1MW Photovoltaic System Yeghegnadzor, Armenia

PIN scrl – Polo Universitario Città di Prato

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Executive Project

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Introduction

The PV 1MW plant design and construction (SPP) is part of the overall project aimed at contributing and enhancing the economic competitiveness of Vayots Dzor region through promotion and wider use of sustainable innovative technologies by SMEs. Specifically, the project aims at fostering employment by improving competitiveness of SMEs in tourism sector in the central part of the Vayots Dzor marz (around Yeghegnadzor and Hereher sanctuaries).

The Specific Objectives of the Project are:

- Specific Objective 1: Increase the employability of population in the target region in ecotourism and renewable energy sectors
- Specific Objective 2: Enhance SMEs' performances in the region in ecotourism and renewable energy sectors;
- Specific Objective 3: Strengthen the institutional and human capacities to promote:
  a) sustainable and productive business practices;
  b) effective CSO-local authorities cooperation.

The Project will achieve the Objective via supporting SMEs to introduce solar energy technologies together with energy saving techniques, building a pilot solar energy power station.

Further, it is worth noting that SPP Station will contribute to the followings also:

- Employment contributing to result indicators (5 quality jobs);
- Basis for establishment of a PPP offering services to enterprises;
- Improved competitiveness of SMEs beneficiating from the SPP contributing;
- Stable flow of revenues fostering financial sustainability of project results.

The SPP Station will be founded as business following the **Social Business principles**, i.e. as a business that has the aim to solve a social and environmental problems. All profits are reinvested in the social business to enlarge it and increase its positive impact or devoted to benefit the community.[1]

The SPP Station will be under the ownership and operated by **the "Sustainable Innovative Technologies Center (SIT Center)" established** through public-private partnership. The founders of the SIT center will be:

- B&B Network, an association of Bed and Breakfast business entities in the region
- the Inter-Community Union (between the 7 village communities involved in the project)
- the Regional Tourism Center in Yeghegnadzor.

The Solar Photovoltaic Power Station (1000kW capacity) will be established in the target region. The SPP station and the sustainable energy practices applied by SMEs will enhance the tourism attractiveness of the region via promotion of the region as a "green region".

[1] As defined by Nobel Peace Laureate Muhammad Yunus.

The installation of a photovoltaic plant was conceived not only in consideration that photovoltaic systems are currently one of the most diffused and consolidated technologies but also on the fact that they are particularly promising for the region of interest. The location where the photovoltaic system will be installed has high annual irradiation values in comparison to similar sites at the same latitude (Figure 1). If one considers a photovoltaic plant with a nominal power of 1 MW and an optimal panel disposition (an azimuthal angle of 2° and an inclination of 32°) it is possible to estimate an annual irradiation of 1840 (kWh/m2) and an electric energy production of 1450 MWh.

The estimated average annual revenue is calculated as follow:

1.450.000 kWh/year x 42,645 AMD/kWh = 61.835.250AMD/year (119.631€/year) [change date 20.03.2017]

Legal Regulations for Solar Power Plants Construction and Operation

According to Article 23 of the “Energy Law” and Article 43 of the “Law on Licensing” of the Republic of Armenia, power generation in Solar power Plants is subject to licensing. License is issued by the Public Services Regulatory Commission (“Commission”), according to the "Energy Law" of the RoA and energy sector activities licensing procedures, approved by the Resolution1 N374N of the Commission, dated November 1, 2013.

The Transmission Operator (TO) is a government-owned company (“High-Voltage Electric Networks (HVEN)” CJSC) that holds all the transmission assets within the country, but does not operate the system.

The power system is dispatched by an ISO (separate dispatch and transmission companies), which is a government-owned company (EPSO CJSC). A supervisory control and data acquisition system has been installed on generation units and 220 kV substations. The distribution system includes 0.4 to 110 kV lines and transformers. The Distribution company (DISCO) serves about one million customers and also provides last-mile service; DISCO is a private company (“Electric Networks of Armenia” ENA CJSC) and holds and operates all the distribution assets within the country.

PV Plant Power purchase and sale contract will be signed with ENA CJSC.

Site Location

39,771° Latitude – 45,352° Longitude

Climatic Data

The climatic data come from Yeghegnadzor Meteostation, 1267m High above Sea Level; the area where the Photovoltaic power station will be built is 1460m high above sea level and is 2200m far from Yeghegnadzor Hydromet station.

Climatic Parameters of **Cold Period of the Year**

Air Temperature During Coldest Days in Yeghegnadzor, °C		
Reliability 0,98		-23
Reliability 0,92		-19
Air Temperature During 5 Coldest Days in Yeghegnadzor, °C		
Reliability 0,98		-19
Reliability 0,92		-16
Air Temperature During 5 Coldest Days in Yeghegnadzor, °C		
Absolute Minimum air Temperature in Yeghegnadzor		-26
Duration, Day and the Average Air Temperature in Yeghegnadzor, °C		
Period with an Average Daily Air Temperature ≤ 0 °C	duration	79
	average temperature	-2.6
Period with an Average Daily Air Temperature ≤ 8 °C	duration	148
	average temperature	0.5
Period with an Average Daily Air Temperature ≤ 10 °C	duration	168
	average temperature	1.4
Average Monthly Relative Humidity of the Coldest Month in Yeghegnadzor, %		73
Average Monthly Relative Humidity During 15 Hours of the Coldest Month in Yeghegnadzor, %		62
Quantity of Precipitations During November - March in Yeghegnadzor, mm		175

Prevailing Wind Direction During December – February in Yeghegnadzor	ЮЗ

Climatic Parameters of **Warm Period of the Year**

Barometric Pressure in Yeghegnadzor	
Barometric Pressure, GPa	870
Air Temperature in Yeghegnadzor,°C	
Average Maximum Air Temperature of the Warmest Month	31.3
Absolute Maximum Air Temperature,°C	39
Average Monthly Relative Air Humidity in Yeghegnadzor, %	
For the Warmest Month	45
During 15 Hours of the Warmest Month	30
Quantity of Precipitations in Yeghegnadzor, mm	
During April - October	251
Daily Maximum of Precipitations	32
Climatic Parameters of Wind in Yeghegnadzor	
Prevailing Wind Direction During June - August	ЮВ

Monthly Average Value of Air Temperature and Partial Pressure of Water Vapor

	Month	**Temperature, °C**	**Pressure, GPa**
I	January	-3.8	0
II	February	-1.8	0
III	March	3.6	0
IV	April	10.3	0
V	May	15.3	0

VI	June	19.8	0
VII	July	24.1	0
VIII	August	24.2	0
IX	September	20.1	0
X	October	12.9	0
XI	November	-6	0
XII	December	-0.8	0
Average Annual Air Temperature °C		10.8	

For inverters, transformer and PV System a derating from nominal characteristics due to site high level and climatic data should be considered on the basis of components technical specifications.

Description of Approximate Weather Conditions of Yeghegnadzor City

1) Number of sunshine hours per year ≈ 2.650 hours.

2) Precipitation-mm

- January 40
- April 70
- July 20
- October 30

Annual precipitation amount ≈ 460 mm.

3) Snowpack

- The average number of snowpack days during the year ≈ 68 days
- The average thickness of snowpack within ten days maximums -20 cm
- The emergence period of stable snowpack -20 / December
- Disappearance period of stable snowpack -1 / March.

4) Wind direction and speed

Cases of windless days from 124 observations during a month -49.

5) Climate Type: BSDsa- with dry, continental severe, cold winters and hot summers.

6) The period of transition from 0 ° C of the daily average air temperature during the increase in temperature

Transition period -25 / II.

7) The amount of hours higher than 0 °C when the weather is hot -4000h, higher than 10°C- 3500°h.

8) Lands: Dry steppe mount-brown soils.

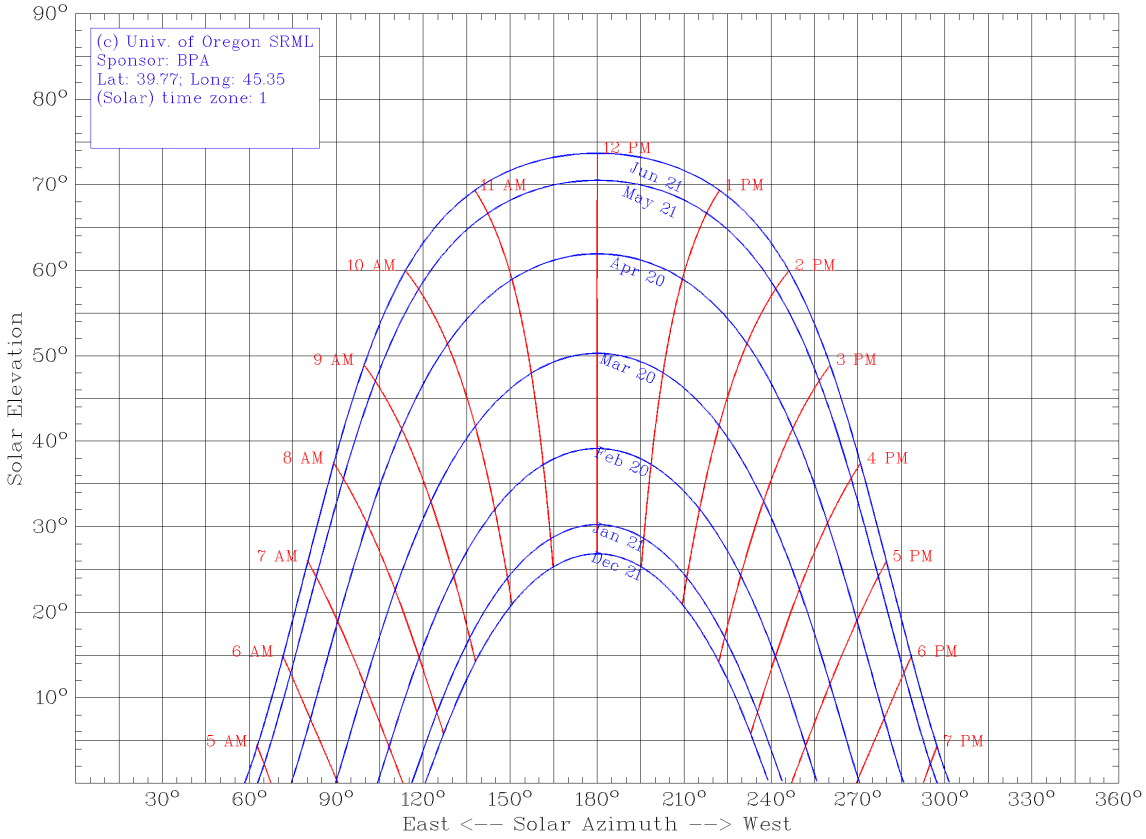
9) Plants: Complex of frigana, tragant and tomilyar.

10) Natural landscape zones: Semi-desert landscape.

Sun Elevation and Azimuth

The Sun Elevation and Azimuth has been calculated with the path chart program developed by the University of Oregon. Considering an inclination of PV panels of 40° (optimum is 32° but the presence of snow brings to higher inclination values) and a panel length of 1.7m generates a vertical dimension of 1.1m; considering an average site level gradient of 8% the 1.1m are reduced to 0.92m (at 4,5m distance). The shadow projection will be then determined by elevation ($\alpha 1$) and azimuth ($\alpha 2$) angles: $0.92/\tan(\alpha 1)*\cos(\alpha 2)$. During winter at 9.00o'clock $\alpha 1=15°$ and $\alpha 2=45°$ therefore the shadow projection in south direction will be 2.43m.

As an example during winter at 10.00o'clock $\alpha 1=20°$ and $\alpha 2=30°$ therefore the shadow projection in south direction will be 2.2m. We assume 2,5m as design input to outdistance the rows of panels.



Geological Survey

A geological Survey has been carried out. The composition of soil for the first 20m is mainly composed by sand-gravels and boulder formations.

PV Plant Lay-out Configuration

Photovoltaic Panels

Reference: BenQSolar PM060P00 or similar

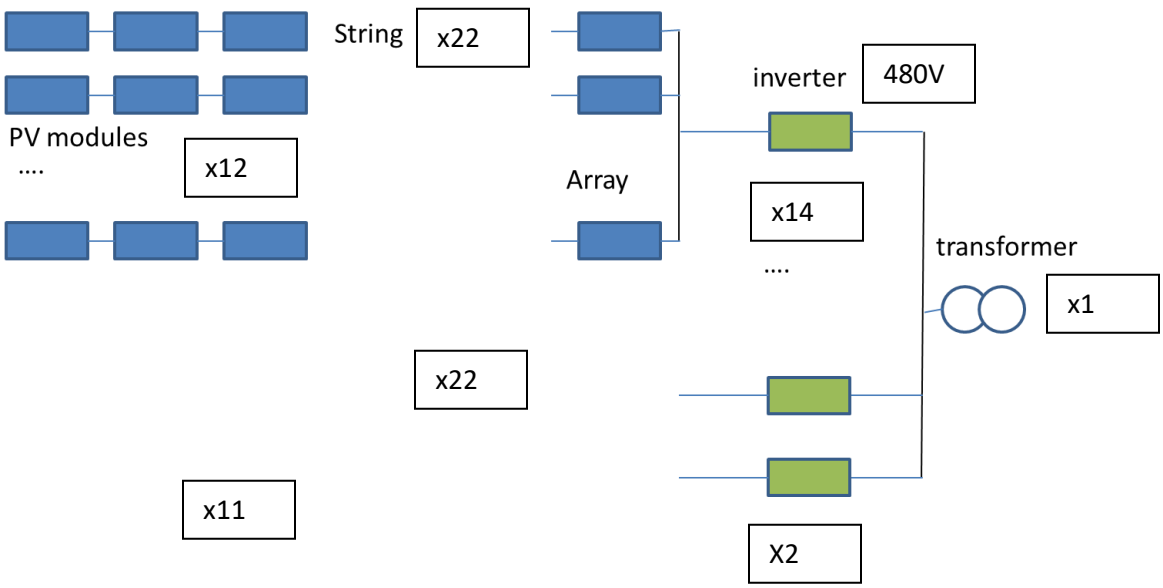
As a preliminary indication of PV panes we refer to multi crystalline photovoltaic modules with the following characteristics:

-	Nominal power	260/265	W
-	Module efficiency	16,1	%
-	Nominal Voltage	31,2	V
-	Nominal current	8,34	A
-	Dimensions	1639x983x40	mm
-	Weight	18,5	kg
-	NOCT	46±2%	

Lay-out will be designed to give maximum power output and flexibility on operation and maintenance:

- Strings with n.22 modules in serial connection (PV modules 260W);
- Array type 1: n.12 Strings in parallel 690V 100A 69kW;
- n.14 Arrays connected to inverter 60kW
- Array type 2: n.11 Strings in parallel 690 V 92A 63,4kW;
- n.2 Arrays connected to inverter 60kW
- Total DC Power 1.087kW

- Total AC Power 960kW



- Total number of PV panels n. 4180
- Total number of inverters n. 16
- DC/AC ratio 112%
- Total number of transformer n. 1

Solar PV Plant main components

Photovoltaic ground mounting systems for mono vertical panel (fixed version)

Reference: TreeSystem or similar

This particular system avoids the concrete footing and it is easy and fast to install without special equipment.

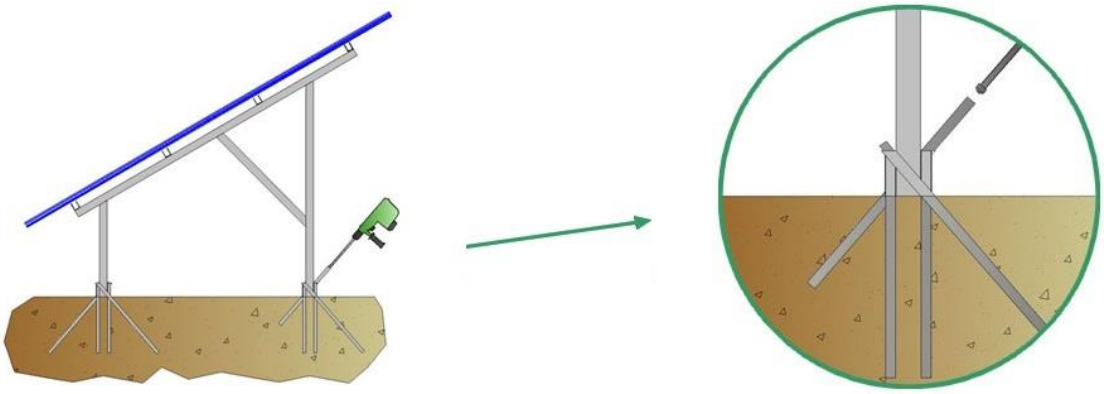
Installation procedure:

1) Place the vertical supports with predetermined inclinations by employing an appropriate spacers (It's enough to mark the departure and arrival point of each array).

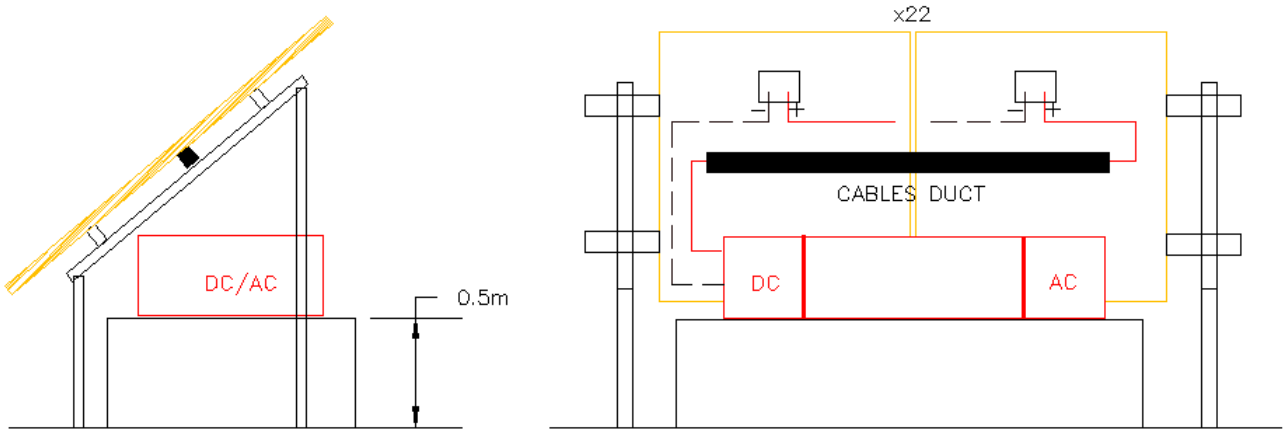
2) House the horizontal profiles within brackets present on the top of vertical support and fix them together through self-drilling screws after inserting elements for the fastening of modules and for checking the correct position with a bubble level.

3) Complete structure installation driving-in inserts to the ground through guides placed at the base of the vertical supports, using a common hammer or a jackhammer.

The mounting system is applicable in the presence of stones and boulders.



A schematic representation of mounting system with PV panels, DC cables duct and inverter with its support structure is reported in the following page.



Inverters

Reference: ABB TRIO 60.0-TL-OUTD-480 or similar

As a preliminary indication we refer to inverter with a nominal power of 60kW, therefore the plant will require the installation of n.16 inverters of the following characteristics:

-	Nominal power	60	kW
-	Nominal current	77	A
-	Frequency	50	Hz
-	Max efficiency	98	%
-	Dimensions	725x1491x315	mm
-	Weight	95	kg
-	Output Voltage	480	V

For the AC and DC Inverter Wiring Boxes the following options are highly recommended (for lightning and overvoltage protection): input connections, fuses, AC/DC switch and surge arrester Type 2.

Cables and Connectors (Low Voltage section) - DC Side

Reference: Prysmian Tecsun, Multi-Contact or similar

As a preliminary indication we refer to cables compliant with IEC and DIN requirements for application in the range of 0.6/1kV.

DC conductors (from PV panels strings to inverter) have been designed considering a voltage loss lower than 1% in order to minimize wire energy losses; the total amount of DC solar cables is 12500m, below are reported the characteristics required.

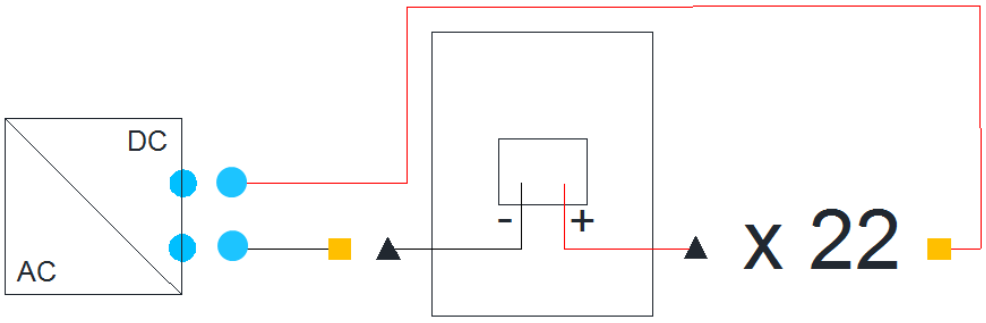
Cable material	Insulation	N. of cores	Cross-section
Copper	PVC insulation or similar	Single core	4 mm^2

As a preliminary indication of connectors we refer to female and male cable coupler MC4 (Multi-Contact).The total amount of connectors required is shown in the table below; the connectors included with panels are excluded.

		N. of connectors per string	N. of connectors Array type 1	N. of connectors Array type 2	Total amount of connectors
■	New Connectors	1 male + 1 female	12 male + 12 female	11 male + 11 female	200 male + 200 female *
▲	Connectors included with panels	22 male + 22 female	264 male + 264 female	242 male + 242 female	4180 male + 4180 female
●	New connectors (connection with Inverter)	1 male + 1 female	12 male + 12 female	11 male + 11 female	200 male + 200 female *

* + 5%

The required connectors listed above are shown in the following diagram: lay-out of connection between panels string and inverter.



Cables and Protection Pipes (Low Voltage section) - AC Side

Reference: Prysmian Tecsun or similiar (cables); Lamplast or similiar (protection pipes)

AC cables (from inverters to cabin) have been designed considering a voltage loss lower than 1% in order to minimize losses. Four-cores cables are required (three phase conductors + one neutral conductor); cross section varies from 25mm^2 to 95mm^2 as shown in the table below.

Conductor Cross Section [mm^2]	Maximum distance Inverter-Cabin [m]	Total amount * [m]
25	30	75
35	40	80
50	65	160
70	85	240
95	115	400

* +5%

For underground installation of AC conductors double wall corrugated pipes are used.

Protection pipe D_{ext}/D_{int} [mm]	N. of AC cables inside	Pipe length [m]	Allowed conductor cross sections [mm^2]	Total amount * [m]
250/213	8			95
200/176	5			85
90/77	1		95	50
75/63	1	< 10	70	95
		> 10	50-70	
63/52	1	< 10	25-50	125
		> 10	25-35	

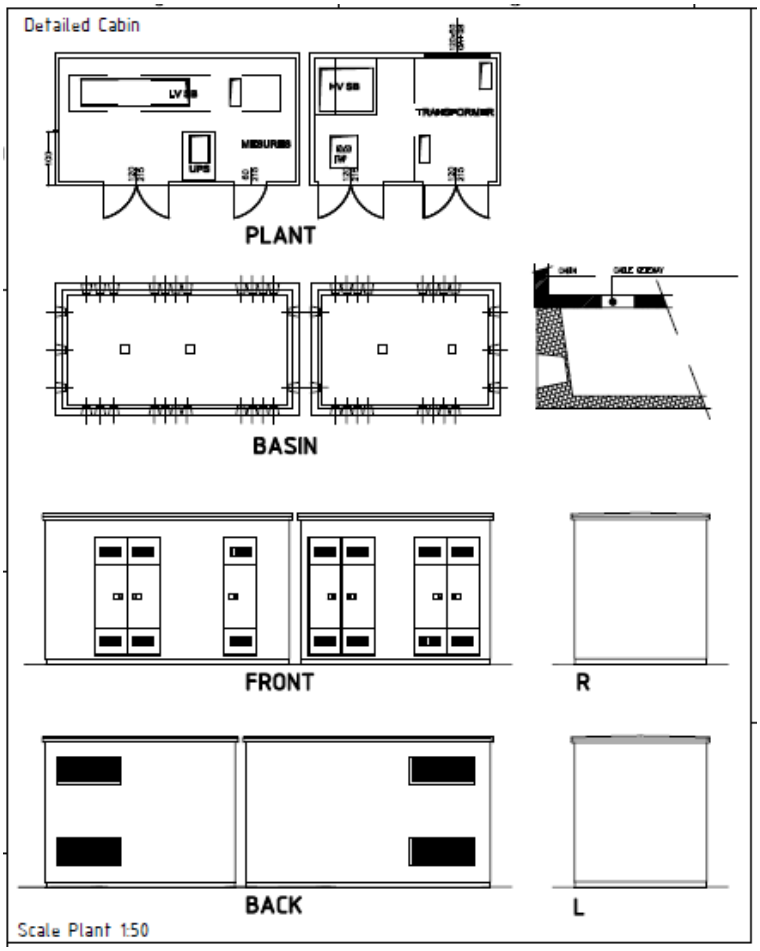
* +5%

In the table above pipe dimensions and relative total amount are shown; all the dimensions have been obtained following the reference regulations (CEI 64-8).

For a detailed representation of pipes with cables inside see Drawings.

Switchboards and Transformation Cabin

The MV/LV precast cabin will contain the transformers, the electrical MV and LV switchboard, the UPS and the relè for net security parallel; it could be built in precast modules. The cabin will be conditioned during summer and ventilated to maintain an inside temperature lower than 30°C.

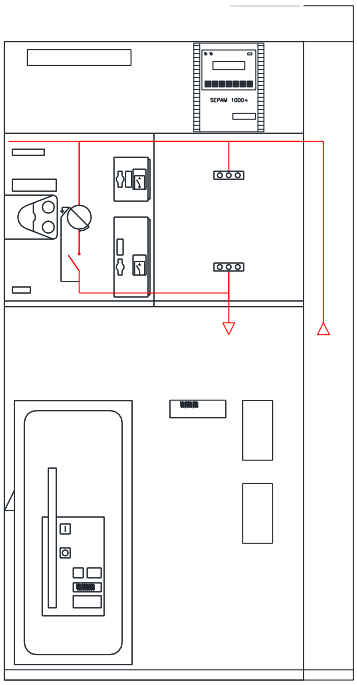


Standards

- Relè IEC 60255
- Safety Integry Level IEC 61508
- Electromagnetic compatibility IEC 801-4

MV Switchboard

-	Nominal Voltage	kV	24
-	Nominal Voltage 50Hz / 1min	kV	50
-	Nominal Voltage 1,2 / 50 µs	kV	125
-	Operating Voltage	kV	10
-	Frequency	Hz	50 / 60
-	Phases	n.	3
-	Nominal current	A	630
-	Dimension	mm	875x1875(h)x1220



See drawings for reference.

Transformer

Reference: Tesar s.r.l. or similar

n.2 transformers are considered one for the SPP (active power) and the other for Users (passive power):

	Transformer type	Liquid Dielectric	Primary Voltage	Secondary Voltage	Nominal Power
Transformer 1	Hermetic	Oil-immersed	10000 V	480 V	1000 kVA
Transformer 2	Hermetic	Oil-immersed	10000 V	400 V	100 kVA

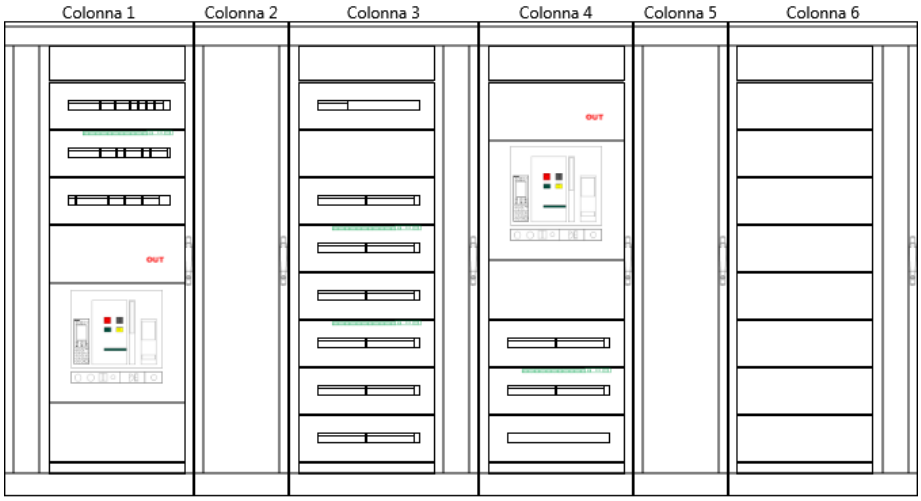
LV Switchboard

The LV/MV Switchboards are designed to control and monitor final distribution boards to any supervision system. Modular devices in the system is used to monitor, measure, and control electrical distribution boards via a Modbus serial line or Modbus TCP/IP communication network.

The system concentrates the data from electrical distribution boards in real time, thus contributing to achieve energy efficiency targets. The system collects data from any meter (including kilowatt-hour, water, air, gas, or steam meters).

The system (Ethernet) can manage a gateway function (Modbus TCP/IP to Modbus RS485). It can support up to eight Modbus RS485 slave devices (address from 1 to 149). The default address of the Modbus master port is 255. The system also manages web page in order to configure settings or to monitor and control the devices.

- SC current kA 25
- Frequency Hz 50/60
- External protection IP 31
- Internal protection IP 20
- Dimensions mm 3906x2200(h)x665



See drawings for reference.

UPS

- Voltage IN/OUT V 230-230
- Power VA 2000
- Frequency Hz 50/60
- Autonomy min 25
- Dimensions mm 170x432(h)x483
- Weight kg 55

Armenian Energy Standards

Armenian Energy Standards are available at the following links:

Ministry of Energy: http://www.minenergy.am/en/page/559 (GOST - IEC -AST – ISO)

National Institute of Standards: http://www.sarm.am/en/standarts

Electric Networks of Armenia: http://www.ena.am/index.aspx?lang=2

Regulatory Commission of the Republic of Armenia: http://www.psrc.am/en

Grid Connection and Facility Supplies

Connection with the National Electric Networks

The connection with the Electric Networks will be realized at medium voltage at 10.000V; the photovoltaic system will produce energy at low voltage (after the inverter) therefore an electrical transformer is required (480V-10kV; 1MW).

For the connection of the auxiliaries load with the Electric Networks another electrical tranformer is required to step down 10kV to 400V and provide power to the auxiliary systems (Total Power of 65kW).

Technical conditions to join the distribution network are defined by “ENA" CJSC, according to the Resolution N314-N3 of the Commission dated July 27, 2007.

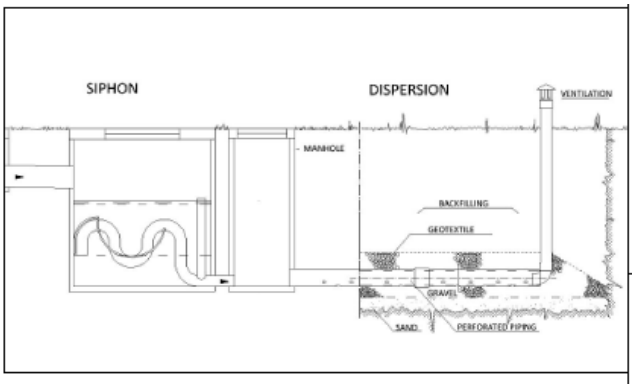
Electric power metering systems must comply with the requirements of the Resolution N72 N of the Commission, dated March 18, 2006.

Facility Supplies and Sewerage

The electricity power for the SPP needs will be provided by the LV line near the service house; it will not come from the SPP. All SPP electricity production will be put in the network.

Water consumption is estimated in 100mc/year mainly for solar panel cleaning; the water will be stored in an underground tank and distributed to SPP.

Sewerage will be treated with a sub-irrigation system with the following lay out:



CCTV System

The CCTV System will be composed mainly by:

n. 32 IP cameras (one camera each 25m)

IP BULLET IP66/IK10 DAY&NIGHT with IR filter and ADAPTIVE IR ILLUMINATION mod. Sarix Professional II with Simple Motion Detector e Camera Sabotage. Sensor ½,8" maximum resolution 2048x1536 (3MPx). Autofocus 9-22mm, 0 lux/F1,2; IR illuminatio up to 35m. Local storage with micro SD 64 GB.

n.1 Storage system

Network Video Recorder DigitalSentry Intel® Xeon E3-1275 v3 - 8 GB RAM with Hard Drive 4TB.

Video Surveillance Station

Monitor 32" Full-HD 1920x1080; Network Video Recorder DigitalSentry Intel® Xeon E3-1275 v3 - 8 GB RAM and Hard Drive 4TB.

n.12 LED Lighting

IR850S-65/IR940S-30 Infrared LED Illuminators IP66 IK 9 12W or similar.

Security Alarm

The Security Alarm System will be composed mainly by:

n.2 Infrared Barriers (for Gate 1 and Gate 2 detection)

type DARWIN DT608 (CIAS Elettronica) or similiar

- Active barriers: 8 IR
- Range: Max. 6m
- Detection coverage highness: 2m
- Power Supply: 13.8Vdc

- Consumption: 60mA
- Tamper output: antiremoval and antiopening
- Alarm logic: automatic management of beam interruptions
- Synchronism: automatic synchronism
- Alignment: self-alignment system
- Doppler: frequency 24.125 GHz with 40mw Eirp

n.1 Fiber optic System (for fence detection)

type Apache Fiber (CIAS Elettronica) or similiar

Fiber optic system with high immunity to electromagnetic disturbances and surges on the field for rigid and mesh fences.

- Technology: Optofonic fiber
- Range (m): 1000m
- Power : 13,8Vdc or PoE
- Consumption (mA): 300mA
- Communication: dry contacts/RS485/IP
- Relay outputs: Alarm and Tamper
- Tuning: On Board and Software
- Software: Apache Test
- Color: black
- IP grade: 55
- Temperature (°C): -40°C+70°C
- Warranty (years): 3
- Dimensions (cm): 23/26/90
- MTBF (Medium Time Before Failure) (h): 150.000
- MTTR (mean time to restore) (mins): 15min
- POD (Probability of Detection): 95%
- FAR (False Alarm Rates): 10/1000m/year
- Certification: CE

Apache Fiber is a perimeter protection system with optical fiber suitable for the detection of intrusion fence. It uses optophonic technology for the detection of all those typical of intrusion attempts like climb, cut or break through the fence. The advantages of the technology of using fiber optics technology in the field of intrusion detection on fences perimeter are:

- Reliability of detection;

- Possibility to make considerable distances without intermediate power supplies;

- Total immunity to interference due to lightning discharges;

- Also particularly suitable for the protection of sites with corrosive atmospheres or explosive as the optical fiber cannot cause fire.

All the components required are listed in the tables below:

Main Components
Fiber optic sensor (Fiber Cable)
Not sensitive optical fiber (Fiber Lead)
Analyzer for “daisy chain”configuration (up to 2.5m high fence)
Accessories
Tool for fiber connectors preparation and termination
Kit for fiber preparation and termination
Kit for fiber cable repair or junction to fiber lead

Lightning and Overvoltage Protection System

Reference: Dehn or similiar

Lightning protection is required for the following SPP sections:

- Earth termination system (components 1, 2, 3, 4);
- Transformers 1 and 2 (components 5, 6, 7);
- LV Switchboard (components 8, 9);
- Inverter (component 10);
- Data interface (components 11, 12);
- CVTT (component 13).

Considering the SPP actual design the list of components required to protect the plant from lightning and overvoltage are shown in the table below.

Component number	Component type	Function and Description	Specifications	Total amount required
1	Round Wire	For use in lightning protection and earth-termination system.	- Cross Section: 10mm - Fe/tZn	1850m
2	Angled air-termination rod with two saddle clamps	For protecting PV system against direct lightning strike.Fixed at the metal support structure of the PV modules by two saddle clamps.	- Diameter = 10mm - Total Lenght = 1m -Al	n. 220
3	Connection clamp for steel girders	For connection to steel constructions.	- Clamping Range: 3-18mm - StSt	n. 380

4	MV clamp with hexagon screw	Multipurpose connecting clamp.	- Clamping Range: 8-10mm -StSt (V4A)	n. 375
5	Medium-voltage arrester	For protecting transformers against atmospheric and switching overvoltages.	- Nominal discharge current: 10kA - Rated voltage (a.c.): 15kV - For indoor and outdoor use	n. 6 (3 for each transformer)
6	Disconnector Unit for Surge Arrester	For electrical isolation of overloaded arresters. Series-connected with the medium-voltage arresters.		n. 6 (3 for each transformer)
7	Arrester Fixing element (for n.6)		- Type of fixing: insulation	n. 6 (3 for each transformer)
8	Coordinated and modular single-pole lightning current arrester	For protecting low-voltage installations against surges and even direct lightning strikes. High discharge capacity; with remote signalling contact for monitoring system. Consisting of a base part and a plug-in protection module.	- SPD: Type 1 - Nominal voltage: 277V - Max. Continuous operating voltage: 320V - Lightning impulse corrent: 25kA	n. 8 (4 for each transformer)
9	Earthing Clip for two-module Enclosures	Earthing clip with terminal for bridging four SPDs (**8**) in two-module enclosures.	- Type: single-phase - N. of contact studs: 4	n. 2 (1 for each transformer)
10	Type 1 + Type 2 Combined Lightning Current and Surge Arrester	For use in phovoltaic generator circuits. Combined disconnection and short-circuiting device with safe electrical isolation.	- SPD: type 1 + type 2 - Max. PV voltage: ≤ 1000V	n. 16
11	Combined lightning current and surge arrester	For protecting two pairs of unhearted high-frequency bus systems.	- SPD monitoring system: LifeCheck - SPD class: Type 1 - Nominal voltage: 24V	n. 1
12	Base parts for protection modules (for n. 11)	Four-pole feed-through terminal for the insertion of a protection module without signal disconnection if the protection is removed.		n. 1
13	Arrester for Data Networks and Ethernet Applications	Arrester for Industrial Ethernet, Power over Ethernet and simililiar applications in structured cabling systems.	- SPD class: Type 1 - Nominal voltage: 48V Nominal Current: 1A	n. 64 (2 for each camera)

For the air-termination system disposition and further details see Drawings.

Construction timeline according to stages

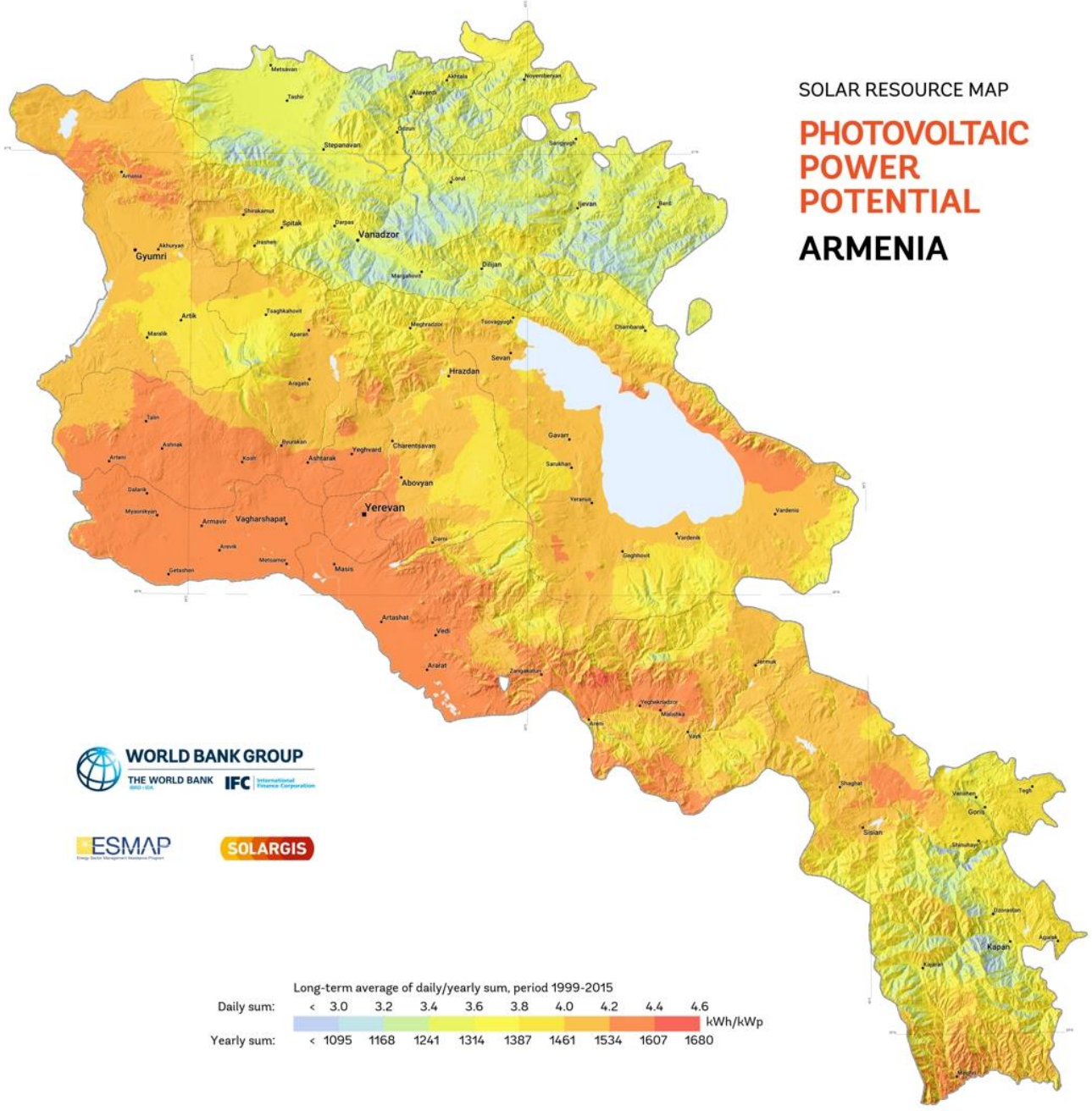
The foreseen gantt is reported:

Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fences																
Demolition building																
Land work and Road																
Office Building (50m2)																
Water (tank+distribution)																
PV mounting systems																
Photovoltaic assembly																
Cables and Connectors																
Inverter																
Cabin MV/LV System																
MV electric line																
Lightning protection																
CCTV																
Security Alarm																
External lighting																
Test and start production																

Construction is estimated in 14-16 weeks; starting in march 2018 the plant could be completed at the end of May 2018.

Business Plan

PV Electricity production



This chart comes from r2e2.am website. From Yeghegnadzor coordinates we may expect a net yearly electricity production of 1.450.000 kWh/year

Electricity purchase price

From the web site of MINISTRY OF ENERGY INFRASTRUCTURES AND NATURAL RESOURCES OF THE REPUBLIC OF ARMENIA*: According to the article 59 of the "Law on Energy" of RA, adopted on 7 March 2001, it is guaranteed the purchase of the whole electricity generated by renewable energy sources according to the established order -15 years for SHPPs, and 20 years for solar, wind, biomass and geothermal.*

By the decision of the Public Services Regulatory Commission the procedure for determining the electricity tariff produced by the power plants using the renewable energy sources was approved. According to it, the tariff for the solar energy is set on an annual basis. According to the decision of the Public Services Regulatory Commission N 128-N dated 25 May, 2016 the tariff for solar energy amounts 42.645 AMD / kWh excluding VAT (0,0825 €/kWh - 0.0886 $/kWh date 20.03.2017*).*

Change 1 € = 516,88 AMD (Armenian Dram) [date 20.03.2017]

Change 1 $ = 481,09 AMD (Armenian Dram) [date 20.03.2017]

Change 1 $ = 0,93 € [date 20.03.2017]

In accordance with the above-mentioned procedure, in the end of every year the tariff for the solar energy is indexed due to the fluctuations in the national currency of Armenia against the USD for a certain period of time and due to the changes of consumer prices in the Republic of Armenia.

This tariff is determined and revised due to the definite method adopted by the Commission decision N 88-N dated 22 April, 2015.

NOTE: the tariff is indexed to $ and to inflation.

Business Plan

The PV plant is founded by the CE therefore the BP reduces itself to an average annual revenue:

1.450.000 kWh/year x 42,645 AMD/kWh = 61.835.250AMD/year (119.631€/year) [change date 20.03.2017]

Yearly operational and maintenance cost are estimated in 20.000 €/year therefore the revenue from the PV solar plant is estimated in 100.000 €/year [ref. year 2017].

From preliminary design Photovoltaic Plant cost estimate is confirmed at 1.050.00 €

Annexes

Drawings

- SPP01_Plant 1:250 Civil Works and Water Distribution
- SPP02_ Plant 1:250 Solar Power Plant
- SPP03_Plant 1:250 Lightning and Overvoltage Protection and Security
- SPP04_Underground distribution
- SPP05 1-8_DC Array Connections Schemes
- MV Switchboard
- LV Switchboard Production
- LV Switchboard Users
- List of main components for procurement