MIEM and DU CTM, the area of DU CTM was selected, and both organizations signed the land agreement. The following are the concerns on the project formulation policy:

1) Showcase effect
2) Introduction of advanced technology and know-how of Japan
3) Establishment of sustainable O&M structure

The project is carried out based on the framework of the Environmental Program Grant Aid by GoJ. The main equipment to be procured, which includes installation and testing, are the PV module and mounting structure, power conditioner and step-up transformer. On the other hand, UTE proposed that the scope of UTE will be to supply, install and test the medium-voltage switchgear for grid connection as they requested to apply UTE standard and SCADA for O&M.

The table below shows the capacity of the PV system and necessary ground area.

Table Capacity of PV System and Necessary Land Area

Site	Necessary Land Area(m^2)	Area (m^2)	Capacity (kW)
DU CTM	12,000	15,500	480

(JICA Study Team)

Main equipment such as PV module, power conditioner and transformer are purchased from Japan.

It is necessary to obtain spare parts for continuous operation during the initial stage. In this project, spare parts are not available locally. Therefore, it is necessary to procure from Japan. As for PV modules, 3% of the total quantities have to be procured as spare parts anticipating short periods of shut down due to lightning or breakdown. Power conditioner is the most important component of the PV system. In this project, one complete set of power conditioner with a capacity of 160 kW will be supplied as a spare unit. In addition, arresters, fans and filter will be procured as spare parts. Spare parts for 15 kV switchgears are not required because as these are included in UTE's scope of supply, installation and testing.

4. Implementation Schedule and Cost

The tendering period is estimated around 4 months. The construction period is estimated to be 12 months from the contract with tenderer up to the completion of the Project.. The demarcated cost of Uruguayan side is estimated to be around ¥5,700,000 for site clearance and 15 kV switchgears.

5. Project Evaluation

1) Conformity with the national strategy on energy sector
The importance of energy diversity is indicated in the strategic guideline on the energy sector in Uruguay. Therefore, it is important to promote the introduction of renewable energy technology and reduce dependence on fossil fuel. As mid-term targets for 2015, wind generators with total capacity of 300 MW, biomass generation of 200 MW and micro hydropower generation of 1 MW or more are clearly mentioned. The goal for the solar PV system is to introduce at least two pilot plants in the plan. Thus, this Project is in conformity with the energy strategy for Uruguay.

2) Showcase effect
There are about 30,000 visitors to Salto Grande Hydropower Station and the visitors' center at DU-CTM per year. The installation of the solar PV system at DU-CTM is expected to synergistically increase awareness on renewable energy. Especially, since there are many school children and students who visit the hydropower station, raising the awareness of the young generation is expected. Moreover, it is possible to increase the showcase effect of the Project by using a monitor which indicates the current situation of power generation. The monitor will be installed along the road, which is part of the visiting route to Salto Grande Hydropower Station. Therefore, guiding of visitors to the PV system by DU-CTM staff will be expected to raise awareness and understanding of the development of renewable energy.

3) Introduction of advanced technology and know-how of Japan
There are experiences on independent small-scale solar systems mainly in rural areas. However, there is no experience on the installation of a grid-connected power generation system. However, grid-connected solar PV systems are commonly disseminated in Japan. In this project, advanced technologies of Japan such as solar PV system and grid-connected technologies can be applied.

4) Establishment of sustainable O&M structure
In the project, the person in-charge of O&M will be trained under the manufacturer's engineer and the soft component program because there is limited experience on O&M of grid-interconnected solar PV system in the country. The technical transfer will be conducted with UTE as the counterpart and implementing organization. Establishment of sustainable O&M structure will be expected to promote renewable energy projects.

5) Influence on environment
Construction works are carried out at DU-CTM. Therefore, it is important to consider taking safety measures to protect visitors from outside. There is no influence to the surrounding conditions if the site is segregated by using fences and putting danger plates around the

construction site.

As mentioned in the above key issues, the adequacy of the implementation in an environmental program grant aid by the GOJ is of great significance in this Project.

The supply of power output and reduction of CO_2 emission are considered as quantitative benefits of the project implementation. Details are as follows:

Table　Effective Index and Target Value

Index	Standard Value（2010）	Target Value（2013）{3 years after project completion}
Annual Estimated Power Output（MWh/year）	0	648 MWh/year
CO_2 Emission（ton/year）	0	168 ton/year

(JICA Study Team)

As a qualitative benefit, it is expected (1) introduction of renewable energy, (2) Demonstration effect, (3) Rising awareness.

Location Map（Uruguay, Salto）

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

PREPARATORY SURVEY REPORT

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Chapter 3 PROJECT EVALUATION

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FIGURE LIST

ABBREVIATIONS

A/A	:	Agent Agreement
AC	:	Alternate Current
ACB	:	Air Circuit Breaker
ADMA	:	The Electricity Market Management
AFE	:	the State Railway Administration
ANSI	:	American National Standards Institute
A/P	:	Authorization to Pay
B/A	:	Banking Arrangement
CCU	:	Climate Change Unit
CDM	:	Clean Development Mechanism
COP	:	Conference of the Parties
CT	:	Current Transformer
CV	:	cross-linked polyethylene vinyl sheathed (cable)
CVT	:	Current Voltage Transformer
CVV		Control-use Vinyl insulated Vinyl sheathed (cable)
CVVS	:	Control-use Vinyl insulated Vinyl sheathed annealed copper tape (cable)
DC	:	Direct Current
DER	:	Directional Earth-fault Relay
DINAMA	:	National Environment Office
DNE	:	National Directorate of Energy
DNETN	:	Energy and Nuclear Technology Department
DS	:	Disconnecting Switch
DU-CTM	:	The Uruguayan delegation to the Joint Technical Committee
EIA	:	Environmental Impact Assessment
E/N	:	Exchange of Notes
ES	:	Earthing Switch
FEP	:	Perfluoro (ethylene-propylene) plastic pipe for underground cable
FIT	:	Feed in Tariff
FOB	:	Free on Board
F/S	:	Feasibility Study
G/A	:	Grant Agreement
GDP	:	Gross Domestic Product
GEF	:	Global Environmental Facility
GHG	:	Greenhouse Gas
GNI	:	Gross National Income
GVT	:	Grounding Voltage Transformer
GWP	:	Global Warming Potential
IDB	:	Inter-American Development Bank
IEA	:	International Energy Agency
IEC	:	International Electro-technical Commission
IEEE	:	Institute of Electrical and Electronics Engineers
IMF	:	International Monetary Fund
IP	:	International Protection (standards)
IPP	:	Independent Power Producer
JCS	:	Japan Cable Standard
JEC	:	Japanese Electromechanical Committee (standards)
JEM	:	Japan Electrical Manufacturers' (standards)
JICA	:	Japan International Cooperation Agency
JIS	:	Japan Industry Standard

LA		Lightning Arrester
LED	:	Light Emitting Diode
MCCB	:	Molded Case Circuit Breaker
MD	:	Minutes of Discussions
MIEM	:	Ministry of Industry, Energy and mining
MVOTMA	:	Ministry of Housing, Land and Environment
NASA	:	National Aeronautics and Space Administration
NEC	:	National Electrical Code
NGO	:	Non Governmental Organization
O&M	:	Operation and Maintenance
OCR	:	Over Current Relay
OCGR	:	Over Current Ground-fault Relay
OES	:	Administración de las Obras Sanitarias del Estado
ODA	:	Official Development Assistance
OFR	:	Over Frequency Relay
ONAN	:	Oil immersed, natural flow, air cooling system
ONAF	:	Oil immersed, natural flow, forced air cooling system
OPP	:	Office of Planning and Budget
OVGR	:	Over Voltage Ground-fault Relay
OVR	:	Over Voltage Relay
PC	:	Power Conditioner
PF	:	Power Factor
PPA	:	Power Purchase Agreement
PV	:	Photovoltaic
PWM	:	Pulse Width Modulation
SA	:	Surge Arrester
SCADA	:	Supervisory Control And Data Acquisition
SHS	:	Solar Home System
SPC	:	Steel plate cold rolled
SPHC	:	Steel plate hot rolled commercial
SS	:	Steel structure
T/D	:	Transducer
TR	:	Transformer
UDELAR	:	University of the Republic, Faculty of Architecture
UFR	:	Under Frequency Relay
UNDP	:	United Nations Development Program
UNCED	:	UN Conference on Environment and Development
UNFCCC	:	UN Framework Convention on Climate Change
UPS	:	Uninterruptible Power Supply
URSEA	:	Regulatory Unit of Energy and Water
USAID	:	United States Agency for International Development
UTE	:	Administración Nacional de Usinas y Trasmisiones Eléctricas
UVR	:	Under Voltage Relay
VCB	:	Vacuum Circuit Breaker
WB	:	World Bank
WB PHRD	:	World Bank Policy and Human Resource Development (Fund)
WTO	:	World Trade Organization
XLPE	:	Cross-linked polyethylene (cable)
ZCT	:	Zero-phase Current Transformer

UNIT

Distance	mm	:	Millimeters
	cm	:	Centimeters (10.0 mm)
	m	:	Meters (100.0 cm)
	km	:	Kilometers (1,000.0 m)
	feet	:	12 inch = 0.30303 meter
Square measure	cm^2	:	Square-centimeters (1.0 cm x 1.0 cm)
	m^2	:	Square-meters (1.0 m x 1.0 m)
	km^2	:	Square-kilometers (1.0 km x 1.0 km)
	ha	:	Hectare (10,000 m^2)
	acre	:	1 acre=4,046.86 Square-meters
Cubic measure	cm^3	:	Cubic-centimeters (1.0 cm x 1.0 cm x 1.0 cm)
	m^3	:	Cubic-meters (1.0 m x 1.0 m x 1.0 m)
Weight	g	:	grams
	kg	:	kilograms (1,000 g)
	ton	:	Metric ton (1,000 kg)
	kN/m^2	:	kilo Newton per Square meters
	kgf/cm^2	:	kilo grams foot per Square-centimeters
Time	sec.	:	Seconds
	min.	:	Minutes (60 sec.)
	hr.	:	Hours (60 min.)
Currency	U$	:	Uruguay Peso
	US$	:	United State Dollars
	J¥	:	Japanese Yen
Electricity	V	:	Volts (Joule/coulomb)
	kV	:	Kilo volts (1,000 V)
	A	:	Amperes (Coulomb/second)
	kA	:	Kilo amperes (1,000 A)
	Ω	:	Ohm
	MΩ	:	Mega-ohm
	Hz	:	Hertz
	W	:	Watts (active power) (J/s: Joule/second)
	kW	:	Kilo watts (10^3 W)
	MW	:	Mega watts (10^6 W)
	Wh	:	Watt-hours (watt x hour)
	kWh	:	Kilo watt-hours (10^3 Wh)
	MWh	:	Mega watt-hours (10^6 Wh)
	GWh	:	Giga watt-hours (10^9 Wh)
	VA	:	Volt-amperes (apparent power)
	kVA	:	Kilo volt-amperes (10^3 VA)
	MVA	:	Mega volt-amperes (10^6 Wh)
	var	:	Volt-ampere reactive (reactive power)
	kvar	:	Kilo volt-ampere reactive (10^3 var)
	Mvar	:	Mega volt-ampere reactive (10^6 var)
	Wp	:	Watt-peak
	kWp	:	Kilo Watt-peak

Chapter 1
BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 Current Situation and Background

1.1.1 Current Situation and Problems

(1) Mitigation of Climate Change

In Uruguay, activities for preventing global warming commenced at the global environmental summit held in Rio de Janeiro, Brazil in 1992. In the summit, 155 countries including Uruguay signed the United Nations Framework Convention on Climate Change (UNFCCC). Subsequently, the convention was adopted by Law No. 16,517 which approves the Framework Agreement of the United Nations on Climate Change, 22 July 1994. The National Environment Office (DINAMA) was established under the Ministry of Housing, Land Management, and Environment (MVOTMA). DINAMA is appointed as the national institution in charge of the implementation of UNFCCC and relevant national policies. Climate Change Unit (CCU) was created as an institution in charge of emission reduction of greenhouse effect gas (GHG) on 29 December 2002. The role of CCU is important for climate change mitigation in Uruguay. Uruguay agreed with the Kyoto Protocol which was signed on 5 February 2001. CCU was then acknowledged as the national authority of Clean Development Mechanism (CDM) by UNFCCC on 18 March 2002.

1) Organization for Climate Change

In Uruguay, the activities on mitigation of climate change are being conducted under MVOTMA. The following figure shows the organizational structure for the mitigation of GHG emissions in Uruguay.

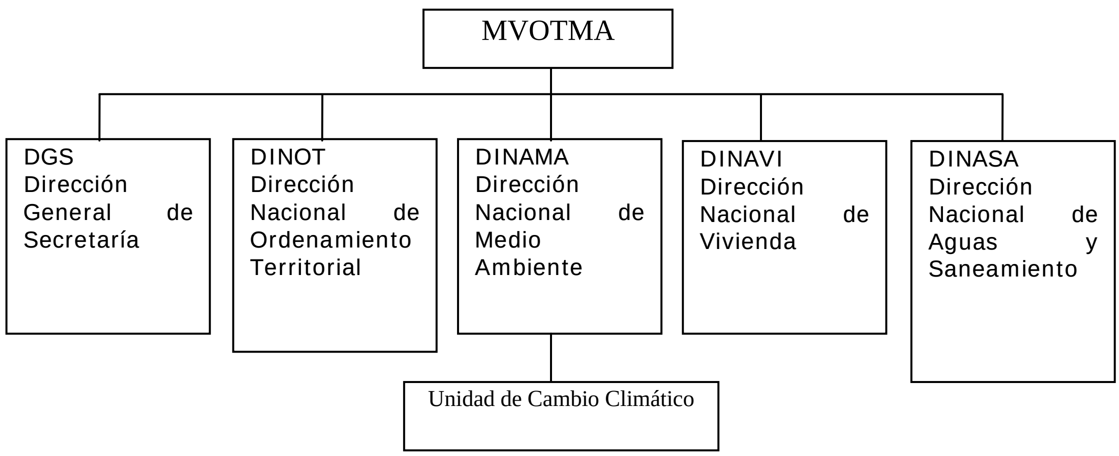


Figure 1-1 Organizational Structure on Mitigation of Climate Change

(Source: MVOTMA)

CCU is the institution in charge of CDM. The following projects were adopted as CDM projects in Uruguay:

・"Partial Replacement of Fossil Fuels with Biomass in Cement Production"

・"Capture and Burning of the Montevideo Landfill Gas"

・"Biomass Energy Generation of Fray Bentos"

・"Congregation-based System in a Tannery Natural Gas"

2）Renewable Energy

For the mitigation of climate change, it is important to consider the introduction of renewable energy technology to reduce emission of GHG which aims to prevent further global warming. In Uruguay, national power generation depends heavily on hydraulic power generation. In the past, the operation of power generation was largely affected due to climate change, especially by drought.　In these years, Uruguay made agreements with neighboring countries on power and natural gas in order to stabilize power supply and avoid the influence of fluctuation on international oil prices. In the energy policy, the importance of reducing dependency on fossil fuel and stabilizing the power supply by adopting diverse energy resources are mentioned. As described above, the installation of renewable power generation is one of best options considered for climate change mitigation.

Wind power development in Uruguay is still in the initial stage. It seems that the promotion of wind power development has been stepping up since a 450 kW capacity wind turbine was installed in 2006. At present, two wind farms with capacity of 10 MW each were installed Nuevo Manantial and Sierra de los Caracoles. The owner of Nuevo Manantial is a private investment group, and of Sierra de los Caracoles is La Administración Nacional de Usinas y Trasmisiones Eléctricas (UTE). UTE has a plan to increase the total installed capacity of the wind farm at Caracoles to 20 MW. In addition, there is a plan for installing a wind farm with a capacity of about 45 MW by 2012. Moreover, the target of wind power development is written in the law of 403/009 accepted on 24 April 2009, which indicates that the targeted capacity reaches 300 MW by 2015. This project will be implemented in two stages. The first stage has already been announced in 2009.

Biomass power generation is still in the initial stage of introduction. In 2009, the total capacity of biomass power generation is 187 MW. Around 66 MW capacity of biomass generation system have been installed by the participation of private sector in 2009. Biomass power generation is connected with the national grid. Some of the generated power is sold under the contract with UTE.　Main sources of biomass power generation are thinned wood and rice husk. Most of the generation systems are large scale, which uses steam turbine. The targeted installed capacity of the biomass power plant is 200 MW by 2015. Table 1-1 shows the installed capacity and planned power plant for wind and biomass power generation.

Table 1-1 Installed Capacity of Renewable Energy (Wind and Biomass)

	Name	Installed Capacity (MW)	Year
Wind	Agroland	0.3	2008
	Nuevo Manantial 1	4	2008
	Nuevo Manantial 2	6	2009
	Amplin 1	2	2010
	Amplin 2	7.5	2012
	Amplin 3	7.5	2012
Biomass	Botnia (*)	120	2007
	Las Rosas	1	2005
	Liderdat	4.85	2009
	Fenirol	10	2009
	Galofer	14	2009
	Bioener	12	2009
	Alur	13	2009
	Los Piques	12	2009
	Ponlar	5	2011

(Source : UTE)

3）Photovoltaic (PV) System

In Uruguay, a wind and solar hybrid generation system (wind 32.5 kW, PV 4.3 kW) was installed at Polanco villige, Lavalleja in 1995. The project was implemented by the Department of National Energy Office under the Ministry of Environment. The pilot plant supplies electricity to 53 households. In 1997, UTE and the University of the Republic, Faculty of Architecture (UDELAR) installed PV systems at rural schools, health clinics and police stations that are located far from the national power grid.

As mentioned above, experiences for installing PV systems are limited. The introduction of solar home systems (SHS) for rural electrification is also limited due to the high electrification rate in Uruguay. It is estimated that the number of un-electrified household is around 6000. In that estimated number, 2000 households are located in areas where grid extension is economically infeasible. The number can be considered as latent demand of SHS in remote areas. The rural electrification project using SHS has been implemented under the UNDP project. The target of electrification is about 1000 households in un-electrified areas.

In Uruguay, solar water heating systems are being promoted as the other option aside from solar energy technology. In January 2009, a draft law on the promotion of solar water heating system was accepted in congress. In this law, there are rules stipulating that new construction of public facilities and swimming pools which require over 20% of power consumption for heating have to install solar water heating systems.

As mentioned above, there is limited experience in installing solar PV systems in Uruguay. It seems that wind and biomass power generation systems are being promoted by the aggressive participation of the private sector. On the other hand, the high initial investment cost is preventing dissemination of grid-connected solar PV systems.

(2) Power Sector

According to UTE, the total capacity of power generation systems in Uruguay in 2008 is 1,392 MW. In the breakdown of the total capacity, hydropower generation is the largest at 593 MW. Second largest is natural gas power generation at 532 MW and third is thermal power station at 255 MW. In 2008, the capacity of wind power generation was at 10 MW. In addition, autonomous diesel power generation system with 2 MW capacity was under the operation. In Uruguay, dependency on fossil fuel for power generation is small since almost 43% of the total capacity consist of hydro and wind power generation. Table 1-2 shows the capacities of power generation in Uruguay.

Table 1-2 Installed Capacity of Renewable Energy (Wind and Biomass)

Hydro (MW)		Thermal (termal and gas) (MW)		Renewables				2009 Total (MW)
				Wind (MW)		Biomass (MW)		
Gabriel Terra	152	Central Batlle	255	UTE	20	Biomass	187	
Baygorria	108	Maldonado	20	Private	10			
Constitución	333	CTR La Tablada	212					
Salto Grande	945	Generadores Diesel	8					
		Punta del Tigre	300					
		Motores	80					
Total	1538	Total	875	Total	30	Total	187	2630

(Source：UTE)

Table 1-3 below shows the share of power consumption in Uruguay. In 2008, the generated power of the thermal power plant is larger than that of the hydropower station. Considering its electricity trade dealing with Argentina and Brazil, import power is slightly larger than that of export.

Table 1-3 Power Generation and International Power Trade (Unit : GWh)

	2003	2006	2007	2008
Production				
Hydro	3,871	1,416	3,165	1,257
Thermal	1	1,871	1,158	3,308
Wind				3
Diesel	6	6	6	1
Purchase				
Salt-Grande	3,655	2,085	4,350	3,139
Argentina	434	2,024	574	834
Brazil	0	809	215	129
Product Agents			23	137
TOTAL	7967	8211	9491	8808
Country				
Brazil	0	10	34	14
Argentina	257	7	576	8
Uruguay	7,710	8,194	8,881	8,786
TOTAL	7967	8211	9491	8808

(Source：UTE)

Table 1-4 below shows the total distance of transmission lines in the nation. This table shows that there is no significant extension of transmission lines after 2006.

Table 1-4 Total Distance of National Transmission Lines (km)

	2003	2006	2007	2008
60 kV	97	97	97	97
110 kV	144	0	0	0
150 kV	3356	3550	3549	3556
230 kV	11	11	11	11
500 kV	771	771	771	771

(Source：UTE)

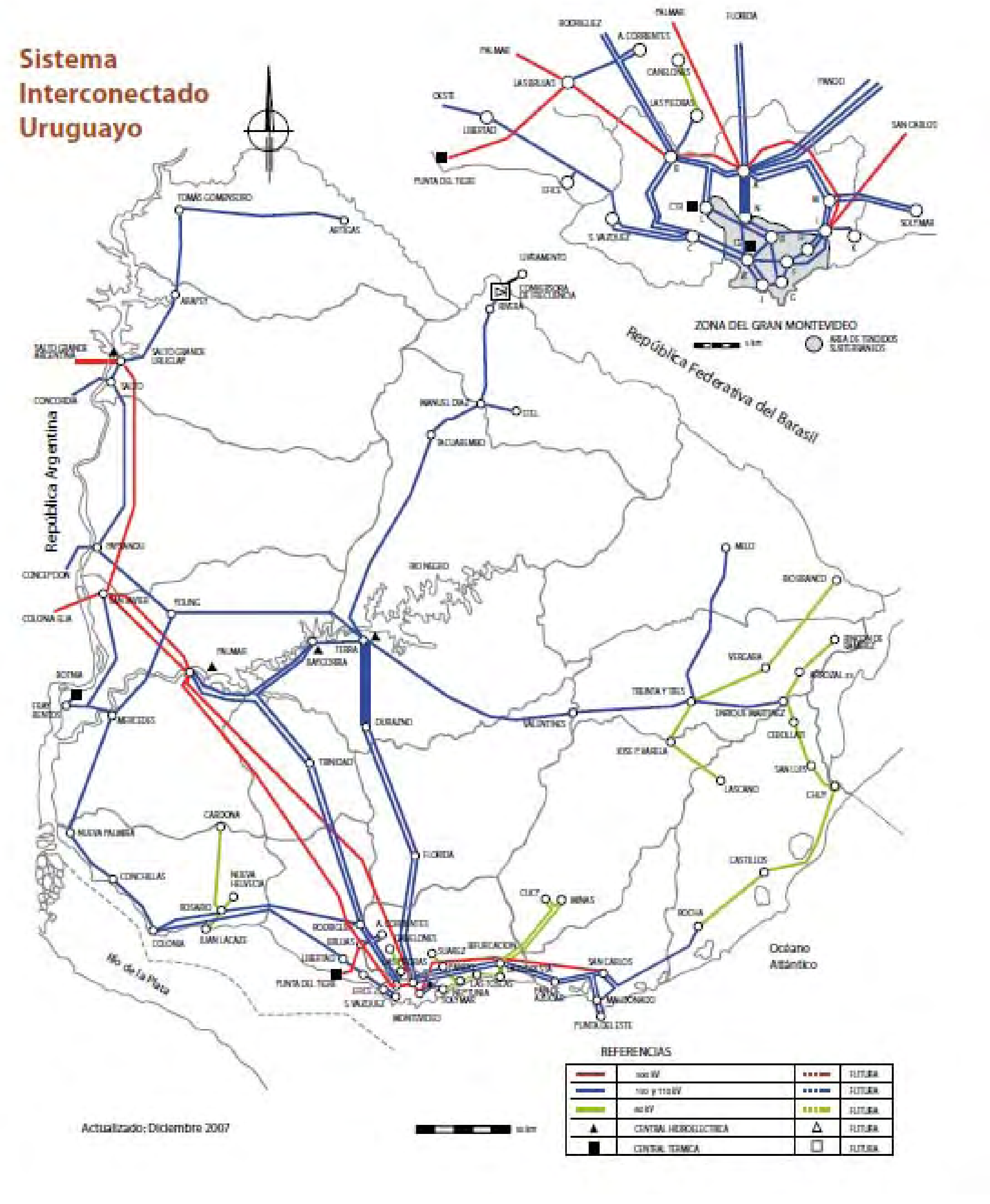
Table 1-5 below shows the total distance of national distribution lines. The distance of distribution lines has been extending every year.

Table 1-5 Total Distance of Distribution Lines (km)

	2003	2006	2007	2008		
				M. video	Interior	Total
30 kV & 60 kV	3,910	3,910	3,982	518	3,582	4,101
6 kV & 15 kV	36,260	40,142	41,334	2,139	40,302	42,441
230 V & 400 V	22,656	24,412	24,736	6,609	18,326	24,935

(Source：UTE)

The following figure shows the interconnected power lines in Uruguay.



(Source : UTE)

Figure 1-2 Inter-connected System of Uruguay

1） Power Supply

Figure 1-3 below shows the daily load curve in Uruguay. This figure shows there are peak demands during the evening and daytime. In the southern hemisphere, the winter season starts in July and the summer season in January. The figure shows the difference of demands between 8 August and 6 January during the summer season. It is considered that the power demand during the winter season is larger due to higher power demand from heating.

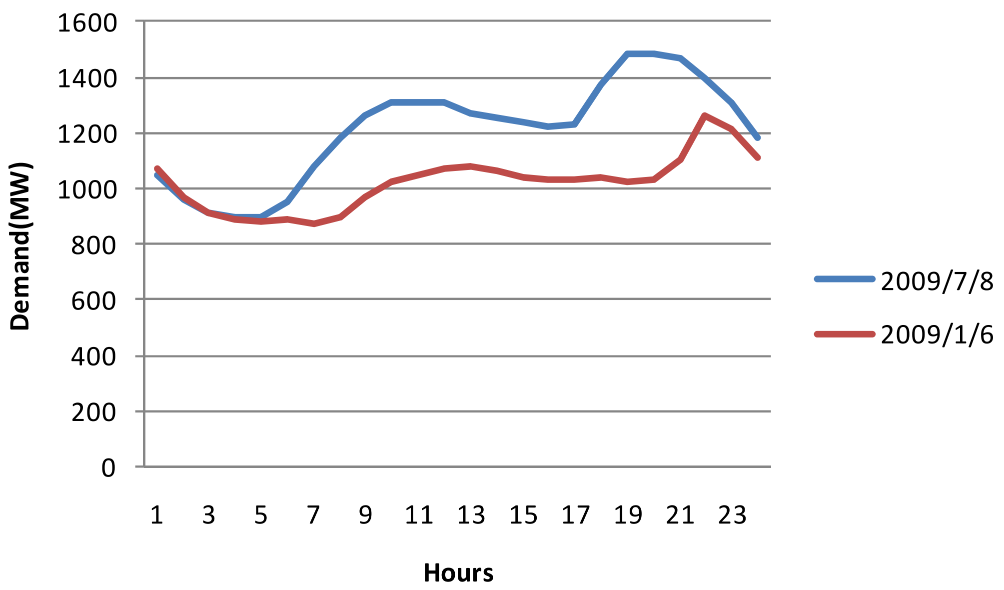


Figure 1-3 Daily Load Curve

(Source：JICA Study team)

2） Maximum Power Demand

Figure 1-4 shows the maximum power potential (MW) from 2000 to summer of 2008. The maximum power potential in the winter season is higher than that of the summer season. This is because the power demand in the winter season becomes larger than that in the summer. There are no large differences on annual power demand; however, the demand is slightly increasing.

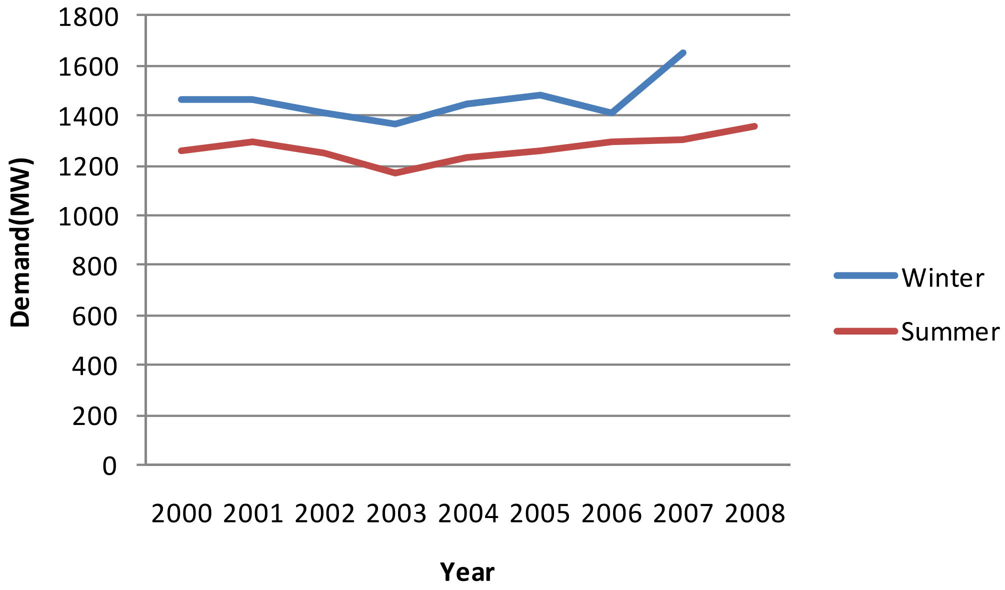


Figure 1-4 Maximum Power Demand (MW)

(Source：JICA Study team)

3）Power Tariff

The power tariff structure of UTE is divided by type of demand and contracted capacity. The example tariff of general and large demand customers are as shown below.

4）Power Tariff

(i) Metering system

1 kWh to 100 kWh/month.	US$ 2.435 / kWh
101 kWh to 600 kWh/month	US$ 3.522 / kWh
Over 601 kWh/month	US$ 3.850 / kWh
(ii) Contracted power tariff	US$ 34.30 / kW
(iii) Monthly fixed tariff	US$ 101.30

5）Large Demand Customer

Table 1-6 below shows the power tariff in case monthly power consumption is 90,000 kWh/month and the maximum contracted capacity is 200 kW.

a) Power tariff（power consumption and capacity）

Table 1-6 Power Tariff for Large Demands

Tariff	Voltage (kVA)	Energy tariff (US$/kWh)			Maximum power (US$/kW)
		value	flat	peak	
GC1	0.230 – 0.440	0.896	1.749	5.413	228.40
GC2	6.4 – 15 – 22	0.838	1.651	4.426	150.20
GC3	31.5	0.832	1.574	3.664	88.30
GC4	60	0.823	1.556	3.229	32.10
GC5	110 - 150	0.810	1.508	2.669	22.20

（Source：UTE）

b) Power tariff（fixed rate）

Power tariff is fixed rate as US$ 6,702.

The following shows the average power tariff on general consumers and industry in 2005. The data is the result of the World Bank’s survey on the power sector in Latin America and Caribbean region.

General Consumer： US$ 0.0614 /kWh
Industry： US$ 0.439 /kWh
（Source：WB / Benchmarking Data in LAC 1995-2005）

6）Organization

Figure 1-5 below shows the organizational structure of concerned project organizations including MIEM / DNETN. Figure 1-6 shows the organizational structure of UTE.

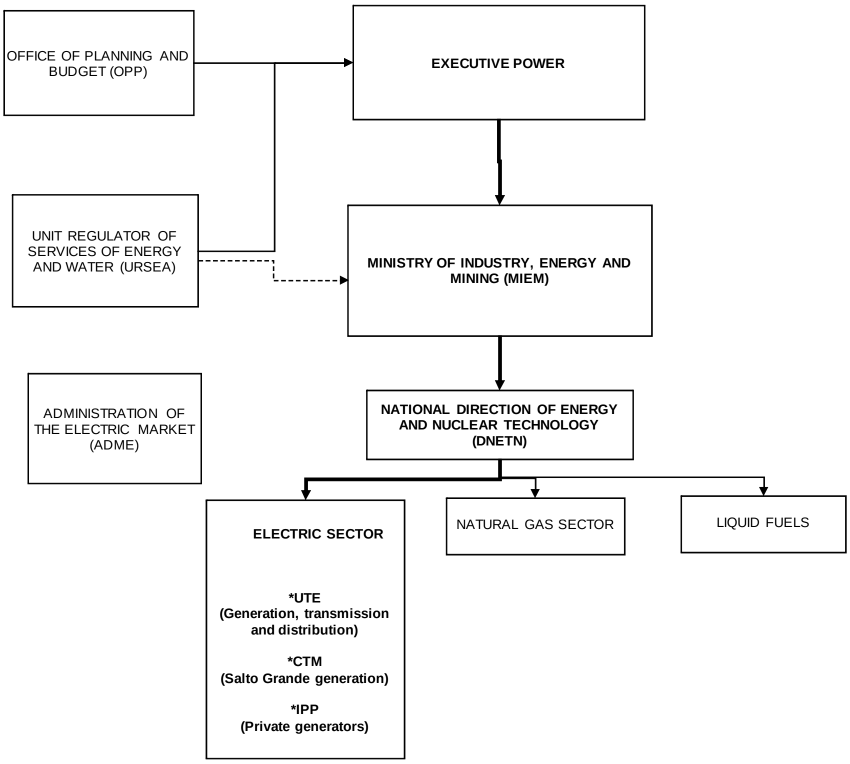


Figure 1-5 Project Relating Organization (Source: MIEM)

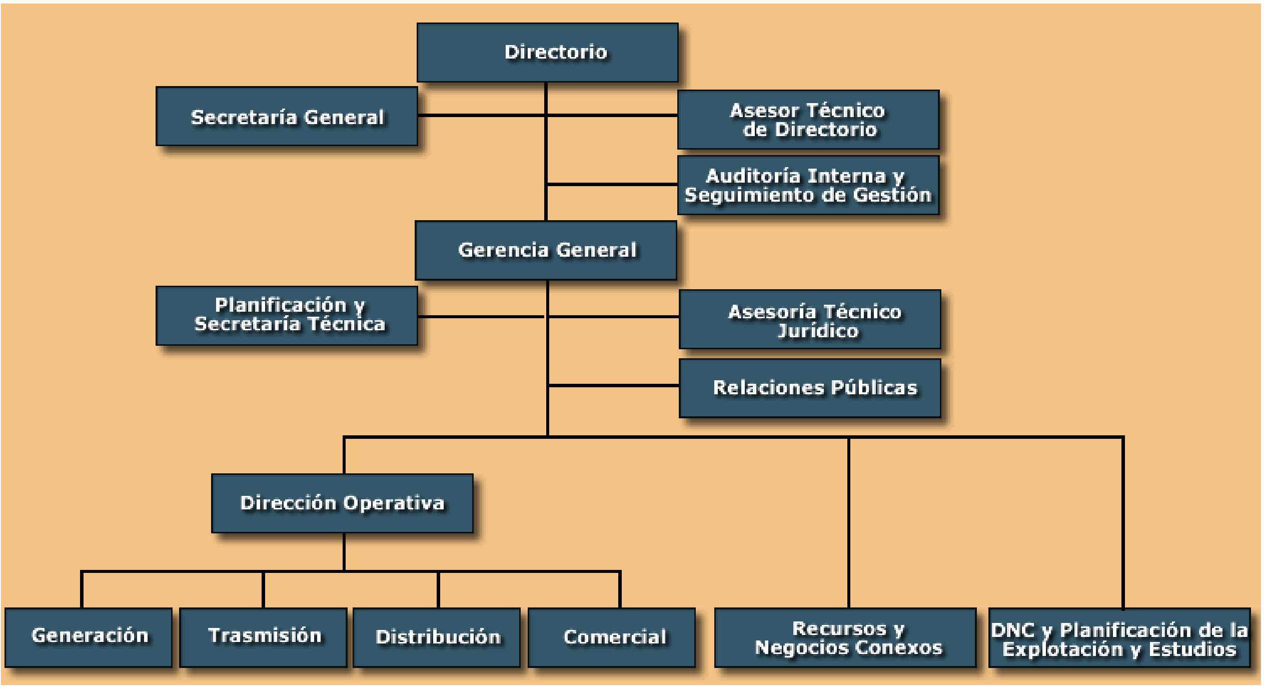


Figure 1-6 Organizational Structure of UTE (Source: UTE)

(3) Natural Circumstances

Uruguay has a mild, temperate climate, humid atmospheric conditions and an irregular rainfall system without a dry season. It has no specific periods of winter and summer, and no intermediate transition seasons of autumn and spring. The annual mean temperature is 17.5 ºC. There is a marked prevalence of northeastern winds with an average speed of l5 km/h up to 200 km/h in stormy conditions. The country’s natural risks are mainly linked to climatic events: droughts, floods, frosts, extreme heat periods and other micro-to-mesoscale meteorological phenomena (hails, tornados, squalls, etc.).

The project area is located in Salto City which is situated 496 km northwest by road of Montevideo. The city is on the Uruguay River, opposite the Argentine City of Concordia, Entre Ríos, to which it is linked by the Salto Grande Bridge built on top of the Salto Grande Dam. The project area is away from city area of Salto and the existing condition of this land is almost vacant. There are some trees on the planned area, however, these were planted artificially and would be transplanted as much as possible.

Photo 1-1 DU-CTM Site
(JICA Study Team)

(4) Environmental and Social Consideration

1) Environmental Impact Assessment

a) Organization of the Ministry of Environment and Water

The governing agency of environmental problems and environmental impact assessment (EIA) in Uruguay is the Ministry of Housing, Land Planning and Environment (Ministerio de Vivienda Ordenamiento Territorial y Medio Ambiente or MVOTMA). MVOTMA consists of five directorates. One of them is the National Directorate of Environment (Dirección Nacional de Medio Ambiente or DINAMA). The Climate Change Unit (CCU) of DINAMA is responsible for EIA.

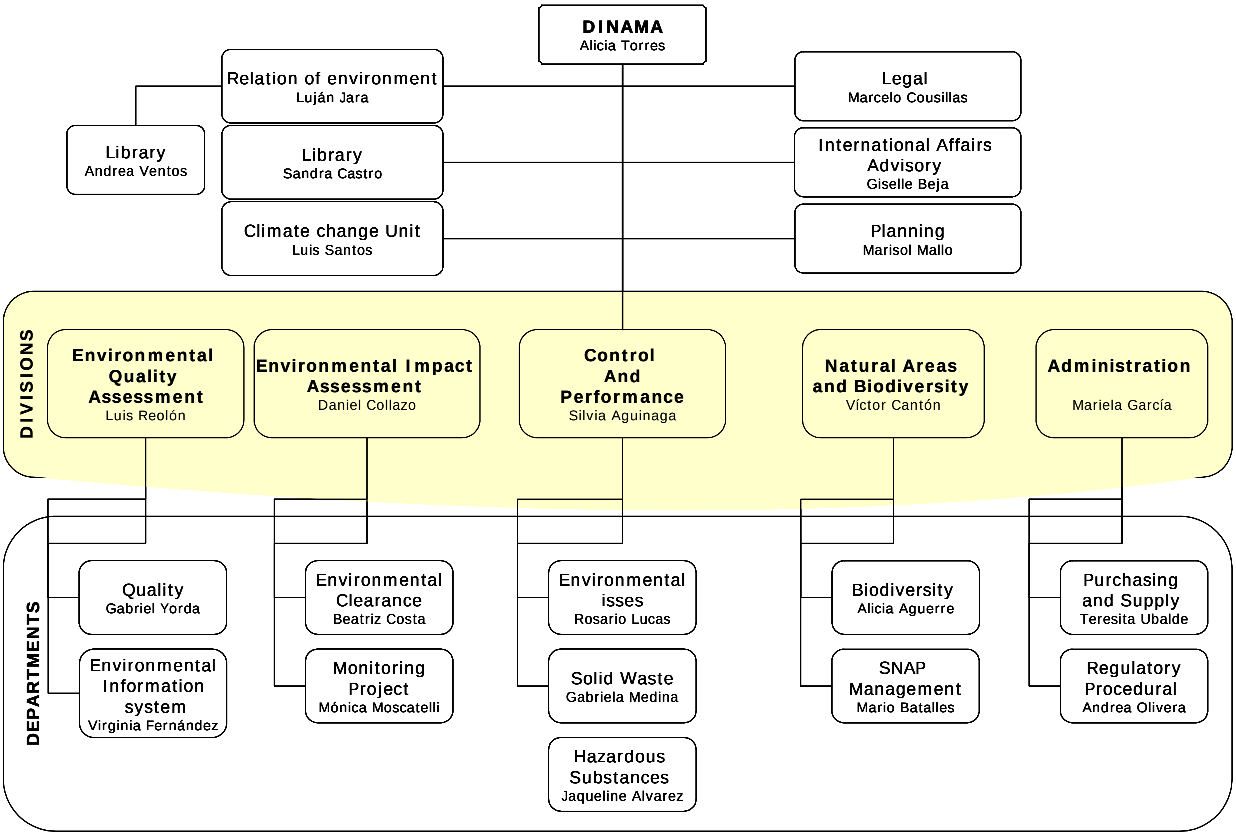


Figure 1-7 Organization of DINAMA

(Source：DINAMA)

b) Target projects (type of industry, land size, water utilization, etc.) of EIA

The EIA Act, passed as Law No. 16.466 had established a national EIA process for 34 types of projects and initiatives, which are listed in the EIA Rules and approved under Decree 349/005 with special measures for public information and participation (i.e. public hearing).

Among those 34 projects types, two project types namely ‘The construction of electricity generation’ and ‘The construction of transmission line’, would be applicable to this project.

c) EIA of the project

The project was categorized under the two types mentioned above. However, the project does not require EIA process because its scale is smaller than the regulated scale (i.e. electricity generation scale is under 10MW and transmission scale is under 150 kV).

As stated above, it is not assumed that negative impacts would not affect the surrounding area of the project because its scale is not large enough and the project is within a developed area.

2) Construction Waste

In Uruguay, regulation and law for construction waste did not exist as of 2010. Salto City also has no law and regulation on construction waste. Salto City has a landfill disposal site wherein the project construction waste would be disposed of.

At the project construction site, effective recycling and utilization should be promoted in order to reduce waste as much as possible. Also, other waste disposal system should be implemented appropriately with the permission of Salto City.

1.1.2 Development Plan

(1) Energy Policy

In the energy policy of Uruguay, the target goals of the mid-term development plan by 2015 are as follows:

- Supply of natural gas will be certified;
- Over 30% of agricultural waste will be used for energy source;
- Over 15% of electrical energy will be generated by renewable energies such as wind, solar PV and biomass;
- Less than 10% of grid power will be generated by fossil fuel power plant;
- In the transport sector, 15% of fossil fuel will be reduced; and
- Reduce portion of fossil oil in energy matrix to be less than 45%.

As mentioned above, the main tasks of the energy strategy in Uruguay is to promote the use of renewable energy and to reduce dependence on fossil fuel. Regarding the targets of the mid-term plan, the installation of 300 MW wind power, 200 MW biomass power, and additional 1MW micro hydropower are cited. The target for solar PV in the plan is the introduction of two or more pilot plans.

1.1.3 Social and Economic Status

The Oriental Republic of Uruguay (Uruguay) is situated in the temperate zone of South America. It borders Argentina to the west, Brazil to the north and northeast, the River Plate to the south and Atlantic Ocean to the east. The Uruguayan coast spans over 680 km. Approximately 70% of the total population of 3,380,177 live in the coastal zone. The rate of population growth (0.6%) has been among the lowest in the American continent since the 1960s. The territory is 175,016 km^2 with approximately 140,000 km^2 of territorial sea, islands and jurisdictional waters of bordering rivers and lagoons.

Uruguay is politically divided into 19 Departments (Montevideo, Artigas, Canelones, Cerro Largo, Colonia, Durazno, Flores, Florida, Lavalleja, Maldonado, Montevideo, Paysandu, Rio Negro, Rivera, Rocha, Salto, San Jose, Soriano, Tacuarembo, Treinta y Tres). The capital city, Montevideo, is situated on the River Plate coast -in the smallest province- with the largest number of inhabitants. Even though the largest part of the territory is engaged in agriculture and cattle breeding, 91% of the population live in urban areas. The topography is undulated, with little variation in altitude with respect to the mean sea level. Uruguayans share a Spanish linguistic and cultural background with its neighbor country, Argentina. Most Uruguayans descended from the colonial era settlers and immigrants from Europe with almost 88% of the population being of European descent.

Uruguay's economy is characterized by an export-oriented agricultural sector, a well-educated work force, and high levels of social spending. After reaching an average growth rate of 5% annually during 1996-98, its economy suffered a major downturn in 1999-2002, stemming largely from the spillover effects of the economic problems of its large neighbors, Argentina and Brazil. During the period 2004-08, economic growth of Uruguay resumed and averaged 8% annually before falling to 1.7% in 2009.

1.2 Background and Outline of Program Grant Aid for Environment and Climate Change

The Program Grant Aid for Environment and Climate Change of the Government of Japan (GoJ) is introduced as assistance to developing countries that are aiming to achieve both emission reduction of GHG with economic growth, and climate stability. As one measure, Japan established a new financial mechanism. Through this, Japan decided to cooperate actively with developing countries in their efforts to reduce emissions, such as promoting clean energy. At the same time, Japan extended their hand of assistance to developing countries suffering adverse impacts as a result of climate change. According to the initiative of this mechanism, the Japan International Cooperation Agency (hereinafter referred to as JICA) in consultation with GoJ decided to conduct a preparatory survey on the Project for Clean Energy Promotion Using Solar Photovoltaic System in Uruguay.

The main objective of this project is to reduce GHG emissions using grid interconnected PV system, which is introduced to Uruguay for the first attempt. The PV system, having an output capacity of 480kW, is installed inside the premises of DU-CTM in Salto city. Therefore, it is necessary to assist operation and maintenance personal by use of soft components (technical assistance) which are required for the technical training on the operation and maintenance of the PV system.

1.3 Assistance by GoJ

There is no official development assistance project in relating to this sector by GoJ.

1.4 Assistance by Donor Country and International Organization

There is limited experience on solar PV projects in contrast with wind, biomass and solar heating projects as these have already been implemented in Uruguay. The project for installation of SHSs at un-electrified communities in remote areas is being implemented as a Global Environmental Facility (GEF) project component. Table 1-7 below shows the assistance given by donor country and international organization.

Table 1-7 Assistance by Donor Country and International Organization
(Climate Change / Solar PV)

Year	Organization / Donor	Title	Amount (US$ millions)	Description
2004-2009	GEF	Energy Efficiency (including SHS program)	81.0 (2.0)	Market share of energy efficient equipment and appliances. Emergence of local ESCOs. (1000 of 50 W PV systems with battery for rural areas)

(Source: GEF Project Brief, Latin America and Caribbean Region,PA9SS)

Chapter 2
CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Basic Concept of the Project

(1) Upstream Plan and Objectives of the Project

1) Upstream Plan

In Uruguay, the importance of energy diversity is indicated in its strategic guideline of energy strategy. Therefore, it is important to promote the introduction of renewable energy technology and reduce dependence on fossil fuel. As mid-term targets for 2015, wind generators with a total capacity of 300 MW, biomass generation of 200 MW and micro hydropower generation of 1 MW or more are clearly mentioned. The goal for the solar PV system is to introduce at least two pilot plants in the plan.

2) Objectives of the Project

Under the project on grid-connected solar PV system, it is possible to contribute to greenhouse gas (GHG) emission reduction with a reduction of fossil fuel consumption in the power generation sector. Therefore, this project shall contribute to mitigation of climate change in Uruguay as a member country of Cool Earth Partnership.

As mentioned above, the Government of Uruguay aims to promote renewable energy projects under its long-term policy. In this project, the PV system with 480 kWp capacity will be introduced as a first grid-connected solar PV project in Uruguay. In addition, the project will contribute through technician training for solar PV system and awareness raising activities on environmental aspects.

3) Summary Description of the Project

In the agreement requested by the Government of Uruguay, necessary equipment for grid-connected solar PV system will be introduced in the project. The equipment should be procured according to necessity, adequacy and sustainability for climate change mitigation. The expected equipment and technical support in this project are as shown below.

Equipment：Grid-connected solar PV system

（Application）: Solar PV system will be connected and supply to the existing distribution network.

（Necessity）: Under the energy policy of the Government of Uruguay, it is possible to reduce GHG emission and consumption of fossil fuel for power generation by operating grid-connected solar PV system.

Soft Component (Technical Assistance)：Solar PV technology

（Contents）:

・Basic knowledge on solar PV system

・Management skills for solar PV plant

・Technology of grid-connected PV system

・Operation and maintenance (O&M)

（Necessity）: ・Limited number of solar PV engineers

・First project of grid-connected solar PV system

2.2 Outline Design of the Requested Japanese Assistance

2.2.1 Design Policy

(1) Basic Policy

This project introduces solar PV system and it will contribute to climate change mitigation in Uruguay. Solar PV is operated through solar irradiation as renewable source of energy with smaller environmental load. Introduction of grid-connected solar PV system is the first case in Uruguay. Therefore, it is necessary to consider maximizing the project effects within short- and long-term periods to establish a basic plan. In general, silicon crystalline type and amorphous type of PV modules are mainly used in the market. For the basic design of this project, selection of module type should consider the conditions for effective benefit. Not only power output from solar PV but also reduction of GHG emission comprise the results of the project. For project sustainability, human resource development of O&M technicians and introduction of awareness raising scheme for environmental aspect are also important components.

(2) Policy for Natural Conditions

Solar PV system will be installed at about 37 m above sea level at Salto City, which is located 500 km north/west of Montevideo. The average temperature is about 26°C during summer and 12°C during winter. Annual precipitation is small at about 1,400 mm. Wind speed is also small because the project site is located inland. Since Salto City is located inland, wind velocity is low in general. The climate is mild compared to Japan. Though special attention to natural conditions is not required, there must be gravel surrounding the PV system for maintenance and growth of plants should be hindered.

The following meteorological conditions are considered in the plan:

i) Ambient Air Temperature

Maximum Ambient Temperature: 40 ^{o}C

Minimum Ambient Temperature: -5 ^{o}C

Annual Average Ambient Temperature: 18.9 ^{o}C

ii) Latitude and Longitude

Latitude: 31^{o} 24’ South

Longitude: 57^{o} 57’ West

iii) Altitude

Altitude: 37 m above sea level (Salto)

iv) Relative Humidity

Relative Humidity: 72% (no seasonal variation)

v) Rainfall

Annual Mean Rainfall: 1,400 mm

vi) Wind Velocity

Maximum Wind Velocity: 30 m/sec

vii) Solar Irradiation

Annual Horizontal Irradiation for Design: 4.7 kWh/m^2/day

viii) Earthquake Factor

Earthquake Factor: 0.1

ix) Salt Erosion None

(3) Policy for Environment

According to the environmental assessment guideline of the Dirección Nacional de Medio Ambiente (DINAMA) or the National Environment Directorate, an environmental impact assessment (EIA) is not required for a PV system with a capacity below 10 MW. It is necessary to remove trees planted as a environmental attention.

(4) Policy for Social and Economic Status

Uruguay is situated in the temperate zone of South America. The country is bordered by Argentina in the west and Brazil in the north and northeast. South of Uruguay is Río de la Plata. The length of coastal area is over 680 km. Approximately 70% of the population lives in the coastal area.

Uruguay's economy is characterized by an export-oriented agricultural sector, well-educated work force, and high levels of social expenditure. Average gross domestic product (GDP) growth rate in 2004 was 4.6% and in 2008, it was 8.9%. On the contrary, the rate drops to 1.7% in 2009.

In these years, economy has been growing steadily. The social and economic status mentioned above shall not affect this project because renewable energy is recommended as a national energy strategy.

(5) Policy for Situation of Construction in Uruguay

This is the first project to introduce grid-connected solar PV system in Uruguay. Most companies related to Usinas Y Transmisiones del Estado (UTE) in Uruguay are conducting electricity through the distribution line. There has been no experience of working with solar PV system with over 480 kWp capacity. However, it is possible to carry out the installation of solar PV system. There is no problem to hire workers at the site. Also, construction materials such as reinforcing bar and cement are available and can be procured at the market in Uruguay.

As mentioned above, installation is included in the scope of works of the Japanese contractor. The contractor will send supervisor for installation work and the worker will be hired at the site.

(6) Ability of Implementation Organization

The following table shows the role of counterpart organization on the O&M of the PV system. Ministerio de Industria, Energía y Minería (MIEM), as the responsible organization, and UTE, as the implementing organization, will be in charge of the management of the PV system and monitoring of the system data such as power output and amount of CO_2 emission reduction. UTE-Salto is the organization in charge of daily O&M and periodical inspection. Delegación Uruguaya de la Comisión Técnica Mixta (DU-CTM) is in charge of providing guidance on the PV facility and brochures to the visitors.

Table 2-1 Role of O&M Organization

Organization	Role
MIEM	Management and monitoring of PV system
UTE	Management and monitoring of PV system
UTE-Salto	Periodical inspection, Daily O&M
DU-CTM	Introduction of facility, Raising awareness

(JICA Study Team)

The table below shows item of daily inspection to be conducted by UTE-Salto technical staff. Basically, it is not important to conduct complicated daily O&M on the PV system since it operates automatically. However, daily inspection is important to find faulty parts promptly. Also, it is important to obtain higher power output as much as possible. In addition, the damage caused by stolen system components and intended malicious actions can be prevented by frequent inspection. In the project area, power distribution lines are maintained regularly by UTE-Salto staff. It is important to transfer the maintenance procedure of PV system and be added as part of the current regular services of UTE-Salto.

Table 2-2 Daily Inspection

	Visual Inspection
PV Array	Dirty and broken module surface
	Corrosion and rust on mounting structure
	Damage of outside cable
Connection Box	Corrosion and rust on box
	Damage of outside cable
Power Conditioner	Corrosion and rust on outside surface
	Damage of outside cable
	Abnormal noise and sound during operation
	Clogging of filter at ventilator exit
	Surrounding circumstances（humidity, temperature）
Grounding	Damage of outside cable
Power Generation	Check operational conditions by display meters and indicators
Surrounding Condition	Damage of fence, growth of vegetation, bird's nest, etc.

(JICA Study Team)

The table below shows the list of periodical inspection items which will be conducted every two months. The detailed items of periodical inspection will be instructed by manufacturers of the installed equipment. The procedure of regular service will be transferred to the UTE Salto technical staff.

Table 2-3 Regular Service

	Visual Inspection	Measurement
PV Array	Dirty and broken module surface	Insulating resistance ( )MΩ
	Corrosion and rust on mounting structure	
	Damage of outside cable	Open circuit voltage ( )MΩ
	Damage of grounding cable, tightness of grounding connection	
Connection Box	Corrosion and rust on box	Insulating resistance ( )MΩ
	Damage of outside cable	
	Damage of grounding cable, tightness of grounding connection	
Power Conditioner	Corrosion and rust on outside surface	Check function
	Damage of outside cable	
	Abnormal noise and sound during operation	Insulating resistance ( )MΩ
	Clogging of filter at ventilator exit	
	Surrounding circumstances（humidity, temperature）	
	Damage of grounding cable, tightness of grounding connection	
Grounding	Damage of outside cable	Grounding resistance ( )MΩ

(JICA Study Team)

It is necessary to confirm the contents of the data monitored at the PV system. Also, it is necessary to store the data properly. When it is difficult to settle problems locally such as repair of malfunctioning parts, UTE and MIEM need support from the manufacturers. Except for the management procedure, monitoring of power generating condition and calculation of CO_2 emission reduction amount will be transferred. The table below shows the details of operation and data management.

Table 2-4 Management of Operation and Data

	Activity
Operational Management	Managing operational condition
	Managing educational structure of O&M technician
	Coordination with manufacturers when necessary
Data Management	Monitoring of power generating condition
	Compiling data of CO_2 emission reduction

(JICA Study Team)

In this project, PV system will be installed near the hydropower station which has over 30,000 visitors annually. There is a plan to include the PV system in the hydropower station visiting course. Therefore, it is important to have some persons who can guide visitors on the PV system and other environmental issues. The guidance increases the showcase effect of the project. In the project methodology, the role of providing guidance on the facility will be transferred to the DU CTM staff.

Table 2-5 Raising Awareness

	Activity
Raising Awareness	Explanation of PV power generation system
	Holding a seminar
	Preparing brochure on the PV system

(JICA Study Team)

(7) Policy for the Procurement Process and Schedule

After conclusion of the exchange of notes (E/N) between Japan and Uruguay, the detailed design, preparation of tender documents, tendering time, contract certification and construction will take 23 months. The construction work will take about 11 months. As most of the PV system equipment are procured in Japan, the procurement and shipping plans are easily managed by the contractor. However, it is necessary to establish the procurement and construction management plans of materials in Uruguay such as foundation, fence, and gravels. Before materials and equipment from Japan arrive, the foundation and fence works must be completed in order to start assembly works for the PV system. All materials for foundation and fence works are available in Salto City. Transportation of cargo from Japan to Montevideo is carried out through shipment. Then, cargo is transported by land, about 500 km to Salto City. During the inland transportation, there are no restrictions such as for weight of cargo on bridges.

(8) Policy for Plan of Grid Connection

Interconnection between the PV system and grid in Uruguay shall follow the "Internal Regulation for Wind and Biomass Generation Facilities" of UTE, “Quality and Service Rules” of URSEA (Regulatory Unit of Services of Energy and Water or Unidad Reguladora de Servicios de Energía y Agua (URSEA), and the “Grid Interconnection Code” of Japan. The guidelines mentioned below are based on the abovementioned regulations.

1) Applicable Scope

a) “Quality and Service Rules” apply to electricity quality of national grid (frequency, voltage, high harmonic distortion).

b) "Internal Regulation for Wind and Biomass Generation Facilities" apply to grid interconnection for wind power generation and biomass generation facilities.

c) “Grid Interconnection Code” apply to the following cases:

(i) Grid interconnection with alternating current generating facilities by diesel engine, gas engine and gas turbine.

(ii) Grid interconnection with PV system and fuel cell with power conditioner

2) Connection Plan to High Voltage Distribution Line

Since the PV system has large capacity, the generated electricity will be fed to the existing distribution grid line of UTE under reverse current flow condition. Therefore, it can be said that this is “the project with reverse current flow” from the PV plant to the grid. The shortage of electricity for station use will be supplied by the grid.

High voltage connection has economic advantages compared to low voltage connection because it is possible to reduce power loss caused by distribution loss using the simple PV system.

3) Requirement for Grid Connection

The condition of grid connection for solar PV system is indicated as follows:

a) Power connection

Power conditioner has to supply power by three phase, three wires because distribution line has three phase, three wires also.

b) Power factor

Power factor at the connection point will be higher than 85% under a reverse current flow condition, and it should not be a leading power factor from the viewpoint of the grid line.

c) High harmonic distortion

Total current distortion rate is 5.0% or less, and each current distortion rate is 3.0% or less.

d) Coordination of system protection

Protection devices will be equipped with the following:
- Protective relay
- Over voltage relay (OVR)
- Under voltage relay (UVR)
- Over frequency relay (OFR)
- Under frequency relay (UFR)

- Island operation prevention relay

In addition to the above requirements, the following functions and equipment will be implemented for keeping electric quality and power suspension:

e) Installation of insulation transformer prevents flow of DC current to connected grid. This insulation transformer is installed in the power conditioner.

f) Circuit breaker in the power conditioner cannot be closed to prevent supply of electricity during power failure. After recovery from power failure, the circuit breaker cannot be closed for a certain period.

4) Influence of PV System on Grid Line

There are features of the PV system that affect the quality of electricity in the grid line such as voltage fluctuation, frequency fluctuation and harmonic distortion.

a) Voltage fluctuation

In the “Grid Interconnection Code”, the range of acceptable voltage fluctuation is limited to within ±10% for high voltage grid connection. The standard range of voltage fluctuation is informed by UTE as 15 kV ± 7%. This range of fluctuation is within the permissible voltage range of electrical equipment such as light, air conditioner and other appliances. Therefore, it is considered that the fluctuation will not affect both the PV system and customers.

b) Frequency fluctuation

There is no indication of frequency fluctuation range in the “Grid Interconnection Code”. Frequency fluctuation range applied for Japanese electric companies is 50 Hz ± 0.2 Hz or 60 Hz ± 0.2 Hz. However, according to UTE, the range is 50 Hz ± 0.2 Hz. Thus, the range is less than ± 1%. Therefore, fluctuation will not affect both the PV system and customers.

c) Harmonic distortion

Based on the “Grid Interconnection Code”, harmonic distortion rate should be 5% or less for the total current, and 3% or less for individual currents. According to UTE, the harmonic distortion rate is equal or smaller than the value specified in the “Grid Interconnection Code”. Therefore, fluctuation will not affect both the PV system and customers because harmonic distortion rate is within the appropriate range.

(9) Policy for Relation of Laws and Regulations and Standards

1) Laws and Regulations

In this project, site tests have to be conducted following internal regulations. The adopted power regulations and laws are related to fluctuation, power factor and preventing run-offs. Thus, the recommendation is to adopt the "Internal Regulations for Grid-connected Wind and Biomass Generations" of UTE, “Quality and Service Rules” of URSEA as well as “Grid Interconnection Code” of Japan.

2) Applicable Standards

The following standards will be applied for the design, manufacturing, inspection and testing for the procurement of equipment from Japan.

a) Electrical equipment and materials

In principle, Japanese standards such as Japanese Industrial Standards (JIS), Japanese Electrical Committee (JEC), Japan Electric Machine Industry Association

(JEM) and Japanese Cable Makers' Association Standard (JCS) will be applied to the electrical equipment and materials supposed to be procured in Japan.

b) Equipment for high voltage grid connection

It is recommendable to apply the regulations and standards of electric companies in Bolivia for high voltage connection equipment because of the maintenance and availability of spare parts. Thus, Japanese standards such as JIS, JEC and JEM, international standards such as IEC, ANSI, IEEE, and electric company standards will all be applied to high voltage equipment for grid connection.

c) Construction codes and rules for electric works

The installation works, cabling works, and site tests for the PV system will adopt Japanese standards for easy prefabricated installation. However, international standards such as IEC and NEC will also be applied.

2.2.2 Basic Plan (Facilities Plan/Equipment Plan)

2.2.2.1 Facilities Plan

(1) Site Plan

From the result of discussions with Uruguayan organizations, the project site for the PV system installation was decided to be near the Salto-Grande Hydropower Station in Salto City, which is the second city in Uruguay. In Uruguay, solar irradiation is larger around Salto City and it was one of the reasons for the selection. An agreement on the free use of land was concluded between MIEM and DU-CTM. Photo 2-1 and Figure 2-1 show the selected site for the PV system.

Photo 2-1 Selected Site
(JICA Study Team)

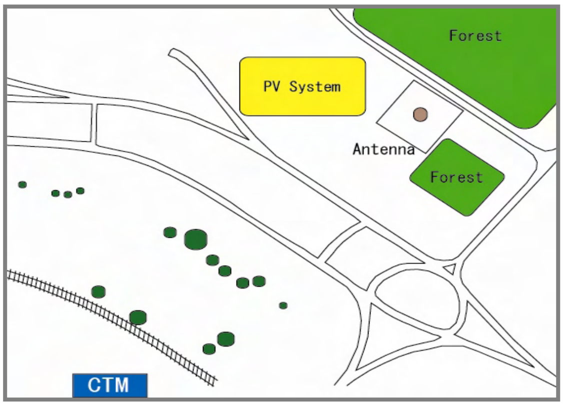


Figure 2-1 Selected Site
(JICA Study Team)

1) Showcase Effect

There are about 30,000 visitors to Salto-Grande Hydropower Station and the visitors' center at DU CTM per year. The installation of the solar PV system at DU CTM is expected to increase the awareness on renewable energy synergistically. Especially, since there are many school children and students who visit the hydropower station, raising awareness of the young generation is expected. Moreover, it is possible to increase showcase effect of the project by using a monitor which indicates the current situation of power generation. The monitor will be installed along the road, which is part of the visiting route in Salto Grande Hydropower Station.

2) Introduction of Advanced Technology and Know-how of Japan

There are experiences on independent small scale solar systems mainly in rural areas. However, there is no experience on the installation of a grid-connected power generation system. However, grid-connected solar PV systems are disseminated in Japan. In this project, advanced technologies of Japan such as solar PV system and grid-connected technologies can be applied.

3) Establishment of Sustainable O&M Structure

In this project, the person in charge of O&M will be trained under a soft component program because there is limited O&M experience on grid-connected solar PV system in Uruguay. Daily and periodical maintenance procedures will also be transferred to technical staff of UTE Salto under the same soft component program. Also under the program, the procedures of management and monitoring of operational condition will be transferred to MIEM and UTE. In addition, the methodology to guide visitors on the PV system will be transferred to DU CTM staff.

(2) Adequacy of the Installed Capacity

At the project site, it is possible to state that the maximum capacity of PV is 480 kW based on the following condition:

(i) There are many kinds of PV modules with different specifications such as type, capacity and dimension by manufacturers.

The silicon crystalline type module has a capacity of 180 to 210 W and conversion efficiency of about 14% to 19%. Amorphous type module has a capacity of 80 to 130 W and conversion efficiency of about 6% to 9%. Thus, the required area using amorphous type is 1.6 times larger than the required area for silicon crystalline type under the same output energy. This means that installation work is longer when required area is larger. Therefore, installation cost for the PV system that uses the amorphous type is about 20% higher than the cost for a system with silicon crystalline type. In this project, the available area is limited. Therefore, it is necessary to select silicon crystalline module because of its higher efficiency. In this study, based on typical performance of 180 Wp PV module, the necessary area and power output are estimated. The dimension of the sample module is 1 m x 1.5 m, and the optimum operational voltage is 30 V.

The selected site is a flat area, about 154 m x 110 m. The area is enough to install a PV system with a capacity of 300 kWp. For said capacity, it is possible to install an amorphous type module. After increasing the capacity of PV system to 480 kWp, the selected area is not enough to install amorphous type PV module. Therefore, silicon crystalline type is adopted.

(3) Plan for Power Generation and Grid Connection

1) Power Grid in Project Area

In Salto City, 150 kV electricity is supplied from a second substation (50,000 kVA, ES2T05) through transmission line and 500 kV substation from Salto-Grande Hydropower Station (1,890 MW), which is managed by DU CTM. Electricity will be supplied from the PV system through a third substation (ES2038) which is located in the area of the second substation （ES2T05）south of Salto City. The distance between the project site in the DU CTM area and the nearest distribution line is about 160 m.

2) Grid Connection and Reverse Flow

30 kV substation (ES2038) operated by UTE is located 15 km away from the PV system installation site. The substation supplies electricity to facilities in the covered area. In the installation area, isolation transformer with 15 kV/400 V for grid connection will be installed. The power generated by the PV system will be connected to the secondary side of distribution board with low voltage of 400 V. The other side will be connected to grid line of 15 kV. The reverse power flow from the PV system will be supplied to the connected grid of UTE. This is the first experience of grid-connected PV system in Uruguay, although "Internal Regulations on Grid Connection of Wind and Biomass Power Generation System" is already existing. The existing regulation will be applied to the PV system. The power generated by the PV system will be supplied to the 15 kV grid line under reverse flow conditions and the PV system equipment will receive electricity from the existing grid at night for supplying load to the control house to be used for light, air conditioners, logging system and monitoring panel. High voltage equipment and watt-hour meter are supplied and installed by UTE.

3) Estimated Power Output

In the project, the estimated appropriate tilting angle of solar module is 30 degrees for the required power output based on the location (latitude: -31.4, longitude: -58.0) and for simple O&M. The direction is decided to face the north direction since the site is located in the southern hemisphere. The table below shows the estimated monthly power output. Irradiation data by NASA is applied in the calculation. The data of NASA were compared to the existing detailed data at the same point. The irradiation was similar, so NASA data were selected for the estimation.

Table 2-6 Estimated Power Output

Month	days	Irradiation angle 30 (kWh/m^2-day)	Ambient Temp (℃)	480 kWp	
				Power Output (kWh/day)	Monthly Output (kWh/Mo)
Jan	31	6.2	26	2,117	65,630
Feb	28	5.7	24.7	1,974	55,273
Mar	31	5.4	22.9	1,873	58,057
Apr	30	4.4	18.9	1,580	47,402
May	31	4.0	15.2	1,457	45,157
Jun	30	3.5	12.6	1,284	38,516
Jul	31	3.9	12	1,432	44,385
Aug	31	4.4	14.2	1,619	50,175
Sep	30	5.2	15.7	1,870	56,088
Oct	31	5.4	19.2	1,907	59,105
Nov	30	5.9	21.7	2,084	62,518
Dec	31	6.1	24.5	2,104	65,230
Average	365	5.0	18.93863	1,775	53,961

(Source：Study Team)

Annual (480 kWp): 647,534 kWh

4) Estimated CO_2 Emission Reduction

Solar PV system has an effect of CO_2 emission reduction as a substitute for power station operated by fossil fuel. The amount of CO_2 emission reduction is calculated based on the estimated power output. In Uruguay, an emission reduction unit is applied similar to the CDM project of UNFCCC. The unit was applied in the biomass project at Fray Bentos in Rio Negro Department. The result shows that the amount of CO_2 emission reduction is about 105 tons per year.

Annual CO_2 emission reduction = emission reduction unit× annual power output

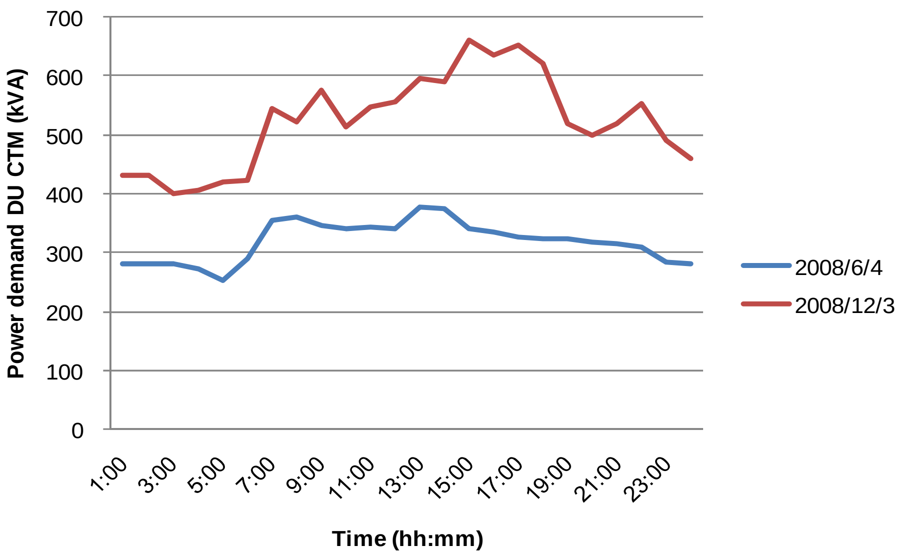
= 0.259 (kg-CO_2/kWh) × 647,534 (kWh/year)

= 167,712 (kg-CO_2/year) ≒ 168 (ton/year)

(CO_2 Emission Reduction Unit＝0.259 kg-CO_2/kWh)

5) Power Generation and Demand

Annual peak demand of the Salto power grid is about 1,100 kVA and the minimum demand is about 150 kVA. Average power demand during summer from October to January is about 700 to 800 kVA, and during winter, it is around 400 to 500 kVA. The figure below shows the diurnal power output during winter (June 4) and summer (December 3). It seems that the power demand of Salto City during summer is large because of the demand for air conditioners in the afternoon during summer and also since Salto City is north of Uruguay.



(JICA Study Team)

Figure 2-2 Power Demand in Salto City

6) Layout and Arrangement of Equipment

The area required is calculated assuming that the capacity of one PV array is 80 kWp. PV array is a cascade connection of four modules with 112 modules for the side connection. The arrays are arranged in one line and six rows (480 kWp). The PV modules face north with tilting angle of 30 degrees to generate power output effectively and to avoid accumulating dust on the surface. From the above conditions, the required area for the necessary power output was calculated. The maximum length of the shadow of the PV array is around 5.8 m on the midwinter day of June 22 from 9 a.m. to 3 p.m.. The required area is calculated based on the area of the PV array and a space of 6 m north of each array to avoid shadows. The space to the south and in both sides is estimated at 5 meters. The table below shows the required area for the 480 kWp PV system.

Table 2-7 Capacity of PV System and Required Land Area

Site	Necessary Land Area(m2)	Area (m^2)	Capacity (kW)
DU CTM	12,000	15,500	480

（JICA Study Team）

7) Geological Condition of the Candidate Site

The bearing capacity of the soil in DU CTM next to the antenna station is 3.0 kg/cm^2 at 1.4 m below the ground level. The data is obtained during the construction of the antenna tower in 1996. Therefore, there is no problem on the soil foundation with the installation of the PV system.

2.2.2.2 Equipment Plan

(1) Design Standard

In Uruguay, the international standard of IEC is applied for electrical equipment. However, in the case of international cooperative program with industrialized countries, other certain level standards can be accepted in general. In the case of procurement under a Japanese Grant Aid project, there is no problem to apply JIS, JEC, JEM and JCS.

However, UTE standards on 22 kV cable, 15 kV/400 V/230 V transformer, commissioning test, communication system and installation will be applied taking into account operation and maintenance.

(2) Equipment for PV System

The table below shows a list of equipment required, specification and number for the PV system.

Table 2-8 List of Necessary Equipment

Name	Item	Specification	No.	Unit
PV system	1) PV module	a) Type：Silicon Crystal b) Module capacity：180 Wp and above c) Maximum power：＊180 W d) Maximum power voltage：＊23.7 V e) Maximum power current：＊7.6 A f) Open circuit voltage：＊30 V	1	set

		g) Short circuit current：＊8.4 A h) Total array capacity：480 kW and above		
	2) Support structure for PV module	a) Type：Support structure for PV module b) Material：SS400 hot dip galvanizing c) Configuration：Base channel, Truss	1	set
	3) Connection box	a) Configuration：Outdoor, hanging type b) Material：SPC steel sheet c) PV input voltage：＊DC 800 V d) PV input current：＊12 A/circuit e) Input circuit：＊Max. 4 circuits f) Output circuit：1 circuit g) Contained equipment：cable breaker, circuit breaker, lightning surge protection	1	set
	4) Power conditioner	a) Configuration：Indoor, independent type b) Main circuit type：self-exciting voltage type c) Switching type：High frequency PWM d) Insulation type：Insulation transformer e) Cooling：forced air cooling f) Rated power output : 480 kW and above (total) g) Rated input voltage: ＊DC 600 V h) Maximum input voltage: ＊DC 900 V i) Input voltage operating range: ＊DC 420 V～850 V j) Maximum power point tracking range: ＊DC 500 V～700 V k) Type of output power: ＊3 phase, 3 line, 3 phase, 4 line l) Rated output voltage: ＊AC 400 V or 230 V m) AC output current distortion factor: total harmonic distortion: 5% and below, each harmonic distortion: 3% and below n) Power control type：Maximum power point tracking o) Efficiency：＊90% and above p) Function : Automatic voltage adjustment、in-out current regulation, output regulation, soft start q) Grid connection protection function: UVR, OVR, UFR, OFR, islanding operation prevention (passive, active detection), prevent power supply after recovery r) Communication：condition・accident・monitoring signal（RS485)	*1	set
	5)Outdoor transformer	a) Rated power output：600 kVA and above b) Primary /secondary voltage：15 kV/400 V/230 V 3 phases, 4 lines, 50 Hz c) Particular specification: Outdoor, Oil self-cooling type, Wiring：Δ－Y, neutral ground、Total load capacity tap ±2.5%, ±5%	1	set
	6)Load distribution board	a) Configuration：Indoor, hanging or autonomous b) Material：SPHC steel sheet c) In-out circuit: input: 1 circuit, output：*10 circuits Contained equipments : molded case circuit breaker (MCCB)	1	set
	8)Monitoring display	a) Configuration：Outdoor, hanging or self standing b) Material：SPHC steel sheet c) Display data：power output/day（kWh), instantaneous power potential（kW), irradiation (kWh/m^2） d) Size：＊W: 800 x L: 600 x H: 60	1	set
	9）Data management and monitoring system	1) Pyranometer： ISO 9060、Second Class 6～8 mV/(kW・m-2) 2) Thermometer：resistance temperature sensor Pt 100 Ω, 4 lines type,－50℃～＋100℃	1	set

		3) Data logger a) Configuration：Outdoor hanging type b) Material：SPHC steel sheet c) Input signal：irradiation (0～10 mV),Thermometer (Pt 100 Ω) d) Output signal：4～20 mA e) Power source：AC 230 V, Battery & Charger (DC 48 V) f) Contained equipment：pyranometer converter (T/D)、thermometer T/D、power T/D、potential T/D（selling, buying electricity） 4) Monitoring equipment (indoor) a) Data monitoring： monitoring cycle：6 seconds, collected data：irradiation, temperature, power output b) Equipment：PC, signal converter, UPS c) Software：display of instantaneous value, figure, form, condition of PC, accident, others d) output signal (UTE): remote wireless monitoring system (inverter and others)		
	10) Control house	a) ＊Size：W: 2,400 x L: 7,200 x H: 2,460 b) Accessory : door, light, airconditioner, dial thermometer（with contact point） c) Contained equipment : power conditioner, load distribution board, monitoring board	1	set
Construction materials	1)Cable 2)Grounding, etc.	1) Cable : 22 kV-CV-60 sqmm-1core, 600 V-CV500, 5.5, 2 sqmm 600 V-CVVS-2.0 sqmm 2) Grounding terminal, PE piping materials	1	set

＊: Reference value, applied from manufacturer's standards

(JICA Study Team)

(3) Basic Design of PV System Component

The basic design of PV system component is prepared as shown below.

1) PV Module (Array)

A photovoltaic array is a linked collection of photovoltaic modules. The total capacity of the PV system should be larger than 480 kWp. The PV module should be equivalent to silicon crystal PV module as specified in JISC8918 or modules with same performance level.

2) Mounting Structure for PV Module / Connection Box

a) The construction cost of mounting structure for PV module and connection box with wiring work represents 20% of the total cost.

b) The mounting structure for PV module is designed based on "Standard design of support structure for PV array: JISC 8955". The structure should withstand wind speed of 30 m/s. Layout of the PV array is decided for effective solar irradiation in a limited area. Moreover, it is decided to be at an angle of 30 degrees based on the sun angle during a midwinter day. The PV modules have to be installed at a higher point to avoid the shadow of modules. The maximum height of PV module is 3 m above ground level. It is necessary to take into account 6 m of free space between PV array to avoid shadows.

c) Basement of supporting structure depends on the combination of PV modules. For 6 180 Wp module supports, vertical load is about 160 kg. Therefore, concrete foundation is necessary for supporting PV array.

d) Connection box consists of breakers for distribution line, input circuit switch, output circuit switch, backflow prevention diode and lightning protection. Connection box is used for interconnecting PV arrays and disconnecting of circuit during maintenance and repair. It is necessary to install reverse flow diode, lightning protector and surge protection device at each direct current circuit.

3) Power Conditioner（Protection Device of Grid-Connected Operation）

a) Power conditioners convert direct current from PV array to alternating current, and consist of inverter and devices for grid-connected operation.

b) Power conditioner is selected according to “Power Conditioner for Small Photovoltaic Power Generation System (JISC8980)” and “Technical Guideline on Grid Connection for Secure Quality of Electricity”.

c) The functions of the power conditioner are regulation and protection of the PV system, power converter and grid connection. The main functions are as shown below. In a grid-connected PV system, reverse flow to the grid is possible but islanding operation is not affordable. Considering safe operation for the PV system, isolated operation will not be planned. Thus, isolated operation is locked during the operation. However, the automatic connection function for a certain time period after the reconnection to the grid will be used.

i) Accuracy of output voltage : AC 400 V±10%

ii) Accuracy of output frequency : ±0.2 Hz

Accuracy of output frequency (grid-connected operation) : ±1 Hz (Adjustable range)

iii) Distortion factor of AC voltage : Total 5% and below

(liner rated load connection)

Distortion factor of AC current

: Total current 5% and below (rated output)

: Each harmonic 3% and below (rated output)

iv) Power-factor (grid connected operation) : 0.85 and above

(except for emergency cases such as to prevent voltage rises)

v) Total efficiency : 90% and above (Adjustable range)

vi) Output voltage unbalanced ratio : 10% and below

vii) Grid-connected operation and protection

: Voltage / frequency monitoring

: Maximum power point tracking function

: Islanding operation prevention function

: Automatic voltage regulating function

: DC output protection function (insulating transformer)

: DC ground detector

: UVR, OVR, UFR, OFR, islanding operation prevention (passive, active detection shall prevent power supply after recovery)

4) Outdoor Transformer

a) Outdoor transformer converts AC power output voltage from power conditioner to high voltage for grid connection.

b) According to “IEC 60076 Standard” and “UTE Standard”, the transformer shall be selected.

c) Main specifications are as follows:

・Type：Outdoor ONAN transformer（ONAN）

・Rated power output：600 kVA and above

・Primary voltage / secondary voltage：15 kV/400 V/230 V, 3 phases. 4 wires, 50 Hz

・Withstand voltage：impulse withstand voltage：1.2 x 50 μs, 95 kV

・Commercial withstand voltage：38 kV, 1 min.

・Particular specification: Outdoor, Oil self cooling type, Wiring : Δ-Y, neutral ground, Total load capacity tap ± 2.5%, ± 5%

High voltage equipment will be supplied and installed based on UTE standard because the remote monitoring system will be equipped by UTE. Also, UTE will be in charge of maintenance services and will install equipment with UTE standard specification. Basement foundation of the transformer and primary power cable will be supplied and installed by the Japanese side.

5) Load Distribution Board

Load distribution board will receive electricity for the PV system operation. The power will be consumed for air conditioner, light, data logger, monitoring display and so on. The total capacity will be about 5 to 10 kW. Load distribution board is made from steel sheets and there are indication lights for power. Circuit breakers (MCCB) shall be equipped for each load.

6) Display Monitor

During discussions with MIEM, DU CTM and UTE, a monitoring display board was decided to be installed at the entrance of the solar PV system in the project site. Solar PV system will be included in the itinerary of the visiting tour to Salto Grande Hydropower Station. Monitoring display has an important role for showcase effect. The monitoring display panel shall display the information below. The contractor might suggest additional information.

The detailed design of the display board will be discussed with MIEM and UTE.

－Power output /day (kWh/day)

－Instantaneous power potential (kW)

－Solar irradiation (kWh/m^2)

－CO_2 emission reduction (kg-C)

7）Management and Monitoring System of Operational Data

Operational data management and monitoring system will be installed in the control room to verify PV system performance.

a) Solar irradiation and outdoor ambient temperature

－Pyranometer：ISO9060/2nd Class, input signal: irradiation (0～10 mV）
－Ambient thermometer：Pt 100 Ω　JIS

b) Monitoring data

The following data and the data suggested by manufacturers will be logged:

－PV output voltage (V)
－PV output current (A)
－Inverter output voltage (V)
－Inverter output current (A)
－Inverter output potential (kW)
－Inverter power output (kWh)
－Inverter operational condition
－Grid connection condition

c) Failure information

－Grid connection failure (grid connection protection function)
－Inverter failure
－Protection function in inverter
－Breaker trip for wiring of load distribution

d) Data logging system

Generated power, consumed power from distribution line, and CO_2 emission reduction will be calculated and recorded in the computer with date (day, month, year) and time.

e) Remote monitoring system (SCADA) by UTE

UTE has a remote monitoring center at Paysandú, which is 100 km south of the project site.　The PV system signal data list shown in the table below will be sent to the remote monitoring center by wireless wide waveband.

Table2-9　PV System Signal List

No.	Name of Signal	Kind of Signal	Q'ty	Output/ Input
1	Power Conditioner “ON”	Digital	1	Output
2	Power Conditioner “OFF”	Digital	1	Output
3	Protection Relay “Normal” (UV, OV, UF, OF, Isolation)	Digital	1	Output
4	Protection Relay “Abnormal” (UV, OV, UF, OF, Isolation)	Digital	1	Output
5	Representative Power Conditioner “Alarm”	Digital	1	Output
6	PC Input Current (DC)	Digital	1	Output
7	PC Input Voltage (DC)	Digital	1	Output
8	PC Input Power (kW)	Digital	1	Output
9	PC Output Current (AC)	Digital	1	Output
10	PC Output Voltage (AC)	Digital	1	Output
11	PV System Temperature	Digital	1	Output
12	PV System Irradiation	Digital	1	Output
13	Temperature High Alarm in Control House	Digital	1	Output

Note: Abovementioned signals will be monitored for each power conditioner.

(JICA Study Team)

8) Control House

Container will be used as a control house.　Indoor type of power conditioner, load distribution board, and management and monitoring system of operational data will be installed in the control house. The control house will also be equipped with door, air conditioner, temperature alarm, lighting and spare power conditioner.

2.2.3 Outline Design Drawings

Basic design drawings of the project are shown below.

Table2-10 List of Basic Design Drawings

No	Code	Figure Title
1	UR-E-101	SINGLE LINE DIAGRAM
2	UR-E-102	PV SYSTEM ARRANGEMENT (1)
3	UR-E-103	PV SYSTEM ARRANGEMENT (2)

(JICA Study Team)

2.2.4 Implementation Plan

2.2.4.1 Implementation Policy

The project is carried out based on the Environmental Program Grant Aid by Government of Japan (GOJ). Figure 2-3 Project Implementation System shows roles and relations with each organizations on this program.

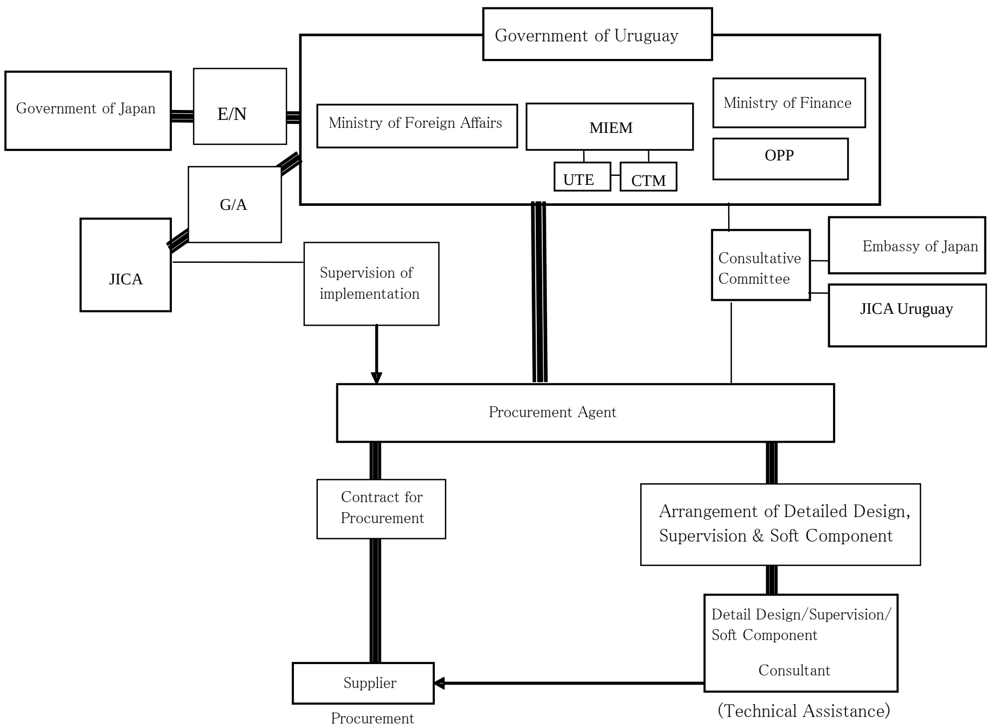


Figure 2-3 Project Implementation System

(JICA Study Team)

For the implementation of this plan, the basic issues and items to be considered are shown below.

The work area of this plan is shown below.

(i) Landfilling and leveling, civil works such as foundations.

(ii) Procurement, supply, installation, testing and taking over of PV system

(iii) Procurement, supply, installation, testing and taking over of 15 kV high voltage equipment for grid connection.

As mentioned in Clause 2.2.4.2 (2), all work items need to be executed with good coordination. Essential matters and items that need special attention are mentioned below.

(1) Executing Agency from Uruguayan Side

In this project, the responsible organization and executing organization are as follows:

- Responsible organization: Ministry of Industrial, Energy, and Mining (or MIEM)
- Executing organization: National Administration of Electrical Generators and Transmissions (or UTE)

In this project, responsible organization from the Uruguayan side is MIEM until completion of the project and UTE is the organization in charge of implementation. UTE has been working on O&M for over 90 years and employs many electrical engineers.

1) Arrangement of Budget and Staff Necessary for Executing Responsibilities of Uruguayan Side

Some of the works in this project have to be executed by the Uruguayan side. These works should be executed on time and under good coordination with the other works included in the implementation schedule of the project. It is necessary to plan the budget and staff for this purpose.

2) Transfer of Technology

In this plan, O&M staffs of Uruguayan side have to participate as observers during the installation work of the PV system. In the series of works, basic principles of the PV system equipment, and assembling of PV system will be transferred to the Uruguayan side. It is necessary for the Uruguayan side to understand that participation of engineers and technicians is required not only for the execution of duties but also for mastery of O&M works for future operation.

(2) Implementing Contractors

Based on the framework of grant aid assistance of the Government of Japan, procurement and installation of equipment will be done by the implementing contractor selected through the bidding conducted by the procurement agency. In this plan, civil works, installation of PV system and grid connection will be executed in the project site. Each works relate closely to operation aspects and schedules. Therefore, the Japanese contractor implements all the works considering aspects such as quality guarantee, guarantee of characteristics, defects liability, and schedule management.

In accordance with the specifications prepared by the consultant, the contractor will carry out the civil works, and will design, manufacture, carry out factory inspection, packing for export, transport to site, erection, site testing and take-over of the PV system. Throughout the site construction, equipment erection works and testing, the contractor will transfer technology to the Uruguayan staff.

2.2.4.2 Implementation and Procurement Conditions

(1) Matters during Implementation

For different work sites and for the erection of heavy equipment, works at high points and other works, works in DU CTM premises shall be executed simultaneously and the road next to the site shall be connected to the resort hotel and sightseeing routes in Salto Grande. Therefore, utmost care must be taken to secure safe working conditions.

Before initiating site works, detailed work plans shall be prepared through detailed discussions among working groups, UTE and DU CTM. It is necessary to confirm a safe and effective working environment especially near the existing grid. In addition, it is necessary to indicate electrically-charged area by installing safety fence and danger sign board.

In case of simultaneous operation of the three power conditioners, it is necessary to confirm during site testing that there is no interference among each other by island operation protection devices.

(2) Coordination of Various Works

In the project site, various kinds of site work such as civil works, assembly of mounting structures, installation of PV system, installation of control house, high voltage electrical work, and connection to 15 kV distribution line must be executed under good coordination. The civil works must be completed before starting the assembly of mounting structures and PV system installation. Also, it is necessary to complete the installation of 15 kV high voltage equipment, which are procured and installed by UTE before the site testing of the PV system.

Therefore, the consultant and contractor must take utmost care in coordinating each work component, responsibility toward each work, safety of workers and facilities, quality control, etc. The implementation plan must be prepared to guarantee efficient and smooth execution of site works jointly under good coordination.

(3) Concerns on the Procurement Works

For the design of PV system, it is necessary to study the site conditions. The main equipment for the PV system such as PV modules, power conditioners, and transformers are supposed to be procured from Japan. Also, during procurement stage, the consultant confirms the origin of the other parts before approving the drawings. These other parts should be procured from an eligible country.

It is important to manage procurement and transportation so that implementation is on schedule. Implementing contractors should conduct procurement, manufacturing, transportation and delivery consistently.

2.2.4.3 Demarcation of Construction Works

(1) Demarcation of Construction Works

Table 2-11 shows the demarcation of construction works between Japan and Uruguay. All of the works related to construction of PV system facilities are carried out by Japanese contractors.

Table 2-11 Demarcation of Construction Works

No.	Item	Japanese side	Uruguayan side
1)	Acquisition of necessary land for construction work		X
2)	Land clearance and removal of trees affecting PV system		X
3)	Foundation work and structure assembly	X	
4)	Construction of PV module and control house	X	
5)	Construction, testing, and commissioning of PV system	X	
6)	Construction, testing, and commissioning of 15 kV switchgear		X
7)	Installation, testing, and commissioning of 15 kV/400-230 V transformer, 22 kV power cable	X	
8)	Installation of sectionalizing switch		X
9)	Installation of watt-hour meter		X
10)	Connection work for 22 kV power cable	X	

(JICA Study Team)

2.2.4.4 Construction Supervision Plan / Procurement Supervision Plan

This project will be implemented after the E/N has been concluded between the two countries. After that, it will be accepted as an environmental program grant aid by the Government of Japan. The Government of Japan will recommend a procurement agency to the Government to Uruguay to manage the project. As for the supervision of the project, the following should be taken into consideration:

(i) Understand the background of the project implementation.

(ii) Confirm the content of the Preparatory Survey Study.

(iii) Understand the framework of grant aid assistance of Japan.

(iv) Confirm the contents of the Exchange of Notes agreed between the two governments.

(v) Site working conditions are to be fully taken into account.

(vi) Confirm stakeholders in this project and future plan.

(vii) Understand the necessity of soft component and its implementation.

Taking the above into account, the contents of consulting services, members of the consultant and the necessary organization for execution are discussed below.

(1) Basic Policies of Construction Supervision

The consultant shall manage and supervise the whole phases of works executed by the contractors so that the project works will surely be on schedule, based on the following three basic principles:

1) Schedule Management

(i) For each facility, progress of manufacture, transport and erection of equipment and materials must be reviewed all the time. The progress of the Uruguayan side works shall also be confirmed.

(ii) Process of works of both Japanese contractors and Uruguayan authorities shall be confirmed and coordinated.

(iii) Schedule meetings shall be held at appropriate times for overall schedule management and its adjustment. The schedule meetings will be held weekly during site erection period and daily during the site testing period.

2) Safety Management

(i) For the persons in charge from MIEM and UTE, daily site works and safety measures shall be explained and confirmed.

(ii) Safety arrangement of site works shall be confirmed before starting works.

(iii) In case many works are executed in the same place, necessary safety measures shall be taken to avoid accidents by confirming working methods and schedules of concerned parties.

(iv) Transporting of equipment into and out of DU CTM shall be executed under supervision of a safety manager.

(v) Before transporting, stockyard of facilities shall be explained and confirmed by Uruguayan authorities.

(vi) Site works near live electrical parts shall be executed under supervision of a safety manager.

(vii) The areas around openings and electrically live parts shall be sectionalized with safety ropes to avoid personnel faults.

3) Quality Control

(i) The implementation contractor should submit drawings, specifications, calculation data, etc. for approval by the consultant, who will review the submitted documents to confirm compliance with applied standards, contract specifications, etc.

(ii) The consultant will attend the factory testing before shipment of major equipment to confirm whether facilities have been manufactured according to the applied standards and contract specifications.

(iii) The completed works will be tested on site before taking over.

(2) Procurement Management Plan

(i) It is necessary to manage the tax exemption for PV system equipment smoothly in Uruguay, when this equipment is imported to the Port of Montevideo.

(ii) It is necessary to manage exemption or refunding tax for procured local materials.

(3) Consulting Services

1) Review of Tender Documents and Cost Estimation

Based on the results of the Preparatory Survey, the detailed design, estimation of installation cost and implementation plan have to be reviewed. The tender documents shall be reviewed based on the results of the detailed design review. The tender document is completed in conjunction with the commercial parts prepared by the procurement agency

2) Construction Supervision

a) Tendering Process

The process includes the call for tender, questions and answers, attendance during tender closing and opening, evaluation of tender results, assistance during tender negotiation and conclusion of implementation contracts.

b) Site Supervision Process

This process comprises meetings among concerned parties before initiation of site works, approval process of design drawings, factory inspection before shipment, supervision of site erection works, preparation of progress reports during site construction and installation, issuance of interim certificates, and attendance during site testing before taking over.

c) Process after Completion of Construction and Erection

This process comprises issuance of completion certificate, processing for taking over, preparation of completion report and defects liability testing to be carried out one year after taking over.

(4) Members of Consultant

To smoothly execute the necessary services itemized in Item (3) above, it is required that a senior engineer with ample experience on similar kinds of services and enough understanding of the contents of the project will be nominated as the project manager. Also, an effective executing organization consisting of staffs for detailed design, tendering procedures, review and approval of design, factory inspection, and site supervision need to be established.

1) Project Manager

Based on the full understanding of the background and purposes of the project, the project manager will manage the overall execution of the project. He will review and understand the progress of the project and current problems, control progress of the works, and instruct and provide advice to the consulting members.

2) Engineers for Detailed Design Review

Based on the established basic criteria, the engineers will review specifications of equipment and materials for the project, layout design, detailed design and construction plan taking into account supply interruption planning, and estimation of project cost.

3) Engineers for Tendering Process

The consultant shall at first prepare the tender documents and carry out the call for tender, questions and answers, tender acceptance, evaluation of submitted tenders, and assistance during negotiation and conclusion of contract.

4) Engineers for Design Review and Factory Inspection

In the home office, the consultant shall review drawings, specifications, instruction manuals, etc. to be submitted for approval by the implementing contractor, decide whether to approve the submittals or not and inform the contractor, and carry out factory inspection prior to shipment.

5) Engineers for Site Supervision

The resident supervising engineer will supervise the entire site works from commencement of construction up to completion of the project. In addition, the electrical engineer in charge of electrical facilities will be dispatched to the site to perform necessary supervising works.

2.2.4.5 Quality Control Plan

(1) Quality Control of Equipment and Materials to be Supplied

Quality of equipment and materials to be supplied under the project will be controlled in accordance with the following steps:

1) Review of Design Drawings and Specifications and their Approval

The consultant will review drawings, specifications, calculations, etc. to be submitted for approval by the implementing contractor after conclusion of the contract to review their conformity to applied standards, contract specifications, etc. and will approve them if there are no problems or give necessary comments. The consultant will perform these services in Japan. Equipment and materials will be manufactured after such approval is obtained.

2) Factory Inspection

After the equipment is manufactured, it will be subject to factory inspection before delivery to the site. The purpose of this inspection is to confirm that the equipment is manufactured in accordance with applied standards and contract specifications. Generally, visual inspection and characteristics tests are carried out. The tests of major equipment are attended by the consultant engineers. UTE engineers also attend during the testing of important equipment.

3) Site Supervision and Tests on Completion

The consultant will carry out construction supervision in cooperation with UTE engineers so that the site construction and erection works are performed in accordance with the specifications. The completion tests are performed before taking over to confirm whether the works are completed in accordance with the specifications or not.

(2) Quality Control of Civil Works

1) Review of Construction Drawings and their Approval

The structural design and construction drawings are to be prepared and subject to review and approval by the consultant. These review and approval services of the consultant will be performed in Tokyo and on site.

2) Inspection of Materials to be Used

The consultant will inspect all the materials to be used for the works before their use. These tests will be performed at the source of the supply or on site as required.

3) Construction Supervision on Site

The consultant will carry out construction supervision in cooperation with UTE engineers on the soil filling, concreting (concrete quality and arrangement of steel bars), steel frames of foundation works, etc., including attendance to some work items.

2.2.4.6 Procurement Plan

(1) Purchasing Sources

The PV module, power conditioner and transformer are purchased in Japan.

(2) Scope of Spare Parts

It is necessary to prepare spare parts for continuous operation under initial conditions. In this project, since spare parts for the main equipment are not available locally and should be procured in Japan, it is necessary to procure in advance. As for PV modules, 3% of total quantities have to be procured as spare parts because of the shortened shutdown period during occurrence of lightning or breakdown. Power conditioner is the most important component of the PV system. In this project, one complete set of power conditioner with same unit capacity will be supplied as spare part. In addition, arresters, fans and filter protection relay and meters will also be procured as spare parts.

(3) Particulars of Defects Liability

A defects liability period of one year after the taking-over will be requested for all the facilities under the project. In case any defects are found on the facilities not included in the project due to reasons attributable to the project works, such defects will be included in the defects liability of the project. The defects liability period is one year.

2.2.4.7 Initial Training and Operation Management

Initial training and operation management will be executed and explained by the manufacturer. Moreover, the soft component (technical assistance) is planned by the consultant as a form of technical transfer of basic technical knowledge, maintenance of data and analysis of records of software for the PV system. With regard to the daily and periodic maintenance, technical transfer will be carried out using a maintenance manual to be prepared by the consultant based on the manufacturer's instructions.

O&M for the PV system have to be executed mainly by the technical staffs of UTE Salto. Thus, it is necessary for them to attend the technical training in the initial stage. For operational management training, MIEM and UTE have to participate with UTE Salto staff. It is not necessary for DU CTM staff to attend the initial and O&M training.

The roles of the relevant organizations of the project are shown below.

- MIEM / UTE: Management, Monitoring
- UTE Salto: Daily and Periodical O&M
- DU-CTM: Guidance on PV system, Provision of brochure

2.2.4.8 Soft Component (Technical Assistance) Plan

(1) Background of the Soft Component Plan

"The Project for Introduction of Clean Energy by Solar Electricity Generation System in Uruguay" aims to introduce solar PV system with 480 kW capacity in the area of Delegación Uruguaya de la Comisión Técnica Mixta (DU CTM) in Salto City. The generated power will be supplied to the existing power grid of UTE (La Administración Nacional de Usinas y Trasmisiones Eléctricas). This project is the first attempt towards the installation of a grid-connected solar PV system in Uruguay. Therefore, it is necessary to assist capacity improvement and basic technical training for engineers in the aspect of technical transfer.

(a) Current Condition

In Uruguay, national power generation depends heavily on hydraulic power generation. In the past, the operation of power generation was largely affected due to climate change, especially by drought. In recent years, Uruguay made agreements with its neighboring countries on power and natural gas in order to stabilize power supply and avoid the influence of fluctuating international oil prices. In the energy policy, the importance of reducing dependency on fossil fuel and stabilizing the power supply by adopting diverse energy resources are mentioned. As described above, the installation of renewable power generation is one of the best options considered for mitigating climate change.

(b) Need for Soft Component

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

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

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

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

The details of activities to be implemented are explained below.

A. Operational Management / Monitoring

An appropriate management structure on solar PV system is necessary to secure sustainability of the project outcome. Therefore, the Ministry of Industrial, Energy and Mining (MIEM) and UTE have to confirm the activities by referring to O&M reports submitted by daily and periodic maintenance staff members of UTE Salto. In addition, it is necessary to collect data on power generation and the amount of CO_2 emission reduction for analysis.

B. Basic Technology / O&M / Troubleshooting

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

C. Education / Awareness-Raising

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

(2) Objectives of Soft Component

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

- Management of operation and monitoring of data can be conducted by MIEM and UTE staff.
- Daily and periodic inspection can be conducted by UTE Salto.
- Finding of malfunctioning parts and determining corresponding countermeasures can be conducted by UTE Salto.
- Visitors can be guided to by DU CTM personnels to see the PV system.

(3) Output of Soft Component

A. Operational Management / Monitoring

Management of operation and monitoring data at the PV facility are conducted by MIEM and UTE. It is necessary to transfer the technology for confirming operational data such as power output, solar irradiation and the amount of reduction of CO_2 emission. In addition, inspection reports written by O&M staff have to be confirmed and adequate countermeasures have to be carried out.

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

- Analysis of monitored data (power output, irradiation, CO_2 emission reduction)
- Training system of O&M technicians

B. Basic Technology / O&M / Troubleshooting

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

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

C. Education / Awareness-Raising

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

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

(4) Contents and Activity of Soft Component

Two persons participate from each organization for soft component. Depending on the role of organization, required technologies to be transferred are different.Table 2-12 shows the contents of activities, number of attendance and organization for the soft components. During the training at site, mainly practical training will be conducted for UTE Salto regional stuff.

As an implementation organization, the person in charge of the project in MIEM and

UTE have to have knowledge on O&M for its management. Technical transfer will be conducted using prepared manuals and the troubleshooting table.

Tabel 2-12 Number of participants according to technical transfer

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

(JICA Study Team)

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

A. Operational Management/Monitoring

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

Table 2-13 Operational Management/Monitoring

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

(JICA Study Team)

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

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

Table 2-14 Basic Technology of PV System

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

(JICA Study Team)

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

Table 2-15 O&M and Troubleshooting Training Activities

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

(JICA Study Team)

C. Education / Awareness-Raising

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

Table 2-16 Awareness- Raising Activities

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

(JICA Study Team)

(5) Problems in Implementation

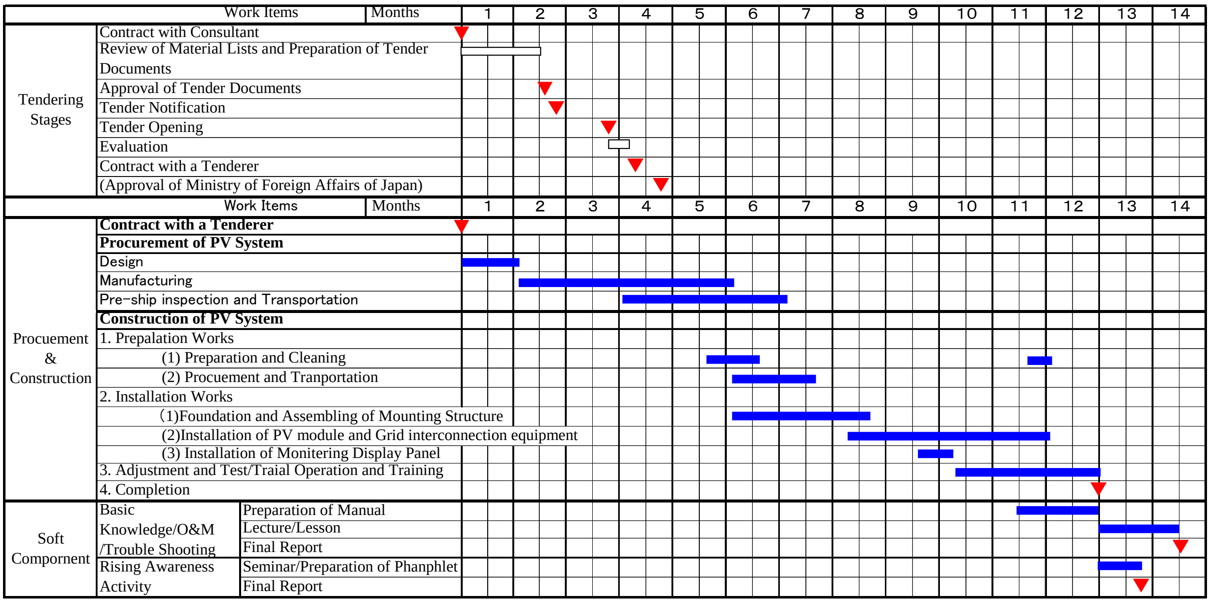
In Uruguay, it is necessary to communicate by Spanish language. Therefore, it is necessary to work with an assistant who will serve as interpreter during seminars and assist in the translation of the manual.

2.2.4.9 Implementation Schedule

The work execution of this project will require 12 months from the design for manufacturing up to completion of the project.

The estimated implementation schedule is shown in Table 2-17.

Table2-17 Estimated Implementation Schedule



(JICA Study Team)

2.3 Obligation of Recipient Country

Items to be executed by Uruguayan authorities in case a grant aid project from Japan is executed are as follows:

(i) Banking arrangement (B/A)

(ii) Authorization to pay (A/P)

(iii) Obtaining an import license to import PV system facilities to Uruguay and payment of the corresponding fees

(iv) Tax exemption for services of Japanese people engaged in the project works, hand tools to be used for work execution, etc.

(v) Right to enter the project area

(vi) Obtaining permissions from related authorities in relation to project works

(vii) Acquisition of land necessary for the PV system and replanting of trees

(viii) Construction of the extension of 15 kV distribution line and switchgear to be connected to the PV system

(ix) Settlement of conflicts with inhabitants in the surrounding area

(x) Other items that cannot be provided under the grant aid

Necessary matters for smooth implementation of this project are explained below.

(1) Acquisition of Power Station Land

There is an agreement between MIEM and CTM on the land needed for the PV system installation. The PV system with total capacity of 480 kWp will be installed at a flat land in DU CTM site in Salto Grande. The area for installation is approximately 15,500 m^2.

Table 2-18 Necessary Land for Project

Site	Necessary Land Area(m2)	Area (m^2)	Capacity (kW)
DU CTM	12,000	15,500	480

(JICA Study Team)

(2) Participation during Installation and Commissioning Tests

As human resource development for the O&M of PV system, it is necessary that the O&M staff candidate participates in the installation process. It is important not only to participate in the installation but also to understand the assembly of the PV system by cooperating with the Japanese engineers.

2.4 Project Operation Plan

(1) Establishment of O&M System

Import tax exemption and arrangement with concerned project organizations will be conducted by MIEM as the responsible organization and UTE as the implementing organization. The land for the project is provided by DU CTM as gratuity. Under the soft component program, O&M technology will be transferred to the technical staff of UTE Salto who is in charge of the periodical O&M. Under the same program, management and monitoring procedure will be transferred to UTE and MIEM. Also, it is necessary to transfer the methodology for visitor guidance on PV system to DU CTM staff. Operation manual, form of reports on O&M and troubles have to be prepared.

(2) Arrangement of Staffs with High School Educational Level

It is necessary to have technical knowledge for the management of the introduced PV system. Staffs that will be part of the future main staff of the O&M team should have technical high school or higher educational background. UTE has to hire the staffs before installation is initiated.

(3) General Technical Training During Construction

In Uruguay, there is no experience on the construction of a PV system. During the construction period, instruction by the manufacturer's supervisor and consultant on site is effective. Therefore, the O&M candidate staffs shall be requested to participate during the construction work and testing on site.

2.5 Project Cost Estimation

2.5.1 Initial Cost Estimation

(1) Demarcated Cost of Uruguayan Side

To implement the grant aid project, the demarcated cost of Uruguayan side is as shown in Table 2-19. It is necessary to complete the demarcated work before equipment arrives at the project site.

Table 2-19 Demarcated Cost of Uruguay

(1US$=¥93.97)

Work Item	Work Detail	Cost
Site clearance cost	Transplant of trees	US$ 7,400 (¥700,000)
Supply and installation of 15 kV distribution line and switchgear (including construction cost)	1) 15 kV distribution line: approx. 160 m from existing line 2) 15 kV switchgear: pole-mounted DS, CB, LA and metering & protection devices	US$ 53,200 (¥5,000,000)
Total		**US$ 60,600 (¥5,700,000)**

(JICA Study Team)

In addition to the above, the expenditures for B/A, A/P, and fees for obtaining import permit from the government and others will be required. For smooth execution of such duties, MIEM needs to secure the necessary budget beforehand.

2.5.2 Operation and Maintenance Cost

Members of the O&M team are estimated to be two engineers and six technicians.

The selling price of energy in 2008, according to the annual report of UTE, is shown below.

Table 2-20 Selling Price of Energy in 2008 (Unit rate: US$ 1000)

Item	2008
General	115,402
Houses	476,825
Large Consumer	179,214
Middle Consumer	146,095
General in Time	3,962
Houses in Time	26,884
Road Lighting	36,405
Limited in summer	6,390
Export	1,021
Total Amount	983,201

(JICA Study Team)

Power demand and selling price of energy of UTE have been annually increasing by 5 to 10% on average. Thus, the implementing organization must reserve budget for O&M of PV system.

(1) Assignment Plan for Operation and Maintenance Staffs

Assignment plan for the O&M staffs is as follows:

Table2-21 Assignment Plan

Position	Number of O&M Staff	Organization
Advisory staff		
Engineer	2	UTE
Engineer	2	MIEM
O&M staff		
Daily O&M	2	UTE Regional Staff
Total	6	

(JICA Study Team)

1) Plan for O&M Staff

For the O&M staff of the PV power station, two engineers will be assigned from UTE Salto, namely, a responsible engineer and a technician. As needed, O&M staff will conduct inspection and repair based on the result of daily maintenance.

2) Operation and Management Plan

Power station will be managed by UTE and MIEM. Both organizations will confirm the O&M reports and monitoring data of operation.

(2) Operation and Maintenance Cost

1) Equipment Maintenance Cost

Basically, PV system is free of maintenance and operational cost consists of costs of spare parts and consumable parts, measuring devices, and erection materials. Maintenance cost is estimated at 0.1% of the equipment cost.

2) Management and Other Costs

In general, the maintenance and other costs are estimated at 1% of the generated power (kWh) costs. Cost of management and others for the newly installed PV system is calculated with the same ratio. This cost becomes around US$2,480, derived by multiplying 1% of the annual power output by the unit power tariff (US$0.2/kWh).

The total operation and maintenance cost is as shown in Table 2-22.

Table 2-22 Operation and Maintenance Cost

	US$	Pesos
Equipment Maintenance Cost	5,000	115,850
Employment Cost	0	0
Management Cost and others	2,480	57,462
Total	**7,480**	**173,312**

Exchange rate: 1US$=19.81 U. Peso (in Feb. 2010)

(JICA Study Team)

Chapter 3
PROJECT EVALUATION

CHAPTER 3 PROJECT EVALUATION

3.1 Recommendations

3.1.1 Preconditions for Implementation of Project

An agreement on the free use of land was concluded between the Ministry of Industry, Energy and Mines (MIEM) and Delegación Uruguaya de la Comisión Técnica Mixta (DU-CTM). Therefore, there is no problem on the land use, but some preconditions are required to be executed before the project implementation, as follows;

1) Removal of planted trees,
2) Extension of the 15-kV distribution line (approx. 160 m) to the site by UTE (the National Administration on Electric Power Generation and Transmissions),
3) Procurement, installation and testing for the grid interconnection equipment by UTE, and
4) Establishment of operation and maintenance structure by MIEM, UTE (head office) and UTE Salto.

3.1.2 Outstanding Issues for Accomplishment of Project Plan

In order to realize sustainable operation of the installed PV system, its effective maintenance is essential. The following outstanding issues will need to be addressed and executed by Uruguayan side.

(1) In Uruguay, the development of a regulation on grid-connected solar power generation systems has not yet been prepared. However, UTE has the "Internal Regulations for Grid-connected Wind and Biomass Generations". At present, these internal regulations are applied to the grid-connected wind and biomass generation systems. It is necessary to adopt these internal regulations for the site test on this project. Besides, it is recommended to promote providing incentives for the introduction of renewable energy using Feed-in Tariff (FIT).

(2) In this project, the person in-charge of O&M will be trained under a soft component program because there is limited O&M experience on grid-connected solar PV system in Uruguay. For the establishment of a sustainable O&M structure, daily and periodical maintenance procedures will also be transferred to technical staff of UTE Salto under the same soft component program. Also under the program, the procedures of management and monitoring of operational condition will be transferred to MIEM and UTE. In addition, the methodology to guide visitors on the PV system will be transferred to DU CTM staff.

(3) Schedule of inspection period shall be planned for the purpose of keeping the system functional and for UTE Salto maintenance staff to detect any malfunction. It is necessary to educate maintenance staff and safeguard the manual for operation and maintenance. Furthermore, inspection and failure records shall be kept as database for future purchasing of spare parts and maintenance work.

JICA has training courses as technical assistance for CDM by inviting participants from least developed countries. According to this system, if JICA follows to invite Uruguayan staff to Japan for participation in organized training courses such as "Technical Training on PV System" and/or "Grid Interconnection Technology for Renewable Power Generation System", it is expected that the above technical training in Japan will bring more effective benefits to this Project.

There is no other project directly related to this solar electricity generation system. However, many renewable power generation systems such as hydroelectric power, biomass and wind power generation systems are utilized in Uruguay. Therefore, introduction of clean energy through solar electricity generation system is encouraged by raising awareness and interest for clean energy.

3.2 Project Evaluation

3.2.1 Project Adequacy

Key issues for adequacy of this project implementation are as follows:

1) Conformity with the national strategy on energy sector

The importance of energy diversity is indicated in the strategic guideline on the energy sector in Uruguay. Therefore, it is important to promote the introduction of renewable energy technology and reduce dependence on fossil fuel. As mid-term targets for 2015, wind generators with total capacity of 300 MW, biomass generation of 200 MW and micro hydropower generation of 1 MW or more are clearly mentioned. The goal for the solar PV system is to introduce at least two pilot plants in the plan. Thus, this Project is in conformity with the energy strategy for Uruguay.

2) Showcase effect

There are about 30,000 visitors to Salto Grande Hydropower Station and the visitors' center at DU-CTM per year. The installation of the solar PV system at DU-CTM is expected to synergistically increase awareness on renewable energy. Especially, since there are many school children and students who visit the hydropower station, raising the awareness of the young generation is expected. Moreover, it is possible to increase the showcase effect of the Project by using a monitor which indicates the current situation of power generation. The monitor will be installed along the road, which is part of the visiting route to Salto Grande Hydropower Station. Therefore, guiding of visitors to the PV system by DU-CTM staff will be expected to raise awareness and understanding of the development of renewable energy.

3) Introduction of advanced technology and know-how of Japan

There are experiences on independent small-scale solar systems mainly in rural areas. However, there is no experience on the installation of a grid-connected power generation system. However, grid-connected solar PV systems are commonly disseminated in Japan. In this project, advanced technologies of Japan such as solar PV system and grid-connected technologies can be applied.

4) Establishment of sustainable O&M structure

In the project, the person in-charge of O&M will be trained under the manufacturer's engineer and the soft component program because there is limited experience on O&M of grid-interconnected solar PV system in the country. The technical transfer will be conducted with UTE as the counterpart and implementing organization. Establishment of sustainable O&M structure will be expected to promote renewable energy projects.

5) Influence on environment

Construction works are carried out at DU-CTM. Therefore, it is important to consider taking safety measures to protect visitors from outside. There is no influence to the surrounding conditions if the site is segregated by using fences and putting danger plates around the construction site.

As mentioned in the above key issues, the adequacy of the implementation in an environmental program grant aid by the GOJ is of great significance in this Project.

3.2.2 Project Effectiveness

(1) Quantitative Benefits

The supply of power output and reduction of CO_2 emission are considered as quantitative benefits of the project implementation. Details are as follows:

Table 3-1 Effective Index and Target Value

Index	Standard Value (2010)	Target Value (2013) {3 years after project completion}
Annual Estimated Power Output (MWh/year)	0	648 MWh/year
CO_2 Emission (ton/year)	0	168 ton/year

(JICA Study Team)

(2) Qualitative Benefits

1) Introduction of Renewable Energy
Introduction of a grid-interconnected PV system is the first project of this kind in Uruguay. After this project, other renewable energy projects will be expected to be promoted and generating electricity through clean energy. The soft component, including O & M and troubleshooting technology on the PV system, contributes to train the maintenance staff, and not only the PV engineer but also the grid interconnection engineer.

2) Demonstration Effect
A monitoring display panel indicating the power output and solar irradiation will be installed along the road, which is part of the visiting route to Salto Grande Hydropower Station. This monitoring plan will have an effect of appeal to visitors at Salto.

3) Raising Awareness
As for the PV system which was introduced in this Project, it is expected to raise awareness on climate change and understanding of the efficient usage of solar energy through the soft component of the Project.

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. Soft Component (Technical Assistance) Plan
6. Drawings
7. References

Appendix-1
Member List of the Study Team

Member of the Study Team(First Survey)

The Preparatory Survey on The Project for Introduction of
Clean Energy by Solar Electricity Generation System in Uruguay

1. Mr. Masashi KINOSHITA
   Leader
   Director, Grant Aid Coordination Division, Financing Facilitation and Procurement Supervision Department, JICA
2. Mr. Hiroyuki TOMURA
   Planning Management
   Deputy Assistant Director, Natural Resources and Energy Conservation Division, Natural Resources and Energy Group, Industrial Development Department, JICA
3. Mr. Masayuki OIKAWA
   Project Manager
   Crown Agents
4. Mr. Toshiaki KOBAYASHI
   Team Leader / Grid-connected PV System
   NIPPON KOEI Co., Ltd.
5. Mr. Tsutomu DEI
   Total PV System
   NIPPON KOEI Co., Ltd.
6. Mr. Kazuo FUJITA
   Equipment and Facility Planner
   NIPPON KOEI Co., Ltd.
7. Mr. Munenori KUMASU
   Institution & Standards/ Grid Operation
   NIPPON KOEI Co., Ltd.
8. Mr. Akio OKAMURA
   Interpreter for Spanish

Member of the Study Team(Second Survey)

The Preparatory Survey on the Project for Introduction of
Clean Energy By Solar Electricity Generation System

1. Mr. Toshiaki KOBAYASHI
   Team Leader / Grid-connected PV System
   NIPPON KOEI Co., Ltd.

2. Mr. Tsutomu DEI
   Total PV System
   NIPPON KOEI Co., Ltd.

3. Mr. Kazuo FUJITA
   Equipment and Facility Planner
   NIPPON KOEI Co., Ltd.

4. Mr. Hitoshi EGAWA
   Deputy Team Leader/Procurement Planner/Cost Estimator1
   NIPPON KOEI Co., Ltd.

5. Mr. Munenori KUMASU
   Institution & Standards/ Grid Operation
   NIPPON KOEI Co., Ltd.

6. Ms. Junko MASAKI
   Environmental& Social Specialist/CO2 Emission Evaluator
   NIPPON KOEI Co., Ltd.

Member of the Study Team(Third Survey)

The Preparatory Survey on The Project for Introduction of
Clean Energy by Solar Electricity Generation System in Uruguay

1. Mr. Yoshikatsu SATO
   Leader
   Representative,, Uruguay Office JICA
2. Mr. Katsuhiko SHINO
   Planning Management
   Assistant Director, Grant Aid Project Management Division 3 Financing Facilitation and Procurement Supervision Department, JICA
3. Mr. Gustavo Rojas
   Crown Agents
   Representative of Bolivia Office
4. Mr. Daiji FUKUDA
   Interpreter
   Japan International Cooperation Center
5. Mr. Toshiaki KOBAYASHI
   Team Leader / Grid-connected PV System
   NIPPON KOEI Co., Ltd.
6. Mr. Tsutomu DEI
   Total PV System
   NIPPON KOEI Co., Ltd.
7. Mr. Hitoshi EGAWA
   Deputy Team Leader/Procurement Planner/Cost Estimator1
   NIPPON KOEI Co., Ltd.

Appendix-2
Study Schedule

Study Schedule in Uruguay(First Survey)

No.	Date	Day	Stay	Officials			Consultants				
				Kinoshita	Tomura	Oikawa	Kobayashi	Dei	Okamura	Kumasu	Fujita
1	2009/7/12	Sun.	Montevideo	JL048 NRT-JFK 1900 1855 AA 955 JFK-EZE 2215 1030 +1			AA060 NRT-DLS 1800 1545 AA 997 DLS-EZE12:0 1305 +1	DL056 NRT-ATL 1900 1855 DL101 ATL-EZE835 745 +1			
2	2009/7/13	Mon.	Montevideo	AA 943 EZE-MVD 1210 1305 JICAOffice: Explanation/Discussion			PU170 EZE-MVD 1105 1200 JICAOffice: Explanation/Discussion				
3	2009/7/14	Tue.	Salto	Courtesy Call/Discussion: Embasy of Japan, Ministry of Foreign affairs Transfer(MVD→Salto)			Courtesy Cal/Discussionl: Embasy of Japan, Ministry of Foreign affairs Transfer(MVD→Salto)				
4	2009/7/15	Wed.	Montevideo	UTE/Site Inspection, Salto/Discussion CTM/SiteInspection, CTM/Discussion Transfer (Salto→MVD)			UTE/Site Inspection, Visit to Hydropower Station CTM/Site Inspection, Visit to Substation Transfer(Salto→MVD)				
5	2009/7/16	Thu.	Montevideo	Technical Discussion (DNETN,UTE, CTM) Preparation of M/D Courtesy Call: MIEM、DNETN			Technical Discussion (DNETN,UTE, CTM) Preparation of M/D Courtesy Call: MIEM、DNETN			Study on site inspection Preparation of questionnaire Collection of data	
6	2009/7/17	Fri.	Montevideo	Signing of M/D AA 900 MVD-EZE 1725 1815 AA956 EZE-JFK 2000 0605+1			Signing of M/D Preparation of Report			SGM, CTM Preparation of Report	
7	2009/7/18	Sat.	Montevideo	JL047 JFK-NRT 1005 1215 +1			Preparation of Report				
8	2009/7/19	Sun.	Montevideo	Arrival in Japan			Preparation of Report				
9	2009/7/20	Mon.	Montevideo				Discussion with MIEM Discussion with UTE			Discussion with SGM,MIEM Discussion withUTE	
10	2009/7/21	Tue.	Montevideo				Discussion with Mesa-Solar: DINAMA Discussion with Republic University			Discussion with MIEM Discussion with Republic University	
11	2009/7/22	Wed.	Montevideo				URSEA	MIEM URSEA		UTE URSEA	
12	2009/7/23	Thu.	Montevideo				Discussiob with Montelecnor s.a. Report to JICA	Report to JICA		Discussion with Montelecnor s.a. Report to JICA	
13	2009/7/24	Fri.	Montevideo				Report to Embassy MIEM				
14	2009/7/25	Sat.	La Paz				TA045MVD-LIM520 945 TA037 LIM-LPZ1038 1328				

MIEM	Ministry of Industry, Energy and Mining
DNETN	National Department of Energy and Newclear Technology
UTE	National Electric Power Plant and Transmissions
CTM	Mixed Technical Comission
DINAMA	National Environment Directorate
SGM	Servicio Geografico Militar
URSEA	Unidad Reguladora de Servicios de Energia y Agua

Study Schedule in Uruguay(Second Survey)

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Date</th><th rowspan="2">Day</th><th rowspan="2">Stay</th><th colspan="6">Consultants</th></tr>
<tr><th>Kobayashi</th><th>Dei</th><th>Fujita</th><th>Egawa</th><th>Kumasu</th><th>Masaki</th></tr>
<tr><td>1</td><td>2009/11/1</td><td>Sun.</td><td>Montevideo</td><td colspan="6">TA038La Paz-Lima (8.52-9:42),TA041Lime-Motevideo(21:50-05:15)</td></tr>
<tr><td>2</td><td>2009/11/2</td><td>Mon.</td><td>Montevideo</td><td colspan="6">Office Settings and Preparation of Documents</td></tr>
<tr><td>3</td><td>2009/11/3</td><td>Tue.</td><td>Montevideo</td><td colspan="6">Courtesy call to JICA Office
Courtesy call toUTE</td></tr>
<tr><td>4</td><td>2009/11/4</td><td>Wed.</td><td>Montevideo</td><td colspan="6">Courtesy call to Japanese Embassy
Discussion with ,UTE</td></tr>
<tr><td>5</td><td>2009/11/5</td><td>Thr.</td><td>Salto</td><td colspan="6">Move to Salto
Discussion with CTM & UTE
Site Survey</td></tr>
<tr><td>6</td><td>2009/11/6</td><td>Fri.</td><td>Salto</td><td colspan="6">Site Survey
Inapection to Substation
Visit to UTE</td></tr>
<tr><td>7</td><td>2009/11/7</td><td>Sat.</td><td>Motevideo</td><td colspan="6">Inspection to Control Center,
Move to Montevideo</td></tr>
<tr><td>8</td><td>2009/11/8</td><td>Sun.</td><td>Montevideo</td><td colspan="6">Preparation of Documents</td></tr>
<tr><td>9</td><td>2009/11/9</td><td>Mon.</td><td>Montevideo</td><td colspan="6">Preparation od Report and Tender Documents</td></tr>
<tr><td>10</td><td>2009/11/10</td><td>Tue.</td><td>Montevideo</td><td>Discussion with Ministry of Environment
Discussion with UTE</td><td colspan="4">Discussion with UTE</td><td>Discussion with Ministry of Environment
Discussion with UTE</td></tr>
<tr><td>11</td><td>2009/11/11</td><td>Wed.</td><td>Montevideo</td><td colspan="6">Preparation of Tender Documents and Report</td></tr>
<tr><td>12</td><td>2009/11/12</td><td>Thr.</td><td>Montevideo</td><td colspan="6">Preparation of Tender Documents and Report</td></tr>
<tr><td>13</td><td>2009/11/13</td><td>Fri.</td><td>Montevideo</td><td colspan="6">Preparation of Tender Documents and Report</td></tr>
<tr><td>14</td><td>2009/11/14</td><td>Sat.</td><td>Montevideo</td><td colspan="6">Preparation of Tender Documents and Report</td></tr>
<tr><td>15</td><td>2009/11/15</td><td>Sun.</td><td>Montevideo</td><td colspan="6">Preparation of Tender Documents and Report</td></tr>
<tr><td>16</td><td>2009/11/16</td><td>Mon.</td><td>Montevideo</td><td colspan="6">Discussion with UTE</td></tr>
<tr><td>17</td><td>2009/11/17</td><td>Tue.</td><td>Montevideo</td><td colspan="5">Preparation of Tender Documents and Report</td><td>Discussion with SNAP</td></tr>
<tr><td>18</td><td>2009/11/18</td><td>Wed.</td><td>Montevideo</td><td colspan="5">Discussion with UTE</td><td>Discussion with CEUTA</td></tr>
<tr><td>19</td><td>2009/11/19</td><td>Thr.</td><td>Montevideo</td><td colspan="6">Discussion with OPP
Report to DNETN & UTE</td></tr>
<tr><td>20</td><td>2009/11/20</td><td>Fri.</td><td>Montevideo</td><td colspan="6">Report to JICA Office
Report to Japanese Embassy</td></tr>
<tr><td>21</td><td>2009/11/21</td><td>Sat.</td><td>Montevideo</td><td colspan="6">Preparation of Report</td></tr>
<tr><td>22</td><td>2009/11/22</td><td>Sun.</td><td>Montevideo</td><td colspan="6">Move to Belize
Motevideo-Miami(AA900), Miami-Belize(AA2103)</td></tr>
</table>

SNAP:SISTEMA NACIONAL DE AREAS PROTEGIDAS (NATIONAL SYSTEM OF PROTECTED AREAS)
CEUTA:CENTRO DE ESTUDIOS URUGUAYO DE TECNOLOGIAS APROPIADAS (URUGUAYAN STUDIES CENTER OF APPROPRIATE TI
UTE:Usinas y Transmisiones Electricas
DNETN:Dereccion Nacional dee Energia y Tecnologia nuclear

Study Schedule in Uruguay(Third Survey)

No.	Date	Day	Stay	Officials				Consultants		
				Sato	Shino	Fukuda	Gustabo Rojas	Kobayashi	Dei	Egawa
1	2010/3/14	Sun.	Montevideo			Lima(21:50)- Montevideo(04:20) TA 047				
2	2010/3/15	Mon.	Montevideo	Meeting with JICA Office Courtesy Call to Japanese Embassy Courtesy Call to MIEM Courtesy Call to UTE Courtesy Cal to OPP						
3	2010/3/16	Tue.	Montevideo	Explanation of Draft Final Report to MIEM,UTE,OPP,and Foreign affairs Discussion with OPP、MIEM、Central Bank and Foreign Affairs						
4	2010/3/17	Wed.	Montevideo	Discussion on M/D with MIEM、UTE and Foreign Affairs Discussion with OPP、MIEM、Central Bank and Foreign Affairs						
5	2010/3/18	Thr.	Montevideo	Signing of M/D Report to Japanese Embassy Report to JICA Office						
6	2010/3/19	Fri.	Montevideo				To Bolivia	Preparation of Report		
7	2010/3/20	Sat.	Minami					Montevideo(21:20)- Miami(05:20+1) AA 984		
8	2010/3/21	Sun.	Belize					Miami(10:35)- Belize(10:45) AA 2103		

SNAP:SISTEMA NACIONAL DE AREAS PROTEGIDAS (NATIONAL SYSTEM OF PROTECTED AREAS)
CEUTA:CENTRO DE ESTUDIOS URUGUAYO DE TECNOLOGIAS APROPIADAS (URUGUAYAN STUDIES CENTER OF APPROPRIA

Appendix-3
List of Parties Concerned
in the Recipient Country

Person in Charge of the Project (Uruguay, First Survey)

1. Ministerio de Industria, Energia y Mineria
   1) Eng. Daniel Martinez — Minister of Industry, Energy and Mining
   2) Ing. Alfonso Blanco — Gerente
   3) Ing. Maria Florencia Juarez — Coordinadra Tecnica UGP
   4) Ing. Ind. Mecanico Pedro Galione — Asesor
   5) Ing. Quim. Wilson Sierra — Asesor
   6) Dr. Ramon Mendez Galain — Direcotor Nacional de Energia y Tecnologia nuclear

2. Department de Cooperacion Internacional
   1) Ms. Fabiana Bianchi

3. Administracion Nacional de Usinas y Transmisiones Electricas
   1) Ing. Beno Ruchansky — Presidente
   2) Ing. Fernando Fontana — Jefe de Department, Coordinador de Estudios de Planificacion
   3) Ing. Marcero Mula San Martin — Subgerencia, Proyectors Mdeo. Int.
   4) Ec. Luis E. Rodriguez — Asesor, Despacho Direcror Ec. Laureiro

4. MVOTMA(Ministry of Housing, Land Planning and Environment)
   1) Ing. Quim. Magdalena Preve — Climete Change Unit,

5. Commision Teccnica Mixta de Salto Grande
   1) Ing, Juan carlos Miguez — Gerente de Ingenieria y Planeamiento
   2) Andres de la Iglesia — Secreario de Delegacion del Uruguay

6. Ministerio de Relaciones Exteriores
   1) Dra. Lulma Guelman- Radtka — Embajadora, Direcora General para Asuntos Culturales y de Cooperacion International

7. URSEA(Unidad regulation de servicio de energia y agua)
   1) Ing. Alfred Piria — Grente de Regulacion

8. CEUTA(Centro Uruguayo de technologies Apropiadas)
   1) Arq. Alicia Mimbacas — Programa de Energia

9. Instituto de Mecanica de los Fluidos e Ingenieria Ambiental
   1) Prof. Jose Alberto Cataldo Ottieri — Doctor en Ingenieria Prof. Titular

10. Crown Agents
    1) Ing.Gustavo A. Rojas B. — Representante de Crown Agents

Person in Charge of the Project (Uruguay, Second Survey)

1. Ministerio de Industria, Energia y Mineria
   1) Eng. Daniel Martinez — Minister of Industry, Energy and Mining
   2) Ing. Alfonso Blanco — Gerente
   3) Ing. Maria Florencia Juarez — Coordinadra Tecnica UGP
   4) Ing. Ind. Mecanico Pedro Galione — Asesor
   5) Ing. Quim. Wilson Sierra — Asesor
   6) Dr. Ramon Mendez Galain — Direcotor Nacional de Energia y Tecnologia nuclear

2. Department de Cooperacion Internacional
   1) Ms. Fabiana Bianchi

3. UTE(Administracion Nacional de Usinas y Transmisiones Electricas)
   1) Ing. Beno Ruchansky — Presidente
   2) Ing. Fernando Fontana — Jefe de Department, Coordinador de Estudios de Planificacion
   3) Ing. Marcero Mula San Martin — Subgerencia, Proyectors Mdeo. Int.
   4) Ec. Luis E. Rodriguez — Asesor, Despacho Direcror Ec. Laureiro

4. MVOTMA(Ministry of Housing, Land Planning and Environment)

   Direccion Nacional de Medio Ambiente
   1) Ing. Quim. Magdalena Preve — Cambio Climatico
   2) Ing,Quim.Mariana Kasprzyk — Cambio Climatico

   SNAP(SISTEMA NACIONAL DE AREAS PROTEGIDAS DE URUGUAY)
   1) Laura Modernell — Especialista de Comunicasion (Environmental education)

5. Commision Teccnica Mixta de Salto Grande
   1) Ing, Juan carlos Miguez — Gerente de Ingenieria y Planeamiento
   2) Andres de la Iglesia — Secreario de Delegacion del Uruguay

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   1) Arq. Alicia Mimbacas — Programa de Energia
   2) Sr. Juan José Oña

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Person in Charge of the Project (Uruguay、Third Survey)

1. Ministerio de Industria, Energia y Mineria

1)	Ing. Quim. Wilson Sierra	Asesor

2. UTE(Administracion Nacional de Usinas y Transmisiones Electricas

1)	Ing. Luis E. Rodriguez	Asesor, Despacho Direcror Ec. Laureiro
2)	Ing. Marcero Mula San Martin	Jefe A/C de Desarrollo de Normalizacion Gcia. Sector Proyectos y Normalizacion)

3. Presidencia de la Republica, Oficina de Planeamiento y Presupuesto

1)	Felipe Ortiz de Taranco	Sub-Director de Cooperacion Internacional)
2)	Fabiana Bianchi	Departmento de Cooperacion Internacional

4. Ministerio de Relaciones Exteriores)

1)	Fernando Sotelo	Direccion General de Cooperacion internacional

5. Banco Central de Uruguay

1)	Dr.. Lic. Gabriel Platzman	Jefe de Departamento gestion de Pasivos Area de Gestion Monetaria y Pasivos)