WOMEN WELFARE DEVELOPMENT CENTER ISLAMABAD

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		33°42'07.0"N, 73°03'58.0"E
ii.	Focal Person Name		Ms. Ismat Afridi
iii.	Focal Person Contact No.		----
iv.	Site Existing Load (kW)		74.754
v.	Site Critical Load (kW)		39.854
vi.	Average Electricity Bill (kWh)		1,276
vii.	Available Area for Solar PV Modules (Square feet)		9,800 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	30 KW+10KVA(UPS)
		Type	Hybrid + Ups For I.T lab
ix.	Annual Expected Power Generation (MWh/Annum)		51.74
x.	DC,AC Rating		As per site
xi.	Array Typ/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications (Rs)			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

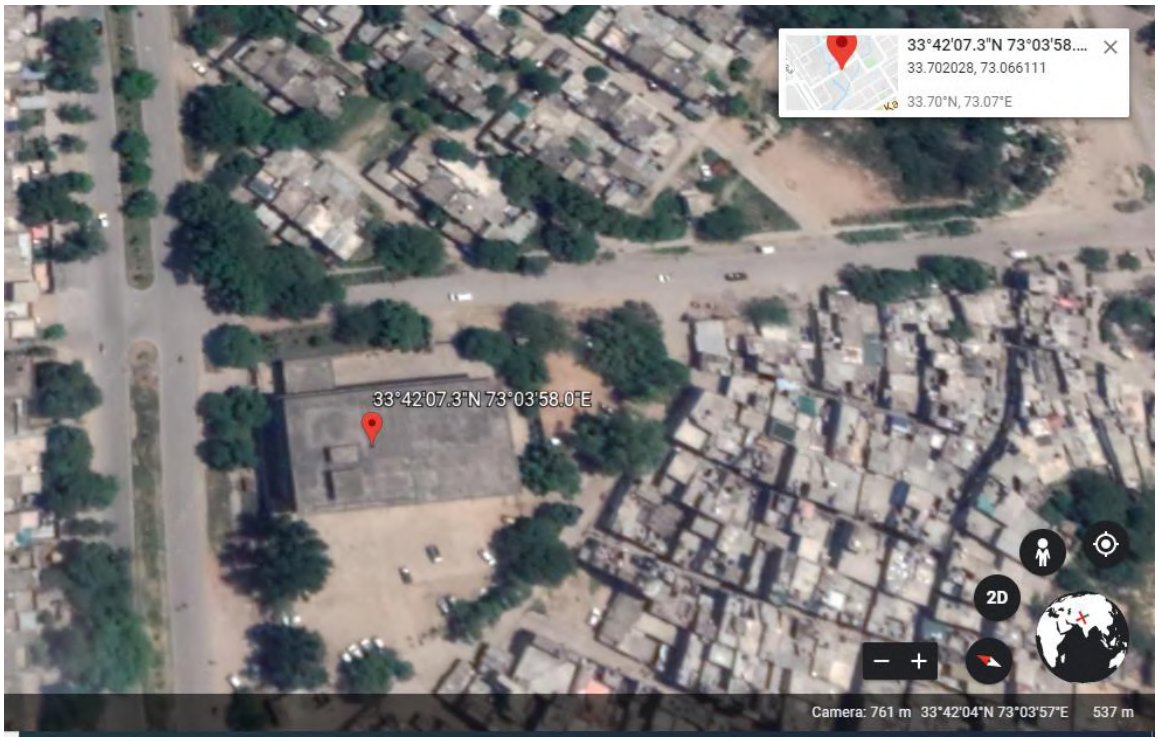
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Women Welfare Development Centre, Islamabad.

2.2 SITE LOCATION

Geographically Women Welfare Development Center, Islamabad is located at Latitude 33˚42' 07" N Longitude 73˚03' 58" E. and Elevation 537m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Women Welfare Development Center, Islamabad	7,4754	39.854	1,276

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 1-A**.

2.4 SITE DESCRIPTION

Currently the premises of Women Welfare Development Centre, Islamabad comprises of two story building. Details about the buildings is explained below:-

2.4.1 WOMEN DEVELOPMENT BUILDING

The Building of Women Welfare Development Centre comprising of two stories (Ground plus First floor).

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are besides the stairs at every floor where solar output will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Women Welfare Development Center, Islamabad is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Women Welfare Development Center, Islamabad is met from National Grid.
Two three-phase meters are installed at the Women Welfare Development Center.
IESCO- G-7 Sector Sub Division

- R/N# 01 14113 0096400 U C-6(Sitara MRT)
- Sanctioned Load: 36 KW
- Tariff A-3A-(66)T

IESCO- G-7 Sector Sub Division

- R/N# 01 14113 0096500 U C-6(Sitara MRT)
- Sanctioned Load: 10 KW
- Tariff A1-(TOD)T

2.4.3.2 EMERGENCY POWER SUPPLY

UPS has been installed for providing back up supply to DDO office.
UPS specifications

- LOBO 2.4KVA (Inverter)
- 12V, 180AH*2 Batteries, (Phoenix)

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 40 kW
Proposed System: 30kW Hybrid PV + 10kVA UPS backup

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **30kW hybrid** solar with an additional **10kVA UPS** backup for the IT Lab has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally, a 30 kW Hybrid PV system with

separate UPS (For I.T lab) is being recommended for Welfare Development Centre, Islamabad. The simulation results are attached as **Annex 1-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are of Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 51.74 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 9822 Square feet (912 Square meter). 2D Drawing of the available area is attached as **Annex 1-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to rain water leakage the building roof is repaired we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 structure has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Women Welfare Development Center building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.Out of three inverters one will be mounted on the wall parrallel to ground floor DB and its battery rack will be placed at available area under the stairs. On other hand remaing two inverters will be placed at wall opposite to the first floor DB, output power will be terminated at DB-1 and DB-2 of the first floor and and battery racks will be placed at available space nearby the inverters just besides first floor staires.

7. DRINKING WATER ARRANGEMENT

Women Welfare Development Centre, Islamabad has following water arrangements.
Water Tank: 2000 Gallons
Water Pump-1: 2 H.P
Water Pump-2: 5 H.P
Water Coolers: 4
It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Women Welfare Development Centre, Islamabad is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 30 kW Hybrid PV system and UPS at the site of Welfare Development Centre, Islamabad is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Same stringing process will be used for the other inverter.
- Battery backup 48V, 300Ah with each inverter will be provided to critical load of building.
- Critical load of IT room will be covered through separate battery UPS of 10 KVA rating with 1 hour battery backup (48V, 300Ah).

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 42) will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV Panel structure design attached as **Annex-1 E.**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm^2.
- AC cables: From Grid to Inverter and Inverter to Load 10 mm^2.

- Data cables : For RS-485 data communication between inverters to web box (data logger)

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	20
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	600

9.5 BATTERY BACKUP

i) Total 12 batteries will be used for this site.
ii) Each battery will be of 100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.
v) 10 kVA UPS for IT Lab will carry 3 batteries too.

10. SYSTEM INSTALLATION CONSIDERATION

The 30 kW Hybrid PV System will be having 84 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 84 panels will cover a total area of 336 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 1 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra

loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

GOVT PRIMARY SCHOOL BOKRA ISLAMABAD

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		N 33º38′02″, E 73º00′18″
ii.	Focal Person Name		Yasir
iii.	Focal Person Contact No.		-
iv.	Site Existing Load (kW)		9.610
v.	Site Critical Load (kW)		5.510
vi.	Average Electricity Bill (kWh)		Not yet
vii.	Available Area for Solar PV Modules (Square feet)		1570 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	10kW
		Type	Hybrid solution
ix.	Annual Expected Power Generation (MWh/Annum)		17.09
x.	DC,AC Rating		As per site
xi.	Array Typ/Tilt		Fixed tilt/ 15˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kWh

2. SITE TECHNICAL INFORMATION

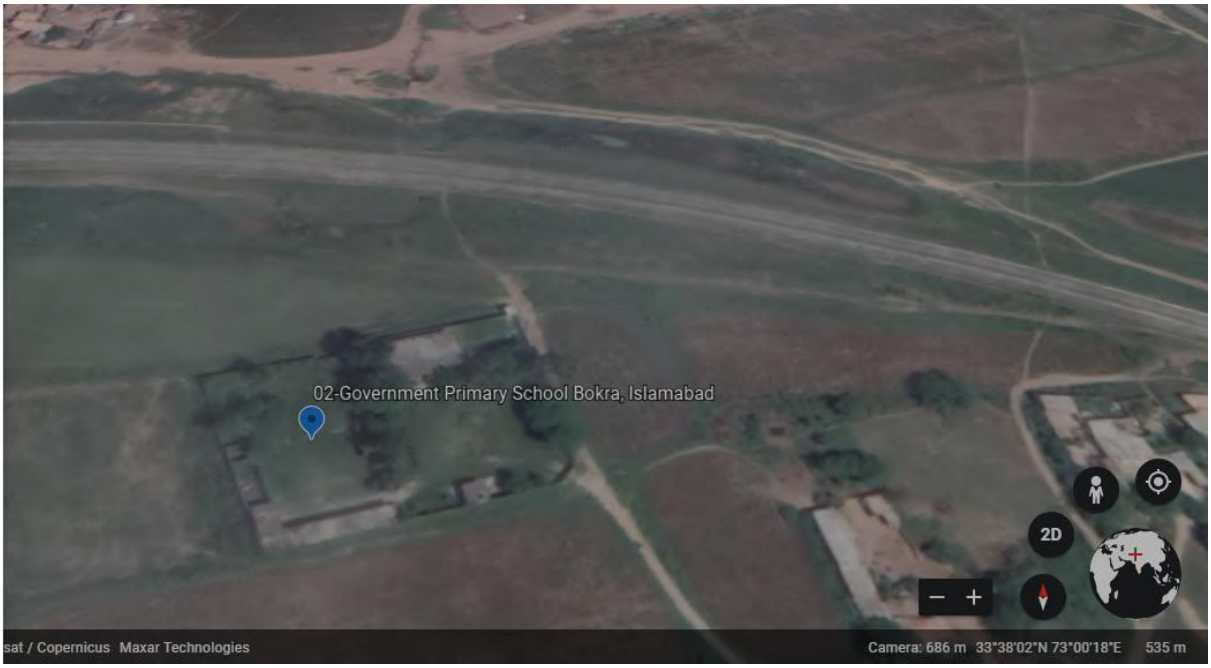
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Primary School Bokra, Islamabad.

2.2 SITE LOCATION

Geographically Primary School Bokra, Islamabad is located at Latitude N 33º38′02″ Longitude E 73º00′18″ and Elevation 535m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)

1	Primary School Bokra, Islamabad	9,610	5,510	95

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 2-A**.

2.4 SITE DESCRIPTION

Currently the premises of Primary School Bokra, Islamabad comprises of one new building and solar will be install on its roof. Details about the building is explained below:-

2.4.1 PRIMARY SCHOOL BOKRA

The Building of Primary School Bokra, School comprising of one new buliding roof.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are inside the old room near national utility meter where the solar power will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Primary School Bokra, Islamabad is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Primary School Bokra, Islamabad is met from National Grid.
One single-phase meters is installed at the Primary School Bokra, Islamabad.
IESCO- Sub-Division, I-12.

2.4.3.2 EMERGENCY POWER SUPPLY

Batteries has been installed for providing back up supply to the Principle office.
UPS specifications

- Cyber Power 1200VA (Inverter)
- 12V, 140AH*2 Batteries, (Phoenix)

3. PROPOSED SOLAR PV SYSTEM

Critical Load 5.5 kW
Proposed System: 10kW Hybrid PV

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **10KW hybrid** solar has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally, a 10 kW Hybrid PV system with Batteries backup is being recommended for Primary School Bokra, Islamabad. The simulation results are attached as **Annex 2-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system of Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.

c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 17.09 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.

d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 1570 Square feet (145 Square meter). 2D Drawing of the available area is attached as **Annex 2-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but there were blocks on the roof top for future extension of building so must design elevated structure for solarization.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-5 structure of 5 frames and L-3 structue of 1 frames has been recommended to install with angle of 15 Degree on the space available at site. It has also informed that the Primary school Bokra building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.we will mounted the inverter in the old class room with the main circuit breaker and also a battery backup system will be install their because of enough space for batteries and ventilated area.

7. DRINKING WATER ARRANGEMENT

Primary School Bokra , Islamabad has following water arrangements.
Water Tank: 200 Gallons
Water Pump: 1.6 H.P
Water Coolers: 1
It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Primary School Bokra, Islamabad is not fulfilling their hot water requirement. So, there is a need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 10 kW Hybrid PV system and battery backup at the site of Primary School Bokra, Islamabad is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V,300Ah with inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 6) will be used. The main mounting structure will be fixed tilted at an angle of 15º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 2-E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm²	M	10
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

9.5 BATTERY BACKUP

i) Total 3 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 10 kW Hybrid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly,28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 2 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

HEALTH FACILITY BHU-3 HARIPUR CAMP

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		33°59'17.0"N, 72°51'17.0"E
ii.	Focal Person Name		Yasir Khan
iii.	Focal Person Contact No.		03008526008
iv.	Site Existing Load (kW)		15.458
v.	Site Critical Load (kW)		5.428
vi.	Average Electricity Bill (kWh)		523.5
vii.	Available Area for Solar PV Modules (Square feet)		452 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	10 kW
		Type	Hybrid
ix.	Annual Expected Power Generation (MWh/Annum)		16.91
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 20˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Health facility BHU-3, Haripur Camp.

2.2 SITE LOCATION

Geographically Health facility BHU-3, Haripur camp is located at 33°59'17.0"N 72°51'17.0"E. and Elevation 20m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Health facility BHU-3 haripur camp	15.5	5.5	523.5

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 3-A**.

2.4 SITE DESCRIPTION

Currently the premises of Health facility BHU-3 Haripur camp comprises of almost ten rooms but two roofs are suitable for solarization. Details about the buildings is explained below:-

2.4.1 HEALTH FACILITY BHU-3 HARIPUR CAMP

The Building of Health facility BHU-3, Haripur Camp comprising of two roof buildings

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are inside the EPI room where solar output will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Health facility BHU-3 Haripur Camp is currently being powered through following supply sources:-

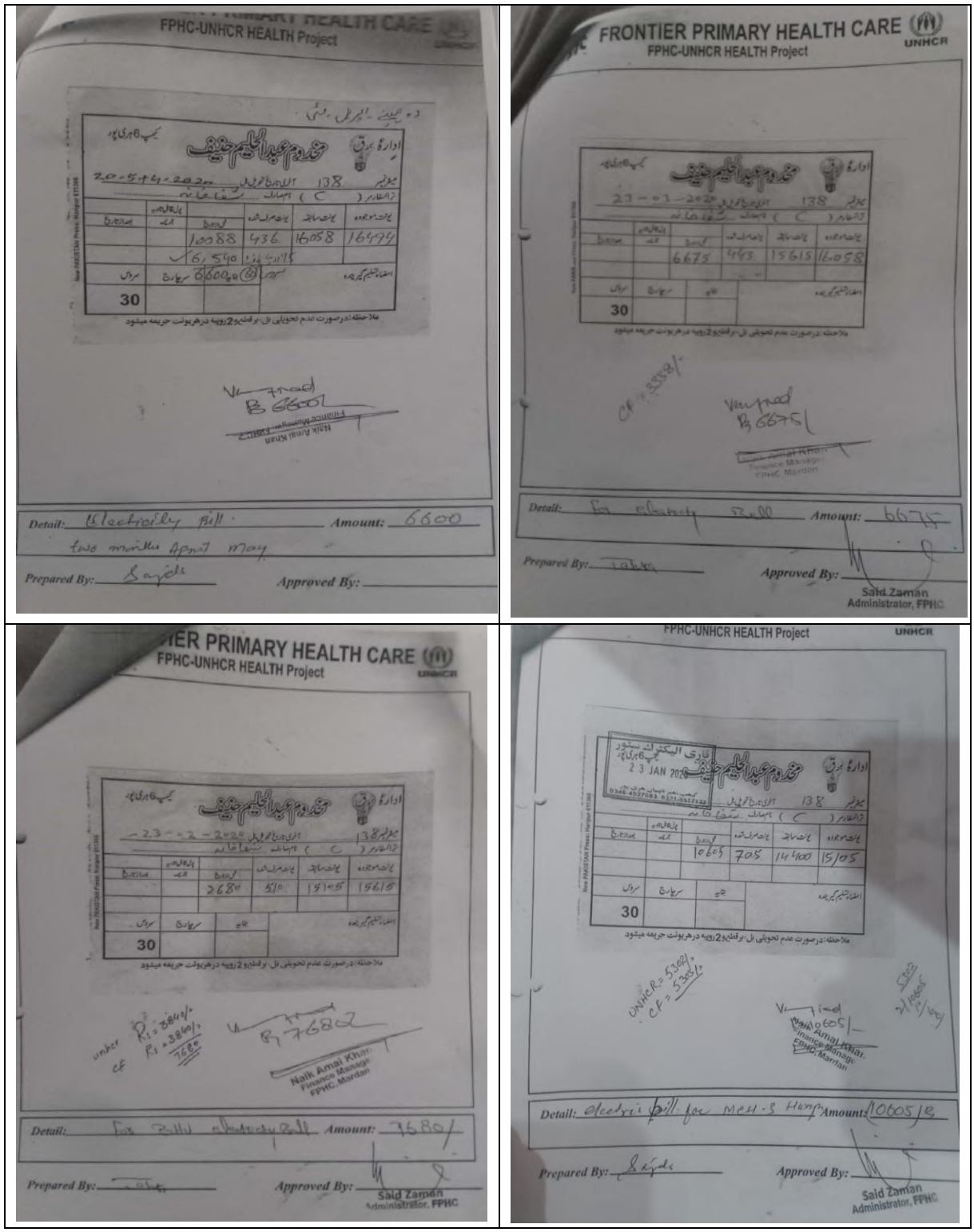
2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Health facility BHU-3 Haripur camp is met from National Grid.

One single-phase meters is installed at the Health facility BHU-3 Haripur camp.

PESCO- Haripur Sub-Division, Bill are payed to the contractor directly by the camp because of no bill issued by the PESCO. PESCO supplies electricity to the contractor and then they sub distribute power supply to the afghan refugees, due to this combine electricity problem there is no need of replacing the Single Phase meter with Three Phase meter.

General electricity bills detailed of the Camp are given below.



2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply to ware house.

Generator specifications

- Rated output 2.8KVA
- Maximum output 3KVA
- Honda EU30

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 5.5 KW
Proposed System: Single Phase 10KW Hybrid PV

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **10kW hybrid** solar system has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 10 kW Hybrid PV system is designed for Health Facility BHU-3 Haripur Camp. The simulation results are attached as **Annex 3-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are of Lithium ion type which are long life, durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 16.91 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 452 Square feet (41 Square meter). 2D Drawing of the available area is attached as **Annex 3-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of just two buildings are flat pre made concrete and other are tilted and in shaded area. Therefore to install solar PV we need to construct 1'×1' RC foundations and those two buildings and a customised shed will be made for the remaining solar PV to meet the installation capacity.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed tilt L-3 structure consist of four frame and flash mount customized L-4 structure consist of four frame has been recommended to install with angle of 20 Degree on the women site where shed is available that will be converted into customized structure. It has also informed that the Health facility BHU-3 Haripur camp building roof is pre made concrete roof. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years. There is a need of shed to fulfill the requirements so we recommend a two L-4 flash mounted structure.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. we will mounted the one 5kW inverter in the EPI room where the main circuit breaker is available and the other one towards female side portion and also a battery backup system will be install for both inverters.

7. DRINKING WATER ARRANGEMENT

Health facility BHU-3 Haripur camp has following water arrangements.

Water Tank: 200 Gallons

Water Pump-1: 1.5 H.P

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Health facility BHU-3 Haripur Camp is not fulfilling their hot water requirement through gas connected water geysers. So, we are providing extra solar power so that in future they can add electric geyser to their system.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 10 KW Hybrid PV system at the site of Health facility BHU-3 Haripur camp is mentioned below:-

10.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 2.8 kW (7 pieces of 400 W modules) is recommended.
- 02 string of 2.8 kW are combined and inserted to the inverter through DC circuit breakers.
- Battery backup 48V, 200Ah with each 5kW inverter will be provided to critical load of building.

10.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

10.3 MOUNTING STRUCTURE

Customize mounting structure (QTY: 8) will be used. The main mounting structure will be fixed tilted at an angle of 20º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV Panel structure design attached as **Annex-3 E.**

10.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 6 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	15
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	300

10.5 BATTERY BACKUP

i) Total 4 batteries will be used for this site.
ii) Each battery will be of 100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 2 batteries as backup.

11. SYSTEM INSTALLATION CONSIDERATION

The 10 KW Hybrid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 3 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the

wiring to the critical load being supported through subject system will be routed through this room.

12. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

TECHNICAL TRAINING INSTITUTE KALABAT HARIPUR
(Boys + Girls)

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		34°01'42.0"N, 72°54'38.0"E
ii.	Focal Person Name		Administrator GTVC
iii.	Focal Person Contact No.		0995-355162
iv.	Site Existing Load (kW)		124.983
v.	Site Critical Load (kW)		93
vi.	Average Electricity Bill (kWh)		5350
vii.	Available Area for Solar PV Modules (Square feet)		28468.84 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	60 kW
		Type	Hybrid +UPS backup
ix.	Annual Expected Power Generation (MWh/Annum)		105.5
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		

Energy Specifications		
xiii.	Cost of Electricity from WAPDA	Rs.25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Technical Training Institute Kalabat Haripur.

2.2 SITE LOCATION

Geographically Technical Training Institute Kalabat Haripur is located at Longitude 34°01'42.0"N Latitude 72°54'38.0"E. and Elevation 20m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while

considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Technical Training Institute Kalabat Haripur	124.983	93	5350

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 4-A**.

2.4 SITE DESCRIPTION

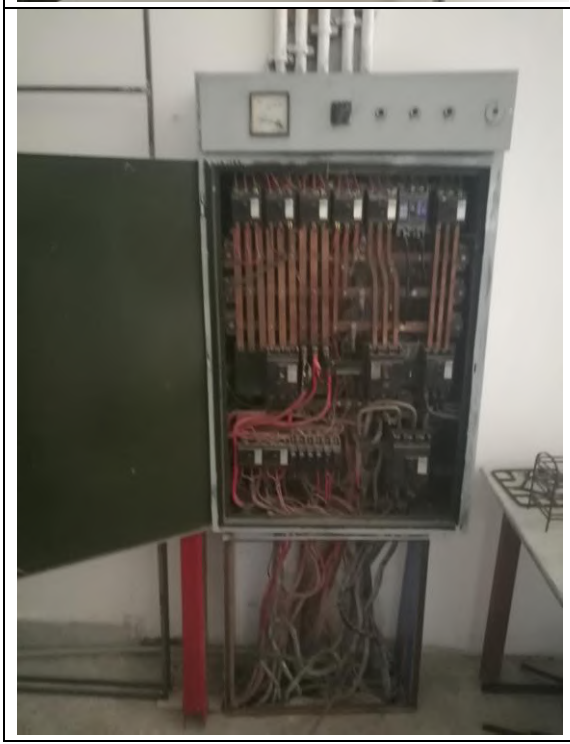
Currently the premises of Technical Training Institute Kalabat Haripur comprises of three roof building. Details about the buildings is explained below:-

2.4 TECHNICAL TRAINING INSTITUTE KALABAT HARIPUR

The Building of Technical Training Institute Kalabat Haripur comprising of three roof buildings two of boys campus and one girls campus

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are on the left and right side of boy's campus rooms and for the girls campus there are two DBs one is on sewing hall and other on the reception.



2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Health facility Technical Training Institute Kalabat Haripur is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Technical Training Institute Kalabat Haripur is met from National Grid.
One Three-phase meters is installed at the Technical Training Institute Kalabat Haripur for both Boys and Girls campus.
General electricity bills detailed of the Camp are given below.

PESCO- sub-division KALABAT T/SHIP

- R/N# 30 26441 0001100 U KALABAT
- Sanctioned Load: 112 kW
- Tariff C-1c(26)T

2.4.3.2 EMERGENCY POWER SUPPLY

Generator and UPS has been installed for providing back up supply to ware house.
UPS specifications (Girls)

- Solar Power 3kVA (Inverter)
- 12V, 155AH*2 Batteries, (Volta)

Generator Specification

- Output voltage 20kVA

Generator Specification (Boys)

- Output voltage 20kVA

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 93 kW
Proposed System: 60kW Hybrid PV

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **60kW hybrid** solar system has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 60 kW Hybrid PV system is designed for Technical Training Institute Kalabat Haripur.The simulation results are attached as **Annex 4-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 105.5 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 28468 Square feet (2644 Square meter). 2D Drawing of the available area is attached as **Annex 4-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is three roofs building are flat and made of RCC . Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 kg/m^2 on the roof. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed tilt three L-2 structure frame has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Technical Training Institute Kalabat Haripur building roof is made of RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 km/hr which is well above the maximum recorded wind speed of 45 km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. we will mounted total six inverter at this site. Out of six inverter four will be installed at boys side and two will be installed at the girls side in the ventilated room near the main circuit breaker, its has enough space for the batteris to put in these room therefore its suitable place for the batteries use in the system due to which life of batteries is enhance. One inverter

at the girls side is installed at the sewing hall and other is installed at the reception.

7. DRINKING WATER ARRANGEMENT

During site survey it is observed that the mentioned site has enough water storage as well as cooling facility (water cooler) available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the already existing national power supply system.

8. HOT WATER ARRANGEMENT

Technical Training Institute Kalabat Haripur is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment/materials/stores going to be used for installation of 60 kW Hybrid PV system at the site of Technical Training Institute Kalabat Haripur is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the each inverter through DC circuit breakers.
- Battery backup 48V, 300Ah with each inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed tilt mounting structure (QTY: 117) will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 4-E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	70
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	1000

9.5 BATTERY BACKUP

i) Total 18 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 60 KW Hybrid PV System will be having 168 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 168 panels will cover a total area of 672 m^2.
The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of

the building placed as **Annex- 4 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

COLD CHAIN WAREHOUSE MANSERA

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		34°20'43.1"N, 73°11'50.3"E
ii.	Focal Person Name		Dr. Yasir
iii.	Focal Person Contact No.		0333-5594791
iv.	Site Existing Load (kW)		29.593
v.	Site Critical Load (kW)		21.633
vi.	Average Electricity Bill (kWh)		1,725
vii.	Available Area for Solar PV Modules (Square feet)		Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	20 kW Inverter with (15.8kW) PV
		Type	Hybrid + UPS
ix.	Annual Expected Power Generation (MWh/Annum)		25.62
x.	DC,AC Rating		As per site
xi.	Array Typ/Tilt		Fixed tilt/20˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

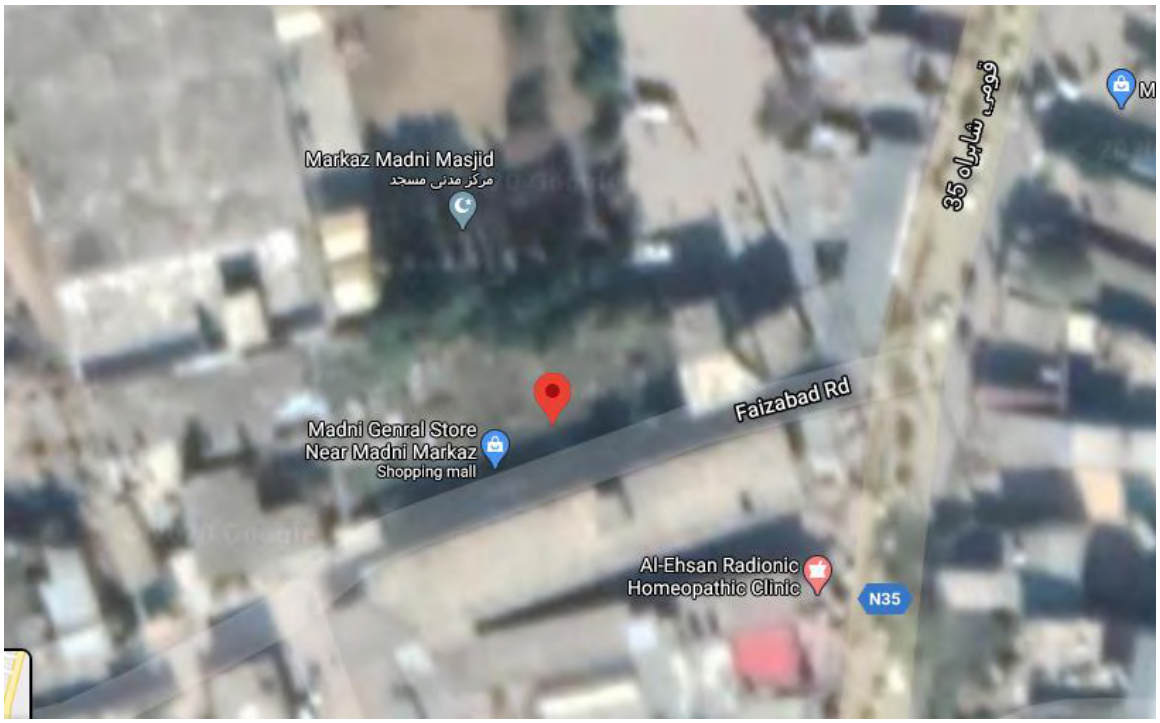
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is not available at roof top buildings of Cold Chain WareHouse Mansher. So, to installed solar two shed type customized structures are designed.

2.2 SITE LOCATION

Geographically Cold Chain WareHouse Manshera is located at Longitude 34°20'43.1"N Latitude 73°11'50.3"E. and Elevation 50m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Cold Chain WareHouse Manshera	29.593	21.633	1,725

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 5-A**.

2.4 SITE DESCRIPTION

Currently the premises of Cold Chain WareHouse Manshera has fiber roof story building so, customized shed type structures recommended for PV solar system installation. Details about the buildings is explained below:-

2.4.1 COLD CHAN WAREHOUSE MANSEHRA

The Building of Cold Chain WareHouse Manshera comprising of fiber roofs.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are in the small room of cold chain room where solar output will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Cold Chain WareHouse Manshera is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Cold Chain WareHouse Manshera, is met from National Grid.
Two three-phase meters are installed at the Cold Chain WareHouse Manshera.
PESCO-Sub Division KHAKI

- R/N# 41 26714 0129032 U KHAKI PSR 132KV-MANSEH Sanctioned Load: 6 kW
- Tariff A-3(A)-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

One Generator has been installed for providing back up supply to cold storage.

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 21.633 kW
Proposed System: 20kW Hybrid PV + UPS

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **20kW hybrid** solar with two additional **UPS** backup. That system will meet the overall load requirement of cold room with strong battery backup and to feed critical load of EPI as well as DHO offices we have designed two backup UPS at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 20kW Hybrid with (15.8 kW) PV system with UPS backup is being recommended for Cold Chain WareHouse Manshera. The simulation results are attached as **Annex 5-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are of Lithium ion type which are long life, durable for the heavy loads and perform much better if exposed in the

cold weather.

c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 25.62 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.

d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is Square feet (Square meter). 2D Drawing of the available area is attached as **Annex 5-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is tilt and made of fiber so we cannot mounted structure on the roof we will make shed at two places for mounting the system.

5.2 STRENGTH OF ROOF

We will make shed for mounting the system because available fiber roofs have nt enough strength to bear the weight of system and these are out of south.

5.3 BASE STRUCTURE

The fixed tilt landscape based two L-6 shed type customized structures have been recommended to install with angle of 20 Degree at site.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. Inverter and batteries are kept in the small room of cold room where the main termination of national grid available. This room was suitable according to ventilation point of view and also have enough space for battries.

7. DRINKING WATER ARRANGEMENT

Cold Chain WareHouse Manshera has following water arrangements.
Water Tank: 2000 Gallons
Water Pump-1: 2 H.P
Water Coolers: 2
It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Cold Chain WareHouse Manshera is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 20 kW Hybrid PV system and ups backup at the site of Cold Chain WareHouse Manshera for offices is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.28 kW PV string (12 pieces of 440 W modules) is recommended.
- 02 string of 5.28 kW are inserted to the one inverter through DC circuit breakers and one string of 5.28kw will be inserted to the other inserted
- Battery backup 48V, 300Ah with each inverter will be provided to critical load of building.
- For each UPS battery backup of 48V, 200Ah will be provided.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 6) will be used. The main mounting structure will be fixed tilted at an angle of 20º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 5-E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	20
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	500

9.5 BATTERY BACKUP

i) Total 10 batteries will be used for this site.
ii) Each battery will be of 48V, 100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.
v) Each 5kw inverter will carry 2 batteries of 48V, 100Ah.

10. SYSTEM INSTALLATION CONSIDERATION

The 20 kW Hybrid with 15.8kW PV System will be having 36 solar panels of 440 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 56 panels will cover a total area of 224 m^2.

The solar panel metallic frame structure is recommended to be installed as shed facing south of the main building as shown on the 3D model of the building placed as **Annex- 5 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

GOVT MIDDLE SCHOOL ZAFAR MADAN MANSERA

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		34°19'36.0"N ,3°12'13.0"E
ii.	Focal Person Name		Shahid Headmaster
iii.	Focal Person Contact No.		0316-5665081
iv.	Site Existing Load (kW)		11.782
v.	Site Critical Load (kW)		10.582
vi.	Average Electricity Bill (kWh)		101.67
vii.	Available Area for Solar PV Modules (Square feet)		2,600 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	10 kW
		Type	Hybrid Solution
ix.	Annual Expected Power Generation (MWh/Annum)		18.57
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kWh

2. SITE TECHNICAL INFORMATION

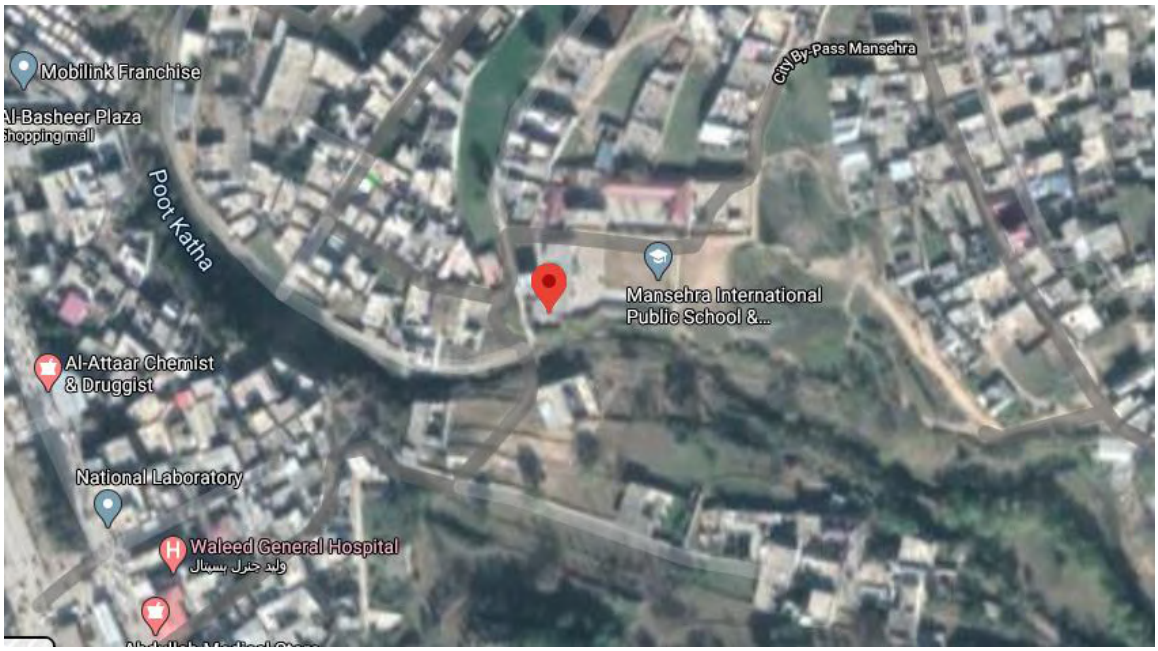
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Gov Middle School Zafar Madan Mansera.

2.2 SITE LOCATION

Gov Middle School Zafar Madan Mansera is located at Longitude 34°19'36.0"N Latitude 73°12'13.0"E. and Elevation 100m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Gov Middle School Zafar Madan Mansera	11.782	10.582	101.67

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 6-A**.

2.4 SITE DESCRIPTION

Currently the premises of Gov Middle School Zafar Madan Mansera comprises of one story building. Details about the buildings is explained below:-

2.4.1 GOV MIDDLE SCHOOL ZAFAR MADAN MANSERA

The Building of Gov Middle School Zafar Madan Mansera comprising of one story.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are besides the stairs at ground and first floor where solar output will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Gov Middle School Zafar Madan Mansera is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Gov Middle School Zafar Madan Mansera is met from National Grid.

One single-phase meters are installed at the Gov Middle School Zafar Madan Mansera

PESCO- MSR CITY 1 Sector Sub Division

- R/N# 19 26711 010287 U CITY-II
- Sanctioned Load: 1 kW
- Tariff A-3 (A) (66)

2.4.3.2 EMERGENCY POWER SUPPLY

No have any emergency power supply for backup during no electricity.

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 10.582 kW
Proposed System: 10kW Hybrid PV

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. A solar system of **10kW hybrid** solar design is to be recommended that system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 10 kW Hybrid PV system is being recommended for Gov Middle School Zafar Madan Mansera. The simulation results are attached as **Annex 6-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
   c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 18.57 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
   d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 2600 Square feet (241 Square meter). 2D Drawing of the available area is attached as **Annex 6-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC). We need to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 and L-3 structure has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Gov Middle School Zafar Madan Mansera building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.inverter and and battery racks will be placed at available space nearby the inverters just besides first floor staires where it will be kept safe and also ventilation will be available to keep battery cool and enhance their life.

7. DRINKING WATER ARRANGEMENT

Gov Middle School Zafar Madan Mansera has following water arrangements.
Water Tank: 500 Gallons
Water Pump-1: 1.5 H.P

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Gov Middle School Zafar Madan is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment/materials/stores going to be used for installation of 10 kW Hybrid PV system and backup at the site of Gov Middle School Zafar Madan Mansera is mentioned below:-

10.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V,300 Ah with inverter will be provided to critical load of building.

10.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

10.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 12) will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 6-E**

10.4 WIRES & CABLES

Solar system will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	10
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

10.5 BATTERY BACKUP

i) Total 3 batteries will be used for this site.
ii) Each battery will be of 48V, 100AH.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 3 batteries as backup.

11. SYSTEM INSTALLATION CONSIDERATION

The 10 kW Hybrid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of

the building placed as **Annex- 6 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

12. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

GIRLS HIGHER SECONDARY SCHOOL TOPI

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		34°04'27.0"N, 72°37'25.0"E
ii.	Focal Person Name		DEO Swabi
iii.	Focal Person Name		03339359575
iv.	Site Existing Load (kW)		49.152
v.	Site Critical Load (kW)		46.176
vi.	Average Electricity Bill (kWh)		1393
vii.	Available Area for Solar PV Modules (Square feet)		15595 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	40kW+UPS for lab
		Type	Hybrid solution
ix.	Annual Expected Power Generation (MWh/Annum)		70.87
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Girls higher Secondary School Topi.

2.2 SITE LOCATION

Geographically Girls higher Secondary School Topi is located at 34°04'27.0"N 72°37'25.0"E and Elevation 20m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Girls higher Secondary School Topi	49	46	1393

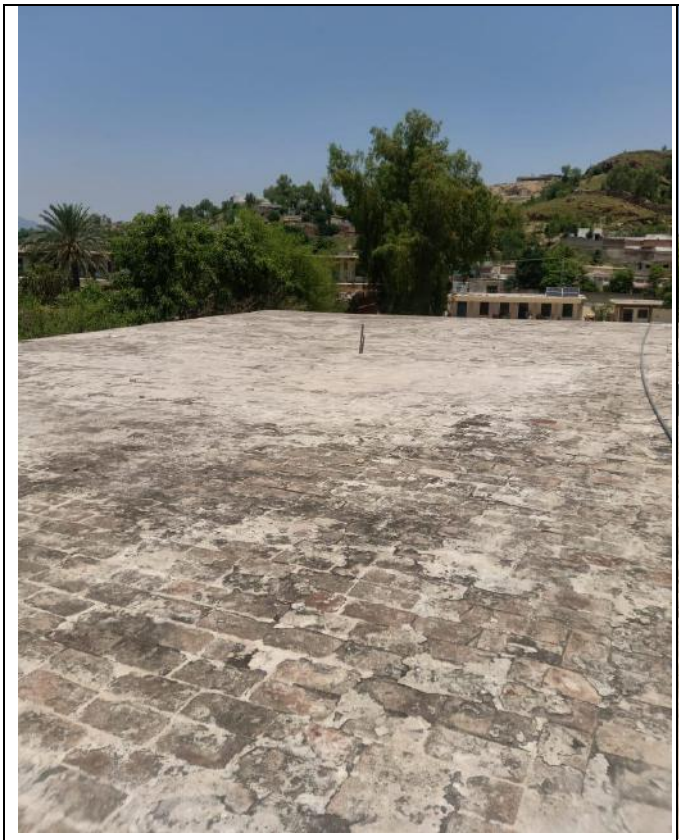
A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 7-A**.

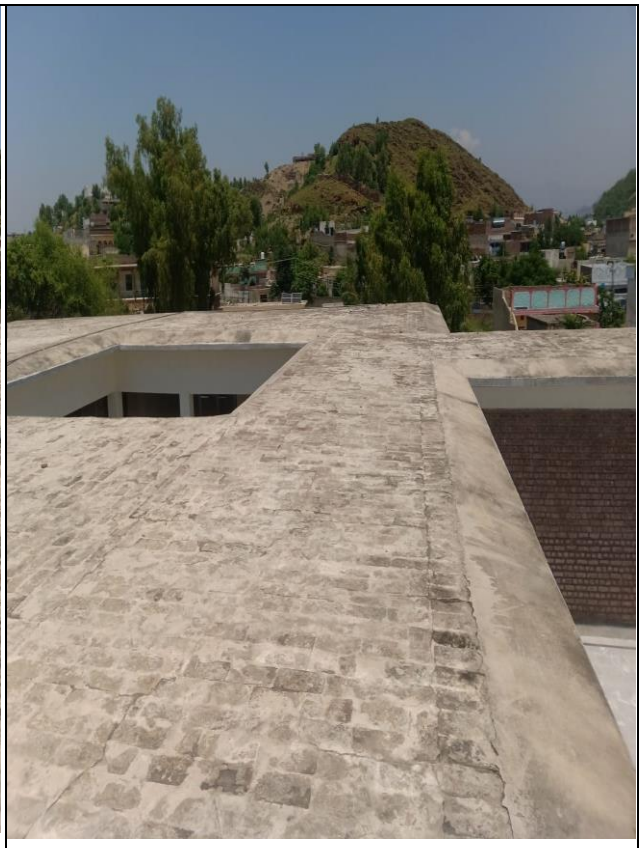
2.4 SITE DESCRIPTION

Currently the premises of Girls higher Secondary School Topi comprises of more than ten buildings, two roofs selected as suitable for solar PV installation. Details about the buildings is explained below:-

2.4.1 GIRLS HIGHER SECONDARY SCHOOL TOPI

The Building of Girls higher Secondary School Topi comprising of two roofs.





2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution system is distributed for the each building .

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Girls higher Secondary School Topi is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Girls higher Secondary School Topi is met from National Grid.

Four meters two single phase and two three phase meter are installed at the Girls higher Secondary School Topi.

PESCO- Sub-Division, TOPI

- R/N# 26 03045621 8 U
- Sanctioned Load: 1 kW
- Tariff A-3A-(66)

PESCO- Sub-Division, TOPI

- R/N# 26 03045621 5 U
- Sanctioned Load: 1 kW
- Tariff A-3A-(66)

PESCO- Sub-Division, TOPI

- R/N# 19 26841 0262200 U
- Sanctioned Load: 1 kW
- Tariff A-3a-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

Batteries has been installed for providing back up supply to the computer lab Principal Office and clerk office.

UPS specifications

- Solar Power 1200VA (Inverter)
- 12V, 150AH*4 Batteries, (Spark)

3. PROPOSED SOLAR PV SYSTEM

Critical Load 46 kW
Proposed System: 40kW Hybrid PV + UPS for computer lab

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **40kW hybrid** solar has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 40 kW Hybrid PV system with UPS backup is being recommended for Girls higher Secondary School Topi The simulation results are attached as **Annex 7-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 70.87 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be

transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 15595 Square feet (1448 Square meter). 2D Drawing of the available area is attached as **Annex 7-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC).

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 40 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based two L-2 structure of 42 and 15 frames has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Girls higher Secondary School Topi roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.We will terminate the two inverters in newly built building under the stairs for classes(9^{th},10^{th},11^{th},12^{th}) and offices, One inverter will be terminated in the building for classes(7^{th} and 8^{th}) and science Lab. One inverter will be mounted in building for class (6^{th}) that will feed hostel as well as class rooms of 6^{th} class.Moreover for computer Lab UPS backup will be provided.

7. DRINKING WATER ARRANGEMENT

Girls higher Secondary School Topi has following water arrangements.
Water Tank: 600 Gallon
Water Pump:1.5 HP
Water Coolers: 1
It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Girls higher Secondary School Topi is not fulfilling their hot water requirement. So, we have proposed a system which will generate enough energy to overcome the future extension of old load in case of electric geyser installation.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 40 KW Hybrid PV system and battery backup at the site of Girls higher Secondary School Topi is mentioned below:-

10.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the each inverter through DC circuit breakers.
- Battery backup 14,400 Wh with each inverter will be provided to critical load of building.

10.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

10.3 MOUNTING STRUCTURE

Customize mounting (QTY 5714) structure will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 7-E**

10.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm²	M	15
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	150

10.5 BATTERY BACKUP

i) Total 14 batteries will be used for this site.
ii) Each battery will be of 48V, 100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.
v) 5kW UPS inverter will carry 2 batteries 48V, 100Ah.

11. SYSTEM INSTALLATION CONSIDERATION

The 40 KW Hybrid PV System will be having 112 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly,112 panels will cover a total area of 448 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 7 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the

wiring to the critical load being supported through subject system will be routed through this room.

12. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

GOVT PRIMARY SCHOOL TEHKAL BALA (1) BOYS. PESHAWAR

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		71.5030159.53 E, 34.0114389 N
ii.	Focal Person Name		Tahir Khan
iii.	Focal Person contact No.		0300-5949662
iv.	Site Existing Load (kW)		13
v.	Site Critical Load (kW)		12
vi.	Average Electricity Bill (kWh)		440
vii.	Available Area for Solar PV Modules (Square feet)		1250 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	10kW
		Type	Hybrid Solution
ix.	Annual Expected Power Generation (MWh/Annum)		19.16
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kWh

2. SITE TECHNICAL INFORMATION

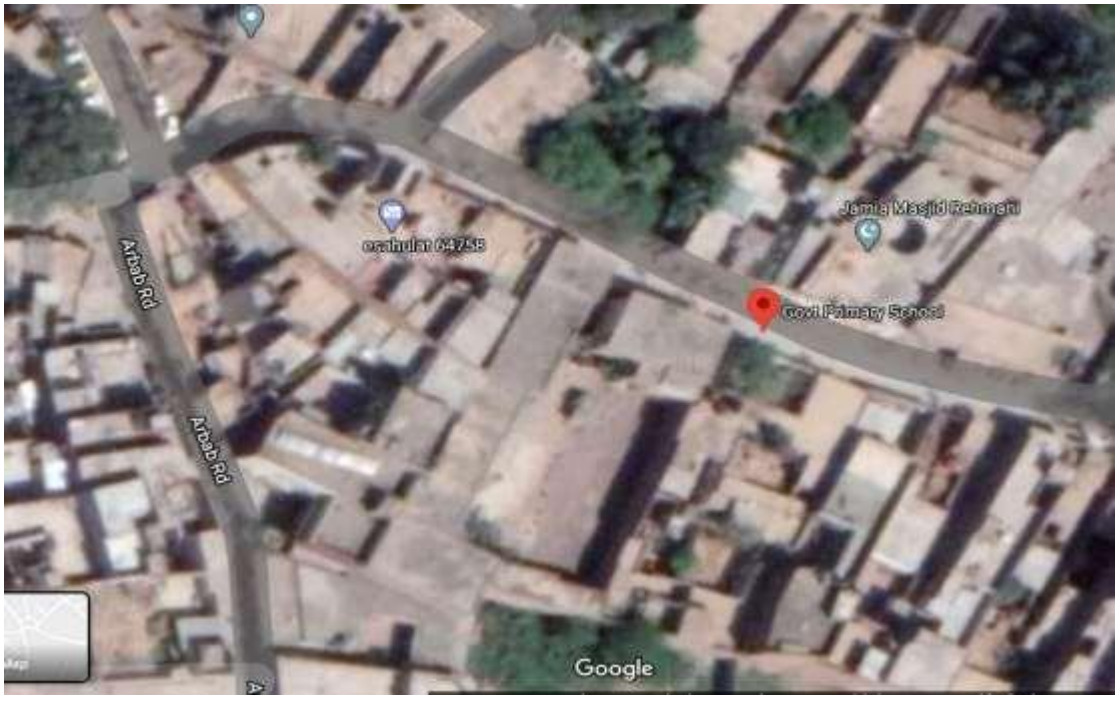
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Government Primary School Tehkal Bala Boys, Peshawar.

2.2 SITE LOCATION

Geographically Government Primary School Tehkal Bala Boys, Peshawar is located at 71.5030159.53 E, 34.0114389 N and Elevation 100m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Government Primary School Tehkal Bala Boys, Peshawar.	13	12	440

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 1-A**.

2.4 SITE DESCRIPTION

Currently the premises of Government Primary School Tehkal Bala Boys, Peshawar comprises of multiple roof tops. A detail about the building is explained below:-

2.4.1 GOVERNMENT PRIMARY SCHOOL TEHKAL BALA BOYS,PESHAWAR

The Building of Government Primary School Tehkal Bala Boys, Peshawar comprises of multiple roof tops.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are available with the entrance.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Government Primary School Tehkal Bala Boys, Peshawar is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Government Primary School Tehkal Bala Boys, Peshawar is met from National Grid.
One single-phase meter is installed at the Government Primary School Tehkal Bala Boys, Peshawar.
PESCO- Division Peshawar Cantt Sub Division U.Town No-II

R/N# 19261340023490 U TEHKAL PSR 66 KV-PSR CA

- Sanctioned Load: 2 kW
- Tariff A-3A-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

Not have any emergency power supply i.e. Generator/UPS/Batteries.

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 12 kW
Proposed System: 10kW Hybrid Solution

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **10kW Hybrid** Solar System has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 10 kW Hybrid System is being recommended for Government Primary School Tehkal Bala Boys, Peshawar.The simulation results are attached as **Annex 1-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are of Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 19.16 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 3478.16 Square feet (323.13 Square meters). 2D Drawing of the available area is attached as **Annex 1-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC).

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based one L-2 structures of 14 frames has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Government Primary School Hayatabad Peshawar building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the building. Inverter will be installed near the space available with main circuit breaker and also a battery backup system will be install their.

7. DRINKING WATER ARRANGEMENT

Government Primary School Tehkal Bala Boys, Peshawar has following water arrangements.

Water Tank: 2000 Gallons **Water Pump:** 1.6 H.P

Water Coolers: 1

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Government Primary School Tehkal Bala Boys, Peshawar is fulfilling their hot water requirement. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 10 kW Hybrid PV System at the site of Government Primary School Tehkal Bala Boys, Peshawar is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- One PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 2 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V, 300 Ah with inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 14) will be used. The main mounting structure will be fixed tilted at an angle of 30°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm²	M	20
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

9.5 BATTERY BACKUP

i) Total 3 batteries will be used for this site.
ii) Each battery will be of 100 Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.

10. SYSTEM INSTALLATION CONSIDERATION

The 10 kW Hybrid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 1 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will

be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

Annex-1 A

Load Calculation sheet

Details of Electrical Equipment Available/ Load to be supported by Solar PV System

Project Location:	**Govt Primary School Tehkal Bala (1) Boys**		
GPS Data:	**Latitude**	**Longitude**	**Elevation**
	34.011222N	**71.502866S**	100
Inclination:			

Load Determination

S.No	Description	Make	Power Consumption (Watts)	Quantity		Total Wattage		Operation hours	Energy Requirement (Watt hrs)	
		Existing Load	Existing Load	Existing Load	Critical Load	Existing Load	Proposed Load		Existing Load	Proposed Load
Existing Class Room*12										
1	Ceilling Fans	Pak Fans	100	48	48	4,800	4,800	6	28,800	28,800
2	LED Light	Philips	15	48	48	720	720	6	4,320	4,320
	Total Load					**5,520**	**5,520**		**33,120**	**33,120**

S.No	Description	Make	Power Consumption (Watts)	Quantity		Total Wattage		Operation hours	Energy Requirement (Watt hrs)	
		Existing Load	Existing Load	Existing Load	Critical Load	Existing Load	Proposed Load		Existing Load	Proposed Load
Office/ Staff Room										
1	Ceilling Fans	Pak Fans	100	2	2	200	200	6	1,200	1,200
2	LED Lights	Philips	15	3	3	45	45	6	270	270
3	PC	HP	250	1	1	250	250	6	1,500	1,500
4	Printer	HP	300	1	1	300	300	6	1,800	1,800
5	Sound System	Sony	150	1	1	150	150	6	900	900
	Total Load					**945**	**945**		**5,670**	**5,670**
Groung Lobby (Warranda)										
1	Ceilling Fans	Pak Fans	100	8	8	800	800	6	4,800	4,800
2	LED Lights	Philips	18	8	8	144	144	6	864	864
3	Water Pump	Pyra	746	1	-	746	-	4	2,984	-
	Total Load					**1,690**	**944**		**8,648**	**5,664**

S.No	Description	Make	Power Consumption (Watts)	Quantity		Total Wattage		Operation hours	Energy Requirement (Watt hrs)	
		Existing Load	Existing Load	Existing Load	Critical Load	Existing Load	Proposed Load		Existing Load	Proposed Load
First Floor Lobby										
1	Ceiling \fans	Pak Fans	100	2	2	200	200	6	1,200	1,200
2	Lights (Energy Saver)	Philips	18	1	1	18	18	6	108	108
	Total Load					**218**	**218**		**1,308**	**1,308**
Existing Rest Room										
1	Exhust Fan	Pak Fans	40	2	2	80	80	6	480	480
2	LED Lights	Philips	15	4	4	60	60	6	360	360
	Total Load					**140**	**140**		**840**	**840**
CCTV										
1	Cameras	Broklyn	8	5	5	40	40	24	960	960
2	DVR	Swann	65	1	1	65	65	24	1,560	1,560
3	Screen(16")	Sony	20	1	1	20	20	24	480	480
	Total Load					**125**	**125**		**3,000**	**3,000**

S.No	Description	Make	Power Consumption (Watts)	Quantity		Total Wattage		Operation hours	Energy Requirement (Watt hrs)	
		Existing Load	Existing Load	Existing Load	Critical Load	Existing Load	Proposed Load		Existing Load	Proposed Load
Under Construction Room*8										
1	Ceiling \fans	Pak Fans	100	32	32	3,200	3,200	6	19,200	19,200
2	LED Lights	Philips	15	32	32	480	480	6	2,880	2,880
	Total Load					**3,680**	**3,680**		**22,080**	**22,080**
Project Location:										
1	Exhaust Fan	Pak Fans	40	6	6	240	240	6	1,440	1,440
2	LED Lights	Philips	15	12	12	180	180	6	1,080	1,080
	Total Load					**420**	**420**		**2,520**	**2,520**
	Grand Total					**12,738**	**11,992**		**77,186**	**74,202**

Annex-1 B

Simulation Report

Design 1 25, 2G63+H6 Peshawar, Pakistan

Report

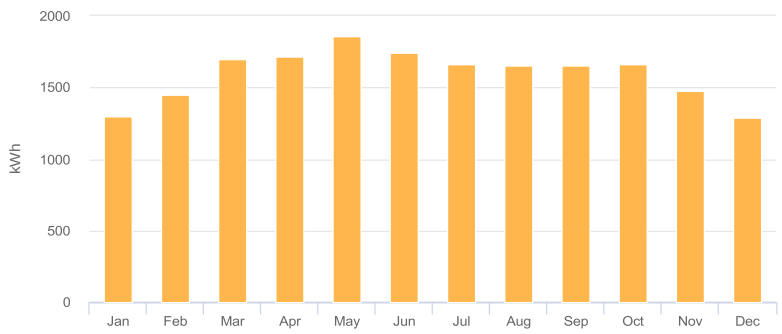
Project Name	25
Project Address	2G63+H6 Peshawar, Pakistan
Prepared By	Muhammad Zubair muhammad.zubair@fsel.com.pk

System Metrics

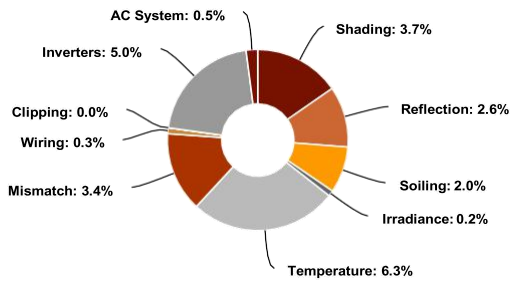
Design	Design 1
Module DC Nameplate	11.2 kW
Inverter AC Nameplate	10.00 kW Load Ratio: 1.12
Annual Production	19.16 MWh
Performance Ratio	78.1%
kWh/kWp	1,710.8
Weather Dataset	TMY, 10km Grid, meteonorm (meteonorm)
Simulator Version	8df3ba8977-b5fd44241f-c7eec90fb7-0331dd75ba

Project Location

Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Energy (kWh)	Annual Global Horizontal Irradiance	1,881.3	
	POA Irradiance	2,190.3	16.4%
	Shaded Irradiance	2,109.2	-3.7%
	Irradiance after Reflection	2,053.9	-2.6%
	Irradiance after Soiling	2,012.8	-2.0%
	Total Collector Irradiance	**2,011.2**	**-0.1%**
	Nameplate	22,527.7	
	Output at Irradiance Levels	22,471.8	-0.2%
	Output at Cell Temperature Derate	21,045.1	-6.3%
	Output After Mismatch	20,322.0	-3.4%
	Optimal DC Output	20,271.0	-0.3%
	Constrained DC Output	20,270.7	0.0%
	Inverter Output	19,257.2	-5.0%
	Energy to Grid	**19,160.9**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		25.1 °C
	Avg. Operating Cell Temp		36.1 °C
Simulation Metrics			
	Operating Hours		4600
	Solved Hours		4600

Condition Set

	Condition Set 1												
	TMY, 10km Grid, meteonorm (meteonorm)												
	Meteo Lat/Lng												
	Perez Model												
	Sandia Model												
		a											
	Fixed Tilt	-3.56	-0.075	3°C									
	Flush Mount	-2.81	-0.0455	0°C									
	2	2	2	2	2	2	2	2	2	2	2	2	
	5%												
	4° C												
	-2.5% to 2.5%												
	0.50%												
	JAM72S10-400MR (JA Solar)	Folsom Labs	Spec Sheet Characterization, PAN										
	InfiniSolar 3P 10kW (InfiniSolar)	Folsom Labs	CEC										

% Components

Component	Name	Count
Inverters	InfiniSolar 3P 10kW (InfiniSolar)	1 (10.00kW)
Strings	10 AWG (Copper)	2 (38.5 m)
Module	jA Solar, jAM72S10-400MR (400W)	28 (11.2kW)

1 Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	11-18	Along Racking

... Field Segments

Description	Racking	Orientation	Tilt Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	30° 180°	1.4 m	2x1	21	28	11.2 kW

@ Detailed Layout

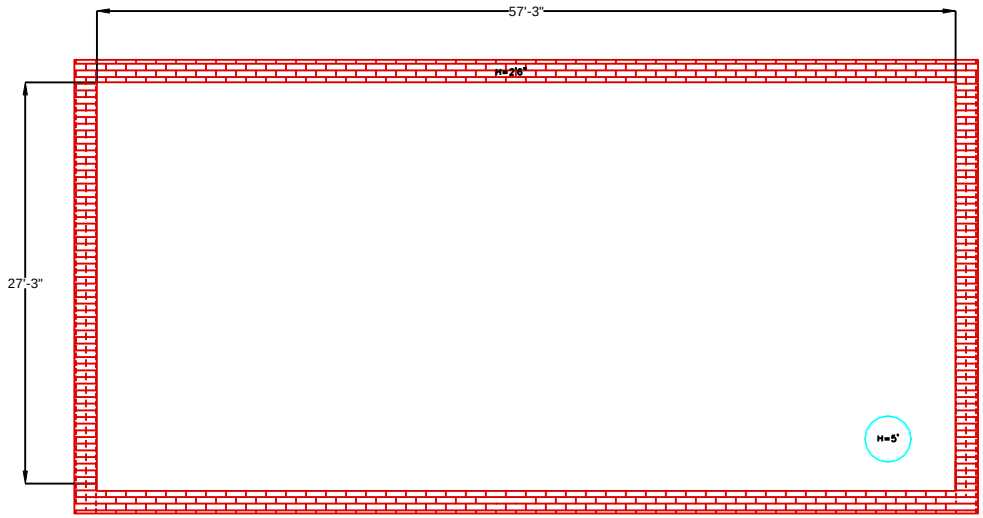
Annex 1-C

2-D Layout of Building

UNHCR SURVEY

N: 33° 35’ 23” E: 71° 26’ 13”

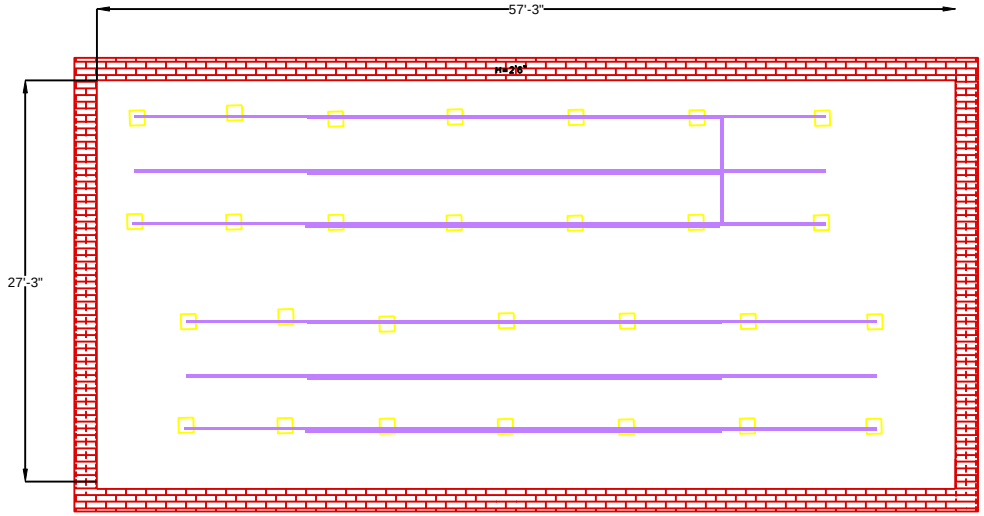
S (11°W)



UNHCR SURVEY

N: 33° 35’ 23” E: 71° 26’ 13”

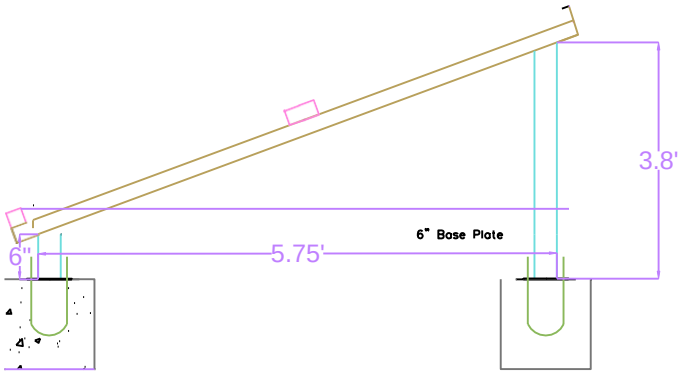
S (11°W)



Annex 1-E

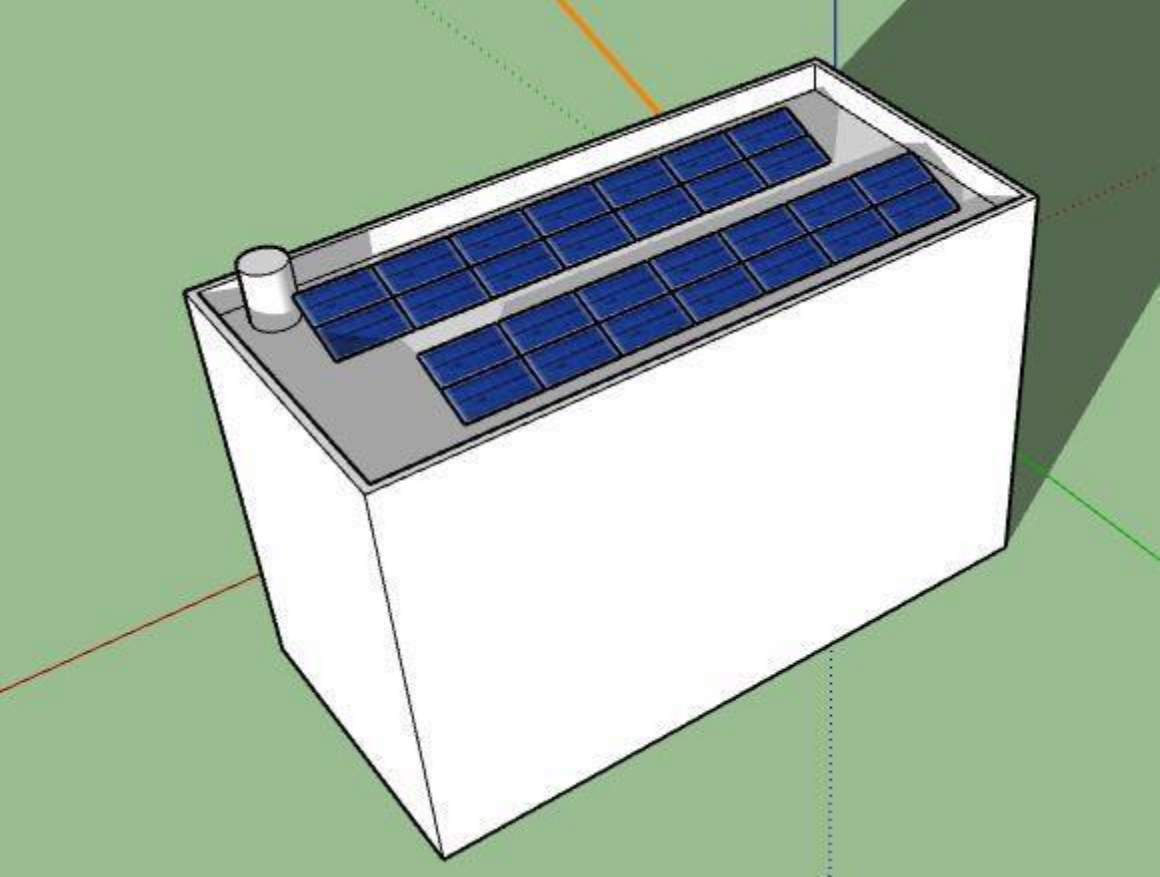
PV Panel Structure Drawing

30* L2



Annex 1-F

3D Modeling Layout



Site Assessment

PSB-136 AKORA KHATTAK

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		33°59'32.0"N,72°05'56.0"E
ii.	Focal Person Name		Faraz
iii.	Focal Peson Contact No.		-
iv.	Site Existing Load (kW)		6.342
v.	Site Critical Load (kW)		6.342
vi.	Average Electricity Bill (kWh)		-
vii.	Available Area for Solar PV Modules (Square feet)		6209.49 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	10 kW
		Type	Off grid hybrid
ix.	Annual Expected Power Generation (MWh/Annum)		18.62
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kwh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top building of PSB-136 Akora Khattak.

2.2 SITE LOCATION

Geographically PSB-136 Akora Khattak is located at Longitude 33°59'32.0"N Latitude 72°05'56.0"E. and Elevation 20m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	PSB-136 Akora Khattak	6.342	6.342	-

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 9-A**.

2.4 SITE DESCRIPTION

Currently the premises of PSB-136 Akora Khattak comprises of one roof building. Details about the buildings is explained below:-

2.4. PSB-136 AKORA KHATTAK

The Building of PSB-136 Akora Khattak comprising of one roof

2.4.2 POWER & CONTROL SYSTEM

The power and control system will be fitted in the room near security room. Also the termination of PV solar will be ended their because of enough and ventilated space. Because of no electricity connection from grid they no have specific wiring and teminations.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Health facility PSB-136 Akora Khattak is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

There is no national grid available for PSB-136 Akora Khattak so they have no power supply, not have any wiring fitting and also lack of electrical equipment's.

2.4.3.2 EMERGENCY POWER SUPPLY

There is no emergency power supply use at the PSB-136 Akora Khattak.

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 6.342 kW
Proposed System: 10kW off grid system

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **10kW off grid** solar system has been designed. That system will meet the overall load requirement and will feed critical

load at the time of load shading.

4 DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 10 kW off grid PV system is designed for PSB-136 Akora Khattak.The simulation results are attached as **Annex 9-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
   c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 18.62 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
   d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 6209 Square feet (576 Square meter). 2D Drawing of the available area is attached as **Annex 9-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is three roofs building are flat and made of RCC . Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus

weight of 30 kg/m^2 on the roof The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed tilt one L-2 structure frame has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the PSB-136 Akora Khattak building roof is made of RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. we will mounted total one inverter at this site. The inverter and batteries are kept at the room near security room because of enough space and ventiated room. By keeping batteries cool it will enhance battery life.

7. DRINKING WATER ARRANGEMENT

PSB-136 Akora Khattak has no water arrangements.

During site survey it is observed that the mentioned site has enough water storage but no have cooling facility (water cooler) available and also no have motor pump so, there is a need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

PSB-136 Akora Khattak not fulfilling their hot water requirement not any water geysers. So, there is need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 10kW off grid PV system at the site of PSB-136 Akora Khattak is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V,300 Ah with inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed tilt mounting (QTY 16) structure will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 9-E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	10
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

9.5 BATTERY BACKUP

i) Total 4 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 10 kW off grid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 9 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

DIVISIONAL COLD CHAIN WAREHOUSE BATKHELA

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		34°36'43.0"N ,71°57'40.0"E
ii.	Focal Person Name		Dr. Murad (EPI Coordinator)
iii.	Focal Person Contact No.		Cell # 03459351352
iv.	Site Existing Load (kW)		19.491
v.	Site Critical Load (kW)		15.791
vi.	Average Electricity Bill (kWh)		839
vii.	Available Area for Solar PV Modules (Square feet)		1870.7Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	20 kW
		Type	Hybrid solution
ix.	Annual Expected Power Generation (MWh/Annum)		35.18
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 20˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kwh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Divisional Cold Change Warehouse Batkhela.

2.2 SITE LOCATION

Geographically Divisional Cold Change Warehouse Batkhela is located at longitude 34°36'43.0"N 71° , Latitude 57'40.0"E. and Elevation 10m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Divisional Cold Change Warehouse Batkhela	19.491	15.791	839

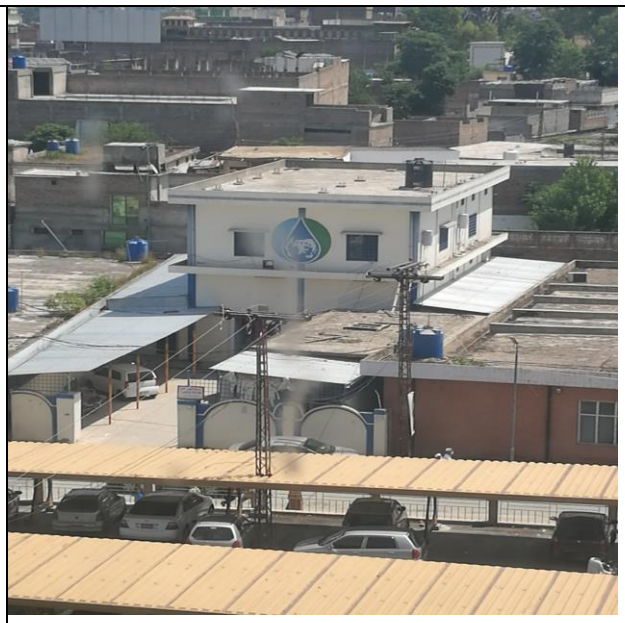
A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 10-A**.

2.4 SITE DESCRIPTION

Currently the premises of Divisional Cold Change Warehouse Batkhela comprises of two story building. Details about the buildings is explained below:-

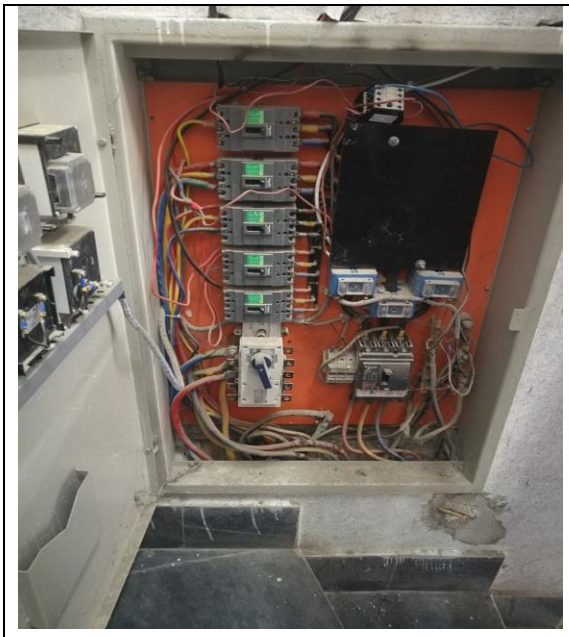
2.4.1 DIVISIONAL COLD CHANGE WAREHOUSE BATKHELA

The Divisional Cold Change Warehouse Batkhela comprising of two stories.



2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are at ground floor and first floor where solar output will be terminated.




2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Divisional Cold Change Warehouse Batkhela is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Divisional Cold Change Warehouse Batkhela is met from National Grid.

One three-phase meters are installed at the Divisional Cold Change Warehouse Batkhela.

PESCO- Sub Division BAKHELA

- R/N# 41 2651300693 30 U EXP-BAT-KHELA
- Sanctioned Load: 15 kW
- Tariff A-3A-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply to cold chain room.

Generator specifications

- Coelmo
- PRP power 20kVA
- LPT power 22kVA

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 15.791 kW

Proposed System: 20kW Hybrid PV

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **20kW hybrid** solar That system will meet the overall load requirement and will feed critical load at the time of load shading.

4 DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 20 kW Hybrid PV system is recommended Divisional Cold Change Warehouse Batkhela. The simulation results are attached as **Annex 10-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
   c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 35.18MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
   d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is1870.7 Square feet (173.79 Square meter). 2D Drawing of the available area is attached as **Annex 10-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC). Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based two L-2 structure and two L-4 structure has been recommended to install with angle of 20 Degree on the space available at site. It has also informed that the Divisional Cold Change Warehouse Batkhela building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.inverter and batteries both are installed and place in the storage room or we may keep it in the first floor.

7. DRINKING WATER ARRANGEMENT

Divisional Cold Change Warehouse Batkhela has following water arrangements.

Water Tank: Available

Water Pump-1: 1 H.P

It is observed that the mentioned site has enough water storage and water pump available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Divisional Cold Change Warehouse Batkhela is not fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 20 kW Hybrid PV system at the site of Divisional Cold Change Warehouse Batkhela is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the each inverter through DC circuit breakers.
- Same stringing process will be used for the second inverter.
- Battery backup 48V,300 Ah with each inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 17) will be used. The main mounting structure will be fixed tilted at an angle of 20º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 10-E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables

(from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	20
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	500

9.5 BATTERY BACKUP

i) Total 8 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 20 kW Hybrid PV System will be having 56 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 56 panels will cover a total area of 224 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 10 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to

enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

GGPS NO 2 HAJI KHEL TEHKAL

NOTE: The following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on actual ground implementation.

1. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top of the building.

2.2 SITE LOCATION

Gov Girls Primary School # 2 is located in Tehkal, Peshawar

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	GGPS NO 2 HAJI KHEL TEHKAL	11.782	10.582	101.67

* There may be 5-10% variation on actual ground implementation.

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 10.582 kW
Proposed System: 10kW Hybrid PV

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. A solar system of **10kW hybrid** solar design is to be recommended that system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 10 kW Hybrid PV system is being recommended for this facility

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 18.57 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for

the building is 2600 Square feet (241 Square meter).

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC). We need to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 and L-3 structure has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Gov Middle School Zafar Madan Mansera building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.inverter and and battery racks will be placed at available space nearby the inverters just besides first floor staires where it will be kept safe and also ventilation will be available to keep battery cool and enhance their life.

9. EQUIPMENT DETAILS

The complete details of the equipment/materials/stores going to be used for installation of 10 kW Hybrid PV system and backup at the site of Gov School is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V,300 Ah with inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 12) will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.

9.4 WIRES & CABLES

Solar system will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	10

	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

9.5 BATTERY BACKUP

i) Total 3 batteries will be used for this site.
ii) Each battery will be of 48V, 100AH.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 10 kW Hybrid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made

responsible for the safety of each and every equipment of Solar PV equipment installed.

GOVT PRIMARY SCHOOL HAYATABAD PESHAWAR

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		33°57'05.0"N, 72°25'51.0"E
ii.	Focal Person Name		Zahid Hussain
iii.	Focal Person contact No.		0302-5563074
iv.	Site Existing Load (kW)		5.547
v.	Site Critical Load (kW)		4.867
vi.	Average Electricity Bill (kWh)		60
vii.	Available Area for Solar PV Modules (Square feet)		3478.16 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	5kW
		Type	On gird solution +UPS
ix.	Annual Expected Power Generation (MWh/Annum)		9.200
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Government Primary School Hayatabad Peshawar.

2.2 SITE LOCATION

Geographically Government Primary School Hayatabad Peshawar is located at Longitude33°57'05.0"N Latitude 72°25'51.0"E and Elevation 100m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Government Primary School Hayatabad Peshawar	5.547	4.867	60

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 12-A**.

2.4 SITE DESCRIPTION

Currently the premises of Government Primary School Hayatabad Peshawar comprises of one roof. Details about the building is explained below:-

2.4.1 GOVT PRIMARY SCHOOL HAYATABAD PESHAWAR

The Building of Government Primary School Hayatabad Peshawar comprising of one roof.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are at each floor.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Government Primary School Hayatabad Peshawar is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Government Primary School Hayatabad Peshawar is met from National Grid.

One single-phase meters is installed at the Government Primary School Hayatabad Peshawar.

PESCO- Sub-Division,KOHAT DARRA

R/N# 08 26216 0302118U HAYAT ABAD 10 132 KV H/ABAD

- Sanctioned Load: 4 kW
- Tariff A-3A-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

Not have any emergency power supply i.e Generator/UPS/Batteries.

3. PROPOSED SOLAR PV SYSTEM

Critical Load 4.867 kW

Proposed System: 5kW On grid PV +UPS

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery

specification etc. a solar system of **5kW On grid** solar and UPS for backup has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 5 kW On grid PV system with UPS backup is being recommended for Government Primary School Hayatabad Peshawar. The simulation results are attached as **Annex 12-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
   c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 9.200MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
   d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 3478.16 Square feet (323.13 Square meter). 2D Drawing of the available area is attached as **Annex 12-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC).

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based one L-2 structure of 8 frames has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Government Primary School Hayatabad Peshawar building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.we will installed the inverter inside the room where main circuit breaker is available and also a battery backup system will be install their.

7. DRINKING WATER ARRANGEMENT

Government Primary School Hayatabad Peshawar has following water arrangements.

Water Tank: 200 Gallons
Water Pump: 1.6 H.P
Water Coolers: 1

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Government Primary School Hayatabad Peshawar is not fulfilling their hot water requirement. So, there is a need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 5 kW On grid PV system and UPS backup at the site of Government Primary School Hayatabad Peshawar is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- One PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 01 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V, 200 Ah with inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 8) will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 12-E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm^2.
- AC cables: From Grid to Inverter and Inverter to Load 10 mm^2.
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC

cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm²	M	15
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	150

9.5 BATTERY BACKUP

i) Total 2 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 2 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 5 kW On grid PV System will be having 14 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly,14 panels will cover a total area of 56 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 12 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

NAHAQI PROVINCIAL COLD CHAINWARE HOUSE

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		34°05'47.0"N ,71°37'09.0"E
ii.	Focal Person Name		Engr. Khurram Shahzad (Cold Chain Engineer)
iii.	Focal Person Contact No.		Cell # 03439027379
iv.	Site Existing Load (kW)		92.778
v.	Site Critical Load (kW)		46.678
vi.	Average Electricity Bill (kWh)		-
vii.	Available Area for Solar PV Modules (Square feet)		10069.08 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	50 kW
		Type	Hybrid solution
ix.	Annual Expected Power Generation (MWh/Annum)		92.73
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 20˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Nahaqi Provincial Cold Chain Warehouse.

2.2 SITE LOCATION

Geographically Nahaqi Provincial Cold Chain Warehouse is located at Longitude 34°05'47.0"N Latitude 71°37'09.0"E and Elevation 200m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been

considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Nahaqi Provincial Cold Chain Warehouse	92.778	46.678	-

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 13-A**.

2.4 SITE DESCRIPTION

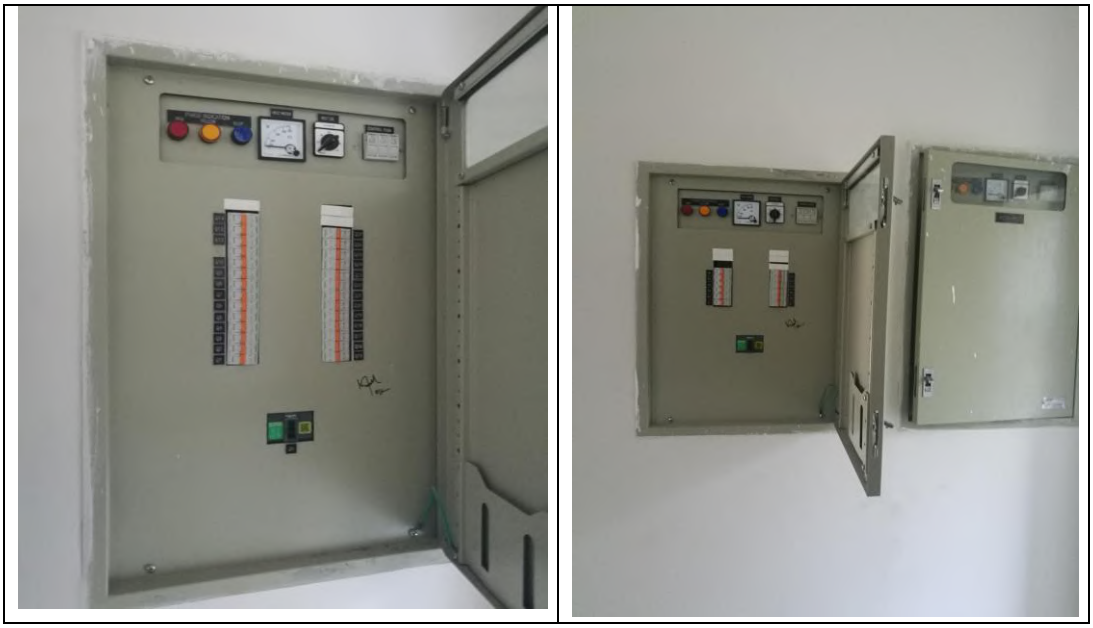
Currently the premises of Nahaqi Provincial Cold Chain Warehouse comprises of one story building suitable for mounting the PV system. Details about the buildings is explained below:-

2.4 . NAHAQI PROVINCIAL COLD CHAINWARE HOUSE BUILDING

The Building of Nahaqi Provincial Cold Chain Warehouse comprising of one stories.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are on floor 1 and floor 2 where solar PV will be terminated. Cold room DB is placed behind the cold room.



2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Nahaqi Provincial Cold Chain Warehouse is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Nahaqi Provincial Cold Chain Warehouse is met from National Grid but yet there is no connection from national grid

2.4.3.2 EMERGENCY POWER SUPPLY

Generator is available for backup emergency supply
Generator specifications

- Rated voltage 200 kVA

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 46.678 kW
Proposed System: 50kW Hybrid PV

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **50kW hybrid** solar. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 50 kW Hybrid PV system is being recommended for Nahaqi Provincial Cold Chain Warehouse The simulation results are attached as **Annex 13-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
   c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 92.73Mh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
   d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 10069.08 Square feet (935.44 Square meter). 2D Drawing of the available area is attached as **Annex 13-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to rain water leakage the building roof is repaired we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 50 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based one L-2 structure has been recommended to install with angle of 20 Degree on the space available at site. It has also informed that the Nahaqi Provincial Cold Chain Warehouse building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.five inverter will be used in the installation invertor and batteries termination will be at cooling room because of enough and ventilated place.

7. DRINKING WATER ARRANGEMENT

Nahaqi Provincial Cold Chain Warehouse has following water arrangements.

Water Tank: one water tank

Water Pump-1: 1 water pump

Water Coolers: 2 cooler

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Nahaqi Provincial Cold Chain Warehouse is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 50 kW Hybrid PV system at the site of Nahaqi Provincial Cold Chain Warehouse is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the each inverter through DC circuit breakers.
- Same stringing process will be used for all five inverter.
- Battery backup 48V, 300Ah with each inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 75) will be used. The main mounting structure will be fixed tilted at an angle of 20º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 13-E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	20
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	500

9.5 BATTERY BACKUP

i) Total 17 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 50 kW Hybrid PV System will be having 140 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 140 panels will cover a total area of 560m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 13 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

DIVISIONAL COLD CHAIN WAREHOUSE, LIAQAT MEMORIAL HOSPITAL (LMH), KOHAT

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		33˚35' 23" N , 71˚26' 14" E
ii.	Focal Person Name		Dr. Muhabat (EPI Coordinator)
iii.	Focal Person Contact No.		Cell # 03339667220
iv.	Site Existing Load (kW)		11
v.	Site Critical Load (kW)		6
vi.	Average Electricity Bill (kWh)		550
vii.	Available Area for Solar PV Modules (Square feet)		1,539 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	10 kW
		Type	Hybrid
ix.	Annual Expected Power Generation (MWh/Annum)		18.34
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs 25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat.

2.2 SITE LOCATION

Geographically Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat is located at Latitude 33˚35' 23" N Longitude 71˚26' 14" E and Elevation 518 m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while, considering the most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has

been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat	11	6	549

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 14-A**.

2.4 SITE DESCRIPTION

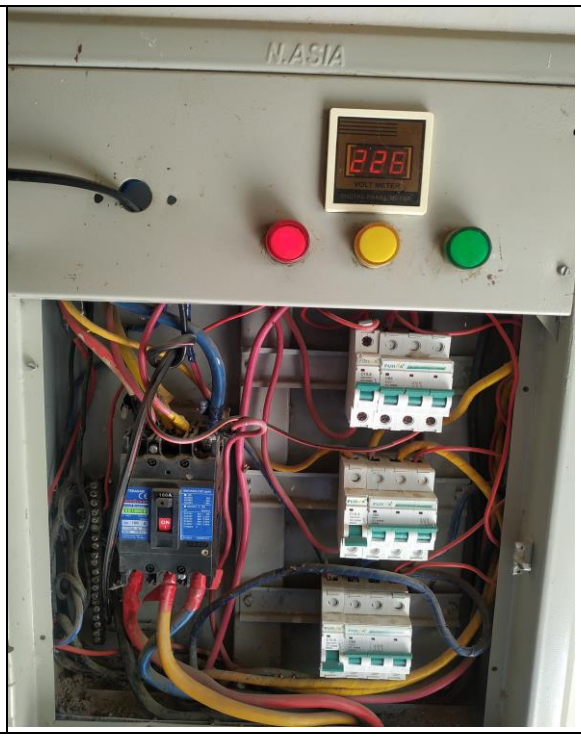
Currently the premises of Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat comprises of two story building. A detail about the buildings is explained below:-

2.4.1 Cold Chain Ware House Building

The Building of Cold Chain Ware House, Kohat comprising of two stories (Ground plus first floor).

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are besides the stairs at every floor where solar output will be terminated.



2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat is met from National Grid.
One three-phase meters was installed at the the Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat.
PESCO- Kohat Division, Sub Division Tall

- R/N# 19 26247 0075325 U
- Sanctioned Load: 5 KW
- Tariff A-3A-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply to DHO Offices and Cold Rooms.
Generator specifications

- **Model:** Coelmo
- 20 kVA, 400 V, 3 Phase

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 6 kW
Proposed System: 10kW Hybrid System
Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **10kW hybrid** has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally, a 10 kW Hybrid PV system is being recommended for Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat. The simulation results are attached as **Annex 14-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are Lithium ion type which are long life

durable for the heavy loads and perform much better if exposed in the cold weather.

c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 18.34 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 KWh/ year) which is the sunniest and hottest belt of the country.

d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 1,539 Sq.ft Square feet (142.97 Square meters). 2D Drawing of the available area is attached as **Annex 14-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to imbalanced building roof so we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 structure has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the

maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. Inverter will be mounted at the available area under the stairs and its battery rack will also be placed at same location(under stairs).

7. DRINKING WATER ARRANGEMENT

Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat has following water arrangements.

Water Tank: 250 Gallons
Water Pump-1: 2 H.P
Water Coolers: 2

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 10 kW Hybrid PV system at the site of Divisional Cold Chain Warehouse, Liaqat Memorial Hospital (LMH), Kohat is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V, 300 Ah with inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 14s) will be used. The main mounting structure will be fixed tilted at an angle of 30°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for Inverter)	M	20
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

9.5 BATTERY BACKUP

i) Total 3 batteries will be used for this site.
ii) Each battery will be of 100 Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.

10. SYSTEM INSTALLATION CONSIDERATION

The 10 KW Hybrid PV systems will be having 28 solar panels of 400 Watts each.

Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 14 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

DIVISIONAL COLD CHAIN WARE HOUSE, ZANANA HOSPITAL DISTRICT HEALTH OFFICER OFFICE, BANNU

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		322˚59' 17" N , 70˚36' 7" E
ii.	Focal Person Name		Dr. Ashraf Younus (EPI Coordinator
iii.	Focal Person Contact No.		Cell #03339302211
iv.	Site Existing Load (kW)		19
v.	Site Critical Load (kW)		11
vi.	Average Electricity Bill (kWh)		1,997
vii.	Available Area for Solar PV Modules (Square feet)		4,977 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	20 kW
		Type	Hybrid
ix.	Annual Expected Power Generation (MWh/Annum)		33.89
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 15˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION

The suggested location for execution of Solar Based Power Project is at roof top buildings of Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu.

2.2 SITE LOCATION

Geographically Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu is located at Latitude 32˚59' 17" N Longitude 70˚36' 07" E. and Elevation 380m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (KW)	Critical Load (KW)	Average Monthly Bill (kWh)
1	Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu	19	11	1,997

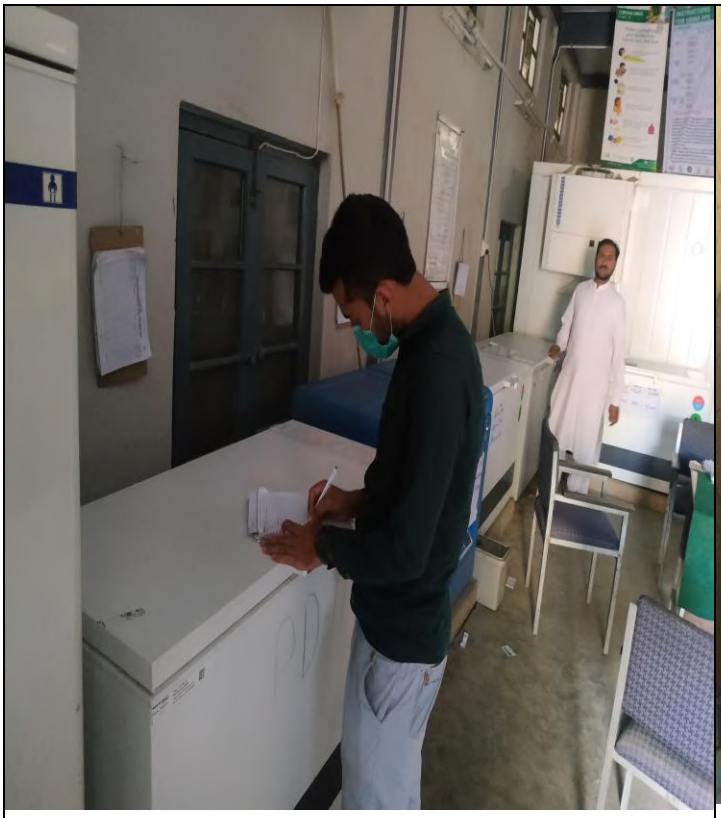
A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 15-A**.

2.4 SITE DESCRIPTION

Currently the premises of Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu comprises of 3 buildings. But only two roofs were suitable for solarisation. Details about the buildings are explained below:-

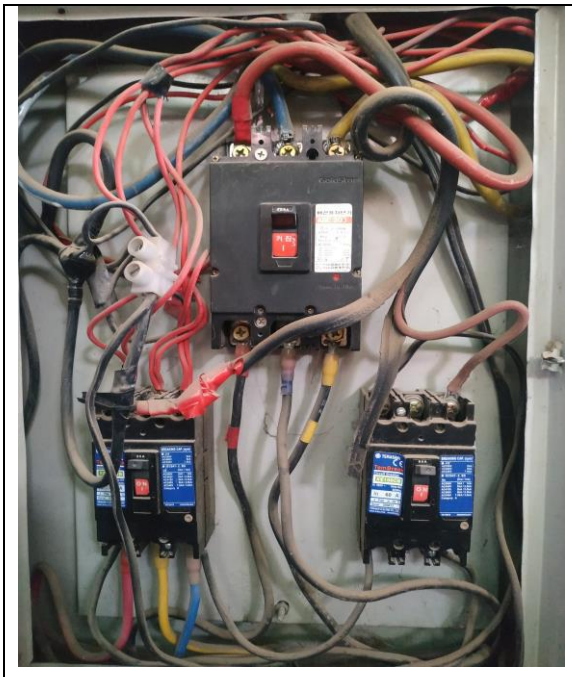
2.4.1 Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu

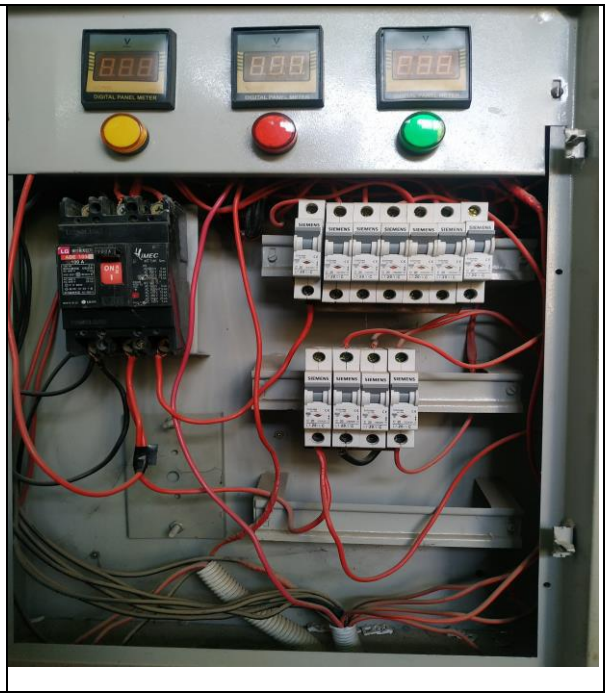
For solar installation purpose two Buildings of Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu have been specified.



2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are besides the room attached with the cold room where solar output will be terminated.





2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu is met from National Grid.
A three-phase meter was installed at the Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu.
PESCO- Division Bannu Sub Division Bannu Urban

- R/N# 19 26611 0624400U 11KV CITY-III BANNU
- Sanctioned Load: 1 KW
- Tariff A-3A-(66)T

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply.
Generator specifications

- **Model** Coelmo
- 20 kVA , 400 V

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 11 kW
Proposed System: 20kW hybrid PV System
Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **20kW Hybrid System** with two separate UPS has been designed. Due to space constraints we have proposed 20kW Hybrid system. System will meet the overall load requirement of cold rooms and to feed offices (DHO Office and EPI Coordinator office) we have designed two UPS, so at the time of load shading it will meet up the energy requirements.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 20 kW Hybrid PV system with two separate UPS is being recommended for Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu. The simulation results are attached as **Annex 15-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 33.89 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 KWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 4,977 Square feet (462.3 Square meter). 2D Drawing of the available area is attached as **Annex 15-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to imbalance roof we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 structure has been recommended to install with angle of 15 Degree on the space available at site. It has also informed that the Divisional Cold Chain Ware

House, Zanana Hospital District Health Officer Office, Bannu building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling.Out of two inverters one will be mounted on the wall parrallel to ground floor DB and its battery rack will be placed at available area under the stairs. On other hand remaing one inverters will be placed in the room attached with cold room,where output power will be terminated at DB Installed in cold room and second output power will be terminated at DB-2 of second building and and battery racks will be placed at available space nearby the inverters.

7. DRINKING WATER ARRANGEMENT

Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu has following water arrangements.

Water Tank: 250 Gallons
Water Pump-1: 2 H.P
Water Coolers: 2

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9 EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 20 kW Hybrid PV system at the site of Divisional Cold Chain Ware House, Zanana Hospital District Health Officer Office, Bannu is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Same stringing process will be used for the second inverter.
- Battery backup 48V, 300 Ah with each inverter will be provided to critical load of building.
- For each UPS battery backup 48V, 200Ah will be provided.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 28) will be used. The main mounting structure will be fixed tilted at an angle of 15°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger)

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	30
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	500

9.5 BATTERY BACKUP

i) Total 10 batteries will be used for this site.
ii) Each battery will be of 48V, 100 Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.

iv) Each Inverter will carry 3 batteries as backup.
v) Each 5kW inverter will carry 2 batteries of 48V, 100Ah.

10. SYSTEM INSTALLATION CONSIDERATION

The 20 kW Hybrid PV System will be having 56 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 56 panels will cover a total area of 224 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 15 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

DIVISIONAL COLD CHAIN WARE HOUSES, GPO CHOWK D.I.KHAN

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		31˚49' 23" N , 73˚54' 43" E
ii.	Focal Person Name		Dr. Irfan Aziz (EPI Coordinator)
iii.	Focal Person Contact No.		Cell # 03419779707
iv.	Site Existing Load (kW)		68
v.	Site Critical Load (kW)		26
vi.	Average Electricity Bill (kWh)		2,513
vii.	Available Area for Solar PV Modules (Square feet)		2,360 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	20 kW
		Type	Hybrid
ix.	Annual Expected Power Generation (MWh/Annum)		33.35
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan.

2.2 SITE LOCATION

Geographically Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan is located at Latitude 31˚49' 23" N Longitude 73˚54' 43" E and Elevation 175m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)

1	Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan	68	26	48,384

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 16-A**.

2.4 SITE DESCRIPTION

Currently the premises of Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan comprises of two story building. Details about the buildings are explained below:-

2.4.1 Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan

Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan comprising of two Stories (Ground plus first floor).

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are besides the stairs at every floor where solar output will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Divisional Cold Chain Ware Houses, GPO Chowk D.I.Khan is met from National Grid. A three-phase meter was installed at the Divisional Cold Chain WareHouses, GPO Chowk D.I.Khan.

PESCO Division D.I.Khan Rural

- R/N# 43266610590203 U Cant 2
- Sanctioned Load: 67 KW
- Tariff A-3A-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply to DHO office.

Generator specification

- **Model** Coelmo
- 20 kVA , 400 V

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 26 kW
Proposed System: 20kW Hybrid

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **20kW hybrid** solar system has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 20 KW Hybrid PV system is being recommended for Divisional Cold Chain Warehouse, GPO Chowk D.I.Khan. The simulation results are attached as **Annex 16-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the

System is slightly oversized.

b) Batteries proposed for the system are Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.

c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 33.35 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 KWh/ year) which is the sunniest and hottest belt of the country.

d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 2,360 Square feet (219.25 Square meters). 2D Drawing of the available area is attached as **Annex 16-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to imbalance roof we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 structure has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Divisional Cold Chain Warehouse, GPO Chowk D.I.Khan building roof is RCC. To install

the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. Inverters will be mounted on the wall parrallel to ground floor DB(under the stairs) and its battery rack will also be placed at available area under the stairs.

7. DRINKING WATER ARRANGEMENT

Divisional Cold Chain Warehouse, GPO Chowk D.I.Khan, has following water arrangements.

Water Tank: 250 Gallons
Water Pump-1: 2 H.P
Water Coolers: 3

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Divisional Cold Chain Warehouse, GPO Chowk D.I.Khan is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 20 KW Hybrid PV System at the site of Divisional Cold Chain Warehouse, GPO Chowk D.I.Khan is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.

- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Same stringing process will be used for remaining inverter.
- Battery backup 48V, 300 Ah with each inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 28) will be used. The main mounting structure will be fixed tilted at an angle of 30°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.

PV panel structure drawing is attached as **Annex-16 G**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	30
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

9.5 BATTERY BACKUP

i) Total 6 batteries will be used for this site.

ii) Each battery will be of 48V,100 Ah.

iii) For the designed system depth of discharge (DOD) is set at 80 percent.

iv) Each Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 20 KW Hybrid PV System will be having 56 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 56 panels will cover a total area of 224 m^2.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

AFGHAN REFUGEES VOLUNTARY REPATRIATION CENTER QUETTA

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		30˚18' 28" N , 66˚56' 05" E
ii.	Focal Person Name		Burq
iii.	Focal Person Contact No.		0333-1511637
iv.	Site Existing Load (kW)		69
v.	Site Critical Load (kW)		27
vi.	Average Electricity Bill (kWh)		639
vii.	Available Area for Solar PV Modules (Square feet)		5,320 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	50 kW
		Type	Hybrid
ix.	Annual Expected Power Generation (kWh/Annum)		98.41MWh
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Afghan Refugees Voluntary Repatriation Center Quetta.

2.2 SITE LOCATION

Geographically Afghan Refugees Voluntary Repatriation Center Quetta, is located at Latitude 30˚18' 28" N Longitude 66˚56' 5" E. and Elevation 1571m.

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Afghan Refugees Voluntary Repatriation Center Quetta	69	27	639

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 17-A**.

2.4 SITE DESCRIPTION

Currently the premises of Afghan Refugees Voluntary Repatriation Center Quetta comprises of five compounds with medical facility and Car Passage. But the management of Afghan Refuges Voluntary Repatriation Centre recommended us to install solar system in the available open air space. Details are explained below:-

2.4.1 AFGHAN REFUGEES VOLUNTARY REPATRIATION CENTER QUETTA

The Buildings of Afghan Refugees Voluntary Repatriation Center, Quetta and available open space is given below.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes available with entrance where solar output will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Afghan Refugees Voluntary Repatriation Center, Quetta is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Afghan Refugees Voluntary Repatriation Center, Quetta is met from National Grid.
A three-phase meter was installed at the Afghan Refugees Voluntary Repatriation Center, Quetta.
QESCO- Division Zarghoon Sub Division Kutchlak

- R/N# 27 48123 0596209 U B.ROAD KUCHLAK NO- 1
- Sanctioned Load: 18 kW
- Tariff A-2c-(06)T

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply

1. Generator specifications
   - Ghadar 17 kVA
   - 3 Phase, 13.6 kW

2. Generator specifications
   - Gesan 20 kVA
   - 3 Phase 16 kW

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 27 kW
Proposed System: 50kW Hybrid

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **50kW hybrid** solar. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 50 kW Hybrid PV system is being recommended for Afghan Refugees Voluntary Repatriation Center, Quetta.

The simulation results are attached as **Annex 17-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 98.41 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 KWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules is 5,320 Square feet (494.2 Square meters). 2D Drawing of the available area is attached as **Annex 17-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to poor condition of the building's roof we can't install system on them. Therefore to install solar PV open air space has been recommended.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is not in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based mesh structure has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the Afghan Refugees Voluntary Repatriation Center, Quetta building roof is RCC but due to poor condition it will not be able to bear the weight of solar system. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. New control room will be contructed with existing DB room. All inverters will be placed in this room and its battery rack will also be placed in this room, output power will be terminated at main DB.

7. DRINKING WATER ARRANGEMENT

Afghan Refugees Voluntary Repatriation Center, Quetta has following water arrangements.

Water Tank: 2,500 Gallons
Total water Pumps: 6
Water Pump-1: 6 (1.5 H.P)
Water Coolers: 4

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Afghan Refugees Voluntary Repatriation Center, Quetta is fulfilling their hot water requirement through electric water geysers. So, there is no need to install more solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 50 kW Hybrid PV System at the site of Afghan Refugees Voluntary Repatriation Center, Quetta is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Same stringing process will be used for the all five inverters.
- Battery backup 48V, 300AH with each inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 70) will be used. The main mounting structure will be fixed tilted at an angle of 30°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.
PV panel structure drawing is attached as **Annex-14 E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm^2.
- AC cables: From Grid to Inverter and Inverter to Load 10 mm^2.
- Data cables : For RS-485 data communication between inverters to web box (data logger)

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	30
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	800

9.5 BATTERY BACKUP

i) Total 15 batteries will be used for this site.
ii) Each battery will be of 48V,100 Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 50 KW Hybrid PV System will be having 140 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 140 panels will cover a total area of 560 m^2.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment

such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

PROVINCIAL INSTITUTE OF TEACHER EDUCATION, QUETTA

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		30˚07' 23" N , 66˚58' 51" E
ii.	Focal Person Name		Aijaz Baloch
iii.	Focal Person Contact No.		0316-3645005
iv.	Site Existing Load (kW)		203
v.	Site Critical Load (kW)		107
vi.	Average Electricity Bill (kWh)		4,121
vii.	Available Area for Solar PV Modules (Square feet)		38,485 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	60kW + 55kW
		Type	On Grid + Hybrid
ix.	Annual Expected Power Generation (MWh/Annum)		185.97
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

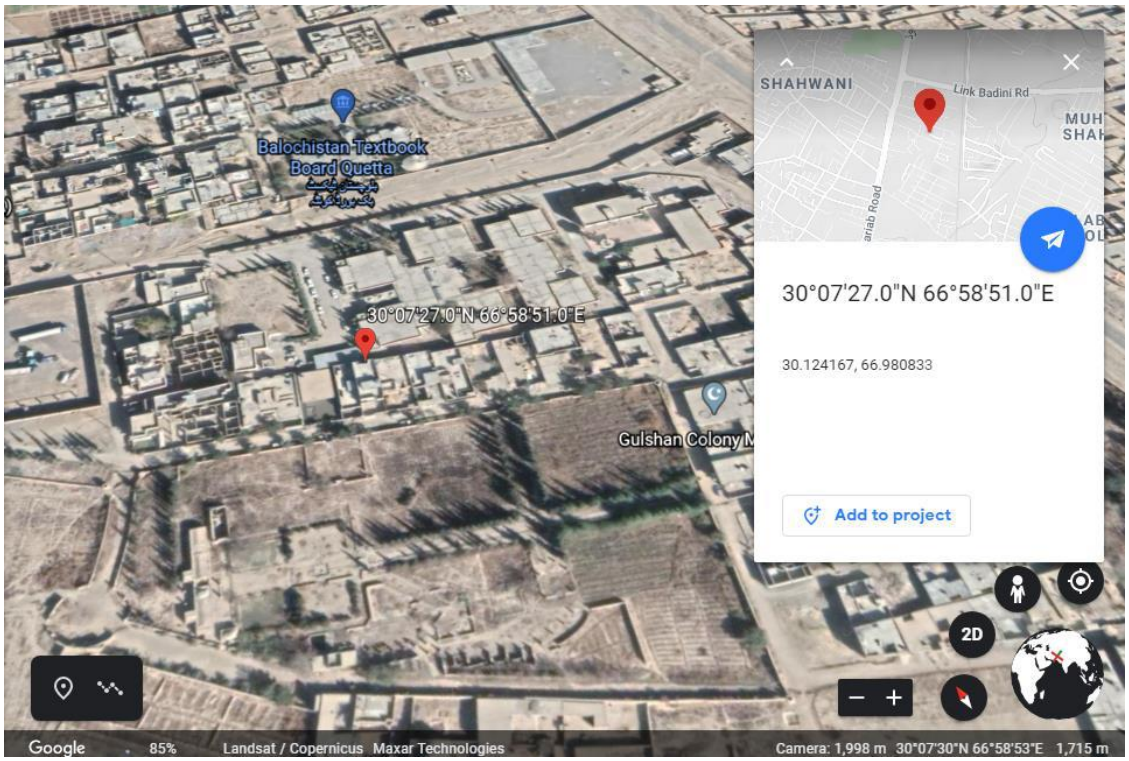
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Provincial Institute of Teacher Education, Quetta.

2.2 SITE LOCATION

Geographically Provincial Institute of Teacher Education, Quetta is located at Latitude 30˚7' 23" N Longitude 66˚58' 51" E. and Elevation 1715m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Provincial Institute of Teacher Education, Quetta	203	103	4,121

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 18-A**.

2.4 SITE DESCRIPTION

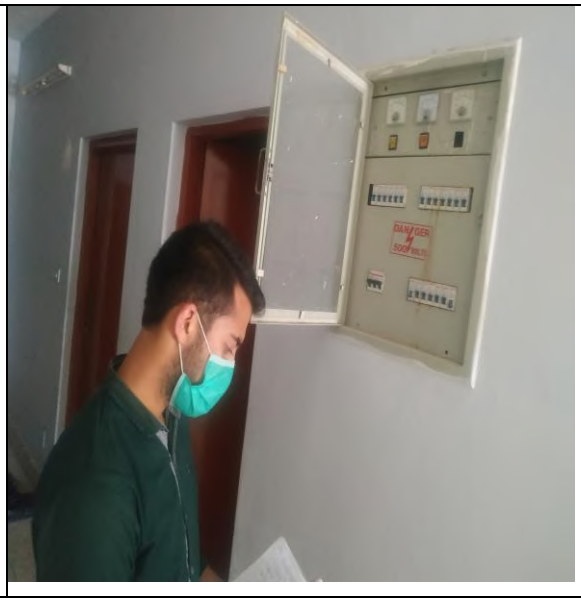
Currently the premises of Provincial Institute of Teacher Education, Quetta comprises of 9 buildings. A detail about the buildings is explained below:-

2.4.1 WOMEN DEVELOPMENT BUILDING

Provincial Institute of Teacher Education, Quetta is comprises of 9 buildings.

2.4.2 POWER & CONTROL SYSTEM

In Provincial Institute of Teacher's Education, main power DB is available at entrance. Power from this main DB is subdivided into no of DB's in each building available with the corridor.



2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Provincial Institute of Teacher Education, Quetta is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Provincial Institute of Teacher Training, Quetta is met from National Grid.
A three-phase meter was installed at the Provincial Institute of Teacher Education, Quetta.
QESCO- Division Sariab Sub Division Sariab

- R/N# 24 48131 0098700U SARIAB NO 2
- Sanctioned Load: 149.25 KW
- Tariff C-1c-(26)T

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply.
Generator specifications

- **Model** SDMO
- 60kVA, 3 Phase

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 107 kW
Proposed System: 60kW for Main Building + 55kW for Hostels and Residency

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of 60kW + 55kW for Hostels and Residency has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 60kW + 55kW PV system is being recommended for Provincial Institute of Teacher Education, Quetta. The simulation results are attached as **Annex 18-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 185.97 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 KWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 38,485 Square feet (3,575 Square meters). 2D Drawing of the available area is attached as **Annex 18-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to imbalance roof building roof is repaired we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 structure has been recommended (for main building and Principal Residency) and L3 structure for (Residential Blocks and Hostels) to install with angle of 30° on the space available at site. It has also informed that the Provincial Institute of Teacher Education, Quetta building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. All inverters will be placed at the availabe free space with DB's where output power will be terminated.

7. DRINKING WATER ARRANGEMENT

Provincial Institute of Teacher Education, Quetta has following water arrangements.

Water Tank: 2000 Gallons
Water Pump-1: 2 H.P
Water Pump-2: 5 H.P
Water Coolers: 4

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Provincial Institute of Teacher Education, Quetta is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 60kW for main building + 55kW for Hostels and Residency at the site of Provincial Institute of Teacher Education, Quetta is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

FOR RESIDENTIAL

- Each PV String of 2.2 kW (05 pieces of 440 W modules) is recommended as input for 3kW single phase inverter in each apartment.
- 1 string of 2.2 kW is inserted to the inverter through DC circuit breakers.
- Same stringing process will be used for all sixteen inverters in residential apartments.
- Battery backup 48V, 100 Ah with each inverter will be provided to critical load of each apartment.

FOR MALE/ FEMALE HOSTELS

- Each PV String of 5.28 kW (12 pieces of 440 W modules) is recommended.
- 02 string of 5.28 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V, 300 Ah with each inverter will be provided to critical load of building.

FOR MAIN BUILDING

- Each PV String of 6.16 kW (14 pieces of 440 W modules) is recommended.
- 10 string of 6.16 kW are inserted to the inverter through DC circuit breakers.
- **FOR PRINCIPAL RESIDENCY**
- Each PV String of 2.64 kW (6 pieces of 440 W modules) is recommended.
- 02 string of 2.64 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V, 300 Ah with each inverter will be provided to critical load of building

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid (for 10 kW Hybrid system).
- AC breaker 16A, 2-P between inverter and grid (for 3 kW Hybrid system).
- AC breaker 125A, 4-P between inverter and grid (for 60 kW On Grid system). .
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed L-3 based mounting structure (QTY: 47) will be used for residential blocks and hostels. Fixed L-2 based mounting structure (QTY: 74) will be used for (main building and Principal residency). The main mounting structure will be fixed tilted at an angle of 30°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	30
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	3000

9.5 BATTERY BACKUP

i) Total 22 batteries will be used for this site.
ii) Each battery will be of 48V, 100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) For male and female hostel 3 batteries of 48V, 100Ah with each inverter will be used.
v) For residency blocks 1 batteries of 48V, 100Ah with each inverter will be used.
vi) For Principal residency 2 batteries of 48V, 100Ah with inverter will be used.

10. SYSTEM INSTALLATION CONSIDERATION

The system consists of 60kW for main building + 55kW for hostels and residency will be having 280 solar panels of 440 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 280 panels will cover a total area of 1120 m^2.

The solar panel metallic frame structure is recommended to be installed further on

the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 18 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

Provisioning of Solar Pumping System

At Provincial Institute for Teacher's Education

Importance of Water for the Education Facility

PITE is located in a relatively plain area but experiences cold weather conditions especially in winters. It was observed that there is no proper arrangement of water at the site. Existing bore has collapsed and the institute has to face lot of issues due to shortage of water. According to the locals, water level is around 1000 feet but Electric Resistivity Survey of the site must be conducted before installation of proposed pumping system. Accordingly, to that survey sufficient water is available at 1000 feet to meet the requirement of the facility. Hence, provision of water through solar pumping system has been recommended for the site.

Water Requirement of the Facility

Recommended water requirement of the facility per day = 60, 000 Liter/ day

Note:-Considering the strength of students and the staff living within the vicinity, 60,000 liters per day water requirement has been proposed.

Electric Resistivity Survey of the Site

It is apprised that Electric Resistivity Survey of the site must be carried out to determine the ground water potential in the project area and for feasibility to dig a bore for possible installation of solar pumping system. Current designing has been done based on the recommendation of focal person of the site i.e. 1000 feet.

Recommended Solar Pumping System:

As per the design conditions (TDH and water requirement of the site) 01 Submersible Pumping System is recommended to be installed in the educational facility, for which, a bore well will have to be dug at the site. The Pumping system will be installed on subject bore well. The turnkey solution will meet the water requirement of the facility, which has been worked out based on 60,000 Liters/per-day as details mentioned above. The 3D model showing installation of SPS system at the medical facility is attached as.

Solar pump capacity/ type :

Lorenz make submersible pump type PSk2-40 C-SJ30-35 is recommended for the site.

Simulation Report

Simulation report covering detailed design and data sheet is attached as Annex 18-I.

3-D Drawing for Solar Pumping System PV Modules

Solar PV modules for pumping system has been recommended on main building of PITE, details has been attached Annex 18-J.

WOMEN TECHNICAL TRAINING CENTER, QUETTA

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Coordinates		30˚12' 49" N , 66˚59' 25" E
ii.	Focal Person Name		Ms. Shabnam Naz
iii.	Focal Person Contact No.		-
iv.	Site Existing Load (kW)		113
v.	Site Critical Load (kW)		56
vi.	Average Electricity Bill (kWh)		3,580
vii.	Available Area for Solar PV Modules (Square feet)		38,486 Sq.ft
PV System Specifications			
viii.	Proposed System	Capacity	50kW
		Type	Hybrid
ix.	Annual Expected Power Generation (MWh/Annum)		96.06
x.	DC,AC Rating		As per site
xi.	Array Type/Tilt		Fixed tilt/ 30˚
xii.	Project Estimated Cost (PKR)		
Energy Specifications			
xiii.	Cost of Electricity from WAPDA		Rs.25/kWh

2. SITE TECHNICAL INFORMATION

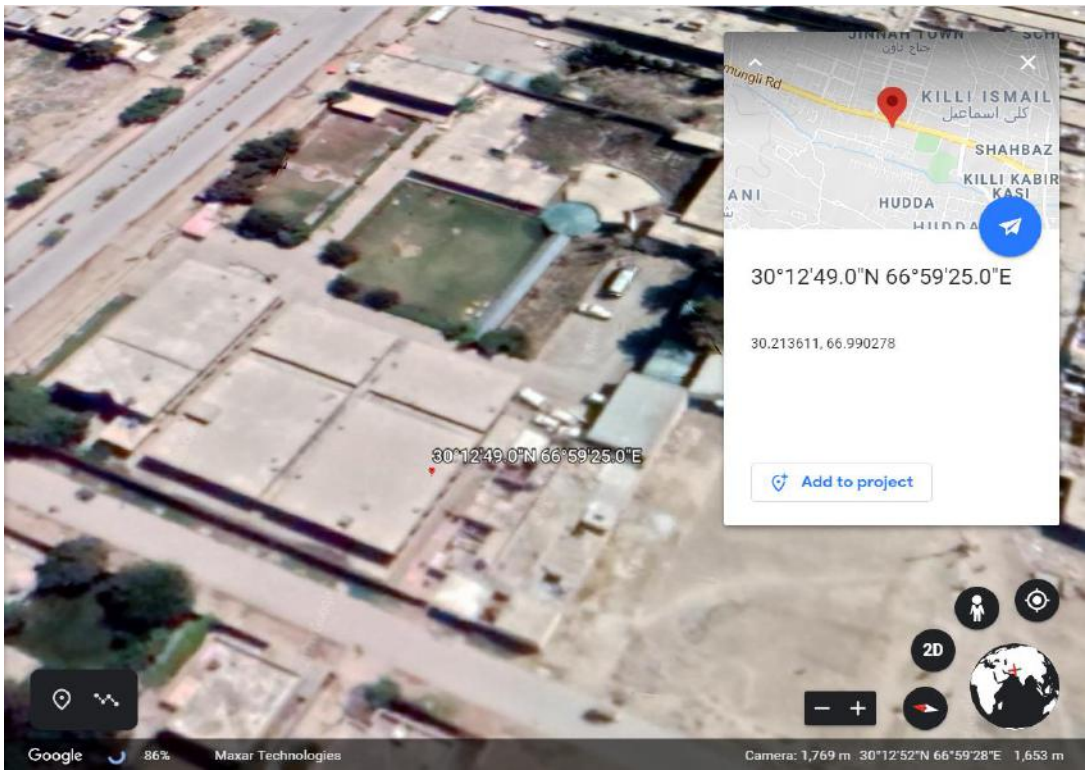
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Women Technical Training Centre, Quetta.

2.2 SITE LOCATION

Geographically Women Technical Training Centre, Quetta is located at Latitude 30˚12' 49" N Longitude 66˚59' 25" E. and Elevation 1652m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Women Technical Training Centre, Quetta	113kW	56	3,580

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 19-A**.

2.4 SITE DESCRIPTION

Currently the premises of Women Technical Training Centre, Quetta comprises of five building. But two buildings have been specified for installation of solar system. A detail about the buildings is explained below:-

2.4.1 WOMEN TECHNICAL TRAINING CENTRE, QUETTA

The premises of Women Technical Training Centre, Quetta comprises of five Buildings. For solarisation two buildings have been specified.

2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are available at ground floor where solar output will be terminated.

2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at the Women technical training centre, Quetta is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Women Technical Training Centre, Quetta is met from National Grid.

A three-phase meter was installed at the Women Technical Training Centre, Quetta.

QESCO Division Sariab Sub Division Browery

- R/N# 19481350024600 U Browery Road
- Sanctioned Load: 5 KW
- Tariff A-3A-(66)

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply.

Generator specifications

- 25kVA
- 3 Phase

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 56 kW

Proposed System: 50KW Hybrid

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **50KW hybrid** solar system. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 50 KW Hybrid PV system is being recommended for Women Technical Training Centre, Quetta. The simulation results are attached as **Annex 19-B**.

Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the

System is slightly oversized.

b) Batteries proposed for the system are Lithium ion type which are long life durable for the heavy loads and perform much better if exposed in the cold weather.

c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 96.06 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 KWh/ year) which is the sunniest and hottest belt of the country.

d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 38,486 Square feet (3575.4 Square meters). 2D Drawing of the available area is attached as **Annex 19-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to imbalance building roof we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 structure has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that for Women Technical Training Centre, Quetta building roof is RCC. To install the Solar PV

modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. Three inverters will be placed in the control room that will be contructed on the roof of workshop block and battery bank bank will also be placed here. On other hand remaing two inverters will be placed in the remaining buildings and and battery racks will be placed at available space nearby the inverters.

7. DRINKING WATER ARRANGEMENT

Women Technical Training Centre, Quetta has following water arrangements.

Water Tank: 2,500 Gallons
Water Pump-1: 2(½) H.P
Water Pump-2: 1.5 H.P
Water Pump-3: 2(½) H.P
Water Coolers: 4

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Women Technical Training Centre, Quetta is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 50 KW Hybrid PV system at the site of Women Technical Training Centre, Quetta is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Same stringing process will be used for all five inverters.
- Battery backup 48V, 300 Ah with each inverter will be provided to critical load of building.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

Fixed mounting structure (QTY: 70) will be used. The main mounting structure will be fixed tilted at an angle of 30°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	40
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	800

9.5 BATTERY BACKUP

i) Total 15 batteries will be used for this site.
ii) Each battery will be of 48V, 100 Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.

10. SYSTEM INSTALLATION CONSIDERATION

The 50 KW Hybrid PV System will be having 140 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 140 panels will cover a total area of 560 m^2.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

CHILDREN HOSPITAL QUETTA, BALOCHISTAN

1. SITE SUMMARY

S.No	Description		Details
Site Load Data			
i.	Site Existing Load (kW)		450
ii.	Site Critical Load (kW)		350
iii.	Average Electricity Bill (kWh)		31,250
iv.	Available Area for Solar PV Modules (Square feet)		31538.24 Sq.ft
PV System Specifications			
v.	Proposed System	Capacity	**300 kW + 10 kW Hybrid**
		Type	On Grid
vi.	Annual Expected Power Generation (kWh/Annum)		511.8MWh
vii.	DC,AC Rating		As per site
viii.	Array Type/Tilt		Fixed tilt/ 20˚
ix.	Project Estimated Cost (PKR)		
Energy Specifications			
x.	Cost of Electricity from WAPDA		Rs. 25/kWh

2. SITE TECHNICAL INFORMATION

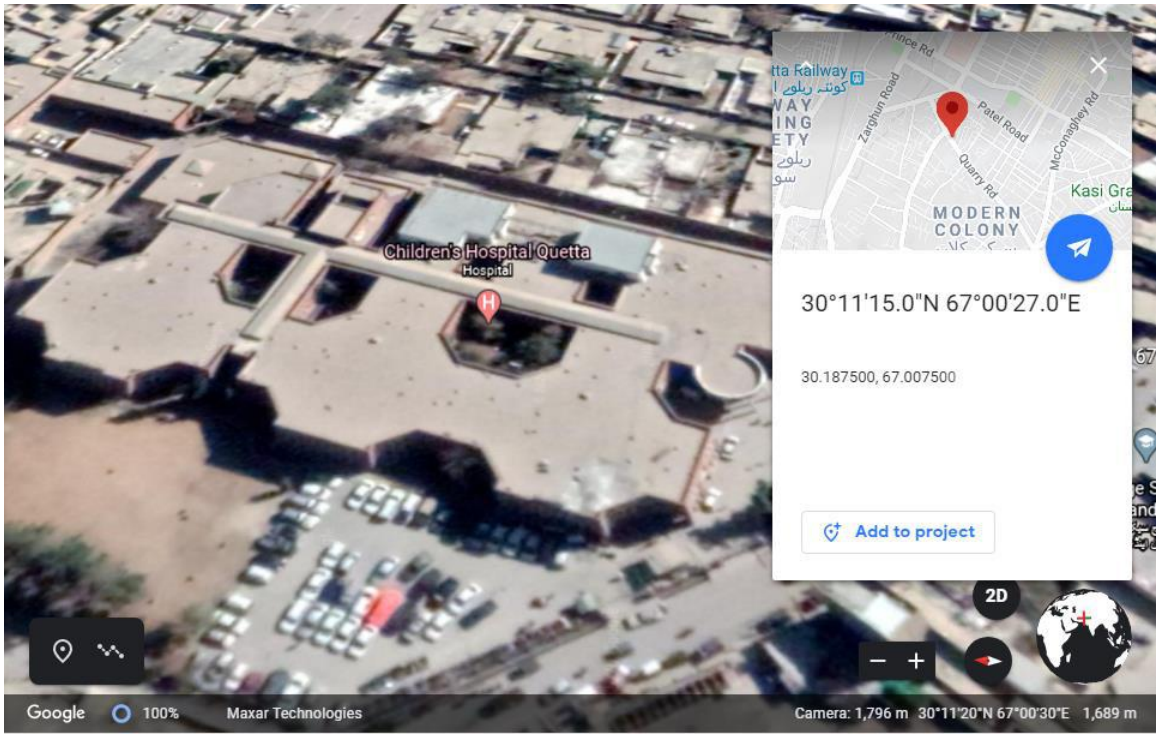
The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top buildings of Children Hospital Quetta, Balochistan.

2.2 SITE LOCATION

Geographically Children Hospital Quetta, Balochistan is located at Latitude 30˚11' 15" N Longitude 67˚00' 27" E. and Elevation 1686m.



2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load (kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	Children Hospital Quetta, Balochistan	450	350	31,250

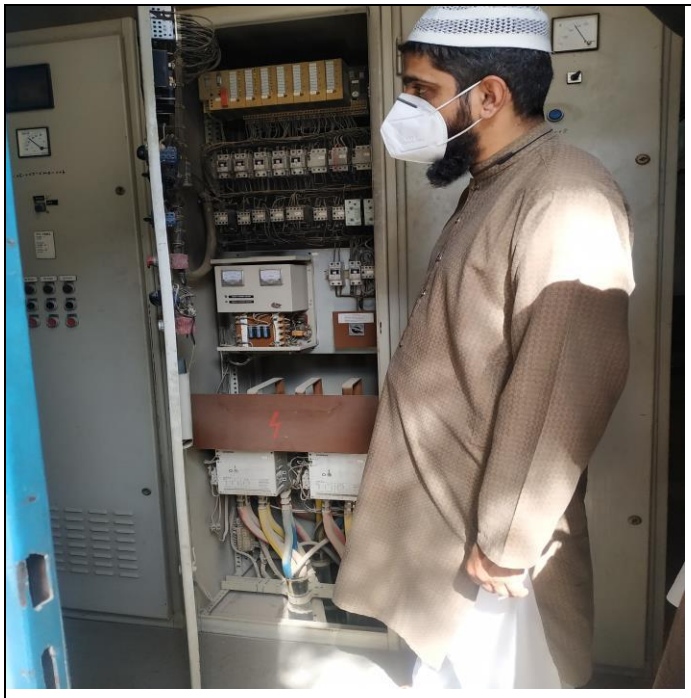
A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 20-A**.

2.4 SITE DESCRIPTION

Currently the premises of Children Hospital Quetta, Balochistan comprises of three buildings. A detail about the buildings is explained below:-

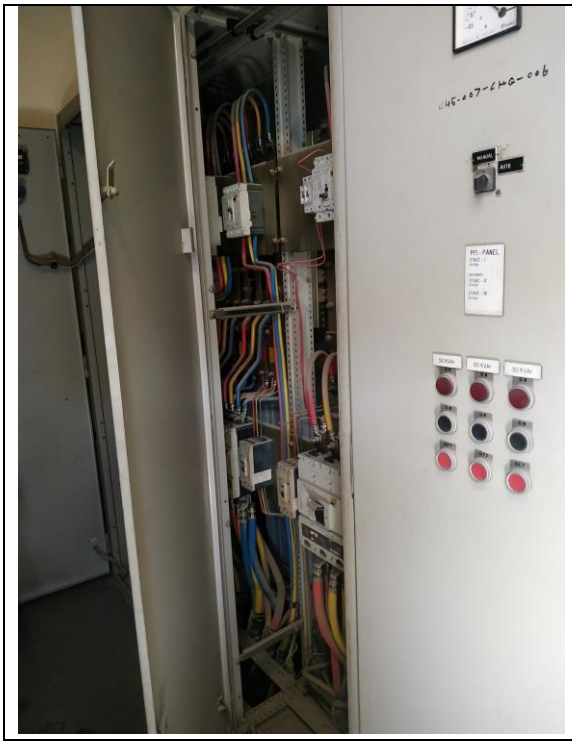
2.4.1 CHILDREN HOSPITAL QUETTA, BALOCHISTAN

The premises of Children Hospital Quetta, Balochistan comprises of three buildings.



2.4.2 POWER & CONTROL SYSTEM

The existing power & control distribution boxes are available at every floor where solar output will be terminated.



2.4.3 EXISTING POWER SUPPLY ARRANGEMENTS

Load at Children Hospital Quetta, Balochistan is currently being powered through following supply sources:-

2.4.3.1 MAIN POWER SUPPLY

Electrical Power requirement for the Children Hospital Quetta, Balochistan is met from National Grid.
A three-phase meter was installed at the Children Hospital Quetta, Balochistan.
QESCO- Division Zarghoon Sub Division Katchery

- R/N# 24 48124 3194804 U STADIUM / V I P FEEDER
- Sanctioned Load: 36 KW
- Tariff A-3A-(66)T

2.4.3.2 EMERGENCY POWER SUPPLY

Generator has been installed for providing back up supply.
Generator specifications

- 300kVA
- 3 Phase

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 350 kW
Proposed System: 300KW ON GRID + 10kW Hybrid for girl's hostel.

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. A solar system of **300kW On Grid** with an additional **10kW Hybrid System** for nursing hostel has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4. DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 300 KW On Grid PV system with additional 10kW Hybrid system for nursing hostel is being recommended for Children Hospital Quetta, Balochistan. The simulation results are attached as **Annex 20-B**.

1. Following are the key considerations for the system designing / simulation:-

a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
b) Batteries proposed for the system are dry, maintenance free and are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 511.8 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 KWh/ year) which is the sunniest and hottest belt of the country.
d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 31538.24 Square feet (2,930 Square meters). 2D Drawing of the available area is attached as **Annex 20-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is flat and Reinforced Cement **Concrete** (RCC) but due to imbalance building roof we can't apply grouting here. Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 Kg/m^2 on the roof and the building is in good condition to bear that weight. The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed based L-2 and L-3 structures has been recommended for 10kW Hybrid System and 300kW On Grid System respectively, to install with angle of 20

Degree on the space available at site. It has also informed that the Children Hospital Quetta, Balochistan building roof is RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. Inverters will be placed in the main power room on the ground floor. Output power will be terminated at amin DB in the power room.

7. DRINKING WATER ARRANGEMENT

Children Hospital Quetta, Balochistan has following water arrangements.
Water Tank: 3000 Gallons
Water Pump-1: 2 H.P
Water Pump-2: 5 H.P
Water Coolers: 4

It is observed that the mentioned site has enough water storage as well as cooling facility available so, there is no need to install solar water pump for the site. However, the electricity requirement of the existing water supply will be fulfilled by the proposed Solar PV System.

8. HOT WATER ARRANGEMENT

Children Hospital Quetta, Balochistan is fulfilling their hot water requirement through gas connected water geysers. So, there is no need to install solar water geyser at the mentioned site.

9. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 300 kW On Grid PV system with 10kW hybrid at the site of Children Hospital Quetta, Balochistan is mentioned below:-

9.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS FOR 10KW HYBRID SYSTEM

- Each PV String of 5.6 kW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Same stringing process will be used for the second inverter.
- Battery backup 48V, 300 Ah with each inverter will be provided to critical load of building.

FOR 300KW ON GRID SYSTEM

- Each PV String of 6.16 kW PV string (14 pieces of 440 W modules) is recommended.
- 10 strings of 6.16 kW are inserted to four inverters and 8 strings will be inserted to the fifth inverter through DC circuit breakers.

9.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

9.3 MOUNTING STRUCTURE

- Fixed mounting structures for 300kW On Grid System are (QTY: 224) will be used. The main mounting structure will be fixed tilted at an angle of 20°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.
- Fixed mounting structures for 10kW On Hybrid System are (QTY: 12) will be used. The main mounting structure will be fixed tilted at an angle of 20°, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level.
  PV panel structure drawing is attached as **Annex-20 E**

9.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	30
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	2500

9.5 BATTERY BACKUP FOR 10 kW HYBRID SYSTEM

i) Total 3 batteries will be used for this site.
ii) Each battery will be of 48V, 100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Each Inverter will carry 3 batteries as backup.

10 SYSTEM INSTALLATION CONSIDERATION

The **300 kW On Grid PV System** with **10kw Hybrid** for nursing hostel will be having total 696 solar panels of 440 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 696 panels will cover a total area of 2784m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 20 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

11. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

PSB-185, Zindai RV, Peshawar

NOTE:

The following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on actual ground implementation.

1 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	PSB	6.342	6.342	-

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 9-A**.

2 SITE DESCRIPTION

Currently the premises of PSB-185 comprises of one roof building. Details about the buildings is explained below:-

POWER & CONTROL SYSTEM

The power and control system will be fitted in the room near security room. Also the termination of PV solar will be ended their because of enough and ventilated space. Because of no electricity connection from grid they no have specific wiring and teminations.

EXISTING POWER SUPPLY ARRANGEMENTS

Load at the facility PSB is currently being powered through following supply sources:-

MAIN POWER SUPPLY

There is no national grid available for PSB so they have no power supply, not have any wiring fitting and also lack of electrical equipment's.

EMERGENCY POWER SUPPLY

There is no emergency power supply use at the PSB.

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 6.342 kW
Proposed System: 10kW off grid system

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **10kW off grid** solar system has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4 DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally a 10 kW off grid PV system is designed for PSB-136 Akora Khattak.The simulation results are attached as **Annex 9-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
   c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which

are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 18.62 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.

d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. AREA AVAILABLE FOR SOLAR PV MODULES

The area available is enough to install proposed capacity of Solar PV modules for the building is 6209 Square feet (576 Square meter). 2D Drawing of the available area is attached as **Annex 9-C.**

5.1 ROOF CONFIGURATION

During the detailed site survey, civil team observed that the roof of the building is three roofs building are flat and made of RCC . Therefore to install solar PV we need to construct 1'×1' RC foundations.

5.2 STRENGTH OF ROOF

It is observed that PV modules along with structure and base will enhance surplus weight of 30 kg/m^2 on the roof The details were also shared with head and the design was discussed in detail and approval was accorded by the concerned authorities.

5.3 BASE STRUCTURE

The fixed tilt one L-2 structure frame has been recommended to install with angle of 30 Degree on the space available at site. It has also informed that the PSB-136 Akora Khattak building roof is made of RCC. To install the Solar PV modules, concrete of size 1 cubic feet would be paved on which structure for solar PV modules will be screwed. Proper civil work will be done so as to cater wind speed of up to 130 Km/hr which is well above the maximum recorded wind speed of 45 Km/hour during the last few years.

6. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. we will mounted total one inverter at this site. The inverter and batteries are kept at the room near security room because of enough space and ventiated room. By keeping batteries cool it will enhance battery life.

7. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 10kW off grid PV system at the site of PSB-136 Akora Khattak is mentioned below:-

7.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V,300 Ah with inverter will be provided to critical load of building.

7.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

7.3 MOUNTING STRUCTURE

Fixed tilt mounting (QTY 16) structure will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 9-E**

7.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².

- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	10
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

7.5 BATTERY BACKUP

i) Total 4 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 3 batteries as backup.

8 SYSTEM INSTALLATION CONSIDERATION

The 10 kW off grid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 9 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

9 PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

PSB-204 OBLEN RV KOHAT

Note:

the following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on the actual ground implementation.

1. SITE TECHNICAL INFORMATION

The necessary technical information about the project site is discussed below:-

2.1 SITE INTRODUCTION.

The suggested location for execution of Solar Based Power Project is at roof top of the building of PSB-204 Oblen RV Kohat.

2.2 SITE LOCATION

Geographically PSB-204 Oblen RV Kohat is located in Union Council Oblen, district Kohat

2.3 SITE LOAD DETAILS

Based on the site visits and detailed analysis/ review of the data collected while considering most efficient electrical appliances / equipment, as part of energy audit measures detailed load of the building has been calculated. Load has been characterized into existing load and the critical load. Critical load means the load which should always be supported by the backup supply and battery backup has been designed for the critical load. Following load/ equipment has been considered to be supported through Solar PV system designed for the site:-

Sr#	Description	Existing Load(kW)	Critical Load (kW)	Average Monthly Bill (kWh)
1	PSB-204 Oblen RV Kohat	6.342	6.342	-

A complete chart covering the electrical appliances / equipment presently installed / available and those recommended as critical load to be supported through Solar PV system is attached as **Annex 9-A**.

3. PROPOSED SOLAR PV SYSTEM

Critical Load: 6.342 kW
Proposed System: 10kW off grid system

Based on the critical load requirement, monthly average consumption and other design consideration inclusive of temperature conditions, wiring status and battery specification etc. a solar system of **10kW off grid** solar system has been designed. That system will meet the overall load requirement and will feed critical load at the time of load shading.

4 DESIGN VERIFICATION THROUGH RUNNING SIMULATION SOFTWARE

The PV System so designed has been successfully verified through running of simulations on the software Helioscope. Finally, a 10 kW off grid PV system is designed for PSB-204 Oblen RV Kohat. The simulation results are attached as **Annex 9-B**.

1. Following are the key considerations for the system designing / simulation:-
   a) Considering the future demand and to cater for any unexpected load the System is slightly oversized.
   b) Batteries proposed for the system are of Lithium ion type which are durable for the heavy loads and perform much better if exposed in the cold weather.
   c) In the system, it is expected that soiling losses are significantly reduced in the cleaner environment of the subject site and module temperature which are normally significantly higher at the hot weather sites will be much lower at the site. Therefore average annual specific yield clearly observed from the simulation is 18.62 MWh/year as compared to the average annual specific yield of any hot/ sunny climate e.g. Bahawalpur (i-e. 1650 kWh/ year) which is the sunniest and hottest belt of the country.
   d) Another advantage from the load prospective is that significant energy would be utilized by the ceiling fans in the summer which would decrease in the winters due to the non operation of the fans. Same energy may be transferred/ utilized for any suitable/ alternate energy application.

5. CONSTRUCTION OF CONTROL ROOM

Power and control system of Solar PV will be merged with the already existing power system of the buidling. we will mounted total one inverter at this site. The inverter and batteries are kept at the room near security room because of enough space and ventiated room. By keeping batteries cool it will enhance battery life.

6. EQUIPMENT DETAILS

The complete details of the equipment / materials / stores going to be used for installation of 10kW off grid PV system at the site of PSB-136 Akora Khattak is mentioned below:-

6.1 PV ARRAY, INVERTER AND BATTERY BACKUP DETAILS

- Each PV String of 5.6 KW PV string (14 pieces of 400 W modules) is recommended.
- 02 string of 5.6 kW are inserted to the inverter through DC circuit breakers.
- Battery backup 48V,300 Ah with inverter will be provided to critical load of building.

6.2 DISTRIBUTION BOXES

Must include AC, DC breakers and surge protection device.

- DC breaker 16A, 2-P per string must be used
- AC breaker 50A, 4-P between inverter and grid must be used.
- AC breaker 30A, 2-P per phase between load and inverter must be used.
- Each Distribution Box must include surge protection device.

6.3 MOUNTING STRUCTURE

Fixed tilt mounting (QTY 16) structure will be used. The main mounting structure will be fixed tilted at an angle of 30º, facing south and will be made of Aluminum and Steel Hot Dip Galvanized material with vertical posts supported by concrete foundations base 12 inches above roof top level. PV panel structure drawing attached as **Annex 9-E**

6.4 WIRES & CABLES

Power plant will use the following types of cables

- Solar PV DC cables: From Modules to Inverters 6 mm².
- AC cables: From Grid to Inverter and Inverter to Load 10 mm².
- Data cables : For RS-485 data communication between inverters to web box (data logger

The length and size of AC cables (from Inverter to Control Room) & DC cables (from Panels to Inverters) are as under:

S. No	AC Cable Spec	Unit	Qty
1.	10 mm² (for each Inverter)	M	10
	DC Cable Spec		
1.	XLPE 1000 V 6 mm²	M	200

6.5 BATTERY BACKUP

i) Total 4 batteries will be used for this site.
ii) Each battery will be of 48V,100Ah.
iii) For the designed system depth of discharge (DOD) is set at 80 percent.
iv) Inverter will carry 3 batteries as backup.

7. SYSTEM INSTALLATION CONSIDERATION

The 10 kW off grid PV System will be having 28 solar panels of 400 Watts each. Each panel in the installed condition (while facing south) will cover an area of 4 m^2. Accordingly, 28 panels will cover a total area of 112 m^2.

The solar panel metallic frame structure is recommended to be installed further on the slant roof top facing south of the main building as shown on the 3D model of the building placed as **Annex- 9 F**.

The space near the existing distribution boxes has been designated as the Solar Control Room for Solar Electrification System for the site. The control room will be equipped with battery bank, Inverter and the main distribution box etc. All the wiring to the critical load being supported through subject system will be routed through this room.

8. PREVENTIVE MEASURES

The electrical equipment of the facility going to be supported by the Solar Electrification System being planned have been clearly mentioned above in the general information. Operation / use of any other equipment can cause extra loading, resulting in failure of PV system(s).

Batteries last longer if kept cool. High ambient / environmental temperature is hazardous for the life of the batteries. Accordingly, it is highly recommended that at least ambient temperature be maintained where battery racks are placed to enhance their useful life and smooth operations of the batteries.

In order to secure PV systems against theft and breakages by children and unauthorized persons it is highly recommended to install a metallic barbed wire fence around the area where the Solar PV array is installed. Moreover, to ensure proper locking of the control room where the electronics and sensitive equipment such as controller, inverter and battery bank will be placed.

The personnel already hired for the security of the institute should also be made responsible for the safety of each and every equipment of Solar PV equipment installed.

BHU Panian, Haripur

NOTE:

The following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on actual ground implementation.

Detailed Bill of Quantities & Estimated Cost Basic Health Unit

Sr. No.	Item Description	Quantity	Unit
01	Supply and Installation at site of A Grad Mono-crystalline /Poly Crystalline PV modules, ,	7200	Wp
02	Supply Installation of PV mounting frame for above PV modules (Sr. No. 1), made of Hot dipped galvanized iron sheet of minimum 14 SWG.	12	Nr
03	Supply and Installation of 05 KW Off Grid hybrid Solar inverters.	02	Nr.
04	Supply and Installation 200 AH Gel Dry Batteries with stand.	16	Nr
05	Supply and Installation of 10 mm^2 Flexible Dc cable along with PVC conduit and Fittings as per attached specifications.	400	Mtr
06	Supply and Installation of 07/44 AC copper cable along with PVC conduit and Fittings as per attached specifications.	140	Mtr
07	Earthing system including excavation, copper rods, earthing connections to inverter and DC power line through surge arresters, wiring and conduiting complete in all respects.	1	Nr.
08	Safety Box with AC /DC breakers as per Attached technical Specifications AC Input : 01X 63 A , AC Output :01X 63 A , DC Input : 01x 63 A , Battery Bank : 01 X 100 A	02	Nos
09	Civil Work	1	Nr
10	Installation		Wp
11	Transportation		Wp

BHU Gadwalian, Haripur

NOTE:

The following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on actual ground implementation.

Detailed Bill of Quantities & Estimated Cost Basic Health Unit

Sr. No.	Item Description	Quantity	Unit	Unit Cost (PKR)	Total Cost (PKR)
01	Supply and Installation at site of A Grad Mono-crystalline /Poly Crystalline PV modules, ,	7200	Wp		
02	Supply Installation of PV mounting frame for above PV modules (Sr. No. 1), made of Hot dipped galvanized iron sheet of minimum 14 SWG.	12	Nr		
03	Supply and Installation of 05 KW Off Grid hybrid Solar inverters.	02	Nr.		
04	Supply and Installation 200 AH Gel Dry Batteries with stand.	16	Nr		
05	Supply and Installation of 10 mm^2 Flexible Dc cable along with PVC conduit and Fittings as per attached specifications.	400	Mtr		
06	Supply and Installation of 07/44 AC copper cable along with PVC conduit and Fittings as per attached specifications.	140	Mtr		
07	Earthing system including excavation, copper rods, earthing connections to inverter and DC power line through surge arresters, wiring and conduiting complete in all respects.	1	Nr.		
08	Safety Box with AC /DC breakers as per Attached technical Specifications AC Input : 01X 63 A , AC Output :01X 63 A , DC Input : 01x 63 A , Battery Bank : 01 X 100 A	02	Nos		
09	Civil Work	1	Nr		
10	Installation		Wp		
11	Transportation		Wp		
				Total Cost (PKR) for 01 BHU	

BHU Meelam, Haripur

NOTE:

The following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on actual ground implementation.

Detailed Bill of Quantities & Estimated Cost Basic Health Unit

Sr. No.	Item Description	Quantity	Unit	Unit Cost (PKR)	Total Cost (PKR)
01	Supply and Installation at site of A Grad Mono-crystalline /Poly Crystalline PV modules, ,	7200	Wp		
02	Supply Installation of PV mounting frame for above PV modules (Sr. No. 1), made of Hot dipped galvanized iron sheet of minimum 14 SWG.	12	Nr		
03	Supply and Installation of 05 KW Off Grid hybrid Solar inverters.	02	Nr.		
04	Supply and Installation 200 AH Gel Dry Batteries with stand.	16	Nr		
05	Supply and Installation of 10 mm^2 Flexible Dc cable along with PVC conduit and Fittings as per attached specifications.	400	Mtr		
06	Supply and Installation of 07/44 AC copper cable along with PVC conduit and Fittings as per attached specifications.	140	Mtr		
07	Earthing system including excavation, copper rods, earthing connections to inverter and DC power line through surge arresters, wiring and conduiting complete in all respects.	1	Nr.		
08	Safety Box with AC /DC breakers as per Attached technical Specifications AC Input : 01X 63 A , AC Output :01X 63 A , DC Input : 01x 63 A , Battery Bank : 01 X 100 A	02	Nos		
09	Civil Work	1	Nr		
10	Installation		Wp		
11	Transportation		Wp		
				Total Cost (PKR) for 01 BHU	

BHU Phando, Peshawar

NOTE:

The following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on actual ground implementation.

Detailed Bill of Quantities & Estimated Cost Basic Health Unit

Sr. No.	Item Description	Quantity	Unit	Unit Cost (PKR)	Total Cost (PKR)
01	Supply and Installation at site of A Grad Mono-crystalline /Poly Crystalline PV modules, ,	7200	Wp		
02	Supply Installation of PV mounting frame for above PV modules (Sr. No. 1), made of Hot dipped galvanized iron sheet of minimum 14 SWG.	12	Nr		
03	Supply and Installation of 05 KW Off Grid hybrid Solar inverters.	02	Nr.		
04	Supply and Installation 200 AH Gel Dry Batteries with stand.	16	Nr		
05	Supply and Installation of 10 mm^2 Flexible Dc cable along with PVC conduit and Fittings as per attached specifications.	400	Mtr		
06	Supply and Installation of 07/44 AC copper cable along with PVC conduit and Fittings as per attached specifications.	140	Mtr		
07	Earthing system including excavation, copper rods, earthing connections to inverter and DC power line through surge arresters, wiring and conduiting complete in all respects.	1	Nr.		
08	Safety Box with AC /DC breakers as per Attached technical Specifications AC Input : 01X 63 A , AC Output :01X 63 A , DC Input : 01x 63 A , Battery Bank : 01 X 100 A	02	Nos		
09	Civil Work	1	Nr		
10	Installation		Wp		
11	Transportation		Wp		
				Total Cost (PKR) for 01 BHU	

BHU Soorezai, Peshawar

NOTE:

The following feasibility is based on another similar type of facility, having almost same electricity load and requirements. Therefore, there may be 5-10% variation on actual ground implementation.

Detailed Bill of Quantities & Estimated Cost Basic Health Unit

Sr. No.	Item Description	Quantity	Unit	Unit Cost (PKR)	Total Cost (PKR)
01	Supply and Installation at site of A Grad Mono-crystalline /Poly Crystalline PV modules, ,	7200	Wp		
02	Supply Installation of PV mounting frame for above PV modules (Sr. No. 1), made of Hot dipped galvanized iron sheet of minimum 14 SWG.	12	Nr		
03	Supply and Installation of 05 KW Off Grid hybrid Solar inverters.	02	Nr.		
04	Supply and Installation 200 AH Gel Dry Batteries with stand.	16	Nr		
05	Supply and Installation of 10 mm^2 Flexible Dc cable along with PVC conduit and Fittings as per attached specifications.	400	Mtr		
06	Supply and Installation of 07/44 AC copper cable along with PVC conduit and Fittings as per attached specifications.	140	Mtr		
07	Earthing system including excavation, copper rods, earthing connections to inverter and DC power line through surge arresters, wiring and conduiting complete in all respects.	1	Nr.		
08	Safety Box with AC /DC breakers as per Attached technical Specifications AC Input : 01X 63 A , AC Output :01X 63 A , DC Input : 01x 63 A , Battery Bank : 01 X 100 A	02	Nos		
09	Civil Work	1	Nr		
10	Installation		Wp		
11	Transportation		Wp		
				Total Cost (PKR) for 01 BHU	