MINISTRY OF HEALTH
THE REPUBLIC OF MOLDOVA

FINAL REPORT ON THE PREPARATORY SURVEY (OUTLINE DESIGN) ON THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA

MARCH 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.

IDD
JR
11-033

MINISTRY OF HEALTH
THE REPUBLIC OF MOLDOVA

FINAL REPORT ON THE PREPARATORY SURVEY (OUTLINE DESIGN) ON THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA

MARCH 2011

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on the Project for Introduction of Clean Energy by Solar Electricity Generation System in the Republic of Moldova, and organized a survey team headed by Mr. Mitsuo OCHI of Oriental Consultants Co., Ltd. between October 2009 to March 2011.

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

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Moldova for their close cooperation extended to the survey teams.

March 2011

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

SUMMARY

SUMMARY

1 Outline of the Recipient Country

(1) Territory and Nature

The Republic of Moldova (hereinafter referred to as “Moldova”) lies between latitude 48° 21´N - 45° 28´N and between longitude 30° 05´E - 26° 30´E that has a total land area of 33,800 square kilometers with north-south distance of 350 km and east-west distance of 150 km. Moldova belongs to a region of Eastern Europe and adjoins with Ukraine and Romania. And, most of rivers in Moldova flow into Black Sea and Dniester River traverses in the eastern territory of the country while Prut River runs along its western border with Romania. In addition, there is a part of a mouth to Danube River at southern end of the country.

According to the data for the year 2008[1], a total population of Moldova is about 3.57 million and the population of Chisinau which is the capital city of Moldova is about 785 thousand. Chisinau has relatively warm continental damp climate and, according to the meteorological data for the year 2009, annual mean temperature is 11.4℃ while annual precipitation is about 446mm.

(2) Socioeconomic Conditions

Moldova was heavily hit after the collapse of Soviet Union such as torn of economical system, sharp decrease in trade, troubles with Transnistria and so on since supplies of resources and energy for Moldova has been dependent on other countries. And, as a result of an economic crisis in Russia, an economic scale in Moldova in 1999 was slashed to one third of its economic scale before independence. However, the economic growth in Moldova after 2000 has become quite steady.

Thereafter, although the economic growth remained stagnant between 2006 and 2007 mainly due to a measure of embargo of wines taken by Russia, damages of crops by drought and soaring of prices of gas, etc, the economic growth was recovered to 7.2% in 2008 because of good yield of agricultural produce blessed with good weather. However, because of a global financial crisis, economy has been decelerated towards the end of 2008 and continued to 2009.

According to the World Bank Forecast (2008), nominal Gross Domestic Product (GDP) was 5,340 million US dollars and per capita Gross National Income (GNI) was 1,500 US dollars while economic growth rate and inflation rate were -6.5% and 0% respectively. Moldova is still placed as poorest country in Europe. Rate of unemployment was 3.2% according to statistical data for the year 2008 published by the Bureau of Statistic.

[1] Source: 2008 ANUARUL STATISTIC AL REPUBLICII MOLDOVA

According to the data for the year 2009[2], key industries in Moldova are wine, tobacco, agriculture including fruit juice and food processing which will occupy 50 to 55% of its nominal GDP; Moldova exports 90% of wine and 75% of sparkling wine produced, and others such as light industries mainly with textile, trading of building materials, etc. Main exports items are textile, processed foods, vegetable, etc while main imports items are chemical products, automobiles, machineries, etc. Main trade partners of Moldova are Russia, Ukraine and Romania.

2 Background of the Project

Moldova imports more than 97%[3] of its energy supplies such as oil, gas, electricity, etc. Thus, reforming the energy sector in Moldova is an urgent requisite. And therefore, improvement of the energy efficiency and development of the renewable energy sources are adopted as most important issues in the National Energy Strategy to 2020 approved in 2007.

And, according to the data[4] for the year 2008 prepared and issued by the National Energy Regulatory Agency (ANRE), amount of the electricity generated and imported for Moldova for past six (6) years i.e. 2003-2008 are as shown in Table 1 below:

Table 1 Change of Domestic Power Generation, Imported Power and Total Power Consumption

Unit: Million kWh

Item	2003	2004	2005	2006	2007	2008
Domestic Power Generation	842.3	830.7	999.8	957.7	903.6	940.0
Imported Power	2,347.5	2,433.9	2,686.7	2,978.3	3,154.2	3,300.0
Total Power Consumption	**3,189.8**	**3,264.6**	**3,686.5**	**3,936.0**	**4,057.8**	**4,240.0**

Source: Prepared by JICA Preparatory Survey Team based on 2008 Annual Report issued by ANRE

On the other hand, amount and ratio of power generation of power plants CHP-1 and CHP-2 which are located in Chisinau, the capital of Moldova, CHP-North which is located in Balti, a main city in the North region, HPP (hydroelectric power plant) which is located in Costesti in the North-West region and other small-scale power plants including the ones belong to sugar cane factories which are located in the North region are as shown in Table 2 below:

2 Source: Home Page for the Embassy of Japan in Ukraine
3 National Energy Strategy to 2020
4 Regulation of the energy market in the Republic of Moldova, 2008 ANRE

Table 2 Ratio of Power Generation and Total Amount of Power Generation

Item	CHP-1	CHP-2	CHP-N'th	HPP	Others	Total
Ratio of Power Generation (%)	11.5	58.8	3.7	3.9	22.1	100
Total Amount of Power Generation (MW)	47	240	15	16	90	408

Source : Prepared by JICA Preparatory Survey Team based on 2008 Annual Report issued by ANRE
CHP : Combined Heat and Power Plant
HPP : Hydroelectric Power Plant

And, according to National Energy Strategy to 2020, share of renewable energy in 2005 including HPP power generation shown in Table 2 above and biomass[5] in total energy consumption in Moldova was 71.4 thousand toe[6] which was only 3.6% of the said total energy consumption.

According to the above-mentioned National Energy Strategy to 2020, achieving to raise the rate of renewable energy contribution of the total energy consumption, which was 3.6% in 2005, to 6% by 2010 and 20% by 2020 is set as a goal. Furthermore, in addition to an international commitment to promotion of measures for global warming, Moldova is required to establish national structure giving consideration of objectives for reduction of greenhouse gases (GHG) emissions expressed by the European Union (EU) since they are aiming to become a member of EU, and consequently, utilization and promotion of the renewable energy including solar power is placed as an important policy in Moldova.

On the other hand, "Program Grant Aid for Environment and Climate Change (GAEC) was introduced in 2008 as part of "Cool Earth Partnership" by the Government of Japan (hereinafter referred to as "GOJ") in order to support the developing countries making an effort to contribute to the climate change and to promote clean energy by balancing their economic growth with reduction of GHG emissions. GAEC aims to promote utilization of clean energies including the renewable energy by positive utilization of Japan's advanced technologies including the ones belong to the private sector. Under these circumstances, Moldova has decided to join the Cool Earth Partnership and to aim balancing its economic growth and reduction of GHG emissions with adaptation activities to climate change.

As a result of the needs survey for GAEC in utilization of photovoltaic (PV) system conducted in Moldova by the Ministry of Foreign Affairs of GOJ, the implementation of the preparatory survey of the Project was decided as Moldova submitted its Application for GAEC of this Project.

---

[5] It is assumed that all biomass were used as fuel since the use of biomass was not mentioned in Regulation of the energy market in the Republic of Moldova, 2008 ANRE

[6] Abbreviation for Ton of Oil Equivalent

3 Outline of the Study Results and Contents of the Project

The Preparatory Survey Team (hereinafter referred to as "the Team") conducted discussions on the Project including the field surveys at the project site with Ministry of Health (MOH), Ministry of Economy (MOE) and Oncology Institute (OI) which is a target site for the Project and other relevant authorities during their stay in Moldova from October 23rd to November 4th 2009 for 1st preparatory survey, and from January 18th to February 18th 2010 for 2nd preparatory survey. And, during their stay in Moldova from December 18th to December 25th 2010 for 3rd preparatory survey, the Team explained and conducted deliberation on the outlines of the draft final report (DFR) of the Project to MOH, MOE, OI and other relevant authorities.

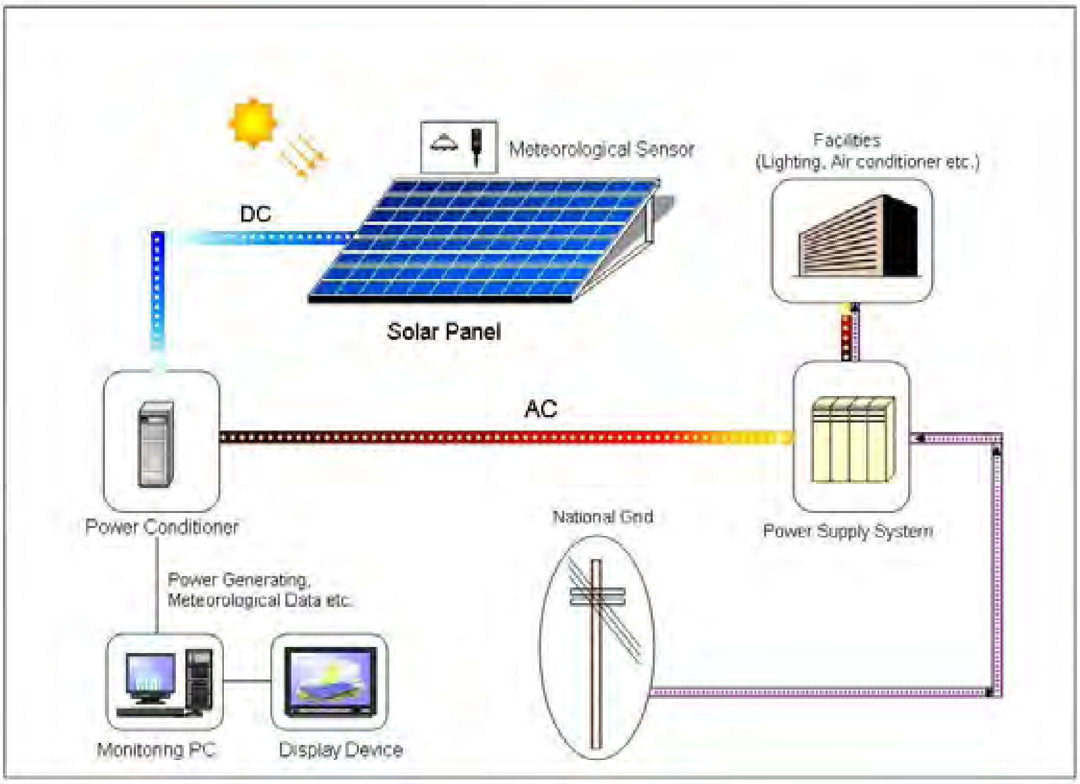
As for the nominal capacity of the PV system to be procured and installed for the Project, it was 250kWp from the beginning which was proposed by the Recipient and the introduction of 250kWp PV system was considered in a positive light. And consequently, the PV system with the capacity of 250kWp for the Project was confirmed during 1st and 2nd preparatory surveys as well as its project site. And thereafter, a 250 kWp PV system for the Project was finally confirmed and agreed upon by the Recipient by signing the Minutes of Discussions (M/D) during 3rd preparatory survey.

As a result of the preparatory surveys, it is found out that no one has any experience and achievement of the installation of the grid-connected PV system so as Red Union Fenosa (hereinafter referred to as "RUF") which is the only power distribution company in Chisinau where the project site i.e. OI is located although there are laws and/or regulations as to the grid-connection, reverse power flow and sale of power in connection with the solar power generation. However, the Team confirmed during 3rd preparatory survey that letters of principal agreement regarding the grid-connection were exchanged between OI and RUF prior to commencement of the implementation of the Project.

On the other hand, it is planned that the Project provides grid-connected PV system in principle in order to supply stable power for the electrical loads at OI. Whereas the Team conducted the field survey to measure actual power demands and consumptions of OI in order to verify whether or not the grid-connected PV system with reverse power flow should be planned with consideration of the case of power generated by the PV system exceeds the said electrical loads. And, as a result of verification of data collected during 2nd preparatory survey, it was judged that the power demands for target electrical loads to be fed by the PV system constantly surpass the effective outputs of the PV system. It is also assumed that an annual total power consumption of OI is approx. 2,130,000 kWh from the verification of the said data.

As a result of above-mentioned analysis, since it was judged that all power generated by the PV system would be consumed for the power loads of OI, it was confirmed and agreed by Moldova side that the Project will introduce the PV system without reverse power flow and will provide necessary equipment and technical support thereof.

As for the procurement and installation of the equipment for the PV system for the Project, it is planned to procure and install necessary equipment for the low voltage grid-connected PV system without reverse power flow described below as a result of discussions and verifications with the Moldovan side and analysis conducted in Japan based on the design policy described in Chapter 2.



Source: Prepared by JICA Preparatory Survey Team

Fig. 1 Conceptual Image of Grid-connected PV System

And, an agreed support plan, image of PV system installation, system description and equipment specification are as shown in the tables and figure below:

Table 3 Support Plan of the Project

Equipment for Solar Electricity Generation			
1	Equipment	Uses	Needs
	Grid-connected PV System	The PV system will be dispersedly installed at roof-top of the existing buildings i.e. Main Building and Poly-clinic Building, and a vacant lot for proposed parking area; there is an existing building to be demolished. Then, generated power will be supplied to the said existing buildings through low voltage distribution panel which will be installed in the existing electrical room of each existing building. Thus, low voltage grid-connected PV system will be established which will contribute to supplement the power demand for the Oncology Institute.	Reduction of greenhouse gases by reducing consumption of fossil fuel for power generation by positive utilization of solar energy is sought in Moldova as mitigation measures for climate change. And, at the same time, the National Energy Strategy to 2020 is aimed at reducing dependence on imported energy resources.
Technical Assistance for Solar Electricity Generation			
2	Technical Assistance for Grid-connected PV System	Technical training necessary for appropriate operation and maintenance of grid-connected PV system which include basic knowledge, coordination with existing power distribution system, method of inspection and maintenance, troubleshooting, etc.	Since the introduction of a grid-connected PV system will be a first time in Moldova, there are no trained specialists and/or engineers who have knowledge of installation of grid-connected PV system and operation and maintenance thereof. Therefore, it is necessary to acquire and improve such knowledge and relevant technologies.

Source: Prepared by JICA Preparatory Survey Team

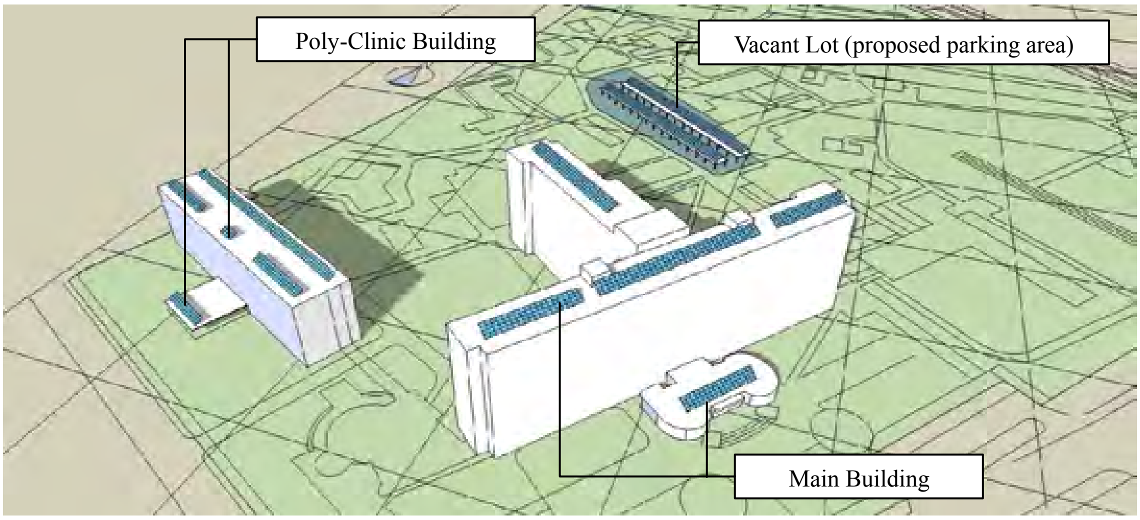
Table 4 System Description

Implementing Agency	Oncology Institute
Candidate Site	Oncology Institute (Roof-top of Main Building and Poly-clinic and Vacant lot)
Location	The area where educational and medical establishments are concentrated in Chisinau which is a capital city of Moldova
Land Owner	Oncology Institute
License Holder	Oncology Institute
Rating Capacity	250 kWp
Expected Amount of Power Generation[7]	Approx. 299,400 kWh
Amount of reduction of carbon dioxide[8]	Approx. 139.3 tons
Area of Installation	Approx. 9,100 m^2 (Roof-top of Main Building and Poly-clinic: 5,140 m^2 and Vacant Lot: 3,960 m^2)
Expected Consumers	General power consumption for Oncology Institute

Source: Prepared by JICA Preparatory Survey Team

7 Expected amount of power generation has been calculated by using Canadian Government Simulation Software called "RET Screen".

8 Amount of reduction of carbon dioxide is calculated based on the data provided by NEDO (refer to Chapter 3 for details)



Source: Prepared by JICA Preparatory Survey Team

Fig. 2 Image of PV System Installation

Table 5 Equipment Specification

Item	Specification	Qty	Uses
PV modules	Mono/poly-crystalline or Mono-crystalline and Amorphous Hybrid type with rating capacity of 250kWp or more	1 lot	To transform solar light to electricity.
Supporting structures for PV modules	Hot-dipped galvanized steel frames	1 lot	Supporting frame to fix PV modules which will be placed on concrete slab foundation.
Power conditioners	Rating capacity of 250kW or more and output voltage shall be 400V	1 lot	To convert direct current power generated by PV modules to alternating current power and to be with protective function for grid-connected PV system
Connection boxes	Devices to be installed: DC circuit breakers, By-pass current diodes, Protector for induced lightning stroke (ZNR), Terminal block etc. Ingress protection rating: not less than IP53	1 lot	To collect DC power generated by PV modules and to feed it to collection box
Collection boxes	Device to be installed: DC circuit breaker Ingress protection rating: not less than IP53	1 lot	To collect DC power from connection boxes by putting it together systematically and feed it to power conditioner
Data management and monitoring system (incl. personal computer)	・Personal computer ・CRT（19 inch or bigger） ・Data sensing instruments ・Signal transmitter ・UPS（more than 10 minutes capacity） ・Color printer (compatible with A3 size printing) ・Software for data monitoring ・Software for display	1 lot	To track the amount of generated power, input and output voltage to and from power conditioners, solar radiation and air temperature as well as to record and display them in the specified format to be set, and in addition, it shall keep monitoring of the performance of the whole PV system and shall control operation of display system.
Meteorological observation instruments	Solar radiation meter	1 No.	To observe solar radiation.
	Thermometer	1 No.	To observe air temperature.
Display	Flat panel 50 inch or bigger（Liquid crystal or PDP）	1 No.	To indicate the amount of generated power (present, daily, monthly and annual), meteorological data (air temperature, solar radiation), the expected reduction of carbon dioxide gas and general description of the PV system.
Low voltage distribution panel	Water proofed, outdoor self-standing type of steel sheet made	1 lot	To connect power generated by PV System to existing substation through power conditioner.

Source: Prepared by JICA Preparatory Survey Team

4 Implementation Schedule and Project Cost

The implementation period of the Project will be 4.5 months for detailed design and tender process including tender evaluation and 15.0 months for procurement and installation works which includes manufacturing of equipment, transportation, adjustment and commissioning, initial operation guidance, final inspection and handover. And, 1.5 months for soft component which includes 0.5 month overlapping period with the procurement and installation works. Thus, the total implementation period of the Project will be 20.5 months after conclusion of consulting services agreement.

And, an estimated cost to be borne by Moldovan side for the implementation of the Project is as follows:

(1) Cost to be borne by Moldovan side : 8.44 Million Japanese Yen (MDL1,045 thousand)

5 Project Evaluation

(1) Validity

As the Project satisfies the following purposes, significances, effects etc and therefore the implementation of the Project is quite significant with giving consideration of that the Project will greatly contribute to extension and promotion of the renewable energy by solar electricity generation system as a pilot project in Moldova, although its scale of power generation is relatively quite small.

And, grounds for indicating the validity of the Project are as follows:

1) By taking opportunity of the implementation of this Project, beneficial of the Project will expand to an entire population of Moldova which is counted as much as 3.57 million through further extension and/or promotion of the PV system.

2) This Project will enable to contribute to stable power supply in Moldova through further extension of the PV system. And, allied industries, such as power supply, housing, construction, manufacturing, etc., involving PV system which is expected world-wide extension and/or expansion from now on will be promoted.

3) This Project is the project which was requested from Moldova in response to invitation by GOJ in order to achieve objectives set for mid-term and long-term development plan in Moldova.

4) This Project will become a test case and/or pilot project for further extension and/or promotion of the PV system for the people in Moldova that is groping for developing and/or exploiting renewable energy.

5) The Project will fulfill the objectives of "Cool Earth Partnership" which is a new financial mechanism for developing countries willing to contribute for stabilization of the climate through balancing reduction of greenhouse gases emission with economic

growth and will contribute to the reduction of GHG and mitigation of global warming. It is expected to achieve further contributions by extension and promotion thereof in near future.

6) The Project can be implemented by a new scheme of grant aid called “GAEC” without any difficulties.

Thus, taking the preceding grounds for indicating the validity of the Project into consideration, it is judged that the validity of the Project is quite high.

(2) Effectiveness

The following outputs are to be expected from the Project and therefore it is considered that the Project will be confidently effective.

Quantitative Outputs

1) Amount of power import will be reduced

Since it is estimated that PV system to be procured and installed by the Project will generate approx. 299,400kWh of solar power per year, an amount of power distribution will be reduced by 299,400kWh. And, as a result, an amount of power import will be reduced by 0.009%.

2) Expenditures of Oncology Institute will be reduced

Since it is estimated that the PV system to be procured and installed by the Project will generate approx. 299,400 kWh of solar power per year, an amount of power purchase for OI which is the Implementing Agency of the Project will be reduced by 14%. And, as a result, an expenditure on power purchase will be reduced by approx. MDL329,340 per year or approx. MDL256,340 per year even if the estimated operation and maintenance costs shown in Table 2-26 are taking into consideration.

3) Approx. 139.3 ton of GHG (CO_2) per year will be reduced

An amount of a reduction of CO_2 is estimated at approx. 139.3 ton per year as shown in Table 6 below when it is assumed that the power generated by the PV system to be procured and installed by the Project is the substitution for the power generated by the combined heat and power plant (CHP) burning natural gas.

Table 6 Amount of Greenhouse Gas (CO_2) Reductions

Project Site/ Output	Oncology Institute/ 250 kW
Lifecycle emission of carbon dioxide (CO_2) by Combined Heat & Power Plant (g-CO_2/kWh)	518.7
Lifecycle emission of carbon dioxide (CO_2) by PV System (g-CO_2/kWh)[9]	53.4
Expected amount of Power Generation (kWh)	299,400
Amount of CO_2 Reduction (t-CO_2/y) when substitute power generation by PV system	(518.7-53.4) x 299,400/1,000,000=**139.3**

Source: Prepared by JICA Preparatory Survey Team based on data provided by New Energy and Industrial Technology Development Organization (NEDO)

Qualitative Outputs

1) The Project will contribute to promoting reduction of GHG and diversification of energy resources in Moldova as mentioned in National Energy Strategy.

2) Extension and promotion of solar power generation in Moldova will gain impetus by introduction of PV system which is relatively large-scale.

3) Allied industries involving PV system which is expected world-wide extension and/or expansion from now on will be promoted with expansion of the PV system in Moldova.

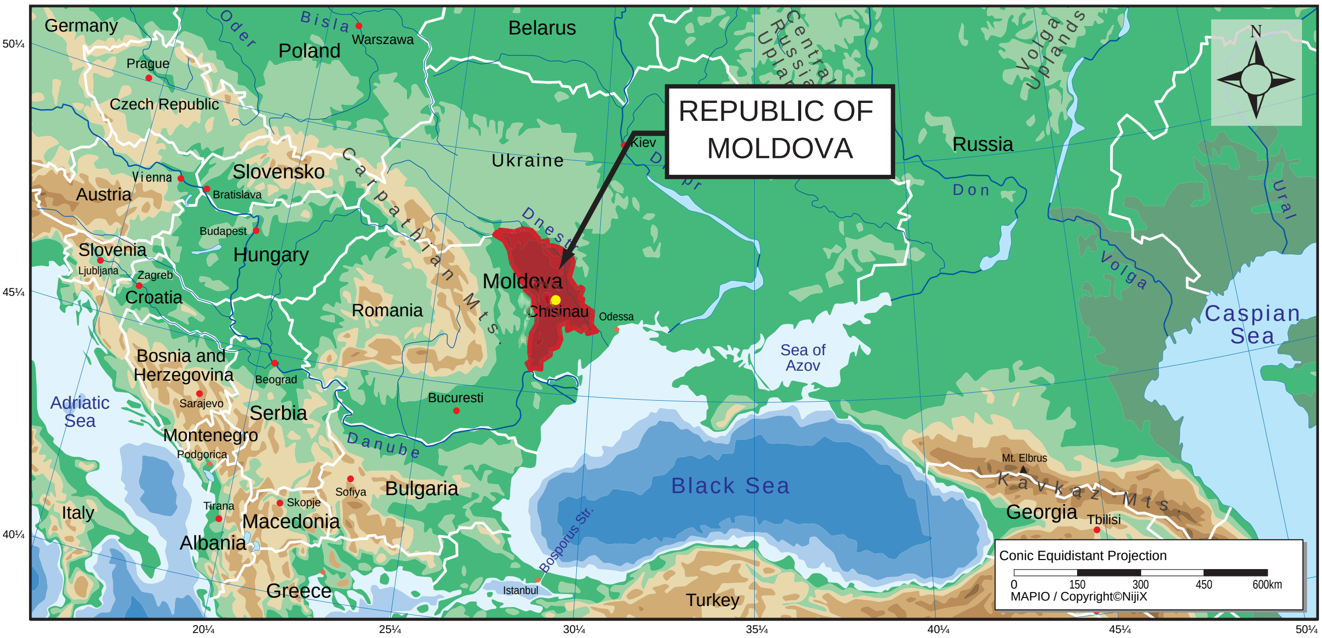
4) Effects of enlightenment with regard to renewable energy and solar power generation to the general public will be heightened by introducing the PV system at OI which is the hospital where an unspecified number of the general public visit and by displaying an amount of real-time power generation and an effect of CO_2 reduction.

Furthermore, the implementation of the Project will help accomplish one of the strategic objectives declared in the National Energy Strategy to 2020 that is to promote energy and economic efficiency, as well as use of renewable energy resources, and will contribute to realizing the following objectives adopted in the renewable energy law:

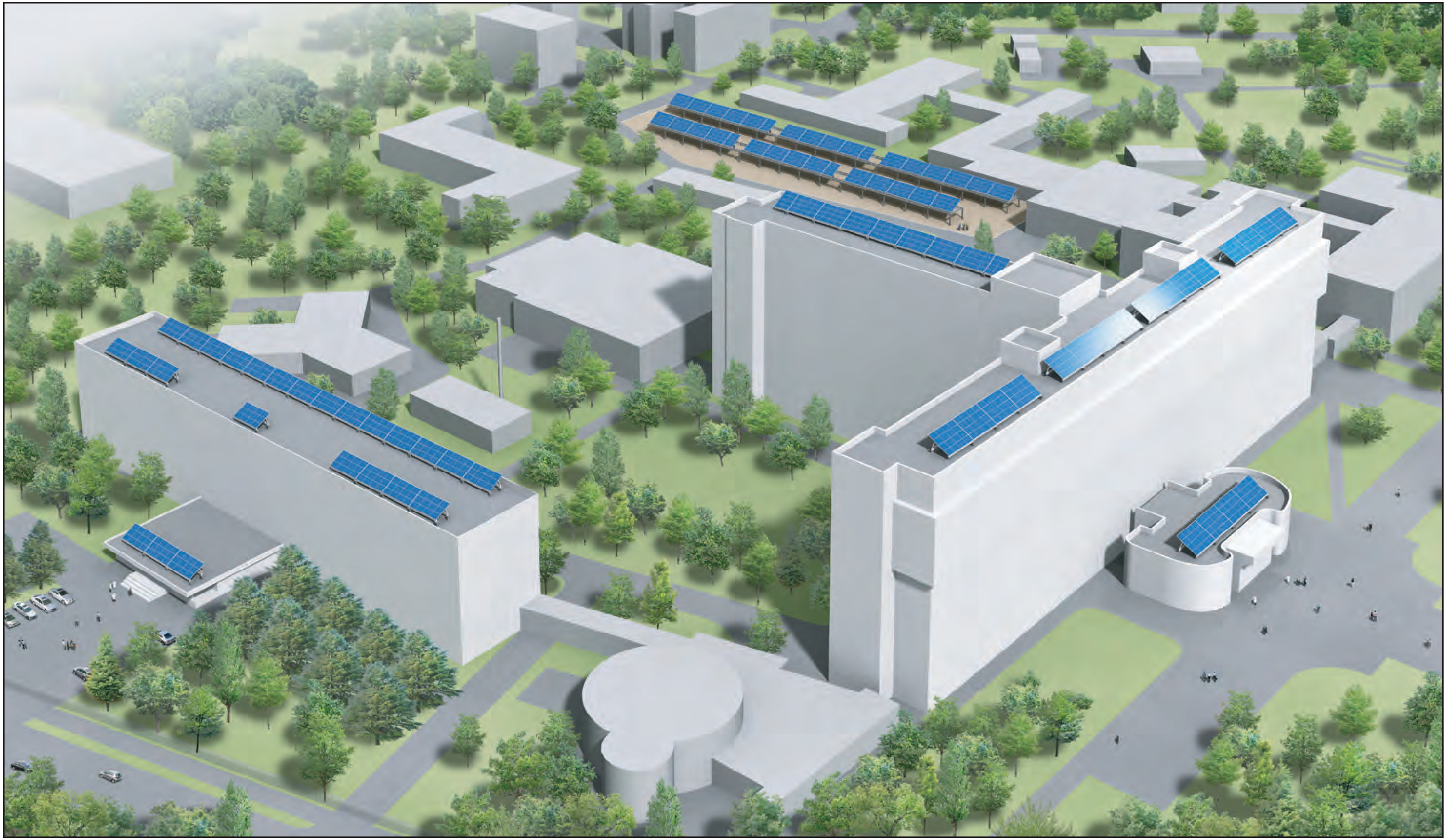
- To diversify local primary energy resources.
- To ensure by 2010 the production of a share of 6% of energy from the renewable energy sources from the total of traditional energy sources and 20-percent share by 2020.
- To develop the production, distribution, commercialization and reasonable consumption of the renewable energy and fuel including establishment of an appropriate system thereof.
- To provide information to the business of turning to renewable energy.

[9] Data provided by New Energy and Industrial Technology Development Organization (NEDO)

CONTENTS



Location Maps



THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY
BY SOLAR ELECTRICITY GENERATION SYSTEM
IN THE REPUBLIC OF MOLDOVA

ORIENTAL CONSULTANTS CO., LTD.

PERSPECTIVE

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AC	Alternate Current
A/M	Agreed Minutes
ANRE	National Energy Regulatory Agency
A/P	Authorization to Pay
ASTM	American Society for Testing and Materials
B/A	Banking Arrangement
B/L	Bill of Lading
BS	British Standard
CHP	Combined Heat and Power Plant
CO_2	Carbon Dioxide
CRT	Cathode Ray Tube
DC	Direct Current
EBRD	European Bank for Reconstruction and Development
EIA	Environmental Impact Assessment
EPS	Electrical Pipe Shaft
E/N	Exchange of Notes
EU	European Union
G/A	Grant Agreement
GAEC	Grant Aid for Environment and Climate Change
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GNI	Gross National Income
GoJ	Government of Japan
HC	High Cube
HPP	Hydroelectric Power Plant
IEC Standard	International Electro technical Commission Standard
JASS	Japanese Architectural Standard Specification
JCS	Japanese Cable Makers' Association Standard
JEAC	Japan Electric Association Code
JEC	Japanese Electro-technical Committee Standard
JEM	Japan Electrical Manufacturers' Association Standard
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standards
M/D	Minutes of Discussions
MDL	Moldova Lei
MENR	Ministry of Ecology and Natural Resources
MOE	Ministry of Economy

MOH	Ministry of Health
NASA	The National Aeronautics and Space Administration
NEDO	New Energy and Industrial Technology Development Organization
OI	Oncology Institute
OFR	Over Frequency Relay
OVGR	Over Voltage Grounding Relay
OVR	Over Voltage Relay
PC	Personal computer
PDM	Project Design Matrix
PDP	Plasma Display Panel
PV System	Photovoltaic System
RES	Renewable Energy Sources
R.H.	Relative Humidity
RPR	Reverse Power Relay
RUF	Red Union Fenosa
toe	Ton of Oil Equivalent
UCTE	Union for the Coordination of Transmission of Electricity
UFR	Under Frequency Relay
UNDP	United Nations Development Programme
UPS	Uninterruptible Power-supply System
UVR	Under Voltage Relay
VAT	Value-Added Tax
VCT	Voltage Current Transformer

CHAPTER 1
BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

1-1 Present Conditions and Issues of the Sector

1-1-1 Present Conditions and Issues

The Republic of Moldova (hereinafter referred to as “Moldova”) is studying development and implementation of policies and measures for climate change as one of the priority subject as Moldova is seriously concerned about the effects by the climate change on national economy and eco-system, welfare, health and a menace to the life of the people of Moldova and the fact that ignoring the menace and delaying of taking measures at not only national level but also world level are worsening the effects by the climate change and consequently delaying sustainable development and creating problems for next the generation.

Moldova imports more than 97%[1] of its energy supplies such as oil, gas, electricity, etc. Thus, reforming the energy sector in Moldova is an urgent requisite. And therefore, improvement of the energy efficiency and development of the renewable energy sources are adopted as most important issues in the National Energy Strategy to 2020[2] which was approved in 2007. And, according to the said strategy, achieving to raise the rate of renewable energy contribution of the total energy consumption, which was 3.6%[3] in 2005, to 6% in 2010 and 20% in 2020 is set as a goal.

On the other hand, Renewable Energy Law approved in 2007 specifies that Power Distributors in Moldova are required to purchase the powers from any renewable energy undertakers and the said requirement was officially effected in March 2010. And in February 2010, the European Bank for Reconstruction and Development (EBRD) announced[4] that Moldova has been selected as 14th candidate country after Ukraine, Russia and Georgia for the regional support in the field of the development of technologies for the renewable energy and energy saving measures.

Although Moldova has already established applicable systems and/or regulations for the renewable energy such as grid-connection with reverse power flow and purchase of power from producers, there is no experience and/or achievement. Furthermore, under the present conditions, Moldova lacks implementing abilities and funds to manage reduction of greenhouse gases (GHG) emission and economic growth at the same time although Moldova is willing to contribute for stabilization of the climate.

---

1 National Energy Strategy to 2020

2 The Energy Strategy of Republic of Moldova until 2020, Official No.141-145/1012 of 07/09/2007

3 The Energy Strategy to 2020 states that the largest share of energy balance has hydropower and biomass, while solar and wind and sources with low thermal potential are insufficiently explored.

4 EBRD announced that 20 million Euro will be available for financing the investment relevant for development of renewable energy and energy saving technologies in Moldova and 5-20% thereof will be available as a grant and that Energy Efficiency in Moldova (MoSEFF) will be responsible for processing applications.

1-1-2 Development Plans

In Moldova, since the measures for the climate change are to be placed as one of the top priority subjects in view of destruction of an ecosystem, increment of material, human and/or social damages associated with climatic disasters and so on, the following strategic objectives are declared in the above-mentioned National Energy Strategy to 2020 for the promotion of introduction of the renewable energy:

- Ensure the energy security.
- Promote energy and economic efficiency, as well as use of renewable energy resources.
- Liberalize the energy market and restructure the energy in line with the integration requirements into the European power system.

And, in order to realize the above-mentioned policies, the following objectives adopted in the above-mentioned National Energy Strategy to 2020:

(1) Energy security objectives:

- Strengthen the energy interconnections with Ukraine and Romania.
- Accession of the national electro-energetic and natural gas systems to the Energy Community Treaty.
- Join the Union for the Coordination of Transmission of Electricity (UCTE[5]).
- Improve the climate for investments in power generation.
- Diversify the types of fuel used in the country and import possibilities of energy resources.
- Strengthen Moldova's role as a significant transit country for natural gas and electricity.
- Increase, to the possible extent, economically competitive power production capacity.
- Exploit oil and natural gas resources in the South Region of Moldova.

(2) Objectives aimed at economic and energy efficiency, achieved in part by promoting competition on energy market:

- Increase energy efficiency in the production, transmission, distribution and supply of power and fuels.

[5] UCTE has been taken over by European Network of Transmission System Operators for Electricity（ENTSO-E）on 1st of July 2009.

- Reduce the costs and set up energy and fuel prices reflecting the prime cost.
- Implement efficient energy technologies with low environment impact (combined thermodynamic cycle and combined heat and power, respecting the principle of cost-benefit).
- Pay up debts and stabilize the financial situation of the energy complex enterprises.
- Attract private investments in the rehabilitation and construction of energy objectives.
- Involve own energy resources, including the renewable energy resources in the consumption balance.
- Promote consistent policies for energy conservation with consumers.

(3) Long-term environmental objectives:

- Align with European Union (EU) rules and standards to restrict and eliminate environmental emissions.
- Implement EU laws under the provision of the Energy Community Treaty.

On the other hand, the following objectives as to the extension and introduction of the renewable energy are adopted in the above-mentioned renewable energy law:

- To diversify local primary energy resources.
- To ensure by 2010 the production of a share of 6% of energy from the renewable energy sources from the total of traditional energy sources and 20-percent share by 2020.
- To enhance environmental security, providing health care and safety in the process of turning to renewable energy.
- To develop the production, distribution, commercialization and reasonable consumption of the renewable energy and fuel including establishment of an appropriate system thereof.
- To attract investments in the renewable energy sources capitalization (attracting investment in renewable energy recovery).
- To implement international scientific and technical performance of renewable energy in international scientific and technical cooperation.
- To provide information to the business of turning to renewable energy.

Furthermore, according to the renewable energy law, National Agency for Energy Regulation (ANRE) which was established in 1997 is responsible for licensing of energy-related undertakings in Moldova.

And, the said renewable energy law specifies that ANRE shall be responsible for establishment of an appropriate pricing policy and can set a tariff by using their own calculation formula for the undertakings of power generation. However, such tariff should also be calculated with consideration of the recovery of investments within up to 15 years and should not exceed the double of the corresponding rates from the traditional power sources.

1-1-3 Socioeconomic Conditions

Moldova was heavily hit after the collapse of Soviet Union such as torn of economical system, sharp decrease in trade, troubles with Transnistria and so on since supplies of resources and energy for Moldova has been dependent on other countries. And, as a result of an economic crisis in Russia, an economic scale in Moldova in 1999 was slashed to one third of its economic scale before independence. However, the economic growth in Moldova after 2000 has become quite steady.

Thereafter, although the economic growth remained stagnant between 2006 and 2007 mainly due to a measure of embargo of wines taken by Russia, damages of crops by drought and soaring of prices of gas, etc, the economic growth was recovered to 7.2% in 2008 because of good yield of agricultural produce blessed with good weather. However, because of a global financial crisis, economy has been decelerated towards the end of 2008 and continued to 2009.

According to the World Bank Forecast (2008), nominal Gross Domestic Product (GDP) was 5,340 million US dollars and Gross National Income (GNI) was 1,500 US dollars while economic growth rate and inflation rate were -6.5% and 0% respectively. Moldova is still placed as poorest country in Europe. Rate of unemployment was 3.2% according to statistical data for the year 2008 published by the Bureau of Statistic.

And, according to the data for the year 2009[6], key industries in Moldova are wine, tobacco, agriculture including fruit juice and food processing which will occupy 50 to 55% of its nominal GDP; Moldova exports 90% of wine and 75% of sparkling wine produced, and others such as light industries mainly with textile, trading of building materials, etc. Main exports items are textile, processed foods, vegetable, etc while main imports items are chemical products, automobiles, machineries, etc. Main trade partners of Moldova are Russia, Ukraine and Romania.

1-2 Background and Outline of Proposal for Official Grant Aid

Government of Japan (hereinafter referred to as "GOJ") announced establishment of "Cool

[6] Source: Home Page for the Embassy of Japan in Ukraine

Earth Partnership" in the address made by the then Prime Minister Fukuda of Japan during World Economic Forum held in Davos, Switzerland in January 2008 as a new financial mechanism for the developing countries making an effort to contribute to the climate change and to promote clean energy by balancing their economic growth with reduction of GHG emissions, and decided that GOJ will positively involve with reduction of GHG in the developing countries and support such developing countries receiving severe damages due to the climate change.

And, as a component of the said new financial mechanism, a new scheme of grant aid called "Program Grant Aid for Environment and Climate Change (GAEC) was also introduced in 2008 by GOJ in order to support developing countries struggling to contribute for the climate change due to lack of abilities and funds for balancing their economic growth with reduction of GHG emissions..

Following the above-mentioned decision made by GOJ, Japan International Cooperation Agency (hereinafter referred to as "JICA") has set a policy to positively utilize Japanese advanced technologies including the technologies among private sector and to utilize clean energy including the renewable energy as a sample of co-benefit type assistance to be promoted.

Under these circumstances, Moldova has decided to join the Cool Earth Partnership and to aim balancing economic growth and GHG emissions with adaptation activities to climate change.

With such background, JICA was requested to positively utilize PV technologies which are clean energy technologies that Japan has extremely high advantage and consequently implementation of "GAEC" to utilize PV system for countries participated in "Cool Earth Partnership" was decided. And, based on the said decision, implementation of the preparatory survey was approved and directed by the Ministry of Foreign Affairs.

Outline of the application for the Project submitted by Moldova is as follows:

(1) Date of Application	:	15 June, 2009
(2) Requested Amount	:	4.56 Million US Dollars
(3) Contents of Request	:	Procurement of equipment for grid-connected PV system and technical assistance for operation and maintenance thereof
(4) Target Site	:	A part of land and roof-tops of the existing buildings at Oncology Institute located in Chisinau, the capital of Moldova

Although three (3) candidate projects were included in the application received from Moldova, since the priority was given to the project for the installation of PV system at Oncology Institute (hereinafter referred to as "OI"), it was decided upon the receipt of agreement from the relevant authorities in Moldova to proceed with a preparatory survey on the Project consists with two (2) stages, 1^{st} of which is to formulate the Project including embodiment thereof and continuously advance to 2nd stage which includes outline design, cost estimate and preparation of tender documents (provisional) after conducting further field survey.

An output capacity of the PV system of the Project originally requested was 250kWp and it was confirmed that installation of the PV system with the output capacity of 250kWp would positively be reviewed and verified although the said output capacity was not mentioned in the Minutes of Discussions (M/D) signed on 28th of October 2009.

As for the candidate sites, three (3) locations were confirmed by both sides and stated accordingly in the M/D signed on 28th of October 2009. However, as a result of field inspection of the roof-top of existing Poly-clinic building as well as hearings from the Design Institute conducted thereafter, it was decided to include the said roof-top of the existing Poly-clinic building as one of the candidate site. On the other hand, one of the candidate sites originally confirmed was excluded because of extensive shadows cast by adjoining buildings, and consequently, three (3) candidate sites were finally agreed by Moldova side. Furthermore, as for one of the said agreed candidate sites which is a vacant lot, OI requested to install PV modules on top of the steel frame structure of about 3m high as OI would like to utilize the said vacant lot effectively such as parking lot and with consideration of security. And, as a result of explanation thereof to JICA and further analysis in Japan, it was finally decided to install the PV modules on top of the steel frame structure.

And finally, total output capacity of 250kWp for the PV system to be procured and installed by the Project was reconfirmed in the M/D signed on 24th of December 2010 and agreed by Moldova side. Furthermore, it was confirmed in principle that any remaining fund which will be known as a result of tender shall be used for the purposes of increasing the said output capacity.

1-3 Japan's Past Assistance

There has been no Japan's grant aid project and/or other form of official assistant in the field of energy development in recent years.

1-4 Other Donor Assistance

Energy development related project implemented in Moldova by other donor is as shown in the Table 1-1 below:

Table1-1 List of Project by Other Donor in Recent Years
(Energy Development Related Fields)

Year	Donor	Project	Amount	Outline
Unknown	UNDP	Pilot Project	Unknown	Introduction of co-generation system for schools

Source: Prepared by JICA Preparatory Survey Team

1-5 Current Situation of the Project Site

1-5-1 Status of Infrastructures

Electrical energy sector in Moldova is divided into three (3) business categories; namely Power Generation, Power Transmission and Power Distribution. As for the power generation, there are four (4) states-own power plants operating in Moldova; namely, CHP-1 (in Chisinau). CHP-2 (in Chisinau), CHP-North (in Balti) and HPP Costesti (in the north-west region) and, in addition, there are other small-scale power plants including the ones belong to sugar cane factories which are located in the north region. And, as for the power transmission in Moldova, state-own company called “Moldelectrica” is solely engaged in the power transmission business in the whole country.

Power distribution companies that deal with distributing low and medium voltage electrical power to the consumers through their own power distribution network which is stepped down from high tension power supplied by aforementioned power generation and transmission companies. There are two state-own distribution companies in the region of north and north-east (including Balti) and one private company in the region of center and south (including Chisinau). Two (2) companies in the region of north and north-west are called “Red North” and “Red North-West” respectively established in 1997 that were transformed from the former state-own company called “Moldenergo”. “Red Union Fenosa (RUF)” is a sole private company which covers the largest area of power distribution in the region of center and south regions including Chisinau. In 2000, “Red South”, “Red Central” and “Red Chisinau” were privatized and they were merged into RUF in 2008. This RUF runs power distribution business which includes operation of distribution network, provision of service drops to consumers, installation of watt-hour meters and sale of power.

Since wholesale of power is liberalized, distribution companies can purchase the power from any generation company. RUF which distributes 70% of total power consumption in Moldova buys 30% of its supplies from domestic power generation companies and imports the rest from Ukraine, Russia etc at high cost.

Through the implementation of the Project, a first PV system with capacity of 250kW output will be installed in Moldova. Outline of the current status of infrastructure owned and managed by power distribution company RUF and the tariff for electricity stipulated by RUF which may have an impact on the implementation of the Project are described here-in-below:

(1) Status of Infrastructure around Oncology Institute

Since OI is a medical center, it receives more reliable power supply through two (2) medium voltage (10kV) lines from the distribution network of RUF. According to the information given by the distribution section of RUF, OI is powered from different two (2) high-tension switchgear stations in Chisinau. The substation of OI which consists of four (4) transformers; 1,000kVA x 2, 630kVA x 2 and a total capacity of 3,260kVA, is fed with two (2) medium voltage power lines. The demarcation point on power supply between OI and RUF is the secondary side (low voltage 230/400V) of high-tension switchgears and the active power consumption and reactive power consumption of the facility are measured through Voltage Current Transformer (VCT) equipped on low voltage Buses. These instruments for measuring power consumptions belong to RUF. Therefore, form of power supply from RUF to OI is considered to be “low voltage power supply”.

Power generated by the PV system to be procured and installed by the Project will be fed to the existing low voltage distribution panels and be consumed in OI. Since it is assumed that the power generated by the PV system will be fully consumed in OI according to the data and information collected during 1st and 2nd preparatory surveys, the PV system shall be grid connected type without reverse power flow.

(2) Quality of Electricity and Reliance on Power Supply

1) Quality of Electricity

The power distribution system with two (2) high-tension lines to OI which is classified in higher priority of Category II in Moldova can be said a stable and reliable power supply system.

During 1st and 2nd preparatory surveys, Preparatory Survey Team (hereinafter referred to as “the Team”) conducted several observations on electrical voltage and frequency with instruments installed in a couple of distribution boards in the existing electrical rooms. (See Photos below) As for the supply voltage, the data recorded indicates that its fluctuation ratio ranged between less than ±5% against the nominal voltage of 400V. Although it was observed that the voltage temporarily dropped due to a variable demand of OI, it is an insignificant issue on the power supply system. Whereas, fluctuations of frequency were observed within ±1% against the nominal frequency of 50 Hz. Therefore, the fluctuation of frequency can be said to count for nothing as well. Thus, it is presumed that the power supply system on both active and reactive power keeps steady operation with stable voltage and frequency.

However, the existing electrical equipment furnished in the substation located within OI has passed 29 years from the completion date of the facility. Compared to the ordinary depletion years of substation equipment that is from 25 to 30 years, they have been severely deteriorated and it can be said that a chance of having critical electrical accidents is quite high.


Photo Left : Measuring voltage and frequency
Photo Right : Connection of measuring instrument

2) Reliance on Electricity Supply

The parent company of RUF which distributes power to an extensive area of Moldova including Chisinau i.e. Central and Southern Region of Moldova is "Union Fenosa", a big energy conglomerate whose headquarter office is in Spain. RUF explained that reliability on electrical power supply had been improved since they had kept implementing improvement of their distribution network after expansion of their business by the merger of three (3) companies in 2008. Although the detailed data on frequency and duration of power failure could not obtain, they said that the frequency and duration of power failure on their grid due to lightning etc have been drastically dropped in recent years.

(3) Tariff for Electricity

Consumption of electricity will be measured by a sealed low-voltage (400V-230V) watt-hour meter and will be charged specifically according to the measured consumption. There is no tariff system with basic charge set on maximum power demand. Also, there is no tariff system with classification of consumers such as residential use, commercial use and industrial use. Thus, tariff for electricity is set at MDL 1.10 /kWh (MDL 1.32 /kWh including VAT) regardless of usage.

1-5-2 Natural Conditions

(1) Climate in Chisinau and Moldova

Moldova lies between latitude 48° 21′N - 45° 28′N and between longitude 30° 05′E - 26° 30′E that has a total land area of 33,800 square kilometers with north-south distance of 350 km and east-west distance of 150 km. Moldova belongs to a region of Eastern Europe and adjoins with Ukraine and Romania. And, most of rivers in Moldova flow into Black Sea and Dniester River traverses in the eastern territory of the country while Prut River runs along its western boarder with Romania. In addition, there is a part of a mouth to Danube River at southern end of the country.

Chisinau a capital of Moldova where the target project site is located has a warm humid continental climate which is relatively mild throughout the year. The census published by the Statistics Bureau says that its annual average temperature is 11.4 degrees Celsius and annual precipitation is approximately 446 millimeter in 2009.

According to the meteorological data for the years 2006 to 2008 issued by the Meteorology Department of the Ministry of Ecology and Natural Resources (MENR), monthly mean air temperature recorded at the Chisinau Observatory is as shown in Table 1-2 below:

Table 1-2 Monthly Mean Air Temperature in Chisinau (2006-2008 Average)

Item	Jan	Feb	Mar	Apr	May	Jun
Mean Air Temp. (℃)	-1.4	-0.1	5.7	10.8	16.7	21.3

Item	Jul	Aug	Sep	Oct	Nov	Dec	Mean
Mean Air Temp. (℃)	23.4	23.3	16.4	11.9	4.8	1.4	11.2

Source：Prepared by JICA Preparatory Survey Team based on the data provided by the Meteorology Department

(2) Solar Radiation in Chisinau

The project site is located in the district where many medical institutes are gathered and faces with three main streets. The site is not affected with the shadow cast by surrounding buildings. However, some part of target site for the Project is shadowed by the existing buildings in the project site. Therefore, during the field survey, the Team assessed the influence of shadows for each target site and planned to install the PV modules in areas where the existing buildings will not cast their shadow on them.

The Team conducted the field survey to observe the actual measurement of solar radiation and air temperature within the compound of OI. The data recorded and the instruments used during 1st and 2nd preparatory surveys are as shown in Table 1-3 and in the Photos below respectively:

Table 1-3 Recorded Data (Solar Radiation and Air Temperature in Chisinau)

1st Preparatory Survey	29 Oct. (Fine)	30 Oct. (Cloudy)	31 Oct. (Fine)	1 No. (Cloudy)	Mean Value
Daily Solar Radiation ($kWh/m^2/d$)	1.36	0.68	2.03	1.03	1.28
Max. Temperature (℃)	6.9	5.3	1.9	0.7	3.7
2nd Preparatory Survey	25 Jan. (Fine)	26 Jan. (Fine)	27 Jan. (Snow)	28 Jan. (Cloudy)	Mean Value
Daily Solar radiation ($kWh/m^2/d$)	1.43	1.43	0.96	1.00	1.21
Max. temperature (℃)	-17.1	-15.5	-10.8	-9.4	-13.2

Note : Mean daily solar radiation shows its value on the horizontal surface.
Source : Prepared by JICA Preparatory Survey Team

Photo Left : The instrument (left) used for measuring solar radiation and temperature
Photo Right : Observation instrument "Weather Hawk"

NASA provides extensive meteorological data world-wide, and their data of solar radiation and air temperature in Chisinau is as shown in Table 1-4 below:

Table 1-4 Monthly Mean Solar Radiation and Air Temperature in Chisinau (NASA)

Item	Jan	Feb	Mar	Apr	May	Jun
Daily Solar Radiation ($kWh/d/m^2$)	1.24	2.07	3.09	4.15	5.46	5.62
Mean Air Temp. (℃)	1.9	1.1	3.2	10.4	16.4	19.6

Item	Jul	Aug	Sep	Oct	Nov	Dec	Mean.
Daily Solar Radiation ($kWh/d/m^2$)	5.61	5.00	3.58	2.33	1.29	1.01	3.37
Mean Air Temp. (℃)	21.6	21.1	16.3	10.2	3.1	0.8	10.5

Note : Mean daily solar radiation shows its value on the horizontal surface.
Source : Prepared by JICA Preparatory Survey Team based on the data provided by NASA

The observed actual data shown in the Table 1-3 could not be simply compared with NASA data shown in the Table 1-4 above due to its too short observation period.

However, the actual data observed are considered to be similar to the NASA data in November and January, since each observation period is end of the month.

1-5-3 Socio-environmental considerations

The Team obtained the Guidelines for Environmental issues (Ordinance #LPN851) and had interviews with relevant officials of MENR in order to avoid any serious socio-environmental impact in accordance with "JICA Guidelines for Environmental and Social Considerations". And, it was confirmed that the implementation of Environment Impact Assessment (EIA) is not required for the Project because the installation and introduction of the grid-connected PV system at the target site will not cause any serious socio-environmental impact.

However, OI as the implementing agency of the Project should submit application documents to MENR together with papers describing the brief outline of the Project, technical specifications, and drawings showing installation areas within the project site. As for the submission and obtaining necessary permit, it was confirmed that there is no prescribed application form and that the permit could be issued within a month or so.

PV system to be introduced by the Project will not give any grave environmental impacts and/or create harmful influence to the project site and its surrounding areas. As for the classification of categories (A, B or C) giving consideration of socio-environmental impacts to the project site and its surrounding areas, it is judged that this Project will fall into Category "C" after screening with "JICA Guidelines for Environmental and Social Consideration April 2004".

CHAPTER 2
CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Objectives

According to the data[1] for the year 2008 prepared and issued by ANRE, amount of the electricity generated and imported for Moldova for past six (6) years i.e. 2003-2008 are as shown in Table 2-1 below:

Table 2-1 Change of Domestic Power Generation, Imported Power and Total Power Consumption

Unit: Million kWh

Item	2003	2004	2005	2006	2007	2008
Domestic Power Generation	842.3	830.7	999.8	957.7	903.6	940.0
Imported Power	2,347.5	2,433.9	2,686.7	2,978.3	3,154.2	3,300.0
Total Power Consumption	**3,189.8**	**3,264.6**	**3,686.5**	**3,936.0**	**4,057.8**	**4,240.0**

Source: Prepared by JICA Preparatory Survey Team based on 2008 Annual Report issued by ANRE

On the other hand, amount and ratio of power generation of power plants CHP-1 and CHP-2 which are located in Chisinau, the capital of Moldova, CHP-North which is located in Balti, a main city in the North region, HPP (hydroelectric power plant) which is located in Costesti in the North-West region and other small-scale power plants including the ones belong to sugar cane factories which are located in the North region are as shown in Table 2-2 below:

Table 2-2 Ratio of Power Generation and Total Amount of Power Generation

Item	CHP-1	CHP-2	CHP-North	HPP	Others	Total
Ratio of Power Generation（%）	11.5	58.8	3.7	3.9	22.1	100
Total Amount of Power Generation（MW）	47	240	15	16	90	408

Source : Prepared by JICA Preparatory Survey Team based on 2008 Annual Report issued by ANRE
CHP : Combined Heat and Power Plant
HPP : Hydroelectric Power Plant

And, according to National Energy Strategy to 2020, share of renewable energy in 2005 including HPP power generation shown in Table 2-2 above and biomass[2] in total energy consumption in Moldova was 71.4 thousand toe[3] which was only 3.6% of the said total energy consumption.

---

[1] Regulation of the energy market in the Republic of Moldova, 2008 ANRE

[2] It is assumed that all biomass were used as fuel since the use of biomass was not mentioned in Regulation of the energy market in the Republic of Moldova, 2008 ANRE

[3] Abbreviation for Ton of Oil Equivalent

(1) Overall Goal

In "National Energy Strategy to 2020", improvement of the energy efficiency and development of the renewable energy are declared as most important issues in Moldova. And, according to the said strategy, achieving to raise the rate of renewable energy contribution of the total energy consumption, which was 3.6% in 2005, to 6% by 2010 and 20% by 2020 is set as a goal.

And, the above-mentioned "National Energy Strategy to 2020" specifies solar and wind energy, hydropower, and biomass such as agricultural wastes, firewood, wastes from wood processing, marc, biogas and biofuel, as renewable energy sources (RES) in Moldova.

Furthermore, in order to achieve the above-mentioned goal, a new law Nr. 321 of 22 January 2009 (an official gazette of Nr. 45-46/172 dated 27 February 2009) that has been prepared based on renewable energy law Nr. 160-XVI of 12 July 2007 (an official gazette of Nr. 127-130/550 dated on 17 August 2007) and that prescribes a single method of determination, approval and implementation of regulated tariffs for all producers of electricity from renewable energy has been established.

(2) Needs on Measures for Climate Change

Moldova imports more than 97%[4] of its energy supplies such as oil, gas, electricity, etc. Thus, reforming the energy sector in Moldova is an urgent requisite. And therefore, improvement of the energy efficiency and development of the renewable energy sources are adopted as most important issues in the above-mentioned National Energy Strategy.

Furthermore, in addition to an international commitment to promotion of measures for global warming such as participating in "Cool Earth Partnership" proposed by Japan, Moldova is aiming to become a member of EU. Thus, Moldova is required to establish national structure giving consideration of objectives for reduction of greenhouse gases emissions expressed by EU, and consequently, utilization and promotion of the renewable energy including solar power is placed as an important policy in Moldova.

On the other hand, the Ministry of Economy (MOE) which is in control of all energy related undertakings in Moldova is desirous to implement this Project as a pilot project in Moldova since there is no achievement of the introduction of photovoltaic (PV) system yet to date.

[4] National Energy Strategy to 2020

Under these circumstances, an introduction of a first PV system in Moldova at OI which was selected as a candidate site for the Project is quite important as a pioneer project for promotion of the renewable energy in Moldova and is expected to contribute to balancing its economic growth and reduction of GHG emissions with adaptation activities to climate change.

(3) Project Objectives

The objectives of the Project are to promote clean energy utilization through the operation of the grid-connected PV system in Moldova as well as to contribute to reduction of GHG emissions. And consequently, reduction of import of the power can be realized.

(4) Project Goal

The project goal is to establish an energy supply system utilizing the energy that can be obtained in Moldova and that will contribute to the diversification of source of energy and measures for climate change.

2-1-2 Outline of the Project

(1) Outline of the Planed PV System

To achieve the above-mentioned objectives, the Project will procure and install a grid-connected PV system and to provide technical assistance for operation and maintenance.

As a result of the preparatory surveys, it is found out that no one has any experience and achievement of the installation of the grid-connected PV system so as RUF which is the only power distribution company in Chisinau although there are laws and/or regulations as to the grid-connection, reverse power flow and sale of power in connection with the solar power generation.

Although the Project is planned to provide grid-connected PV system, in order to supply stable power for the electrical loads at OI and to verify whether or not grid-connected PV system with reverse power flow should be planned with consideration of the case of power generated by the PV system exceeds the said electrical loads, the Team measured actual power demand and consumption of OI during the 2nd preparatory survey. And, as a result of the analysis of the data collected, it was judged that an expected amount of power generated by the PV system planned for the Project is constantly less than low voltage electrical loads at OI to be connected with.

Furthermore, according to the above-mentioned data collected and analysis, it is assumed that an annual power consumption of OI is approx. 2,130,000kWh and that power generated by the PV system will be consumed by the electrical loads of OI. Therefore, the Project will introduce the grid-connected PV system without reverse power flow. (Please refer to Section 2-2-3 (2) hereinafter)

The support plan of the Project is as shown in Table 2-3 below. As for the reverse flow of the power, relevant technical assistance will also be included since RUF which is the power distribution company is quite keen to purchase the power in accordance with an intention set forth by the MOE.

By implementing this Project, a first grid-connected PV system will be introduced in Moldova which will contribute to promotion of utilization of a renewable energy in Moldova.

Table 2-3 Support Plan of the Project

Equipment for Solar Electricity Generation			
1	Equipment	Uses	Needs
	Grid-connected PV System	The PV system will be dispersedly installed at roof-top of the existing buildings i.e. Main Building and Poly-clinic Building, and a vacant lot for proposed parking area; there is an existing building to be demolished. Then, generated power will be supplied to the said existing buildings through low voltage distribution panel which will be installed in the existing electrical room of each existing building. Thus, low voltage grid-connected PV system will be established which will contribute to supplement the power demand for OI.	Reduction of greenhouse gases by reducing consumption of fossil fuel for power generation by positive utilization of solar energy is sought in Moldova as mitigation measures for climate change. And, at the same time, the National Energy Strategy to 2020 is aimed at reducing dependence on imported energy resources.
Technical Assistance for Solar Electricity Generation			
2	Technical Assistance for Grid-connected PV System	Technical training necessary for appropriate operation and maintenance of grid-connected PV system which include basic knowledge, coordination with existing power distribution system, method of inspection and maintenance, troubleshooting, etc.	Since the introduction of a grid-connected PV system will be a first time in Moldova, there are no trained specialists and/or engineers who have knowledge of installation of grid-connected PV system and operation and maintenance thereof. Therefore, it is necessary to acquire and improve such knowledge and relevant technologies.

Source: Prepared by JICA Preparatory Survey Team

2-2 Outline Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

(1) Scope of cooperation

Based on the policy and goal of Moldova as mentioned in “2-1-1 Overall Goal and Project Objectives”, it is planned to install grid-connected PV system without reverse power flow aiming at managing to reduce greenhouse gas emissions and awareness of climate change with economic growth at the same time and in order to contribute to tackling with stabilization of the climate change.

Moldova requested OI located in Chisinau as a candidate site for the installation of the PV system. OI is a key hospital for cancer treatment in Moldova having more than 1,000 beds and stable electrical load throughout the year. The power generated by the PV system to be procured and installed by the Project will be consumed as an electrical load of OI. Thus, the said PV system is planned to be interconnected with existing low voltage distribution line (230/400V) and to supplement the power consumption of OI.

(2) Overall design guidelines

The outline design of the Project is based on the following guidelines:

1) Although there are no relevant laws and regulations as well as proven experiences and/or achievement of grid-connected PV system in Moldova, the Project will install the grid-connected PV system without reverse power flow based on the agreement to be concluded between OI which is the Implementing Agency of the Project and RUF in regard to the grid-connection.

2) The Project will procure and install equipment necessary for the grid-connected PV system and relevant technical assistance.

3) In planning of the grid-connected PV system, it is quite important to plan the grid-connection appropriately and provide reliable equipment so that the grid-connection will not adversely affect the quality of power distribution system.

4) OI which is the target site of the Project receives low voltage power (230V/400V) which is step-downed from 10KV high tension power by the transformers that managed and maintained by RUF; power distribution company in Chisinau. Therefore, the connection point of the supply cables of the PV system shall be low voltage side of the distribution panel.

5) Although the Project will provide the grid-connected PV system without reverse power flow, the PV system shall carefully be designed so as to enable reverse power flow in order to utilize the power generated by the PV system in future.

2-2-1-2 Policy for natural conditions

(1) Altitude

Chisinau city where the project site i.e. OI is located lies in low land. The altitude of the project site is approximately 85 meters above sea level where procured equipment will be installed and then operated. Thus, there will be no adverse influence that the altitude and atmospheric pressure could cause to such equipment. And therefore, all equipment shall be designed with manufacturers' standard specifications for the altitude and pressure

(2) Solar radiation and air temperature

The Team conducted the field survey to observe the actual measurement of solar radiation and air temperature at the project site in Chisinau i.e. OI during 1st and 2nd preparatory surveys. The data recorded are as shown in the Table 2-4 below:

Table 2-4 Recorded Data (Solar Radiation and Air Temperature in Chisinau)

1st Preparatory Survey	29 Oct. (Fine)	30 Oct. (Cloudy)	31 Oct. (Fine)	01 Nov. (Cloudy)	Mean Value
Daily Solar Radiation ($kWh/m^2/d$)	1.36	0.68	2.03	1.03	1.28
Max. Temperature (℃)	6.9	5.3	1.9	0.7	3.7
2nd Preparatory Survey	25 Jan. (Fine)	26 Jan. (Fine)	27 Jan. (Snow)	28 Jan. (Cloudy)	Mean Value
Daily Solar Radiation ($kWh/m^2/d$)	1.43	1.43	0.96	1.00	1.21
Max. Temperature (℃)	-17.1	-15.5	-10.8	-9.4	-13.2

Note 1 : Observation instrument: 「Weather Hawk」
Note 2 : Mean daily solar radiation shows its value on the horizontal surface.
Source : Prepared by JICA Preparatory Survey Team

Furthermore, the Team received the meteorological data which included the monthly accumulated amount of solar radiation for the past three years (2006, 2007 and 2008) from the Meteorology Department of MENR. Based on the said data received, the Team calculated the daily average amount of solar radiation, result of which is as shown in the Table 2-5 below. On the other hand, NASA provides extensive meteorological data world-wide, and their data of solar radiation and air temperature in Chisinau is as shown in the Table 2-6 below:

Table 2-5 2006-2008 Monthly Mean Solar Radiation and Air Temperature in Chisinau (The Meteorology Department)

Item	Jan	Feb	Mar	Apr	May	Jun
Monthly Solar Radiation ($Mj/m/m^2$)	113	180	332	422	631	718
Daily Solar Radiation ($kWh/d/m^2$)	1.01	1.72	2.89	3.90	5.65	6.41
Mean Air Temp. (℃)	-1.4	-0.1	5.7	10.8	16.7	21.3

Item	Jul	Aug	Sep	Oct	Nov	Dec	Mean.
Monthly Solar Radiation ($Mj/m/m^2$)	692	545	356	255	117	63	4,423 (total)
Daily Solar Radiation ($kWh/d/m^2$)	6.20	4.88	3.30	2.28	1.08	0.56	3.32
Mean Air Temp. (℃)	23.4	23.3	16.4	11.9	4.8	1.4	11.2

Note : Mean daily solar radiation shows its value on the horizontal surface

Source : Prepared by JICA Preparatory Survey Team based on the data provided by the Meteorology Department

Table 2-6 Monthly Mean Solar Radiation and Air Temperature in Chisinau (NASA)

Item	Jan	Feb	Mar	Apr	May	Jun
Daily Solar Radiation ($kWh/d/m^2$)	1.24	2.07	3.09	4.13	5.46	5.62
Mean Air Temp. (℃)	1.9	1.1	3.2	10.4	16.4	19.6

Item	Jul	Aug	Sep	Oct	Nov	Dec	Mean.
Daily Solar Radiation ($kWh/d/m^2$)	5.61	5.00	3.58	2.33	1.29	1.01	3.37
Mean Air Temp. (℃)	21.6	21.1	16.3	10.2	3.1	0.8	10.5

Note : Mean daily solar radiation shows its value on the horizontal surface

Source : Prepared by JICA Preparatory Survey Team based on data published by NASA

Compared the above-mentioned calculated results and NASA data shown in the Table 2-5 and Table 2-6 respectively to the observed actual data shown in the Table2-4, both actual data observed in November and January are considered to be quite similar to the one provided by NASA, taking the observation period into account. Consequently, it can be judged appropriate to adopt the meteorological data provided by NASA to simulate the amount of power which will be generated by the PV system to be procured and installed by the Project.

(3) Precipitation

According to the meteorological data provided by the Meteorology Department of MENR, the annual precipitation observed at Chisinau meteorological station is relatively quite little; that is, annual recorded precipitation of approximately 540mm. The project is planned to install PV modules at the three (3) different locations, that is, on the roof-top of the two (2) existing buildings and on top of the steel frame structures to be erected on the ground. And therefore, the foundations to be constructed on the roof-top of the existing buildings which will support the supporting frames for the PV modules shall be carefully designed with consideration of appropriate rainwater drainage. Moreover, renewal of waterproofing of the roof-top of the existing buildings shall be properly implemented.

On the other hand, the ground where the steel frame structures will be erected has a gentle slope; however, it was confirmed that rainwater drainage system shall be provided by the Recipient at the time of the leveling of the said ground.

(4) Wind

The data for the monthly maximum wind velocities in Chisinau for the last three (3) years (2006, 2007 and 2008) provided by the Meteorology Department of MENR are as shown in the Table 2-7 below. And, according to the said data, a maximum wind velocity of 21.0 meter per second (21m/s) was recorded in June, 2008.

Table 2-7 2006-2008 Maximum Wind Speed in Chisinau
(The Meteorology Department)

Unit: m/s

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max.
2006	16	10	15	12	12	11	13	11	14	14	13	14	16
2007	17	14	17	14	14	16	20	12	13	11	15	14	20
2008	17	14	17	18	18	21	19	20	16	18	17	16	21

Source：Prepared by JICA Preparatory Survey Team based on the data provided by the Meteorology Department

Verification of resistance to wind of PV modules and structural calculation of supporting structure, anchor bolts and reinforced concrete foundations shall be done in accordance with “Design Guide on Structure for Photovoltaic Array (JIS C 8955）”. Since Moldova belong to the area without rainstorm such as typhoon or hurricane and with consideration of maximum wind velocity recorded for past three (3) years as shown in Table 2-7, design wind pressure was calculated using wind velocity of 30 meters per second (m/s) and based on calculation formula for wind load specified in Japanese Building Code.

And, in addition, the design wind pressure at the highest place of the Project, that is on the roof-top of the Main Building, would be about 900Pa when calculated in accordance with the calculation method of wind load defined by the said Japanese Building Code, giving consideration of that the project site belongs to “Category IV: Heavily urbanized area” in the urban area stipulated by the Urban Planning Law. However, the Project will adopt the design wind pressure of 2,000 Pa taking an absolute safety into account.

(5) Lightning

The data for the monthly occurrence of lightning in Chisinau for the last three (3) years (2006, 2007 and 2008) provided by the Meteorology Department of MENR are as shown in the Table 2-8 below.

Table 2-8 2006-2008 Monthly Occurrence of Lightning in Chisinau (The Meteorology Department)

Unit: Times

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2006	0	0	1	2	5	9	11	7	0	0	0	0	35
2007	0	0	0	0	6	8	1	6	1	0	0	0	22
2008	0	0	0	1	7	10	8	4	0	1	0	0	31

Source：Prepared by JICA Preparatory Survey Team based on the data provided by the Meteorology Department

Through discussion with the electrical engineers at the Design Institute in Chisinau, it was confirmed that most of buildings in Chisinau were furnished with lightning protection system according to the Russian standard. Therefore, although the Project will provide the PV modules to be installed at three (3) different locations, each one of which shall be furnished with external lightning protection system (air termination conductor, overhead ground wire etc.) in accordance with International Electro-technical Commission Standard (IEC62305 Lightning Protection).

On the other hand, the damage to electronic devices, computers, etc caused by lightning has become a serious issue lately in most countries. In case of the lightning, the equipment will be damaged because an abnormal current and voltage caused by direct lightning or induced lightning will enter into electronic device of the equipment. Therefore, the Project will consider the provision of reliable power supply to the power conditioners, measurement and monitoring equipment, and a display in order to avoid such damages caused by an abnormal current and voltage and so as to enable to provide stable power supply.

(6) Ground and existing structure

The substructures for the Project will be concrete foundations to be constructed on the roof-top of the two (2) existing buildings and steal frame structures to be erected on the ground planned to be used as parking area that will support steel supporting frames for the PV modules to be installed. As a result of the survey, it was confirmed that the existing building had enough strength to bear both the long term load including the weight of PV modules, steel supporting frames and concrete foundations and the short term load that were seismic load, wind load and snow load. Structural design of the said substructures required for the installation of the PV modules will be prepared in accordance with the local standard and guideline.

(7) Salt damage

Since the project site is located in the inland area, any countermeasures for salt damage will not be considered in the technical specifications for the Project.

(8) Seismic load

For the preparation of structural design, it is mostly prepared in compliance with the former Russian technical standard since there is none of its own design criteria for structural design in Moldova. According to the chief engineer of the Design Institute, Moldova is classified as "Category 7" under the former Russian design standard for seismic load calculation. There are three (3) categories i.e. Category 7, Category 8 and Category 9, all of which are referred to "Richter Scale". Seismic load can be deduced from various factors including importance of building, type of ground, height of building and firmness of building based on the corresponding "Equivalent category".

Since the PV modules are planned to be installed on the roof-top of the existing buildings and on the steal frame structure on the ground of which height is about three (3) meters, the design condition of the horizontal seismic intensity for supporting steel frames and fixing anchor bolts should be 1.0G giving consideration of the safety factor. Meanwhile, design condition of the horizontal seismic intensity for the steal frame structures and concrete foundations for PV modules should be 0.3G based on the former Russian standard.

(9) Snowfall

According to the meteorological data provided by the Meteorology Department of MENR, maximum daily snow fall during the last three years (2006, 2007 and 2008) was 26 centimeters which was observed in 2006. 26 centimeters of snow fall is an equivalent to a load of about 51kgs/m^2 assuming that an average unit weight of snow is 20N/cm/m^2.

On the other hand, the Design Institute applies a snow load of 70kgs/m^2 to their structural calculations. And therefore, the Project shall adopt the said snow load of 70kgs/m^2 for the structural calculation of the PV modules and supporting steel frames.

2-2-1-3 Policy relating to socio-economic conditions

Moldova has insufficient capacity and fund to balance economic growth with reduction of GHG emissions. Consequently, infrastructure required for promotion of the utilization of renewable energy is not ready for use and there is no incentives provided and it has become an issue; that is to raise nation-wide consciousness for introduction of the renewable energy from now on. And therefore, the PV system shall be planned and designed giving consideration of the extension and promotion of the renewable energy.

Moreover, since Moldova is willing to be affiliated with Energy Community Treaty, an importance of aligning its energy strategy to EU energy objectives is stipulated in the aforementioned “National Energy Strategy to 2020”.

2-2-1-4 Policy concerning procurement affairs and special situations/commercial customs of industry

(1) Permits and approval and laws related to the implementation of the Project

The Project includes foundation work, small-scale construction work including erection of steel frame structure, waterproofing work etc., supporting structure work, electrical work and equipment installation work. In Moldova there is a labor code[5] that defines contract and employment, gender equality, working hours and intermissions, wage and salary, rules and regulations, working environment and so on; thus, the said labor code will be applied for the construction work and equipment installation work of the Project.

And, as for the construction of substructures including steel frame structures and installation of supporting structures, the outline design shall be prepared in conformity with relevant Moldovan standard and regulation and design documents thereof shall be submitted to relevant agencies to obtain their confirmation and/or approval prior to the commencement of the work. And, as for the installation of PV system, it is not required to obtain a permit separately although general installation plans thereof may have to be attached to the application documents for the building permit.

(2) Applicable laws, regulations and standards

In order to promote extension of solar power generation from now on in Moldova, all equipment shall be compatible with international standards in principle. The Recipient has requested the major equipment to be Japanese products and it is judged appropriate to procure the Japanese products for the major equipment of the Project since, as a result of the survey, it was confirmed that quite a few Japanese manufacturers had their factories, sales offices and agents in and around Europe.

[5] Labor Code of the Republic of Moldova dated 25 May 1973

On the other hand, since there are no regulations and/or guidelines for grid-connected PV system in Moldova yet to date, Japanese guidelines will be applied for the equipment to be used for grid connection. Applicable standards are as follows:

- Japan Electrical Law
- Japan Technical Standard for Electrical System
- Japanese industrial Standard（JIS）
- Japan Electrical Manufacture's Association Standard (JEM)
- Japanese Electro-technical Committee Standard (JEC)
- Japan Cable Maker's Association Standard (JCS)
- Guidelines for technical requirements on interconnection to grids
- Code for interconnection to grids (JEAC)
- International Electro-technical Commission (IEC) Standards (IEC61215, IEC61646, IEC61730-1 and IEC61730-2)
- Japan Laborer's Safety and Health Law

(3) Design standards to be complied with for installation work

Although applicable standards and regulations for civil/construction work, electrical work and so on shall be the ones available in Moldova in principle, such local standards and regulations shall be supplemented with relevant standards and regulations of Japan which is a donor country of the Project.

2-2-1-5 Policy for utilizing local company

It is a first time for Moldova to install the PV system of this scale and local companies have no experiences of the installation of equipment to be procured by the Project. Thus, Japanese company which will be the Contractor for this Project shall supervise entire installation work and it is absolutely necessary to provide training and guidance to local companies by the experts dispatch by the Contractor.

And therefore, as for the installation of the PV system including electrical works and construction of substructures including supporting steel structures, it is planned to utilize the local companies under the supervision of the Japanese company i.e. the Contractor.

2-2-1-6 Policy concerning operation and maintenance abilities of the executing agency

The PV system of this scale to be provided by the Project will be a first case in Moldova and will be a first experience for not only the staff of OI but also staff of the MOE which is in control of all electricity-related undertakings and RUF staff; thus, they have no technical knowledge as to the grid-connected PV system.

As for the operation and maintenance of the said PV system, OI that is the Implementation Agency of the Project is planning to assign four (4) maintenance staff in charge of electrical works and equipment who is currently employed by OI. However, since MOE that is in control of energy-related undertakings placed this Project as pilot project for solar power generation, MOE requested for the participation in proposed trainings together with RUF that will be purchaser of renewable energy in future in aiming to acquire technical knowledge as to the grid-connected PV system.

Therefore, the Project shall include provision of initial operation guidance to be conducted either by the Contractor and educational training to be conducted by the Consultant as a soft component of the Project for the engineers who will be responsible for the operation and maintenance of the system from OI, engineers in charge from the MOE and selected engineers from RUF who will be responsible for the management and maintenance of the existing substation.

2-2-1-7 Policy for grades of equipment and materials

As the Project is expected to continuously exhibit its intended effects, equipment and materials to be procured must be of general-use, durable types, and have high cost-performance ability. In addition, such equipment shall be easily repairable and maintainable. For these reasons, those types of equipment that have proved good performance shall be procured.

There are many kinds of PV cells which are the components of the PV modules such as mono-crystal, poly-crystal, thin layer amorphous, chemical compound and hybrid materials. And, all these different types of PV modules have their own characteristic of power generation efficiency, temperature-maximum output, and voltage-current performance and so on.

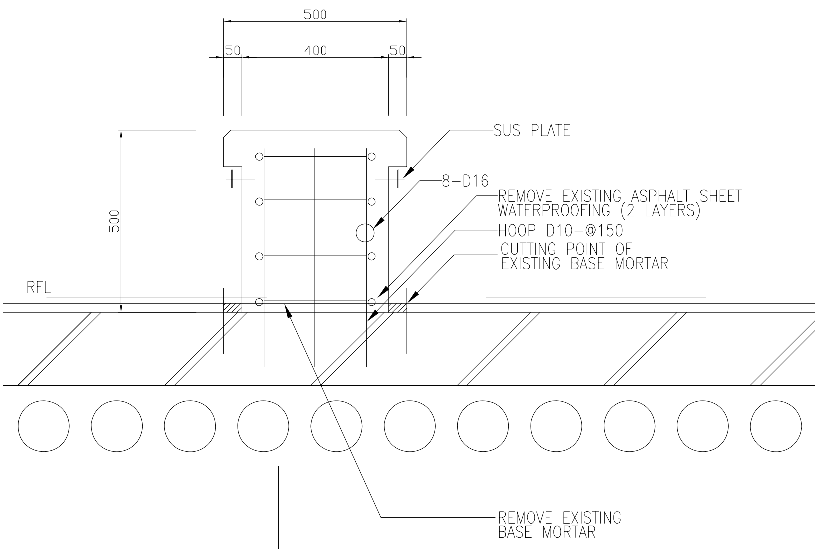
On the other hand, the project site i.e. OI has only limited area for the installation of PV modules and is situated at high latitude and under climatic conditions of relatively low annual mean temperature. Thus, it is planned to adopt mono-crystal or poly-crystal silicon cells which has relatively high efficiency and long and good performance records in order to generate as much power as possible with limited space for the installation of PV modules.

The technical specifications shall specify minimum outputs at each location, available installation areas with giving consideration of shadows and other functional requirements.

2-2-1-8 Policy concerning installation/procurement method and installation schedule

(1) Installation method

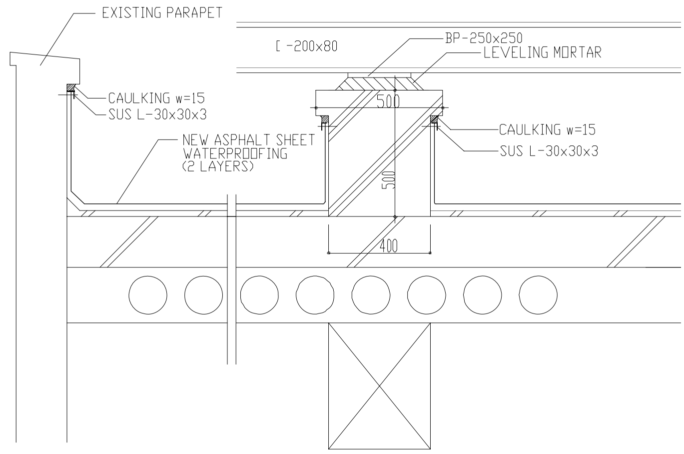
Foundations to be constructed on roof-top of the existing buildings and entrance canopies that steel support structures for the PV modules will be placed on shall be pillar-type independent foundation which is shown in Fig. 2-1. The said foundations shall be reinforced concrete structure and shall be constructed with the methods commonly adopted in Moldova. And, it should be noted that completion of preparatory works such as removal of the existing waterproofing layers, cleaning, marking, removal of base mortar, and so on is necessary prior to proceeding with construction of the foundations.



Source: Prepared by JICA Preparatory Survey team

Fig. 2-1 Foundations on Roof-top of Existing Buildings and Entrance Canopies

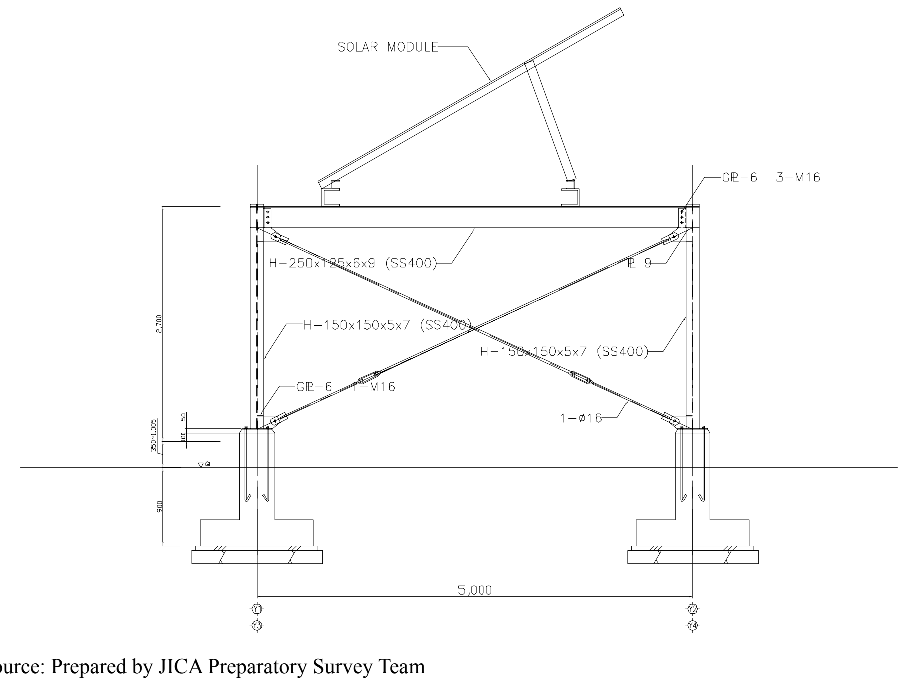
And, as for the renewal of waterproofing layers, two (2) layers of asphalt sheet shall be laid by using a burner which is commonly adopted in Moldova as shown in Fig. 2-2. And, it should be noted that repairing of cracked and/or lifted parts of the base mortar is necessary prior to proceeding with laying new waterproofing layers.



Source: Prepared by JICA Preparatory Survey Team

Fig. 2-2 Waterproofing on Roof-top of Existing Buildings and Entrance Canopies

Steel frame structures that steel support structures for the PV modules will be placed on shall be erected on top of independent pad foundations to be constructed at the vacant lot for proposed parking area as shown in Fig. 2-3. Since there is no appropriate facilities for hot-dip galvanizing in Moldova and there are some doubts concerning welding skills and testing skills thereof, the said steel frame structures as well as steel support structures for the PV modules shall be fabricated in and shipped from Japan and erection and assembling thereof shall be carries out local workers under the supervision of an technical expert dispatched by the Contractor.



Source: Prepared by JICA Preparatory Survey Team

Fig. 2-3 Steel Frame Structure

(2) Procurement method

Procurement of the equipment and materials for the Project shall be implemented with consideration of the followings:

1) Connection between PV modules, support structures, power conditioners, measuring and monitoring system and so on shall be guaranteed to function as an integrated system.

2) Establishment of an appropriate support structure for operation and maintenance of the system is essential since introduction of grid-connected PV system is first time in Moldova.

3) The Project shall be implemented within a limited time period so specified without fail in accordance with the guidelines for Japanese grant aid scheme.

4) Even if major equipment for the Project such as PV modules and power conditioners are to be procured from Japanese manufacturers, competitiveness among those manufacturers are maintained.

5) Since construction materials and other materials such as cables for the electrical works and so on to be used for the installation of equipment and construction of the foundation shall be procured in Moldova in order to reduce the cost for the installation work since it is judged that such materials have no problems in quantity and quality. All cables shall be laid in buried conduit pipes.

2-2-2 Basic plan (Equipment plan)

2-2-2-1 Formulation of basic plan

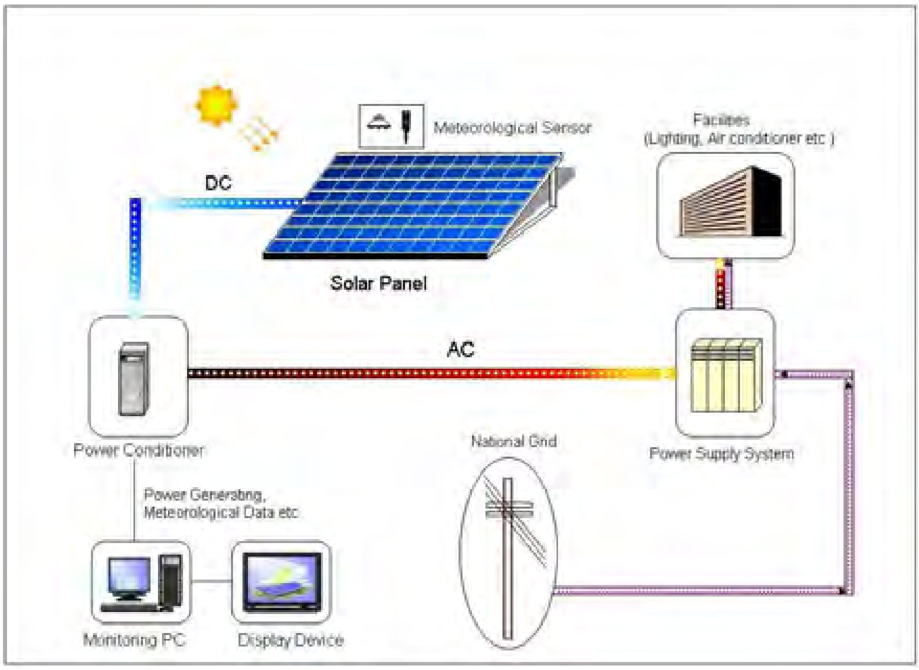
(1) Study of the equipment plan

As a result of studies and discussions conducted with Moldovan side as well as necessary analysis conducted in Japan thereafter regarding the equipment for the PV system to be procured for the Project, the Project will include the procurement of the following equipment for the grid-connected PV system without reverse power flow.

For the above-mentioned analysis conducted in Japan, references were made to Japanese “Grid-interconnection Code” and “Quality Assurance Guidelines relating to Power System Integration Requirement” since there are regulations and/or guidelines as to the grid-connection.

Although OI is supplied with low voltage power, technical analysis of the PV system has been made in accordance with requirements for high tensile grid-connection since the total capacity of the Project is 250kW which exceeds specified capacity of 50kW for low voltage grid-connection.

As a result of the above-mentioned analysis conducted in Japan, the low voltage grid-connected PV system without reverse power flow as shown in Fig. 2-4 is planned for the Project:



Source: Prepared by JICA Preparatory Survey Team

Fig. 2-4 Conceptual Image of Grid-connected PV System

1) PV modules

There are different types of PV modules of which cells are made of such as mono-crystal, poly-crystal, thin layer amorphous, chemical compound and hybrid materials. All these different types of PV modules have their own characteristic of power generation efficiency, temperature-maximum output, and voltage-current performance.

The space for the installation of the PV modules within the compound of OI is limited. But, three (3) different locations were selected for the installation of the PV modules i.e. 1) the roof-top of the main building, 2) the roof-top of the polyclinic building and 3) on top of the steel frame structure to be erected on vacant lot (proposed parking area). Meanwhile, the air temperature of Moldova is relatively low throughout the year. Thus, in order to procure the most durable, economical and efficient PV system in the condition of ambient environment in Moldova and giving consideration of the limited available space for the installation thereof, it was concluded that the type of PV modules to be procured for the Project should be mono-crystal, poly-crystal or mono-crystalline and Amorphous hybrid type to meet the requirements specified in Table 2-9 below, since power generation efficiency of these types of the PV modules are relatively quite high.

Table 2-9 Required Performance for PV Modules

Type	Nominal Max. Output (W/m^2)	Conversion Efficiency (%)	Remarks
Mono or Poly-crystalline Module/ Mono-crystalline and Amorphous Hybrid Module	130 or more	12.5 or more	

Note: Nominal maximum output rate is defined under the condition of AM1.5 or "Air Mass 1.5" that means solar radiation is 1,000 watts per square meter, at cell temperature of 25℃.

Source : Prepared by JICA Preparatory Survey Team

2) Power conditioners

Since suitable installation spaces for the PV modules are quite limited within the compound of OI, it is planned that the installation of the PV modules shall be dispersed in three (3) different locations; 1) the roof-top of the main building, 2) the roof-top of the polyclinic building and 3) on top of the steel frame structure to be erected on vacant lot (proposed parking area). And consequently, three (3) outdoor housings containing power conditioners of outdoor type shall be installed in the vicinity of each location where the PV modules are installed in order to efficiently distribute AC power (400V) that are converted by power conditioners to the low voltage distribution panel to be provided and installed at outside of the existing substation.

These power conditioners shall be contained in the outdoor housings that have enough space to carry out an appropriate maintenance for power conditioners with interior lighting fixtures. Taking account for the severe environmental condition in Chisinau, particularly in winter when an air temperature comes under minus 25 degree Celsius, the outdoor housing shall be furnished with heating system to keep its internal space under allowable indoor condition for power conditioners and the outdoor housing shall also be furnished with mechanical ventilation system for removing a heat during summer. In addition, the outdoor housings are designed to meet water proof requirement specified as IP 43.

Power conditioners should be equipped with protection devices that could prevent spreading damages in case of both system failure and grid accident. Moreover, power conditioners shall be composed of more than two (2) units in order to assure system redundancy.

It is planned that the Project provides grid-connected PV system in principle in order to supply stable power for the electrical loads at OI. Whereas the Team measured actual power demands and consumptions of OI in order to verify whether or not the grid-connected PV system with reverse power flow should be planned with consideration of the case of power generated by the PV system exceeds the said electrical loads. And, as a result of the field survey and analysis, the PV system that can be installed at OI with expected output thereof is described hereinafter:

a. Planned output of PV system

PV modules are planned to be separately installed at three (3) places; namely, on the roof-top of Main building, on the roof-top of Polyclinic building and on the ground (to be used as a parking lot in the future), planned output capacity of which is as shown below. Power generated by the PV system will be connected to the existing low voltage distribution panels by means of low voltage grid-connection and be mainly distributed to the Main building.

Main building roof-top	Nominal output of PV Modules	90kW
Polyclinic building roof-top	Nominal output of PV Modules	65kW
On the ground	Nominal output of PV Modules	95kW
	Total	250kW

b. Power demand for Oncology Institute

Actual power demands for transformers bank-3 and bank-4 and expected outputs of the PV system to be connected to have been verified as to the changes during the day i.e. between 08:00 and 16:00. And, the actual power demands for transformers bank-3 and bank-4 are summarized based on the actual data measured during the 2nd preparatory survey (Thursday 21st of January to Saturday 30th of January 2010). However, as to the output of the PV system, some assumptions has been made for the months of June and July which expected to have most solar radiations by adjusting the actual data for solar radiation measured during the same period. The changes during the day of the actual power demands and of the expected effective outputs by the PV system to be procured and installed by the Project are shown in Table 2-10 below:

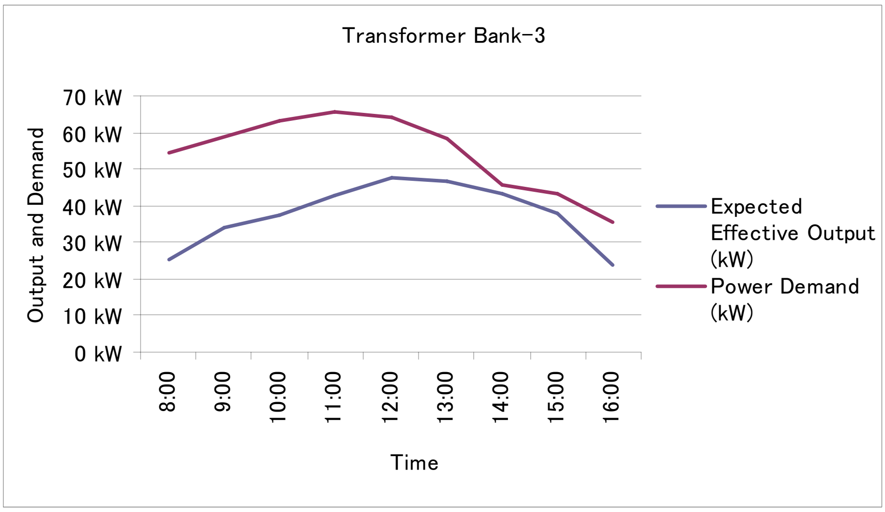
Table 2-10 Recorded data of power demands and effective output of PV

Time		8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00
Transformer Bank-3	Expected Effective Output (kW)※1	25.5	34.1	37.6	42.7	47.8	46.5	43.2	38.1	24.0
	Power Demand (kW)	54.3	58.6	63.0	65.5	64.2	58.4	45.9	43.3	35.7
Transformer Bank-4	Expected Effective Output (kW)※1	45.4	60.6	66.9	84.9	82.6	76.8	67.7	51.1	42.7
	Power Demand (kW)	74.5	88.2	86.2	92.7	91.0	84.7	75.7	66.6	54.9

Note (※1) : Effective output of PV = Nominal output x 0.60 x 0.85 = Nominal output x 0.51
Integrated system coefficient of PV system 0.85

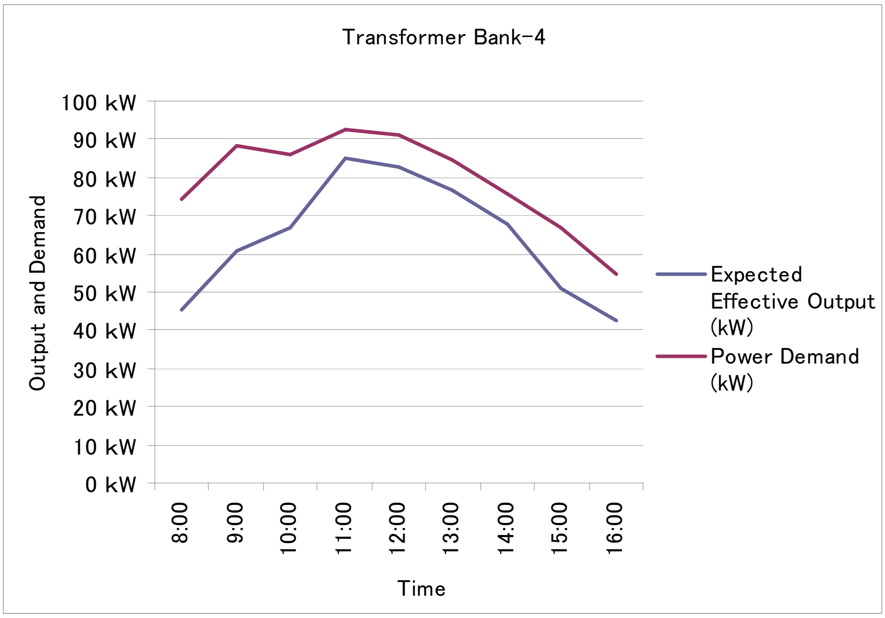
Source : Prepared by JICA Preparatory Survey Team

And, as a result of the above-mentioned verification and comparison of the actual power demands and expected effective outputs by the PV system, the said actual power demands for the transformers bank-3 and bank-4 exceed the said expected effective outputs of the PV system at anytime throughout the day as shown in Fig. 2-5 and Fig. 2-6 below:



Source : Prepared by JICA Preparatory Survey Team

Fig. 2-5 Comparison of power demands and outputs of the PV (Bank-3)



Source : Prepared by JICA Preparatory Survey Team

Fig. 2-6 Comparison of power demands and outputs of the PV (Bank-4)

Transformers bank-3 and bank-4 to be connected with the planned PV system supply power to the Main building. Polyclinic building which is closed every weekend is fed with power from transformers bank-1 and bank-2.

Since the recorded data of actual power demands shown in Table 2-10 were for the Main building which contains department of surgery and treatment, ward, it is assumed that the said demands will be the same for weekend. And, since heating system installed in OI which may consume the largest amount of energy during winter utilizes circulating hot water heated by gas-burned boilers and consumes less electrical energy, the power demand of the Main building is assumed to have no seasonal fluctuation. Therefore, the power demands for cooling and heating system are relatively constant throughout the year. Whereas, the effective outputs of PV system can be estimated at values shown in Table 2-10 above, taking account of actual solar radiation in Chisinau and integrated coefficient of the PV system.

And consequently, it can be judged that the power demands for target electrical loads to be fed by the PV system constantly surpass the effective outputs of the PV system as shown in Table 2-10 above:

On the other hand, annual power consumption of OI is estimated to be approx. 2,130,000kWh according to the verification conducted during the 2nd preparatory survey. And, the said annual power consumption is substantially large when compared to the expected amount of annual power generation of 299,400kWh by the planned PV system.

As a result of above-mentioned analysis, it was judged that all power generated by the PV system would be consumed for the power load of OI. Therefore, the planned PV system is not designed to reverse its generated power flow back to the high tension (10KV) grid managed and maintained by RUF.

3) Data Management and Monitoring System

Data management and monitoring system shall consist of a personal computer, a solar radiation meter, a thermometer, sensing instruments and signal transmitters. The system shall be able to track the amount of generated power, input and output voltage from and to power conditioners, solar radiation and air temperature as well as to record and display them in the specified format to be set. In addition, it shall keep monitoring the performance of the PV system as a whole. And, if unusual state of the PV system takes place, it shall display and record it accordingly.

Data management and monitoring system shall consist of equipments as shown in the following subparagraph ①, and shall collect, process and record automatically the data as specified in the following subparagraph ③ under the conditions specified in subparagraph ②.

① Components of Data management and monitoring system

- Desktop PC : 1 set
- Solar radiation meter : 1 set
- Thermometer : 1 set
- Sensing instruments and signal transmitter : 1 lot

② Measuring period, Calculation period and Data storage period

- Measuring period : 6 seconds
- Calculation period : 6 seconds (or 1 hour)
- Data storage period : 1 minute or 1 hour

③ Items to be observed

Items to be observed are as shown in Table 2-11 below:

Table 2-11 Items to be observed

Items	Measuring Point	Data Storage
1. Solar radiation	One	Yes
2. Air temperature	One	Yes
3. Input voltage to power conditioner	Three (3) or more	Yes
4. Output voltage from power conditioner	Three (3) or more	Yes
5. Amount of generated power by PV	Three (3)	Yes

Source: Prepared by JICA Preparatory Survey Team

4) Display system

The Project will provide a display system at the main entrance in the Main building by which the staff of the OI and many visitors including inpatients could see the running state of the PV system and its effectiveness on a reduction of carbon dioxide gas emission and the effectiveness of the PV system to the environment could also be appealed.

The display system shall indicate the amount of generated power (present, daily, monthly and annual), meteorological data (air temperature and solar radiation), the expected reduction of carbon dioxide gas and general description of the PV system. It is also required that the viewing contents shall be set and changed by using the personal computer of the data management and monitoring system.

5) Substation (Existing)

The existing substation was designed in 1974 and completed construction thereof including installation of all equipment in 1981. The existing substation consists of ex-Russian equipment including transformers. The said substation simultaneously receives two (2) lines of high tension power (10KVA) from RUF through one pair of transformers i.e. high tension receiving line No.1: 630KVA+1000KVA and another pair of transformers i.e. high tension receiving line No.2: 630KVA+1000KVA. Thus, total capacity of the existing substation is 3,260KVA. Since power supply to the OI is categorized as “Category II” in Moldova which means OI can receive reliable and stable power supply from RUF.

Disconnection switch installed on bus-bar which connects two (2) high tension lines is always kept open. The high tension distribution panel contains disconnection switches and open type knife switches. The transformers are protected with mere fuses instead of mold case circuit breakers. The low voltage distribution panel consists of open type knife switches as well and low voltage main feeders are also protected with fuses.

As a result of the site surveys and hearings from RUF which is a power distribution company, it was confirmed that RUF is responsible for the management and maintenance of the high tension equipment including transformers while OI is responsible for low voltage (230/400V) electrical system after the secondary side of transformers. The power consumptions which include active power and reactive power are measured by metering devices such as Voltage Current Transformer (VCT), Active power Watt-hour Meter (WhM) and Reactive power WhM installed on the secondary bus line which belong to RUF. Consequently, an agreement concluded between RUF and OI stipulates low voltage power supply (230V/400V, 3 phases 4 wires, 50Hz) as an agreed power supply system for OI.

The planned PV system should be of grid-connected type by which generated power is distributed to the low voltage side of the existing substation. During the site surveys, the power consumptions of the OI were measured at the four transformers and the state of power load of each transformer was also measured in order to determine appropriate connection points onto low voltage side of the OI. Prior to determining appropriate connection points of the generated power at low voltage side of the existing substation, the following data for power consumptions were reviewed and analyzed:

a. Consumptions from 27 November to 28 December 2009 (32 days) which measured and recorded by RUF;

b. Consumptions from 29 December 2009 to 27 January 2010 (30 days) which measured and recorded by RUF; and,

c. Consumptions from 26 January to 29 January 2010 (4 days) which measured and recorded by JICA Preparatory Survey Team.

During the above-mentioned period from 26 to 29 January 2010, JICA Preparatory Survey Team measured and recorded an actual consumption of the power by reading figures on Active power Watt-hour Meters (WhM) and Reactive power WhMs and measured and recorded load currents of low voltage branch feeders of each transformer at the same time. And as a result of the analysis of the data recorded, it was confirmed that the power consumption of No.3 1,000KVA and No.4 1,000KVA transformers which supplies the power to the Main Building and Canteen Building were always high. Therefore, it was concluded that the planned PV system should be connected to the grid through spare switches provided in the low voltage distribution panels of No.3 and No.4 transformers.

According to Japanese “Grid-interconnection Code”, Grid-connected PV system without reverse power flow should be equipped with Over Voltage Grounding

Relay (OVGR) and Reverse Power Relay (RPR). Meanwhile, the existing substation which managed and maintained by RUF which is a power distribution company in Chisinau is considerably deteriorated due to exceeding its expected life. And therefore, it is extremely difficult to refurbish the high tension side of the existing substation including the installation of OVGR since there are no protective devices are provided for the transformers etc and all equipment are considerably deteriorated. Thus, the Project shall provide and install RPR only at the secondary side of the substation.

Grid-connected PV system should also keep the power factor of not less than 85% at the power receiving point in compliance with Japanese "Grid-interconnection Code". On the other hand, there is no such regulation that stipulates improving of power factor in Moldova. The existing substation is furnished with no capacitor for improving power factor. If the Project provides capacitors and install them for the existing substation, it will result in refurbishing of the existing substation as a whole with interruption of power supply to the entire facilities of the OI. Since the installation of the capacitors by RUF is not required by any regulations and with giving consideration of the anticipated disturbance to the functionality of the OI, JICA Preparatory Survey Team concluded not to provide capacitors for improving power factor.

6) Spare parts and consumables

The following spare parts and consumables shall be included in the project:

a. Spare parts:
Two percent (2%) of total amount of the PV modules which is approximately 5.0 kW of the PV Modules shall be provided.

b. Consumables:
One pieces each fuse and lamp for the power conditioners and distribution panels shall be provided.

(2) Selection of installation site

Although four (4) locations were selected for the installation of the PV system at the time of 1st Preparatory Survey, only three (3) locations shown in Table 2-12 have been finally selected since one of the said four (4) locations was found to be inefficient because sunlight was extensively blocked by the surrounding existing buildings.

Table 2-12 Summary of Locations for PV Modules Installation

No.	Location	Area (m^2)	Outline
1	Roof-top of Main Building and Entrance Canopy	2,750 (Roof-top) 590 (Canopy)	10 story (above ground) building completed in 1991. Existing waterproofing is extensively deteriorated but a part thereof has been repaired. Since this building is the highest structure in the OI, there will be no problem receiving sunlight. Canopy has no problem receiving sunlight as well.
2	Roof-top of Poly-Clinic and Entrance Canopy	1,540 (Roof-top) 260 (Canopy)	6 story building (above ground) completed in 1981. Roof-top waterproofing has recently been renewed. There will be no problem receiving sunlight. Entrance canopy has slight problem receiving sunlight due to tall trees planted both sides.
3	Vacant Lot (proposed parking area)	3,960 (Ground)	Vacant lot is almost facing to south-west direction and has no trees that will block the sunlight. Although the PV modules will be installed on top of 3.0 m high steel frame structure, a part thereof will have slight seasonal problem receiving sunlight due to nearby main building.

Source: Prepared by JICA Preparatory Survey Team

And, during 3rd Preparatory Survey, the Team discussed with OI regarding the selection of additional candidate sites with consideration of the use of the remaining fund which may become available as a result of the tender. The said additional candidate sites were confirmed by signing the Technical Note on 24th of December, 2010. (Please refer to ATTACHMENT-5)

(3) Installation method of PV modules

Since Moldova is situated in high latitude i.e. 47 degrees north, spacing of rows of PV modules have to be wider in order to avoid shadows casted by PV modules itself particularly during winter.

With consideration of above-mentioned restrictions, most efficient layout plan of the PV modules which will enable to maximize power generation and to minimize the reduction of the amount of annual power generation at the same time has been prepared which is shown in the outline design drawing PV-01 enclosed hereinafter.

For the installation of the PV modules at the roof-top of the existing buildings, the PV modules have been laid out in longitudinal direction of the existing building so as to maximize the number of PV modules. And, as for the PV modules to be installed on top of the steel frame structures, the said steel frame structures have been laid out in longitudinal direction of the vacant lot as well so as to maximize the number of PV modules can be accommodated. As a result, all of the PV modules laid out ended up not facing to dew south. Thus, verification on various installation conditions of the

PV modules was made in terms of assumption of the amount of annual power generation by the PV modules installed at each location which are described hereinafter. The summary of installation conditions of the PV modules is as shown in Table 2-13 below:

Table 2-13 Installation conditions of PV modules

Place of Installation	Orientation	Capacity	Tilted Angle	Azimuth
Main Building	South-east	65kw	30°	51°
	South-west	25kw	30°	39°
Poly-Clinic Building	South-south-west	65kw	30°	25°
Steel Frame Structure (proposed parking area)	South-west	100kw	30°	39°

Source: Prepared by JICA Preparatory Survey Team

Simulation of the amount of annual power generation on various installation conditions of the PV modules shown in Table 2-13 above and in case of as if the PV modules at each location were facing to dew south was made in order to verify the amount of reduction.

The results of simulation are as shown in Table 2-14 below. When compared the amount of annual power generation by planned layout of the PV modules to the ones for facing to dew south, Poly-clinic building which has most efficient layout of the PV modules was 98.5% and Main building which has relatively insufficient layout of the PV modules was 93.8%. And, since an average of all installation conditions was 96.8% i.e. reduction of 3.2%, it is judged that the planned layout of the PV modules for each location is appropriate.

Table 2-14 Expected Amount of Annual Power Generation

Location of Installation	Orientation	Dew South (kWh/year)	Planned (kWh/year)	Ratio（%）
Main Building	South-east	80,8000	75,800	93.8
	South-west	32,300	31,100	96.3
Poly-Clinic Building	South-south-west	84,800	83,500	98.5
Steel Frame Structure (proposed parking area)	South-west	113,100	109,000	96.4
Total		311,000	299,400	96.8

Note: Calculation of annual power generation has been made by using the simulation software called “RET Screen” which developed by Canadian government in condition of Chisinau.

Source: Prepared by JICA Preparatory Survey Team

(4) Place for installation of data management and monitoring instruments and display

As for the place of installation of the data management and monitoring instruments and a display (50 inch), the following locations were selected as most appropriate locations for the maintenance thereof and publicity through discussion with representatives from OI:

1) Data management and monitoring instruments:
Existing staff room for maintenance staff (electrical works and equipment) to be renovated as "Monitor Room", Basement floor of the Main building

2) Display:
Main entrance hall, Ground floor of the Main building

The above-mentioned existing staff room has no finishing on walls and ceiling has exposed drainage pipes etc, and therefore, the room shall be renovated as "Monitor Room" having appropriate internal finishing and new entrance door by OI.

(5) Route for buried electrical cables

Electric power of direct current (DC power) generated by the PV modules will be converted to electric power of 400V alternate current (AC power) by the power conditioners contained in the outdoor housing which will be installed in the vicinity of three (3) different locations where the PV modules are installed; 1) the roof-top of the main building, 2) the roof-top of the polyclinic building and 3) the steel frame structure to be erected on vacant lot (proposed parking area). Then, the said 400V AC power will be connected with buried cables to the low voltage distribution panel to be provided and installed at outside of the existing substation.

As for the routes for the cables to be laid in buried conduit pipes which will be laid between the low voltage distribution panel and outdoor housings contain the power conditioners, JICA Preparatory Survey Team surveyed location of all existing buried electrical and communication cables and buried water supply pipes and drainage pipes, and so on then established most appropriate routes for the said underground cables which will not interfere with the existing buried cables and so on.

The above-mentioned cables to be laid in buried conduit pipes which shall be laid at a minimum depth of 60cm below ground surface in principle. In addition, where the external walls of the existing buildings can be used for laying cables, the cables will be laid in exposed conduit pipes fixed to the said external walls.

Routes for the cables to be laid in the buried conduit pipes and cables to be laid in exposed conduit pipes fixed to the external walls have been explained to the representatives of OI on the spots during 2nd preparatory survey and agreed by them accordingly.

(6) Route for electrical cables to be pulled down from roof-top along external wall

As for the cables to be laid between PV modules which will be installed at roof-top of the existing main building and poly-clinic building and power conditioners contained in the outdoor housings which will be installed on the ground, it was first considered to utilize the existing electrical pipe shaft (EPS). However, it was finally decided to pull down the cables from roof-top of the existing buildings along external walls since works involving boring into concrete structure which will be associated with disturbing noise is inevitable and a part of the OI may have to be closed during its work as well as piping work etc which will disturb the management and operation of the hospital facilities.

Moreover, an appropriate method of laying the above-mentioned cables including the installation of the cable racks or so along the external walls of the existing building shall be carefully studied in order to minimize the extent of the damages since the said existing buildings are quite old and deteriorated and finishing materials of the external walls may lift and/or fall off during installation of the cable racks or so.

(7) System plan

Design conditions for the PV system are as follows:

1) Meteorological conditions

Meteorological conditions for planning and outline design of the PV system shall be complied with "Section 2-2-1-2 Policy for natural conditions" and the engineering practice in Moldova shall also be taken into consideration. (Refer to the following data)

a. Air temperature (meteorological data for the year 2006, 2007 and 2008)

1) Annual Mean	:	11.2℃
2) Maximum mean (August)	:	36.7℃ Max: 39.5℃ (July 2007)
3) Minimum mean (January)	:	-18.5℃ Min: -24.2℃ (January 2006)
4) Average in summer (August)	:	23.4℃(August)
5) Average in winter (January)	:	-1.4℃ (January)
6) Design outdoor temperature	:	Based on product standard

b. Air humidity (2008)	:	Monthly mean in August R.H.57.7% Annual mean R.H.68.3%
c. Wind velocity (2008)	:	Annual mean 2.2 m/sec.

Maximum 21.0m/ s (June 2008)

d. Precipitation : Annual mean 503.3mm

Daily maximum 33.0mm

e. Snow load : Daily maximum 26.0cm

f. Freeze depth : 80.0cm

2) Condition of electrical requirement

Since the PV system to be procured and installed for the Project is proposed to be a grid-connected system without reverse power flow, it is necessary to conclude an agreement between the Implementing Agency of the Project i.e. the OI and RUF which manages and maintains the grid. And consequently, OI has sent a letter dated 9th of February 2010 to RUF requesting their agreement in principle in this regard and in return RUF sent their agreement in writing with their letter dated 10th of February 2010 which was confirmed during the 3rd Preparatory Survey.

It was confirmed through the discussions with RUF that the OI made a low voltage power supply contract i.e. 400/230V with RUF and their responsibility is only secondary side of the transformers. On the other hand, RUF requested the Team that the output power from the PV system shall be consistent and synchronized with the one distributed by them. The Team explained to RUF that the PV system will be designed in conformity with the electrical characteristics of the power being supplied by RUF which are as follows:

a. High tension power supply

10 KV 50Hz 3Phase No earthing

b. Low voltage power supply

- Voltage 400V/230V 4-wires
- Frequency 50Hz
- Voltage range ±10%
- Frequency range ±0.01%

Since the above-mentioned electrical supply conditions indicate a steady fluctuation range, the electrical equipment to compose the PV system shall meet the following design conditions that reflect transient fluctuation range:

- Steady voltage range ±10%
- Instantaneous voltage range ±15%
- Steady frequency range ±0.01%
- Instantaneous frequency range ±0.05%

3) System requirement for PV system

Operation and control of the PV system shall be as follows:

a. PV modules convert sunlight to electricity with direct current and feed it to power conditioners.

b. Power conditioners convert this direct current power into an alternating current power that shall synchronize with the voltage, frequency and phase of the grid to be connected. Then the alternating power converted by power conditioners will be distributed to the electrical load in the premise.

c. If the power generated by the PV system exceeds the power demand of the premise, the power conditioners will shut off the connection between the grid and itself at low voltage side by RPR.

d. Power conditioners shall be incorporate with protective functions that will shut off the connection between the grid and itself in case of its own faults and failures of the grid.

e. Data management and monitoring system shall monitor the performance of the PV system and record its operating data.

4) Operation of power conditioners

Power conditioners shall run and stop automatically in the following manners:

a. Power conditioners shall keep monitoring the performance of PV modules and automatically start when the output voltage of the PV modules reaches the set value.

b. Power conditioners shall automatically stop when either output voltage or power generated by the PV modules comes down to below the set value.

c. In principle, PV system shall distribute its generated power during daytime only. PV system shall automatically stop its power distribution in case of the shortage of sunlight.

d. When the performance of PV system recovers, power conditioners shall resume its operation automatically after a specified period of delay time in order to avoid an excess in runs and stops.

e. In case the electrical system to be connected to the PV system has accidents or power conditioners themselves fail, PV system shall automatically shut down and disconnect the electrical system immediately.

f. When an accident takes place in the grid to be connected to the PV system, PV system shall shut down. When the grid recovers, it shall restart automatically after specified period of delay time.

5) Protective measures for Grid-connected PV system

In Moldova, there is no regulation or guideline with regard to grid-connected PV system. And therefore, protective measures for the grid-connected PV system for the Project are planned in accordance with "Quality Assurance Guidelines Relating to Power System Integration Requirements" and "Grid-Interconnection Code" of Japan. Protection relays shall be provided and descriptions thereof are as shown in Table 2-15 below:

Table 2-15 Schedule of Protection Relays

Type of Protection Relay	No. of Phase	Detecting Location
1. Reverse Power Relay (RPR) Activation Value: 0.25 to 10% (5 stages +) Activation Time: 0.1 to 10 seconds (5 stages +)	1 phase	Inside Existing Low Voltage Distribution Panel
2. Over Voltage Relay (OVR) Activation Value: 105-110-115-120% Activation Time: 0.5-1.0-1.5-2.0 seconds	1 phase	Inside Power conditioner
3. Under Voltage Relay (UVR) Activation Value: 95-90-85-80% Activation Time: 0.5-1.0-1.5-2.0 seconds	3 phases	
4. Over Frequency Relay (OFR) Activation Value: 100.3-100.5-101-102% Activation Time: 0.5-1.0-1.5-2.0 seconds	1 phase	
5. Under Frequency Relay (UFR) Activation Value: 99.7-99.5-99-98% Activation Time: 0.5-1.0-1.5-2.0 seconds	1 phase	
6. Detection of individual run (Passive・Active) Activation Value: 3-5-7-9 times Activation Time: 0.35-0.7-1.5-3.0 seconds	—	

Source : Prepared by JICA Preparatory Survey Team

6) Grounding work

In Moldova, TN-C system in compliance with the relevant IEC standard is adopted for grounding of electrical system and equipment; thus, neutral line and grounding line are installed as one common line.

Components of the PV system which are required to be grounded are power conditionaers, steel supporting frames for PV modules, connection and collection boxes, and so on. According to the "Japanese Electrical Standard", grounding resistance for such componets shall be less than less than 10 (ten) ohms. Thus, the PV system shall be designed to be connected with the existing grounding conductor in order to assure grounding resistance of less than 10 (ten) ohms.

7) Seismic Restraint

Calculation of seismic restraints for anchorages of equipment shall be made in accordance with "Guidelines for Design and Installation for Seismic Restraints of Equipment 2005" issued by Ministry of Land and Transportation, Japan.

(8) System Description

Based on the aforementioned equipment planning, facility planning and system analysis, the proposed PV system shall be planned as follows:

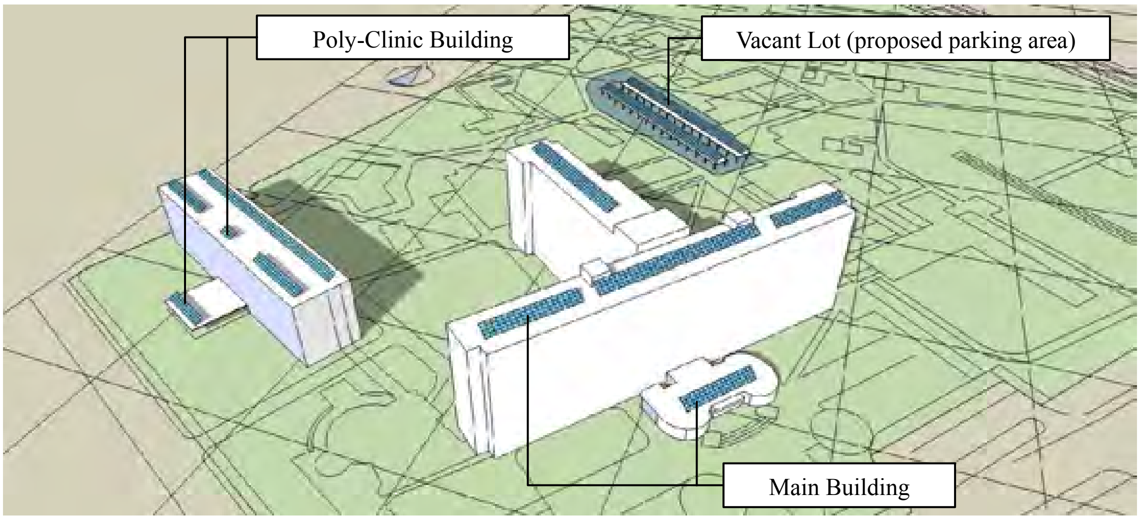
Table 2-16 System Description

Implementing Agency	Oncology Institute
Candidate Site	The roof of Main building, the roof of Polyclinic building and vacant space in the Oncology Institute
Location	Educational and Medical area in Chisinau (Capital city of Moldova)
Land Owner	Oncology Institute
License Holder	Oncology Institute
Rating Capacity	250kWp
Expected Amount of Power Generation[6]	Approx. 299,400kWh
Amount of reduction of carbon dioxide (CO_2)[7]	Approx. 139.3tons
Area of Installation	Approx.9,100 ㎡（On the roofs：5,140m^2、On the ground：3,960m^2）
Expected Consumers	Utility power for the Oncology Institute

Source：Prepared by JICA Preparatory Survey Team

6 Expected amount of power generation has been calculated by using Canadian Government Simulation Software called "RET Screen".

7 Amount of reduction of carbon dioxide is calculated based on the data provided by NEDO (refer to Chapter 3 for details)



Source：Prepared by JICA Survey team

Fig. 2-7 Image of PV System Installation

2-2-2-2 Equipment plan

Specifications for the equipment to be provided for the Project with its corresponding quantity and uses which have been prepared based on examinations and analysis described in Section 2-2-2-1 “Formulation of basic plan” is as shown in Table 2-17 below:

Table 2-17 Specification and Use of Planned Equipment

Item	Specification	Qty	Uses
PV modules	Mono or poly-crystalline or Mono-crystalline and Amorphous Hybrid type with rating capacity of 250kWp or more	1 lot	To transform solar light to electricity.
Supporting structures for PV modules	Hot-dipped galvanized steel frames	1 lot	Supporting frame to fix PV modules which will be placed on concrete slab foundation.
Power conditioners	Rating capacity of 250kW or more and output voltage shall be 400V	1 lot	To convert direct current power generated by PV modules to alternating current power and to be with protective function for grid-connected PV system
Connection boxes	Devices to be installed: DC circuit breakers, By-pass current diodes, Protector for induced lightning stroke (ZNR), Terminal block etc. Ingress protection rating: not less than IP53	1 lot	To collect DC power generated by PV modules and to feed it to collection box
Collection boxes	Device to be installed: DC circuit breakers Ingress protection rating: not less than IP53	1 lot	To collect DC power from connection boxes by putting it together systematically and feed it to power conditioner
Data management and monitoring system (incl. personal computer)	・Personal computer ・CRT（19 inch or bigger） ・Data sensing instruments ・Signal transmitter ・UPS（more than 10 minutes capacity） ・Color printer (compatible with A3 size printing) ・Software for data monitoring ・Software for display	1 lot	To track the amount of generated power, input and output voltage to and from power conditioners, solar radiation and air temperature as well as to record and display them in the specified format to be set, and in addition, it shall keep monitoring of the performance of the whole PV system and shall control operation of display system.
Meteorological observation instruments	Solar radiation meter	1 No.	To observe solar radiation.
	Thermometer	1 No.	To observe air temperature.
Display	Flat panel 50 inch or bigger（Liquid crystal or PDP）	1 No.	To indicate the amount of generated power (present, daily, monthly and annual), meteorological data (air temperature, solar radiation), the expected reduction of carbon dioxide gas and general description of the PV system.
Low voltage distribution panel	Water proofed, outdoor self-standing type of steel sheet made	1 lot	To connect power generated by PV System to existing substation through power conditioner.

Source: Prepared by JICA Preparatory Survey Team

2-2-3 Equipment List and Basic Design Drawing

The equipment which has been planned based on the examination and analysis that described in Section 2-2-2 “Basic plan (Equipment plan)” and outline design drawings such as schematic diagram of PV system; general arrangement plan for PV system and plans for steel frame structure and so on are described hereinafter.

(1) Schedule of planned equipment

The schedule of planned equipment is as shown in Table 2-18 below.

Table 2-18 Schedule of planned equipment

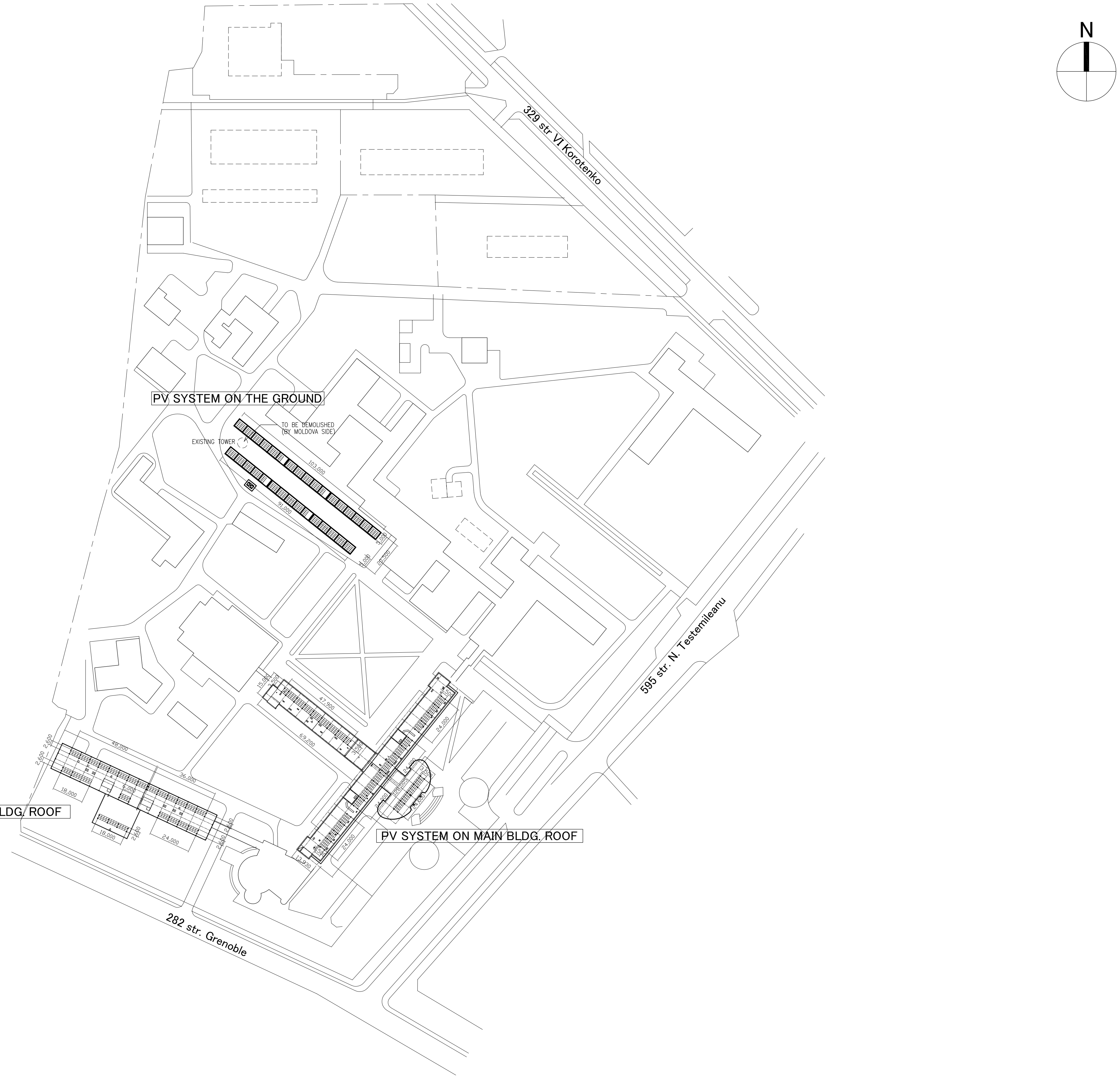
No.	Item	Specification	Quantity	Location
EQ-01-1	PV modules	Mono/poly-crystalline or Mono-crystalline and Amorphous Hybrid type with rating capacity of 90kWp or more	1 lot	Roof-top Main building
EQ-02-1	Supporting structures for PV modules	Hot-dipped galvanized steel frames	1 lot	Roof-top Main building
EQ-03-1	Power conditioners	Rating capacity of 90kW or more (more than 2 units) and output voltage shall be 400V	1 lot	Outside Main building
EQ-04-1	Connection boxes	Device to be installed: DC circuit breakers, etc.	1 lot	Outside
EQ-05-1	Collection boxes	Device to be installed: DC circuit breakers	1 lot	Outside
EQ-01-2	PV modules	Mono/poly-crystalline or Mono-crystalline and Amorphous Hybrid type with rating capacity of 65kWp or more	1 lot	Roof-top Poly-clinic building
EQ-02-2	Supporting structures for PV modules	Hot-dipped galvanized steel frames	1 lot	Roof-top Poly-clinic building
EQ-03-2	Power conditioners	Rating capacity of 65kW or more (more than 2 units) and output voltage shall be 400V	1 lot	Outside Poly-clinic building
EQ-04-2	Connection boxes	Device to be installed: DC circuit breakers, etc.	1 lot	Outside
EQ-05-2	Collection boxes	Device to be installed: DC circuit breakers	1 lot	Outside
EQ-01-3	PV modules	Mono/poly-crystalline or Mono-crystalline and Amorphous Hybrid type with rating capacity of 95kWp or more	1 lot	Top of steel frame structure on ground
EQ-02-3	Supporting structures for PV modules	Hot-dipped galvanized steel frames	1 lot	Top of steel frame structure on ground
EQ-03-3	Power conditioners	Rating capacity of 95kW or more (more than 2 units) and output voltage shall be 400V	1 lot	Outside steel frame structure on ground
EQ-04-3	Connection boxes	Device to be installed: DC circuit breakers, etc.	1 lot	Outside
EQ-05-3	Collection boxes	Device to be installed: DC circuit breakers	1 lot	Outside
EQ-06	Data management and monitoring system (incl. personal computer)	・Personal computer ・CRT（19 inch or bigger） ・Data sensing instruments ・Signal transmitter ・UPS（more than 10 minutes capacity） ・Color printer (compatible with A3 size) ・Software for data monitoring ・Software for display	1 lot	Monitor room Main building (BF)
EQ-07	Meteorological observation instruments	Solar radiation meter	1 No.	Roof-top, Main bldg.
EQ-08		Thermometer	1 No.	Roof-top, Main bldg.
EQ-09	Display	Flat panel 50 inch or bigger (Liquid crystal or PDP)	1 No.	Main entrance lobby Main building
EQ-10	Low voltage distribution panel	Water proofed, outdoor self-standing type of steel sheet made	1 lot	Outside Existing substation

Source: Prepared by JICA Preparatory Survey Team

(2) Outline design drawing

See attached following outline design drawings.

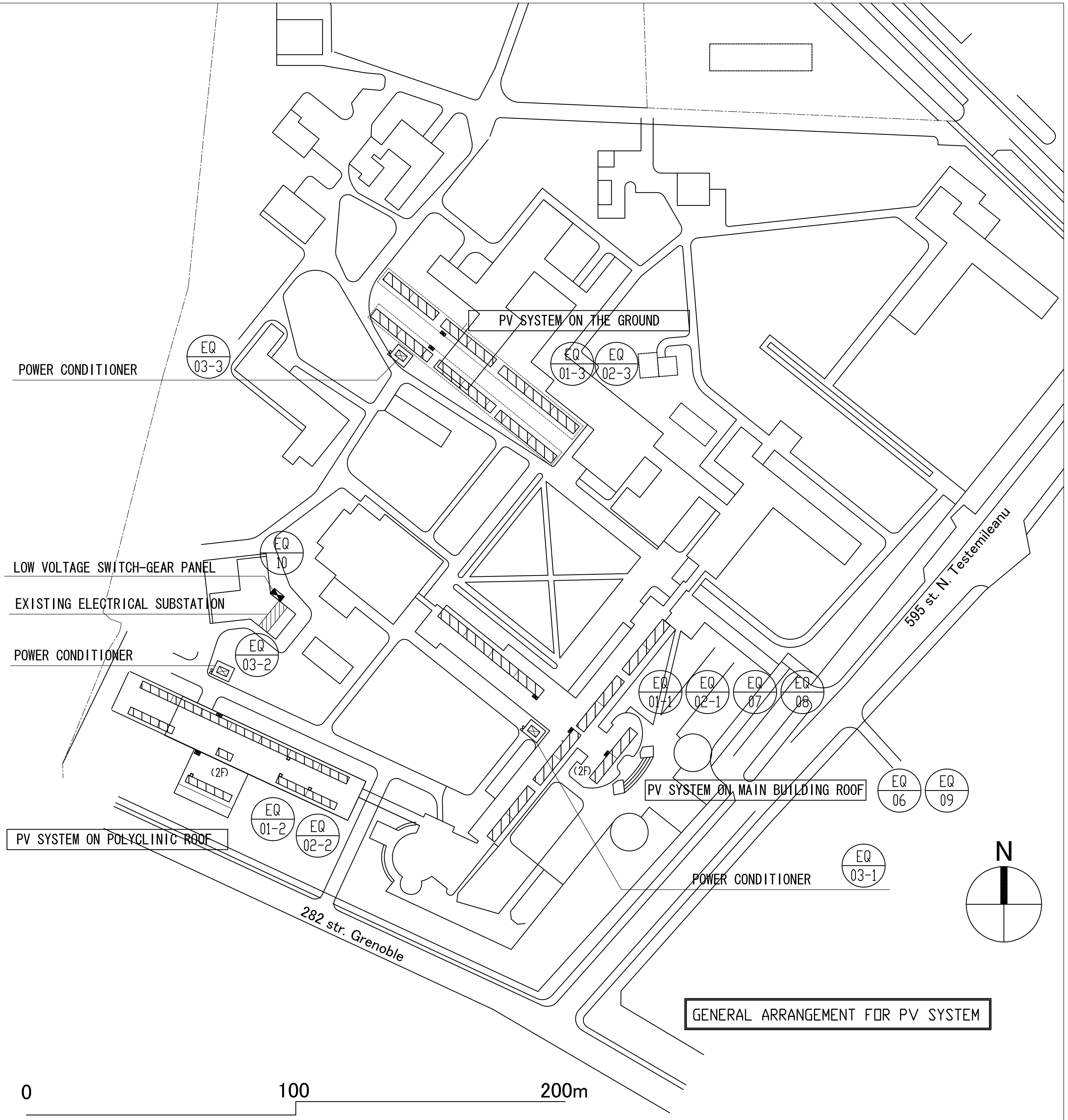
PV-00	Site Layout Plan
PV-01	Equipment Schedule for PV System ＆ General Arrangement for PV System
PV-02	Exterior Wiring Plan for PV System
PV-03	Main Building Roof Plan for PV System
PV-04	Poly-Clinic Roof Plan for PV System
PV-05	Ground Floor Plan for PV System
PV-06	Schematic Diagram for PV System
PV-07	Single Line Diagram for PV System
PV-10	Lightning Protection System for Main Building Roof Plan
PV-11	Lightning Protection System for Poly-Clinic Roof Plan
PV-12	Lightning Protection System for Ground Floor Plan
PV-13	Layout for Existing Electrical Substation
PV-14	Single Line Diagram for Existing Electrical Substation
A-01	Site Area
A-02	Section



PROJECT TITLE: THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA	GENERAL NOTE	NO / DATE / DESCRIPTIONS / BY / APP'D — REVISIONS	SCALE: 1/2,500	DATE: MAR. 2011	DWG TITLE: SITE LAYOUT PLAN	DWG NO: PV-00
			DRAWING BY	CHECKED BY	DESIGNED BY: ORIENTAL CONSULTANTS CO., LTD.	

EQUIPMENT SCHEDULE OF PLANNED EQUIPMENT

NO.	ITEM	SPECIFICATION	QUANTITY	LOCATION
EQ－01-1	PHOTOVOLTAIC MODULES	MONO OR POLY－CRYSTALLINE CELLS WITH RATING CAPACITY OF NOT LESS THAN 90 KWP	1LOT	ON THE ROOF OF THE MAIN BUILDING
EQ－02-1	SUPPORTING STRUCTURES FOR PV MODULES	HOT-DIPPED GALVANIZED STEEL FRAMES	1LOT	ON THE ROOF OF THE MAIN BUILDING
EQ－03-1	POWER CONDITIONERS	RATING CAPACITY OF NOT LESS THAN 90KW AND OUTPUT VOLTAGE SHALL BE 400V	1LOT	OUTSIDE THE MAIN BUILDING MORE THAN TWO (2) UNITS
EQ－01-2	PHOTOVOLTAIC MODULES	MONO OR POLY-CRYSTALLINE CELLS WITH RATING CAPACITY OF NOT LESS THAN 65 KWP	1LOT	ON THE ROOF OF THE POLYCLINIC BUILDING
EQ－02-2	SUPPORTING STRUCTURES FOR PV MODULES	HOT-DIPPED GALVANIZED STEEL FRAMES	1LOT	ON THE ROOF OF THE POLYCLINIC BUILDING
EQ－03-2	POWER CONDITIONERS	RATING CAPACITY OF NOT LESS THAN 65KW AND OUTPUT VOLTAGE SHALL BE 400V	1LOT	OUTSIDE THE POLYCLINIC BUILDING MORE THAN TWO (2) UNITS
EQ－01-3	PHOTOVOLTAIC MODULES	MONO OR POLY－CRYSTALLINE CELLS WITH RATING CAPACITY OF NO LESS THAN 95 KWP	1LOT	OUTSIDE
EQ－02-3	SUPPORTING STRUCTURES FOR PV MODULES	HOT-DIPPED GALVANIZED STEEL FRAMES	1LOT	OUTSIDE
EQ－03-3	POWER CONDITIONERS	RATING CAPACITY OF NOT LESS THAN 95KW AND OUTPUT VOLTAGE SHALL BE 400V	1LOT	OUTSIDE MORE THAN TWO (2) UNITS
EQ－06	DATA MANAGEMENT AND MONITORING SYSTEM (INCL. PERSONAL COMPUTER)	・PERSONAL COMPUTER ・CRT(19 INCH OR BIGGER) ・DATA SENSING INSTRUMENTS ・SIGNAL TRANSMIT R ・UPS(MORE THAN 10 MINUTES CAPACITY) ・COLOR PRINTER (COMPATIBLE WITH A3 SIZE) ・SOFTWARE FOR DATA MONITORING ・SOFTWARE FOR DISPLAY	1LOT	IN THE MONITOR ROOM ON THE BASEMENT FLOOR OF THE MAIN BUILDING
EQ－07	METEOROLOGICAL OBSERVATION INSTRUMENTS	SOLAR RADIATION METER	1NO.	ON THE ROOF OF THE MAIN BUILDING
EQ－08		THERMOMETER	1NO.	ON THE ROOF OF THE MAIN BUILDING
EQ－09	DISPLAY	FLAT PANEL 50 INCH OR BIGGER (LIQUID CRYSTAL OR PDP)	1NO.	AT THE ENTRANCE OF THE MAIN BUILDING
EQ－10	DISTRIBUTION PANEL		1LOT	OUTSIDE THE EXISTING ELECTRICAL SUBSTATION

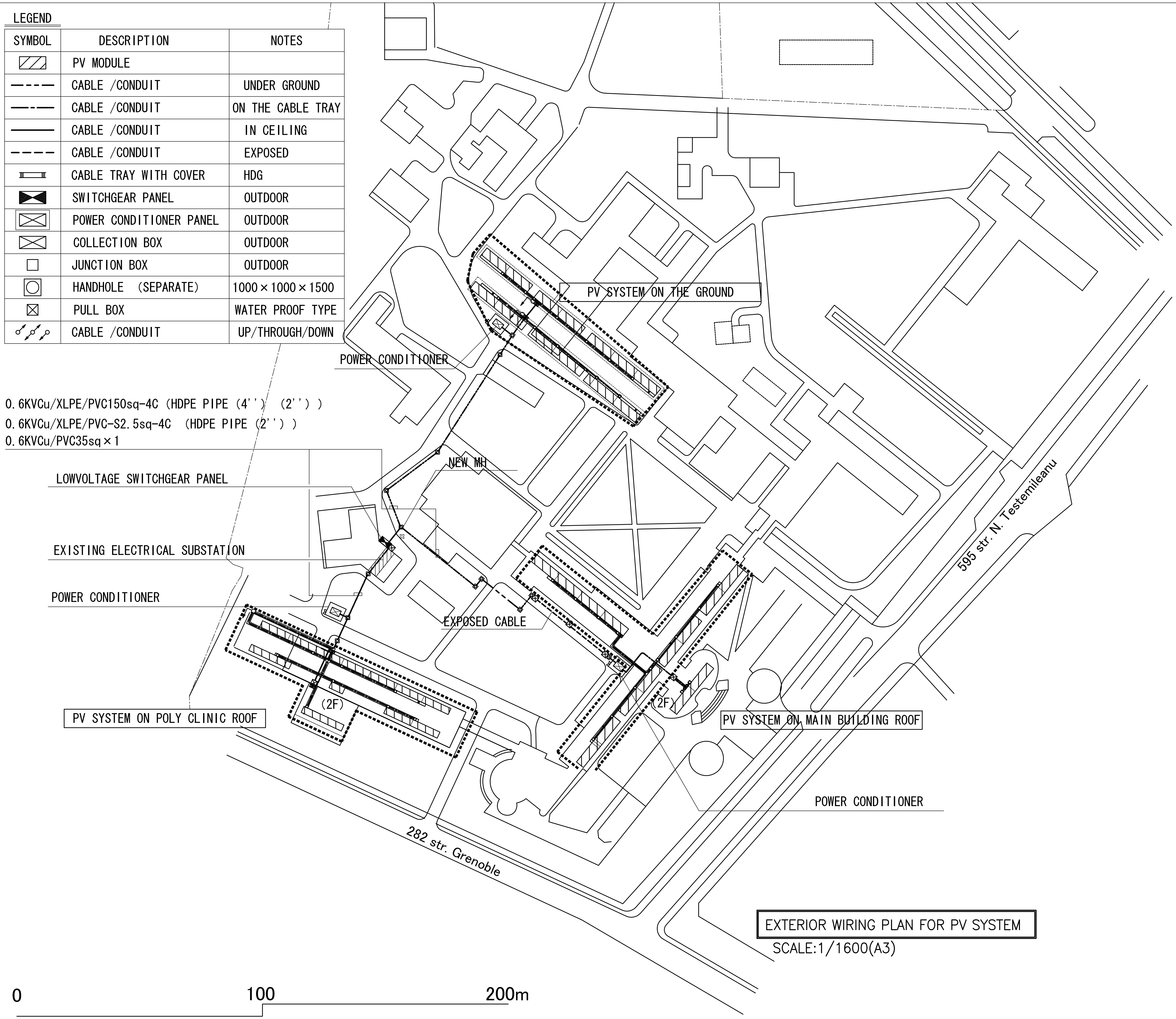


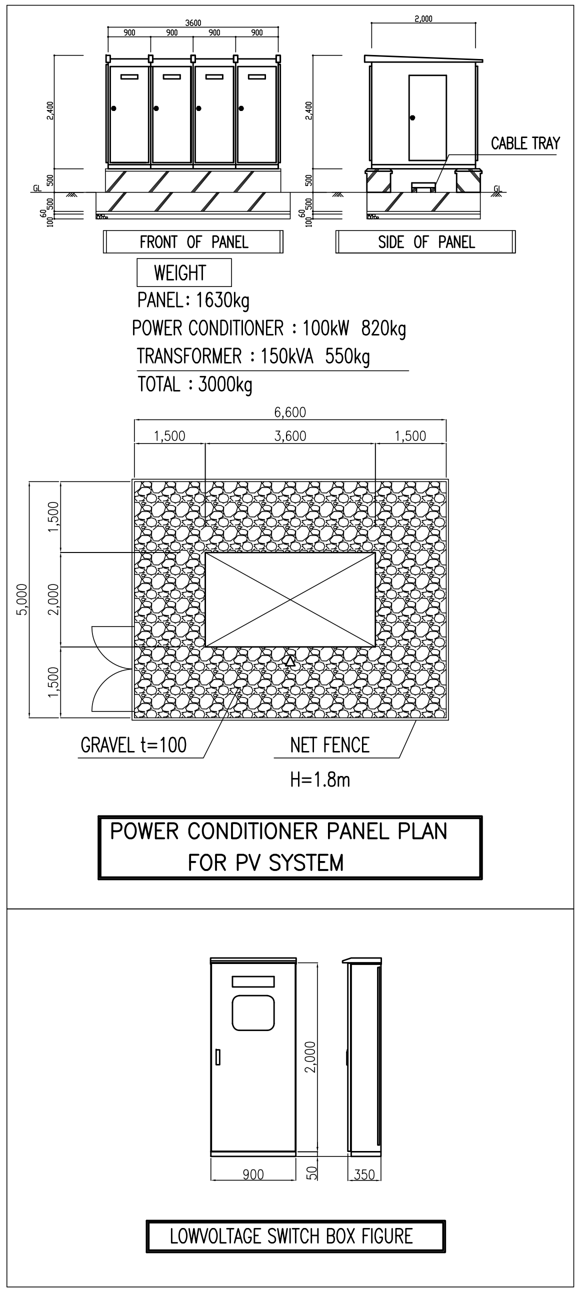
GENERAL ARRANGEMENT FOR PV SYSTEM

PROJECT TITLE	GENERAL NOTE	SCALE	DWG TITLE	DWG NO
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA		A3:1/1600	EQUIPMENT SCHEDULE FOR PV SYSTEM GENERAL ARRANGEMENT FOR PV SYSTEM	PV-01
		DATE MAR. 2011	DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.	
		DRAWING BY		
	NO / DATE / DESCRIPTIONS / BY / APP'D — REVISIONS	CHECKED BY		

LEGEND

SYMBOL	DESCRIPTION	NOTES
(hatched box)	PV MODULE	
(dashed line)	CABLE /CONDUIT	UNDER GROUND
(dash-dot line)	CABLE /CONDUIT	ON THE CABLE TRAY
(solid line)	CABLE /CONDUIT	IN CEILING
(dashed line)	CABLE /CONDUIT	EXPOSED
(tray symbol)	CABLE TRAY WITH COVER	HDG
(filled bowtie)	SWITCHGEAR PANEL	OUTDOOR
(boxed X)	POWER CONDITIONER PANEL	OUTDOOR
(X box)	COLLECTION BOX	OUTDOOR
□	JUNCTION BOX	OUTDOOR
(circle in square)	HANDHOLE (SEPARATE)	1000×1000×1500
⊠	PULL BOX	WATER PROOF TYPE
(arrows)	CABLE /CONDUIT	UP/THROUGH/DOWN





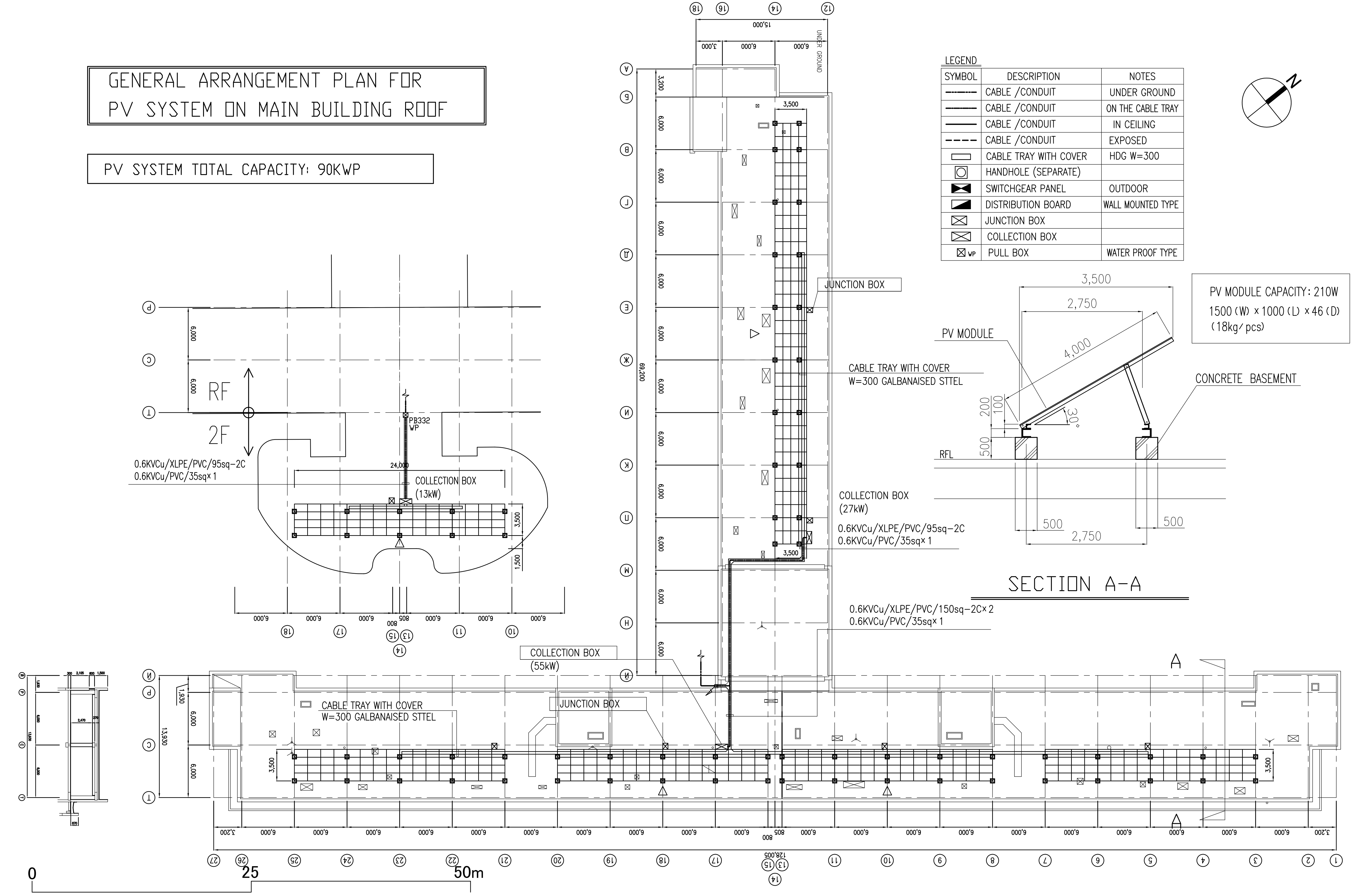
EXTERIOR WIRING PLAN FOR PV SYSTEM

SCALE:1/1600(A3)

PROJECT TITLE	SCALE	DWG TITLE	DWG NO
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA	A3:1/1600	EXTERIOR WIRING PLAN FOR PV SYSTEM	PV-02
GENERAL NOTE	DATE MAR. 2011	DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.	
NO / DATE / DESCRIPTIONS / BY / APP'D — REVISIONS	DRAWING BY / CHECKED BY		

GENERAL ARRANGEMENT PLAN FOR PV SYSTEM ON MAIN BUILDING ROOF

PV SYSTEM TOTAL CAPACITY: 90KWP



LEGEND

SYMBOL	DESCRIPTION	NOTES
	CABLE /CONDUIT	UNDER GROUND
	CABLE /CONDUIT	ON THE CABLE TRAY
	CABLE /CONDUIT	IN CEILING
	CABLE /CONDUIT	EXPOSED
	CABLE TRAY WITH COVER	HDG W=300
	HANDHOLE (SEPARATE)	
	SWITCHGEAR PANEL	OUTDOOR
	DISTRIBUTION BOARD	WALL MOUNTED TYPE
	JUNCTION BOX	
	COLLECTION BOX	
WP	PULL BOX	WATER PROOF TYPE

PV MODULE CAPACITY: 210W
1500 (W) × 1000 (L) × 46 (D)
(18kg/ pcs)

PROJECT TITLE: THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA

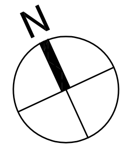
GENERAL NOTE

NO	DATE	DESCRIPTIONS	BY	APP'D

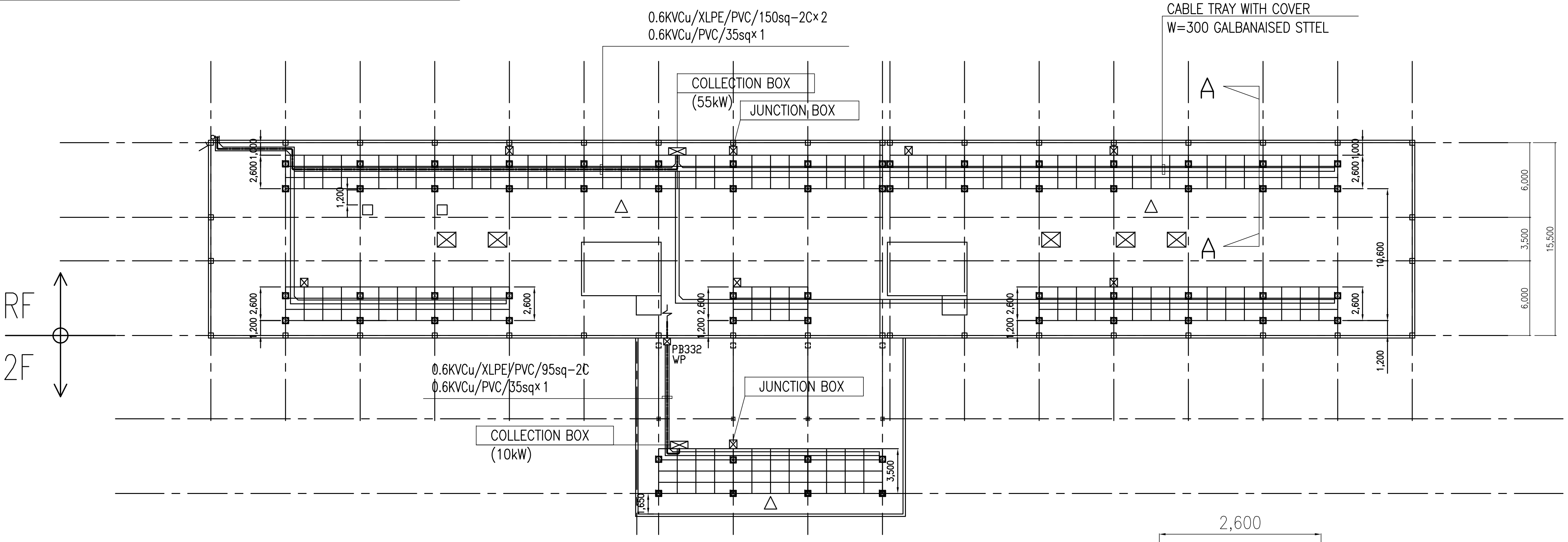
REVISIONS

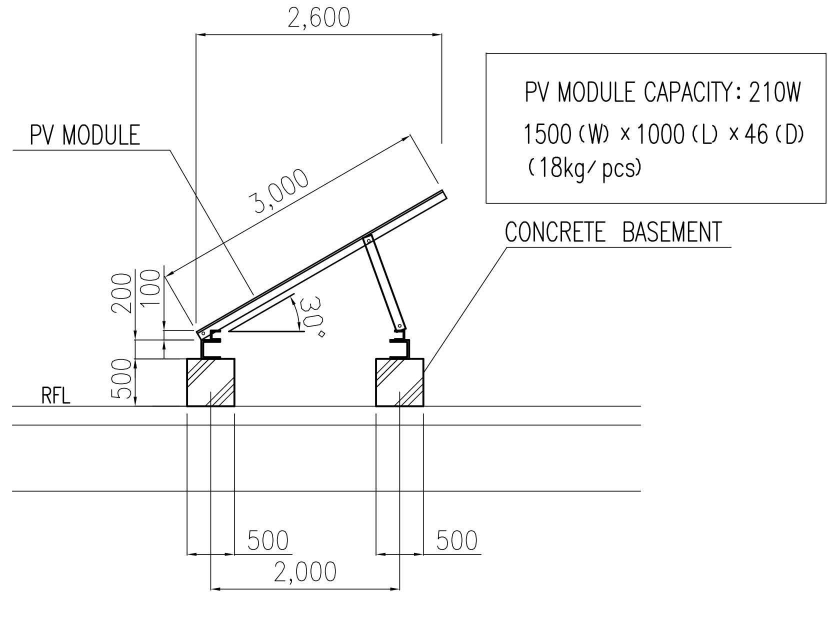
SCALE: A3:1/400
DATE: MAR. 2011
DRAWING BY
CHECKED BY
DWG TITLE: MAIN BUILDING ROOF PLAN FOR PV SYSTEM
DWG NO: PV-03
DESIGNED BY: ORIENTAL CONSULTANTS CO., LTD.

GENERAL ARRANGEMENT PLAN FOR PV SYSTEM ON POLY CLINIC ROOF



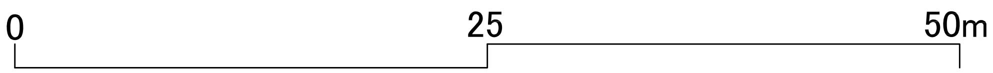
PV SYSTEM TOTAL CAPACITY: 65KWP



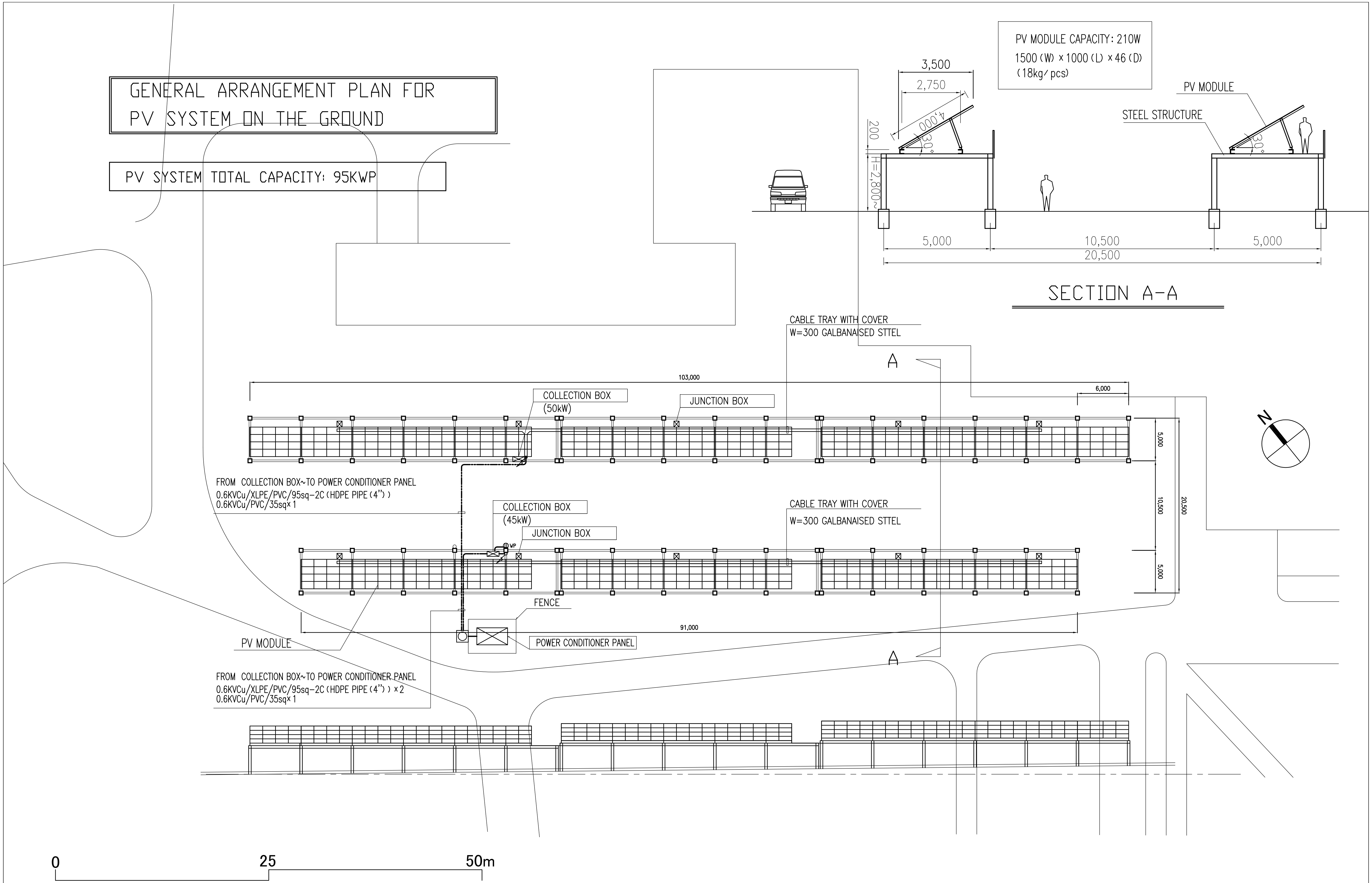


PV MODULE CAPACITY: 210W
1500 (W) × 1000 (L) × 46 (D)
(18kg/ pcs)

SECTION A-A



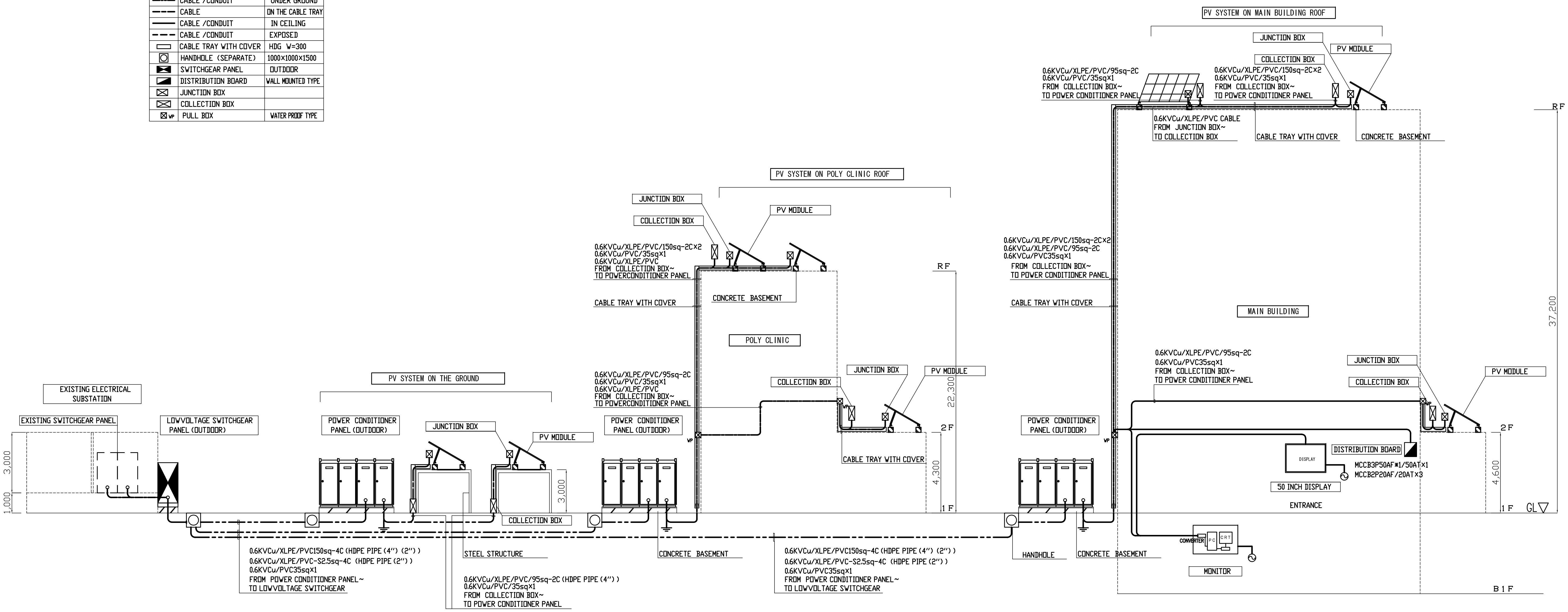
PROJECT TITLE: THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA	GENERAL NOTE	SCALE: A3:1/400	DWG TITLE: POLY-CLINIC ROOF PLAN FOR PV SYSTEM	DWG NO: PV-04
		DATE: MAR. 2011	DESIGNED BY: ORIENTAL CONSULTANTS CO., LTD.	
	NO / DATE / DESCRIPTIONS / BY / APP'D — REVISIONS	DRAWING BY / CHECKED BY		



PROJECT TITLE	GENERAL NOTE	SCALE	DWG TITLE	DWG NO
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA		A3:1/400	GROUND FLOOR PLAN FOR PV SYSTEM	PV-05
		DATE MAR. 2011	DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.	
NO / DATE / DESCRIPTIONS / BY / APP'D — REVISIONS		DRAWING BY / CHECKED BY		

LEGEND

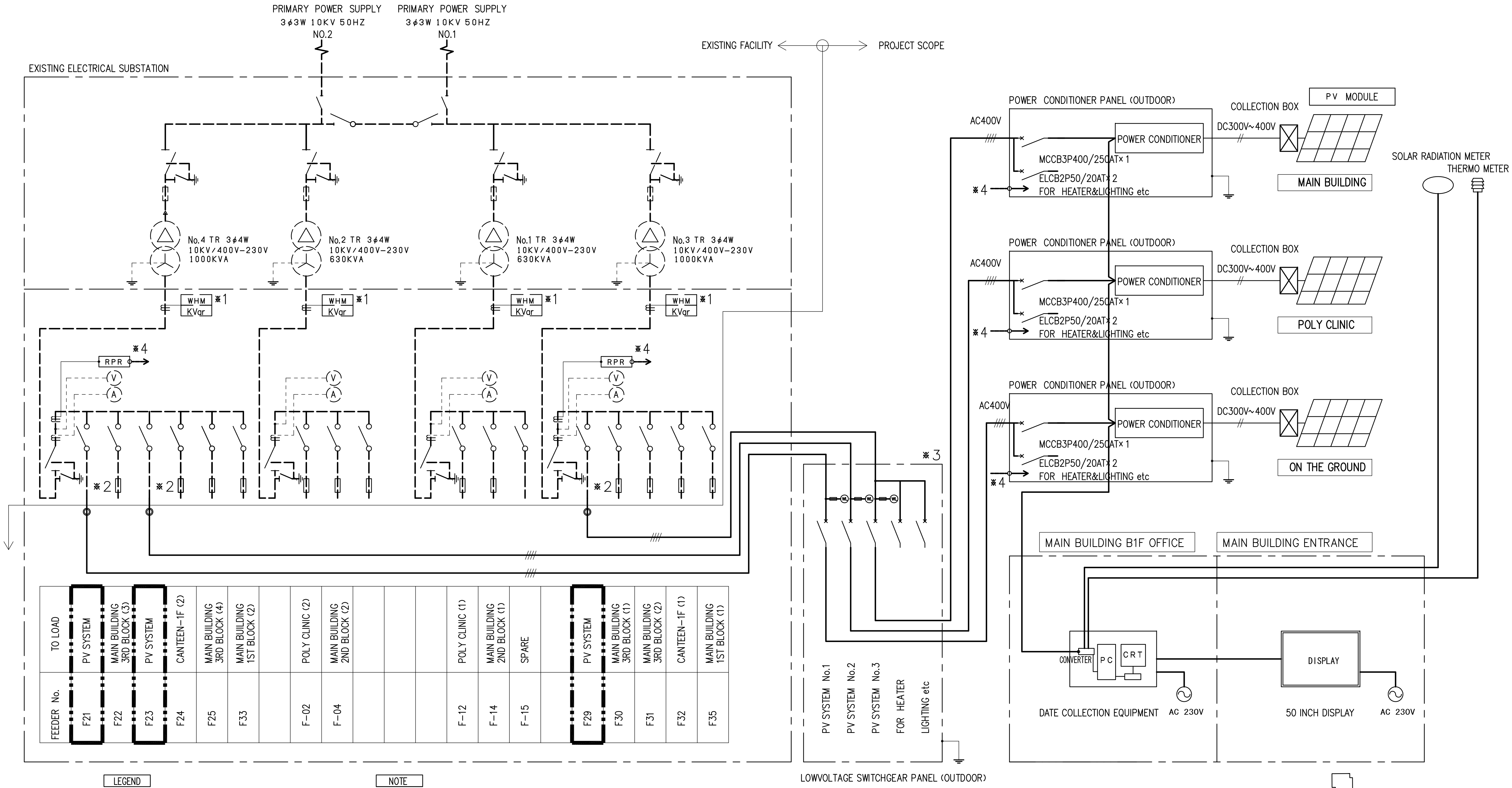
SYMBOL	DESCRIPTION	NOTES
	CABLE /CONDUIT	UNDER GROUND
	CABLE	ON THE CABLE TRAY
	CABLE /CONDUIT	IN CEILING
	CABLE /CONDUIT	EXPOSED
	CABLE TRAY WITH COVER	HDG W=300
	HANDHOLE (SEPARATE)	1000×1000×1500
	SWITCHGEAR PANEL	OUTDOOR
	DISTRIBUTION BOARD	WALL MOUNTED TYPE
	JUNCTION BOX	
	COLLECTION BOX	
VP	PULL BOX	WATER PROOF TYPE



SCHEMATIC DIAGRAM FOR PV SYSTEM

PROJECT TITLE	GENERAL NOTE	SCALE	DWG TITLE	DWG NO
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA		NS	SCHEMATIC DIAGRAM FOR PV SYSTEM	PV-06
		DATE MAR. 2011	DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.	
		DRAWING BY		
		CHECKED BY		

NO	DATE	DESCRIPTIONS	BY	APP'D
		REVISIONS		



LEGEND

SYNBOL	DESCRIPTION
WHM	WATT HOUR METER
KVar	VAR METER
DS	DISCONNECTING SWITCH
V	VOLTMETER
VS	VOLTMETER CHANGE-OVER SWITCH
A	AMMETER
AS	VOLTMETER CHANGE-OVER SWITCH
W	WATTMETER
LBS	LOAD BREAK SWITCH
ZCT	ZERO-PHASE CURRENT TRANSFORMER
ZPD	ZERO-PHASE POTENTIAL DEVICE
OVGR	OVER VOLTAGE GROUND RELAY
RPR	REVERSE POWER RELAY

NOTE

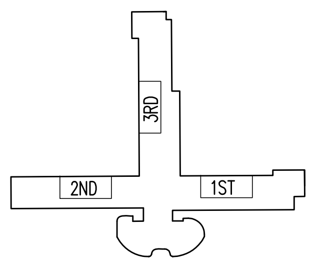
※1 EXISTING PURCHASE METER
(RECEIVING FROM UNION FENOSA)

※2 THE INSTALLAION OF COPPER BAR FOR
CONNECTING TO THE PV SYSTEM CABLE

※3 LOWVOLTAGE SWITCHGEAR PANEL (OUTDOOR)
ELCB3P400AF/250AT×3
ELCB2P50AF/20AT×2
INCLUDE THE SPACE HEATER

※4 RPR PANEL (INDOOR)
(CT1000/5A×2,VT440/110V×4)

SINGLE LINE DIAGRAM FOR PV SYSTEM



EXISTING MAIN BUILDING SWITCH BOX LAYOUT

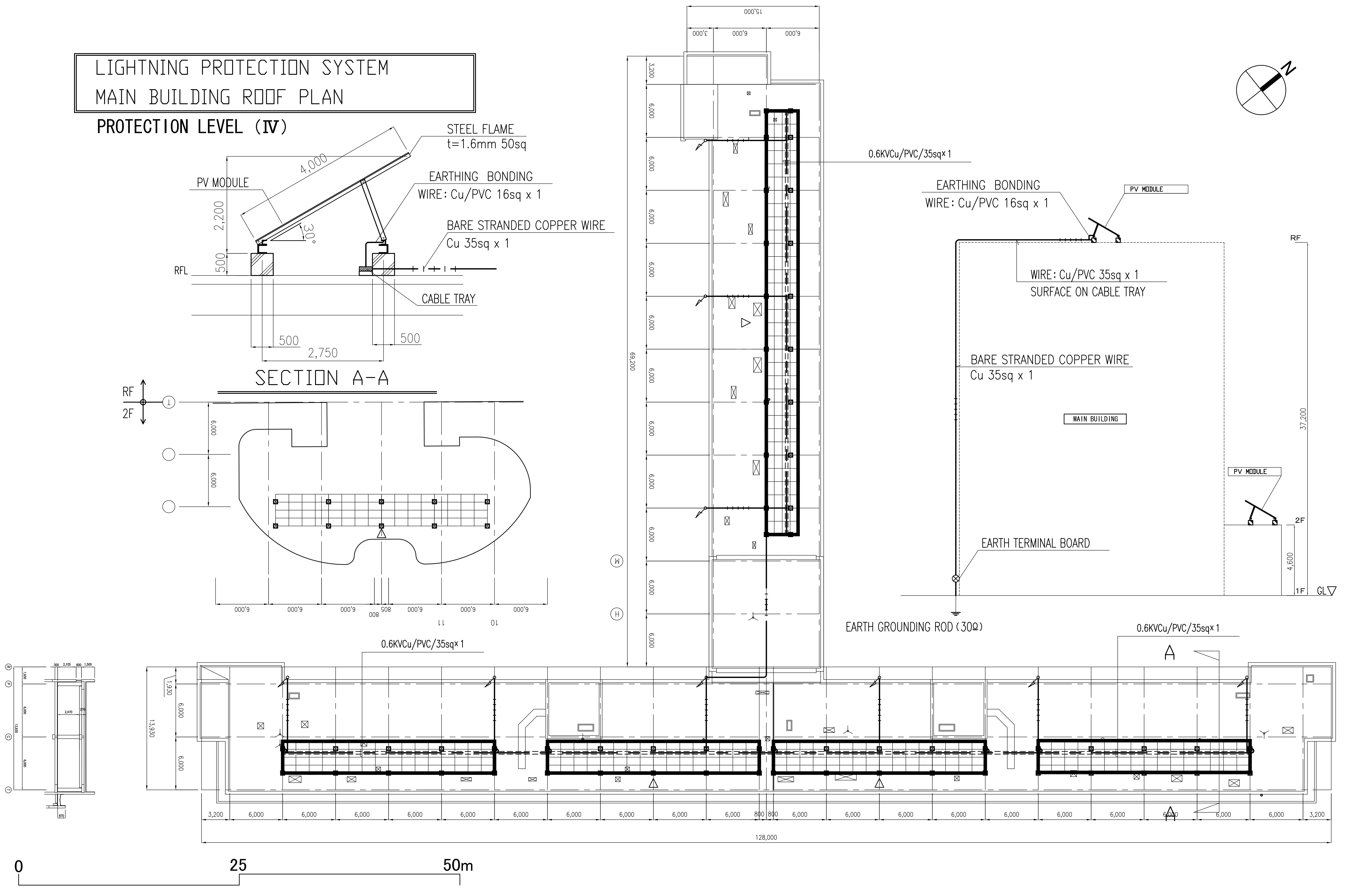
PROJECT TITLE: THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA

GENERAL NOTE

NO	DATE	DESCRIPTIONS	BY	APP'D

REVISIONS

SCALE: NS
DATE: MAR. 2011
DRAWING BY
CHECKED BY
DWG TITLE: SINGLE LINE DIAGRAM FOR PV SYSTEM
DESIGNED BY: ORIENTAL CONSULTANTS CO., LTD.
DWG NO: PV-07

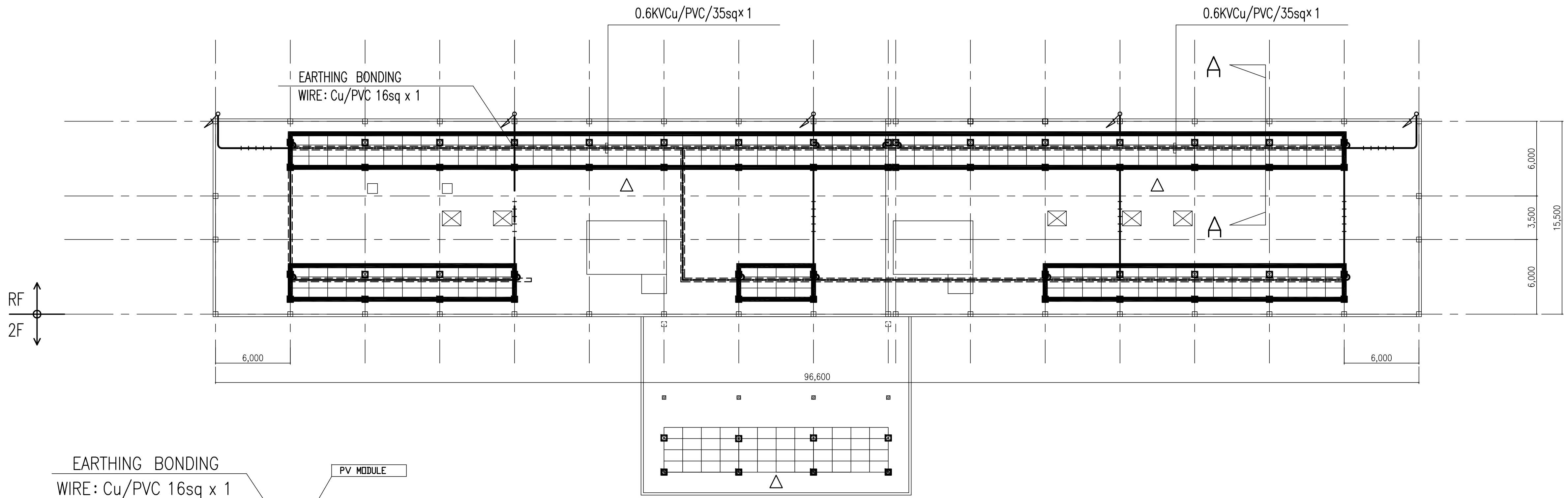


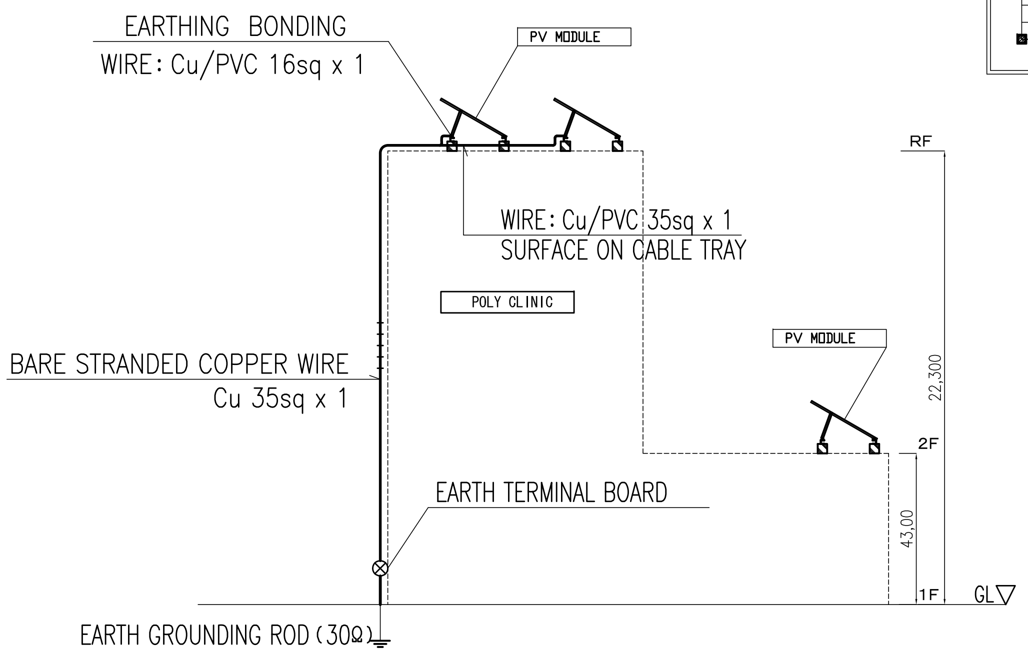
2-47

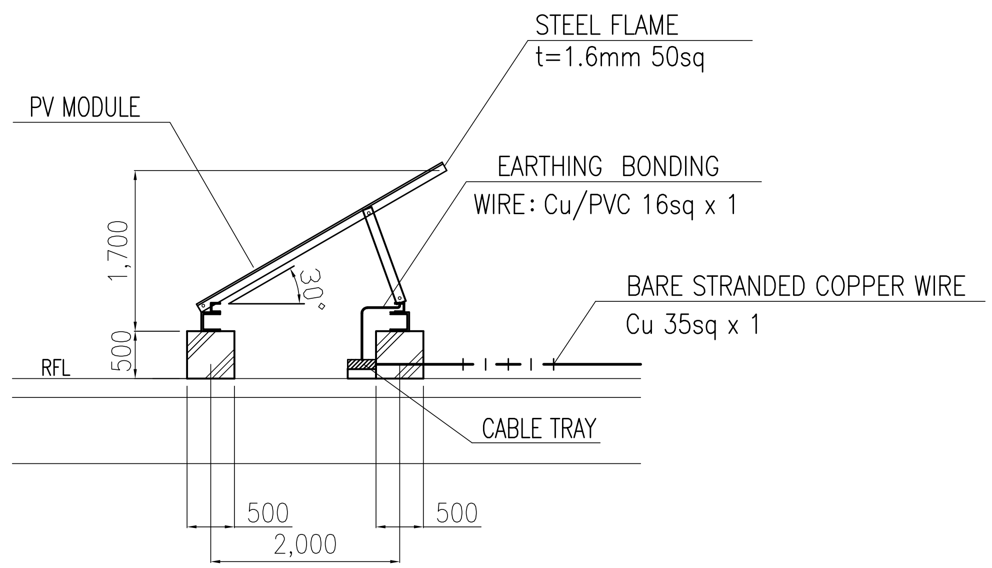
PROJECT TITLE	THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA
SCALE	A3:1/400
DATE	MAR. 2011
DWG TITLE	LIGHTNING PROTECTION SYSTEM FOR MAIN BUILDING ROOF PLAN
DWG NO	PV-10
DESIGNED BY	ORIENTAL CONSULTANTS CO., LTD.

LIGHTNING PROTECTION SYSTEM
POLY CLINIC ROOF PLAN

PROTECTION LEVEL (Ⅳ)





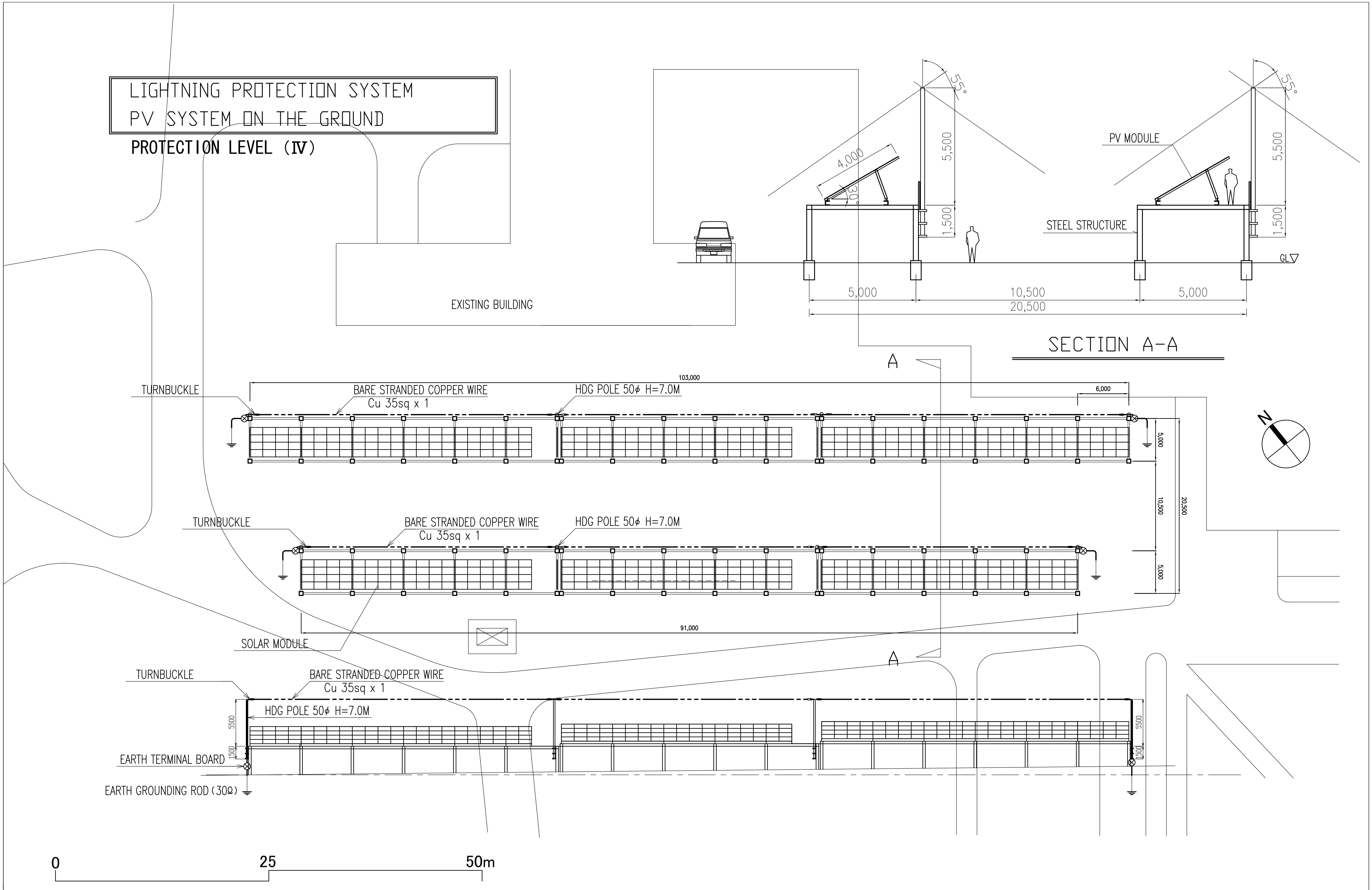


SECTION A-A

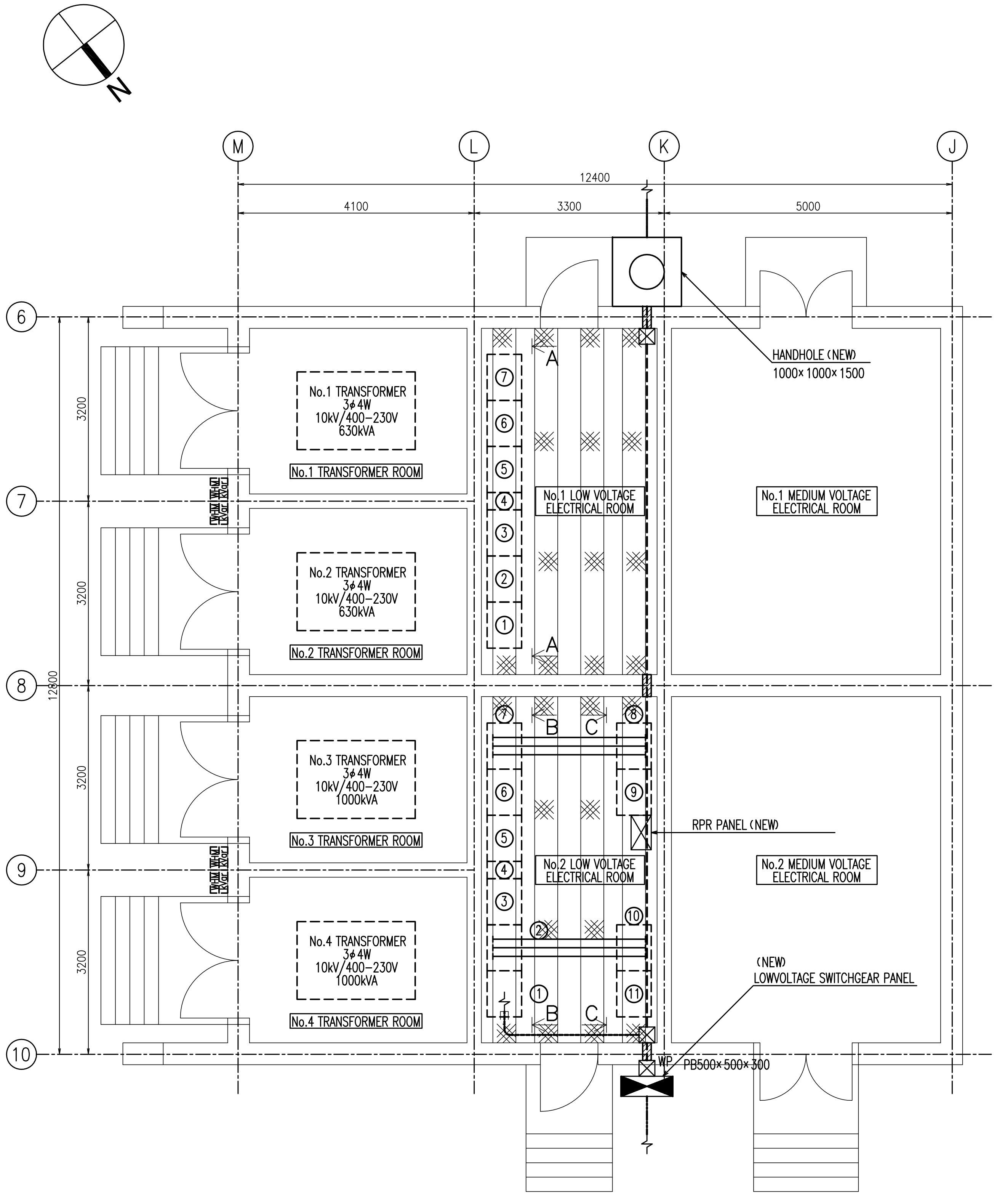
0 25 50m

PROJECT TITLE	GENERAL NOTE	SCALE	DWG TITLE	DWG NO
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA		A3:1/400	LIGHTNING PROTECTION SYSTEM FOR POLY-CLINIC ROOF PLAN	PV-11
		DATE MAR. 2011	DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.	
		DRAWING BY		
		CHECKED BY		

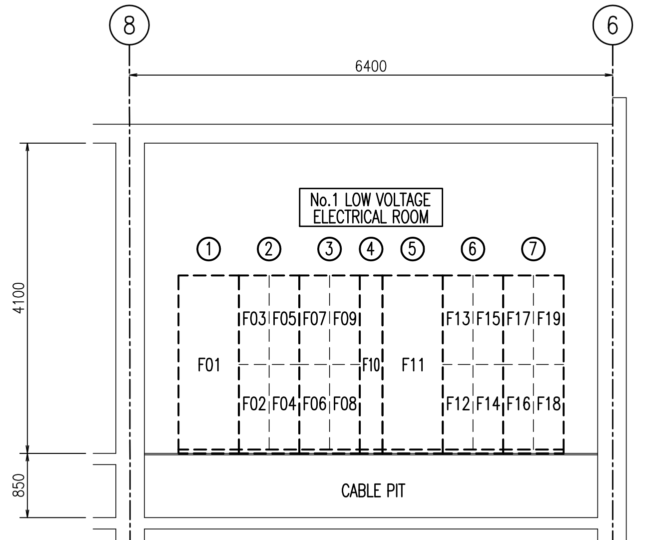
NO	DATE	DESCRIPTIONS	BY	APP'D
		REVISIONS		



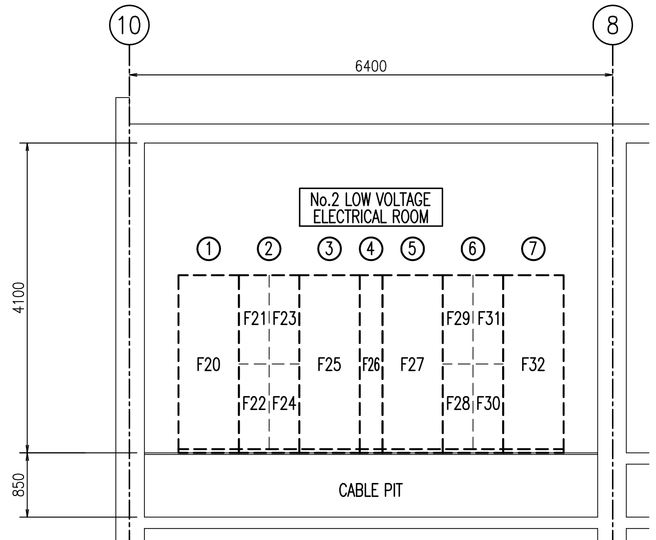
PROJECT TITLE	GENERAL NOTE	SCALE	DWG TITLE	DWG NO
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA		A3:1/400	LIGHTNING PROTECTION SYSTEM FOR GROUND FLOOR PLAN	PV-12
		DATE MAR. 2011	DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.	
	NO / DATE / DESCRIPTIONS / BY / APP'D — REVISIONS	DRAWING BY / CHECKED BY		



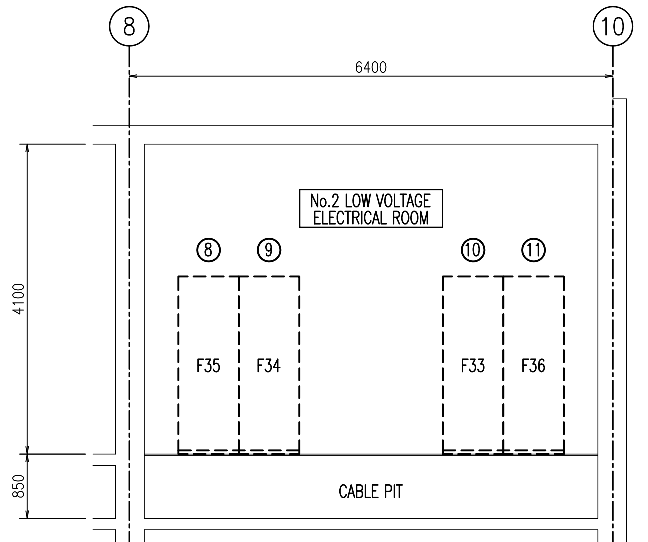
EXISTING ELECTRICAL SUBSTATION



A–A SECTION



B–B SECTION



C–C SECTION

No.1 LOW VOLTAGE ELECTRICAL ROOM EXISTING EQUIPMENT

PANEL No.	FEEDER No.	DESCRIPTION	CABLE CONNECTION	REMARKS
①	F01	No.2 TRANSFORMER INCOMING	AL.BUSBARE IS CONNECTED.	
②	F02	POLY CLINIC (2)	TWO CABLES ARE CONNECTED.	
	F03	OUTDOOR LIGHTING PANEL	ONE CABLE IS CONNECTED.	
	F04	MAIN BUILDING 2ND BLOCK (2)	TWO CABLES ARE CONNECTED.	
	F05	BOILER STATION (2)	ONE CABLE IS CONNECTED.	
③	F06	CANTEEN 1FL BUILDING (2)	ONE CABLE IS CONNECTED.	
	F07	CONFERENCE HOLE (2)	ONE CABLE IS CONNECTED.	
	F08	ENTRANCE HOLE MECHANICAL ROOM (2)	ONE CABLE IS CONNECTED.	
	F09	OUTDOOR CABLE BOX	ONE CABLE IS CONNECTED.	
④	F10	No.2–No.1 BUS COUPLER (N.O)	–	
⑤	F11	No.1 TRANSFORMER INCOMING	AL.BUSBARE IS CONNECTED.	
⑥	F12	POLY CLINIC (1)	TWO CABLES ARE CONNECTED.	
	F13	SPARE	IT IS NOT CONNECTED.	NOT FUSE.
	F14	CANTEEN 1FL BUILDING (1)	ONE CABLE IS CONNECTED.	
	F15	SPARE	ONE CABLE IS CONNECTED.	NOT FUSE.
⑦	F16	ENTRANCE HOLE MECHANICAL ROOM (1)	ONE CABLE IS CONNECTED.	
	F17	CONFERENCE HOLE (1)	ONE CABLE IS CONNECTED.	
	F18	MAIN BUILDING 2ND BLOCK (1)	TWO CABLES ARE CONNECTED.	
	F19	BOILER STATION (1)	ONE CABLE IS CONNECTED.	

No.2 LOW VOLTAGE ELECTRICAL ROOM EXISTING EQUIPMENT

PANEL No.	FEEDER No.	DESCRIPTION	CABLE CONNECTION	REMARKS
①	F20	No.4 TRANSFORMER INCOMING	AL.BUSBARE IS CONNECTED.	
②	F21	SPARE	IT IS NOT CONNECTED.	NOT FUSE.
	F22	MAIN BUILDING 3RD BLOCK (3)	ONE CABLE IS CONNECTED.	
	F23	SPARE	IT IS NOT CONNECTED.	NOT FUSE.
	F24	MAIN BUILDING 3RD BLOCK (4)	TWO CABLES ARE CONNECTED.	
③	F25	CANTEEN 1FL (2)	TWO CABLES ARE CONNECTED.	
④	F26	No.4–No.3 BUS COUPLER(N.O)	–	
⑤	F27	No.3 TRANSFORMER INCOMING	AL.BUSBARE IS CONNECTED.	
⑥	F28	SPARE	IT IS NOT CONNECTED.	NOT FUSE.
	F29	SPARE	IT IS NOT CONNECTED.	NOT FUSE.
	F30	MAIN BUILDING 3RD BLOCK (1)	TWO CABLES ARE CONNECTED.	
	F31	MAIN BUILDING 3RD BLOCK (2)	ONE CABLE IS CONNECTED.	
⑦	F32	CANTEEN 1FL (1)	TWO CABLES ARE CONNECTED.	
⑧	F35	MAIN BUILDING 1ST BLOCK (1)	TWO CABLES ARE CONNECTED.	
⑨	F34	CANTEEN 2FL (1)	TWO CABLES ARE CONNECTED.	
⑩	F33	MAIN BUILDING 1ST BLOCK (2)	TWO CABLES ARE CONNECTED.	
⑪	F36	CANTEEN 2FL (2)	TWO CABLES ARE CONNECTED.	

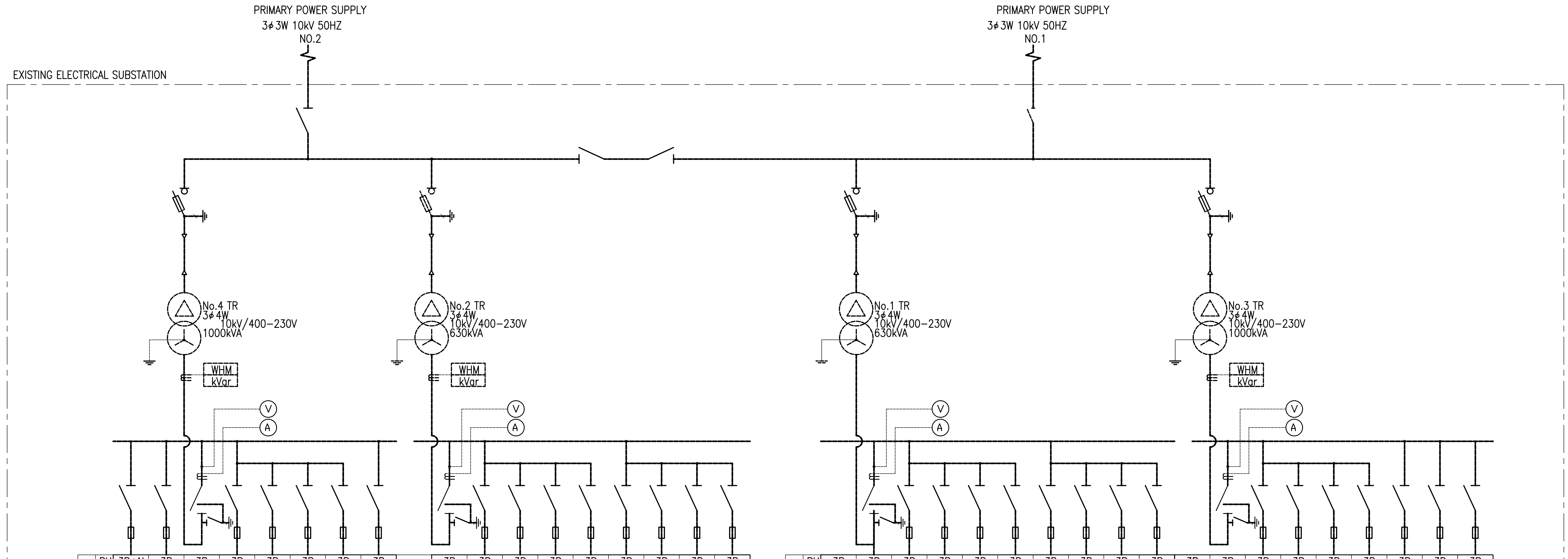
PROJECT TITLE
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA

GENERAL NOTE

NO	DATE	DESCRIPTIONS	BY	APP'D

REVISIONS

SCALE A3:1/100
DATE MAR. 2011
DRAWING BY
CHECKED BY
DWG TITLE LAYOUT FOR EXISTING ELECTRICAL SUBSTATION
DWG NO PV-13
DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.



PF PH	PF AF	PF AT	EXISTING LOAD	FEEDER No.	PANEL No.	REMARKS
3P+N			MAIN BUILDING 1ST BLOCK (2)	F33	10	25–JAN–'10 46.5kW
3P			CANTEEN 2FL (2)	F36	11	
3P			No.4 TRANSFORMER INCOMING	F20	1	
3P	–	–	SPARE	F21	2	
3P			MAIN BUILDING 3RD BLOCK (3)	F22	2	
3P	–	–	SPARE	F23	2	
3P			MAIN BUILDING 3RD BLOCK (4)	F24	2	28–JAN–'10 28.5kW
3P			CANTEEN 1FL (2)	F25	3	26–JAN–'10 24.0kW
3P			No.2 TRANSFORMER INCOMING	F01	1	
3P			POLY CLINIC (2)	F02	2	02–FEB–'10 2.0kW
3P			OUTDOOR LIGHTING PANEL	F03	2	
3P			MAIN BUILDING 2ND BLOCK (2)	F04	2	01–FEB–'10 12kW
3P			BOILER STATION (2)	F05	2	
3P			CANTEEN 1FL BUILDING (2)	F06	3	
3P			CONFERENCE HOLE (2)	F07	3	
3P			ENTRANCE HOLE MECHANICAL ROOM (2)	F08	3	
3P			OUTDOOR CABLE BOX	F09	3	

PF PH	PF AF	PF AT	TO LOAD	FEEDER No.	PANEL No.	REMARKS
3P	–	–	No.2–No.1 BUS COUPLER (N.O)	F10	4	
3P			No.1 TRANSFORMER INCOMING	F11	5	
3P			POLY CLINIC (1)	F12	6	
3P	–	–	SPARE	F13	6	
3P			CANTEEN 1FL BUILDING (1)	F14	6	
3P	–	–	SPARE	F15	6	
3P			ENTRANCE HOLE MECHANICAL ROOM (1)	F16	7	
3P			CONFERENCE HOLE (1)	F17	7	
3P			MAIN BUILDING 2ND BLOCK (1)	F18	7	02–FEB–'10 1.0kW
3P			BOILER STATION (1)	F19	7	
3P	–	–	No.4–No.3 BUS COUPLER(N.O)	F26	4	
3P			No.3 TRANSFORMER INCOMING	F27	5	
3P	–	–	SPARE	F28	6	
3P	–	–	SPARE	F29	6	
3P			MAIN BUILDING 3RD BLOCK (1)	F30	6	27–JAN–'10 4.2kW
3P			MAIN BUILDING 3RD BLOCK (2)	F31	6	
3P			CANTEEN 1FL (1)	F32	7	
3P			MAIN BUILDING 1ST BLOCK (1)	F35	8	21–JAN–'10 13.0kW
3P			CANTEEN 2FL (1)	F34	9	

SINGLE LINE DIAGRAM

PROJECT TITLE: THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA

GENERAL NOTE

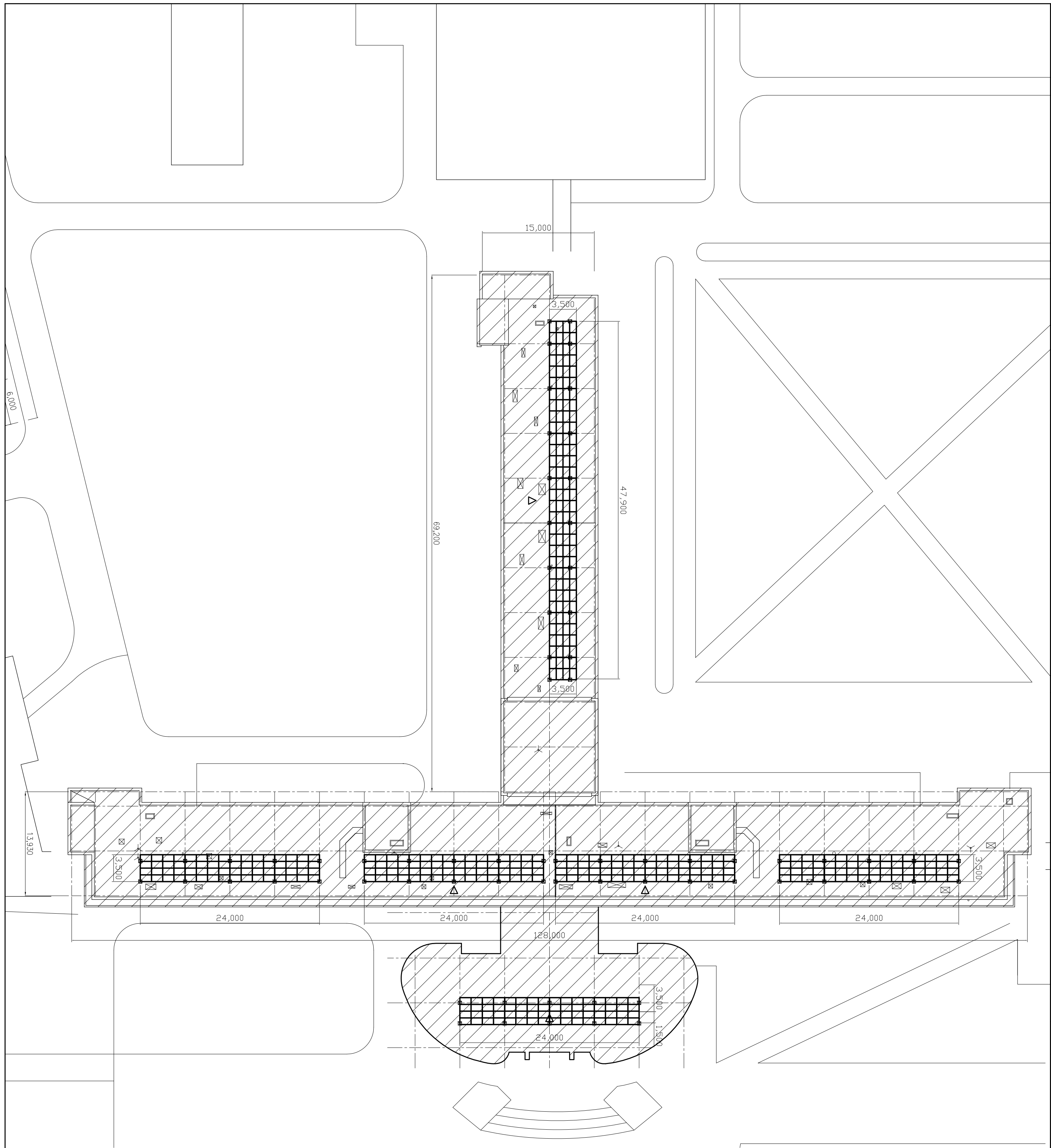
NO	DATE	DESCRIPTIONS	BY	APP'D
		REVISIONS		

SCALE: NS | DATE: MAR. 2011 | DRAWING BY | CHECKED BY

DWG TITLE: SINGLE LINE DIAGRAM FOR EXISTING ELECTRICAL SUBSTATION

DESIGNED BY: ORIENTAL CONSULTANTS CO., LTD.

DWG NO: PV-14

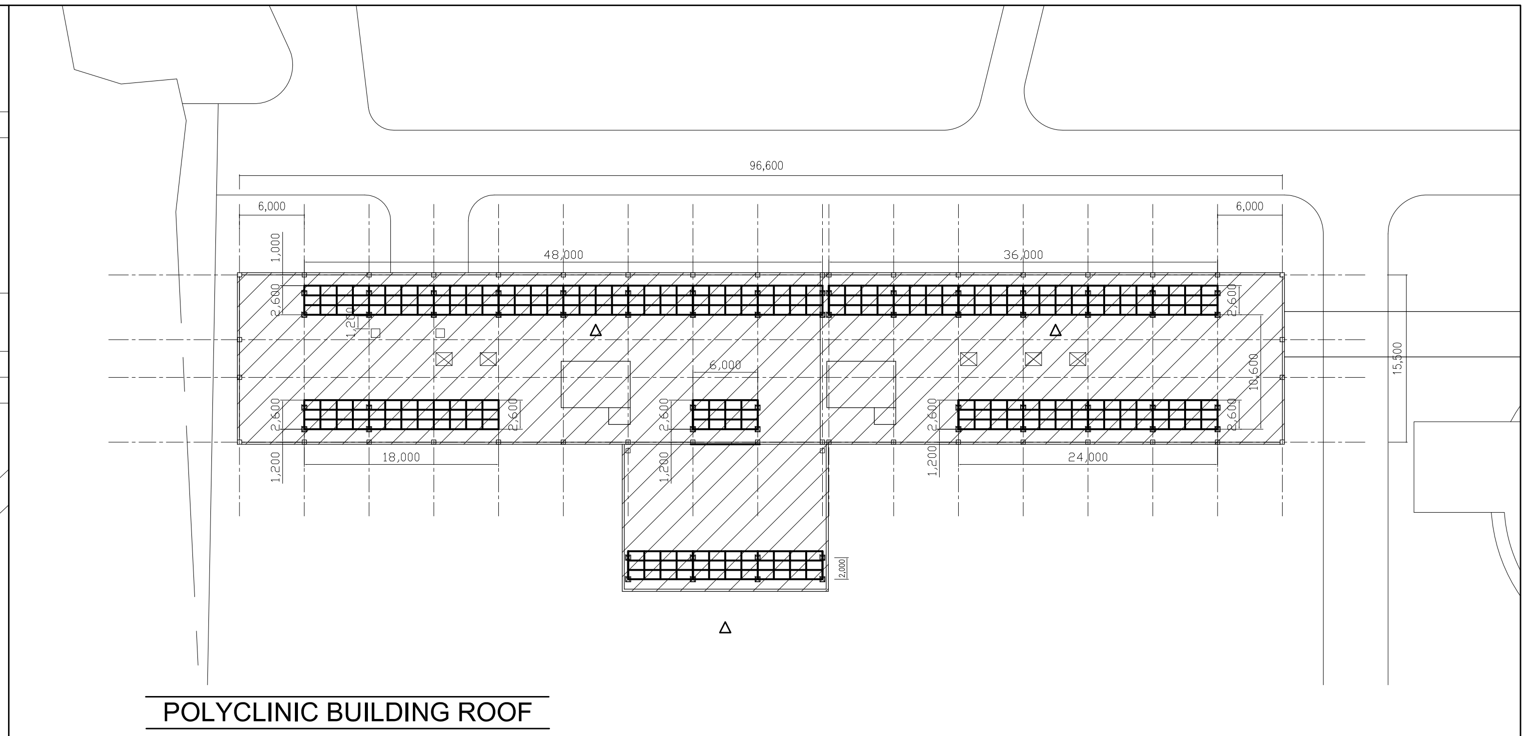


MAIN BUILDING ROOF

SITE AREA (EXISTING BLDG.)

TOTAL SITE AREA 3,337m²

SITE AREA IS CALICULATED BY CAD
FOR REFERENCE.

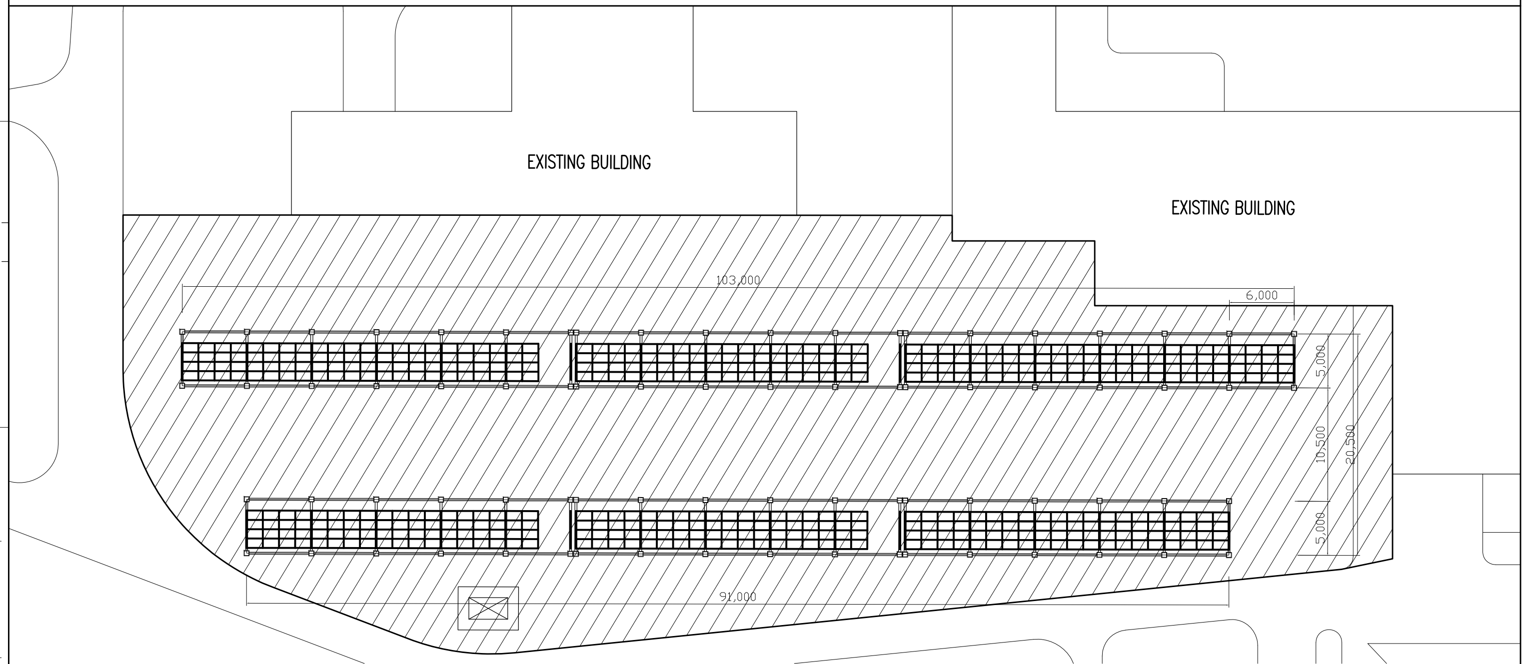


POLYCLINIC BUILDING ROOF

SITE AREA (EXISTING ROOF)

TOTAL SITE AREA 1,802m²

SITE AREA IS CALICULATED BY CAD
FOR REFERENCE.



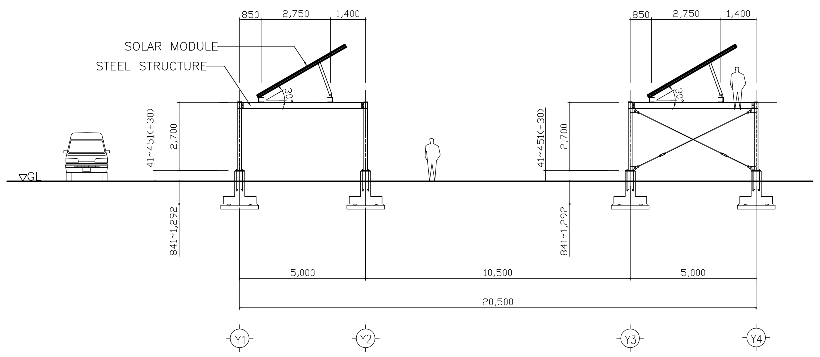
GROUND AREA

SITE AREA

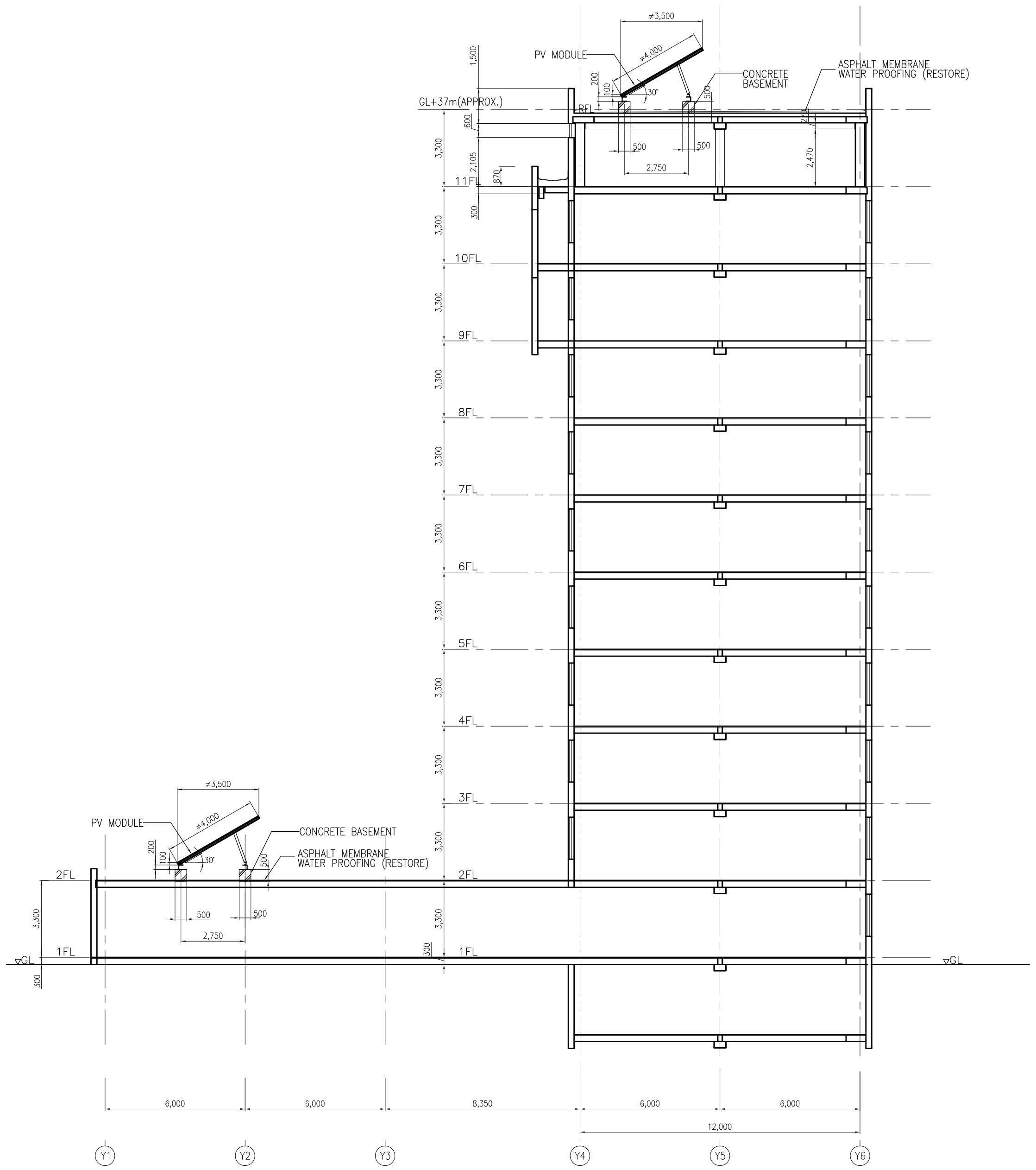
TOTAL SITE AREA 3,959m²

SITE AREA IS CALICULATED BY CAD
FOR REFERENCE.

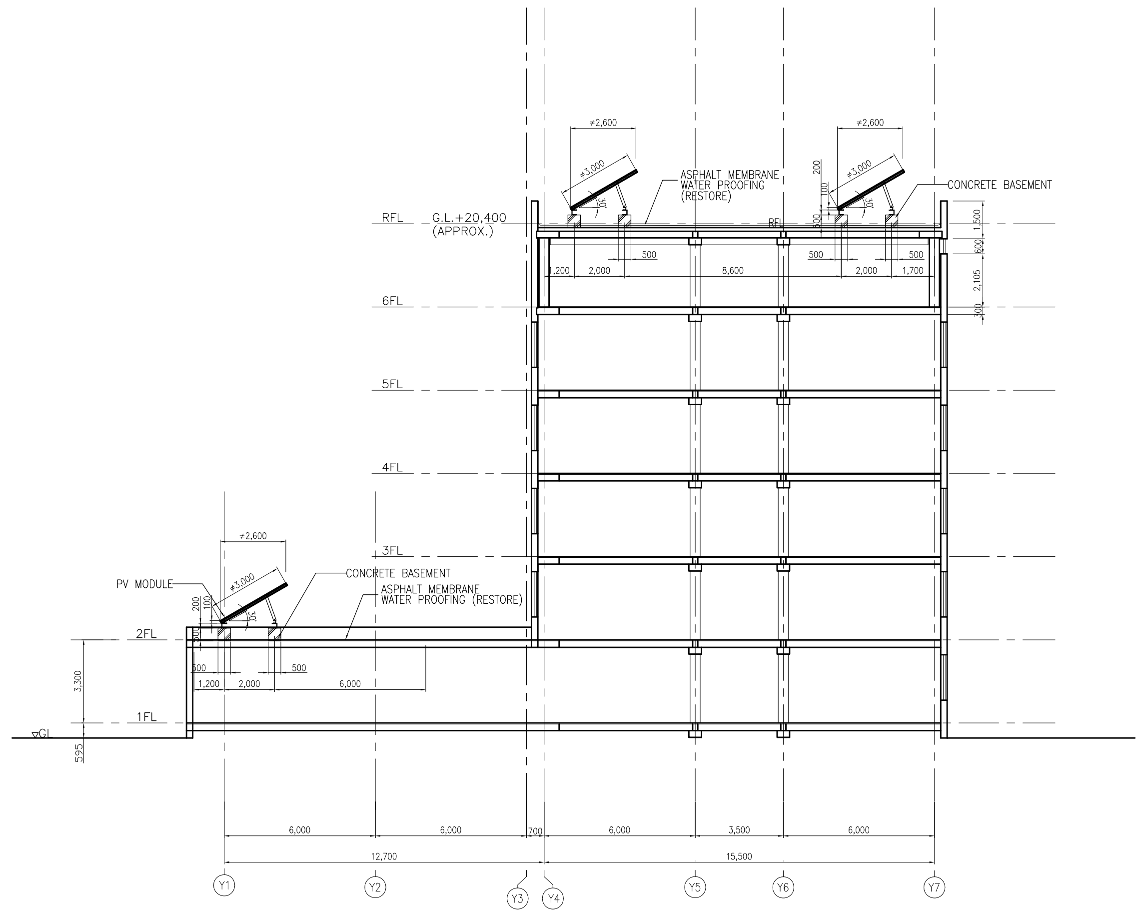
PROJECT TITLE	GENERAL NOTE	REVISIONS	SCALE	DWG TITLE	DWG NO
THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY BY SOLAR ELECTRICITY GENERATION SYSTEM IN THE REPUBLIC OF MOLDOVA		NO / DATE / DESCRIPTIONS / BY / APP'D	1/700	SITE AREA	A-01
			DATE MAR. 2011	DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.	
			DRAWING BY / CHECKED BY		



SECTION OF GROUND AREA



SECTION OF MAIN BUILDING



SECTION OF POLYCLINC BUILDING

PROJECT TITLE

THE PROJECT FOR INTRODUCTION OF CLEAN ENERGY
BY SOLAR ELECTRICITY GENERATION SYSTEM
IN THE REPUBLIC OF MOLDOVA

GENERAL NOTE

NO	DATE	DESCRIPTIONS	BY	APP'D

REVISIONS

SCALE 1/200

DATE MAR. 2011

DRAWING BY

CHECKED BY

DWG TITLE SECTION

DWG NO A-02

DESIGNED BY ORIENTAL CONSULTANTS CO., LTD.