QA SOLAR

QUAID-E-AZAM
Solar Power (Pvt) Ltd.

For information & n/a pl.
- DIR(RA)
Copy. - DG(Lic)
- MR
N 17/X/22

cc: Chairman
- MCM&E/CA)
- MC(Lic. /T)

To,
THE REGISTRAR
NATIONAL ELECTRIC POWER REGULATORY AUTHORITY
NEPRA Tower Attaturk Avenue (East)
Sector G-5/1, Islamabad
Pakistan

SUBJECT: **APPLICATION FOR A MICROGRID SYSTEM LICENSE**

I, Muhammad Badar ul Munir, Chief Executive Officer, being the duly authorized representative of Quaid-e-Azam Solar Power (Private) Limited by virtue of being the Chief Executive Officer, hereby apply to the National Electric Power Regulatory Authority for the grant of a Microgrid system license to Quaid-e-Azam Solar Power (Private) Limited pursuant to Section 14-B, 20 and 23-E of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Microgrid) Regulations, 2022, and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

REGISTRAR OFFICE
Diary No.: 1078
Date: 17-10-2022

Date: 14 October, 2022

Chief Executive Officer
Quaid-e-Azam Solar Power (Private) Limited

3rd Floor, 83-A, E/1, Main Boulevard Gulberg III Lahore, Pakistan +92 99332261-65 FAX 042-35790366

info@qasolar.com, www.qasolar.com

10758

QA SOLAR

QUAID-E-AZAM
Solar Power (Pvt) Ltd.

BEFORE THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

APPLICATION FOR SEEKING MICROGRID SYSTEM LICENSE

ON BEHALF OF

QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED

FOR PROJECT

PROVISION OF ELECTRICITY TO THE COMMUNITIES USING INDIGENOUS RESOURCES

Dated: 14th October, 2022

Applicant	Legal Consultant
Quaid-e-Azam Solar Power (Private) Limited 3rd Floor, 83-A, E/1, Main Boulevard, Gulberg-III, Lahore, Pakistan. Phone: +92 423 5790363 Website: https://www.qasolar.com/	**Muhammad Saqlain Arshad** Advocate High Court 65/3, FCC Gulberg IV, Lahore. Phone: 04235752306 Website: www.snhlawfirm.com

QA SOLAR

QUAID-E-AZAM
Solar Power (Pvt) Ltd.

CHECKLIST FOR EXAMINATION OF APPLICATION FOR THE GRANT OF MICROGRID SYSTEM LICENSE

Serial No.	Information/Documents required under National Electric Power Regulatory Authority Licensing (Microgrid) Regulations, 2022	Information/Documents Submitted
1.	Application for Microgrid License in Accordance with Schedule-II of the Regulations.	Yes. Attached as **Annexure-I.**
2.	Board Resolution and Power of Attorney	Yes. Attached as **Annexure-I.**
3.	Certificate of Incorporation, Memorandum and Articles of Association	Yes. Attached as **Annexure-II.**
4.	Annual Report of the Company	Yes. Attached as **Annexure-III.**
5.	Information relating to Safety and Emergency plans	Yes. Attached as **Annexure-IV.**
6.	Feasibility Study of the Project and Business Plan (Financial Analysis)	Yes. Attached as **Annexure-V.**
7.	Copy of Certificate of Occupancy or Lease Agreement and Building Permit	[redacted]
8.	Power System Layout Drawings	Yes. Attached as **Annexure-VI.**
9.	Map with position of power station and distribution network marked using indicators to distinguish single phase and three phase as well as medium voltage networks	Yes. Attached as **Annexure-VI.**
10.	Tariff Application Table and Description of Intended Tariff Scheme and Service Availability	Initially the Applicant shall provide the services to the Consumers free of any charge. Subsequently, the tariff shall be charged to the Consumers as per mutually agreed between the Applicant and the Consumers in accordance with the principles of

		fairness and equity as provided under Regulation 6 of the NEPRA Licensing (Microgrid) Regulations, 2022. Certain information on the matter of Tariff is provided in the Tariff Table attached as **Annexure-VII**.
11.	Standard Consumer Service Agreement	The Applicant is still in the process of drafting a Standard Consumer Service Agreement. The Applicant shall submit the copy of the Standard Consumer Service Agreement with the Registrar NEPRA as soon as it drafts the Agreement in accordance with the principles provided under Regulation 7(2) of the NEPRA Licensing (Microgrid) Regulations, 2022 read with Schedule-III of the said Regulations.
12.	Certified copy of Building Permit	N/A
13.	All necessary approvals from other government agencies	As per our knowledge, the Applicant Company has complied with all necessary approvals from all government agencies.
14.	**Letters of Support:**	
	i. Commercial entities being served by the generating station	Since the Applicant does not intend to supply electric power to any commercial entities at any of the sites of the project as detailed out in the Application, therefore, this requirement is not applicable.
	ii. Landowner agreements (license/Concession/Lease for use of land/river)	N/A
	iii. Any other letters of support the Applicant would like to include	N/A
	iv. Provincial Government	The Project is approved by the Provincial Government.

	v.	Host DISCO for implementation of specification for distribution network	Since no Host DISCO's network exists at any of the sites of the Project, therefore, this requirement is not Applicable.
	vi.	Any other	N/A

ANNEXURE-I

Application for Microgrid License along with Authorization from Board and Power of Attorney

QA SOLAR

QUAID-E-AZAM
Solar Power (Pvt) Ltd.

NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

SCHEDULE 2. APPLICATION FOR MICRO GRID SYSTEM LICENSE

APPLICATION FOR MINI-GRID SYSTEM LICENSE OF X.X MW OR LESS FOR COMMERCIAL PURPOSES

(Pursuant to NEPRA Licensing (Microgrid) Regulations, 2022 S.R.O. No. 994(I)/2022 dated 6th July 2022)

IMPORTANT NOTES -

Your Application for Micro Grid System License is incomplete unless all required documents are submitted.

NEPRA reserves the right to verify the accuracy of this information.

Electronic copies may be submitted via mail on a flash drive or CD-ROM.

For NEPRA Use Only	
Date Received:	Number:
Time Received:	Received by:

In compliance with the NEPRA Licensing (Microgrid) Regulations, 2022 I am herewith certifying that I, **Muhammad Badar-ul-Munir**, am applying to construct, operate, and maintain a micro-grid system of 600 kWp or less for commercial purposes on 14-10-2022.

1.0 PARTICULARS OF APPLICANT AND CONTACT PERSON

Name of Applicant:	Quaid-e-Azam Solar Power (Pvt.) Ltd.
Address:	3rd Floor, 83-A E/1, Main Boulevard Gulberg-III, Lahore.
Tel:	042-99332261

Fax:	042-35790366
Mobile Phone:	0333-4878877
E-mail:	ceo@qasolar.com
FBR/NTN Registration Number:	_____
Website Address:	www.qasolar.com
Name of Contact Person:	Muhammad Badar-Ul-Munir
Address of Contact Person:	Quaid-e-Azam Solar Power (Pvt.) Ltd., 3rd Floor, 83-A/E1, Main Boulevard, Gulberg-III, Lahore
Telephone Number of Contact Person:	042-99332261
Mobile Phone of Contact Person:	0333-4878877
E-mail for Contact Person:	ceo@qasolar.com

2.0 LEGAL STATUS OF APPLICANT

Indicate legal status of Applicant (Tick relevant option)

- ☐ Sole Proprietorship
- ☐ Partnership
- ☐ Public Limited Liability Company
- ☐ **Private Limited Liability Company****
- ☐ Cooperative Society
- ☐ Incorporated Trustee
- ☐ Other (please specify) _____

(Attach Certificate of Registration, Certificate of Incorporation, Memorandum and Articles of Association, Deed of Partnership, Deed of Trust, as applicable)

3.0 DETAILS OF THE DIRECTOR/ CEO of THE APPLICANT

- ☐ **Director/CEO Name:** Muhammad Badar-Ul-Munir
- ☐ **Postal address:** Quaid-e-Azam Solar Power (Pvt.) Ltd., 3rd Floor, 83-A/E1, Main Boulevard, Gulberg-III, Lahore

- Cellular Phone: 0333-4878877
- Email: ceo@qasolar.com

3.1 DETAILS OF THE Employees / Staff

- **Number of Engineers:** 6
- **Number of skilled employees:** 18
- **Total Number of employees:** 34

4.0 NATURE OF APPLICATION

4.1 State whether Application is a new Application or Renewal

- ☐ **New Application**
- ☐ Renewal

4.2 Refusal, Suspension or Cancellation of Isolated Grid System License

Has the Applicant ever been refused a Mini-Grid System License or had its Mini-Grid System License suspended and/or cancelled by the Authority?

- ☐ Yes
- ☐ **No**

4.3 If yes, give details of the refusal, suspension, and/or cancellation.

Not Applicable

5.0 MAIN BUSINESS ACTIVITIES OF APPLICANT

Please indicate the main business activities the Applicant is currently engaged in (add additional pages if needed):

Quaid-e-Azam Solar Power (Pvt.) Limited is a public-sector for-profit company established by the Government of the Punjab. The company has been established for the setting up of renewable energy projects in general and Solar Energy Power Projects in particular. Quaid-e-Azam Solar Power (Pvt.) Limited is the first ever utility scale solar power plant in the country. It aims to initiate solar energy programs and research projects with respect to Solar Energy power generation plants.

6.0 DESCRIPTION OF PROJECT

6.1 Name of Project: Provision of Electricity to the Communities Using Indigenous Resources

6.2 Requested length of Microgrid System License (Years): 10 Years

6.3 Please provide a detailed description of the project (add additional pages if needed):

The Government of Punjab realizing its responsibility for provision of electricity to homes in remote villages, has decided to undertake the challenge for provision of electricity to the off-grid population through its Energy Department. The statistics obtained from DISCOs of Punjab shows that 6,103 villages are off-grid due to remoteness and high infrastructure cost. The Quaid e Azam Solar Power (Private) Limited has been declared as the executing agency for the execution of this project.

This project shall help to provide solar solutions to Off-grid Villages/poor grid villages of Punjab and shall pave a way towards implementation on a large scale. The project shall enable occupants of the said villages to get a clean and reliable source of electricity with reduced burden on the national grid.

The solar solutions include Solar panels, Inverters, Battery banks, SCADA, distribution system and billing system. The systems will be installed at available land of government at the sites mentioned in the schedule at the outskirts of the selected villages. In view of the above, the Quaid e Azam Solar Power (Private) Limited has proposed this project of combined capacity of 600 kWp to be implemented at 6 different sites, details of which are mentioned in the Documents attached with the Application.

6.4 Is this project for multiple micro-grid systems?

- ☐ **Yes**, how many individual systems will fall under this Application: **6**
- ☐ No

If yes, please provide the following information for each system using a consistent reference (I.e. 6.5a for the first system, 6.5b for the second). If information is similar across multiple systems, this may be noted in place of repeating information.

6.5 Site of the microgrid system(s) (Village(s), Sub-county and District):

Site No.: A: Basti Chawli Mouza Machka, Rajanpur

Site No.: B: Basti Kaleem Ullah, Rahim Yar Khan

Site No.: C: Basti Buzdar Wali, Muzaffargarh

Site No.: D: Chak No. 129 ML, Muzaffargarh

Site No.: E: Azafi Abadi 322/HR, Bahawalnagar

Site No.: F: Basti Jam Rafiq Jhaloo, Multan

(Attach title document to the land, relevant maps of the planned distribution envelope and drawings as appropriate. Use a consistent numbering system)

6.6 Generation (Expected): 1GWh

If multiple specific units are planned, if similar indicate the number or add additional lines if dissimilar:

	Type of system	**Rated Size (kW)**	**Equipment Specifications** Add additional lines if needed or specify if multiple similar units are being planned
Generation	☐ **Solar**	100	**Site No.: A** **Basti Chawli Mouza Machka, Rajanpur** Solar irradiance at site: 1895.9 kwh/m^2 Manufacturer/Make PV: Tiger Pro 72 HC 545 Watt Technology : Fixed Tilt Solar Cell Type: Mono crystalline Total Number of PV Panels: 184 Nominal Power of each PV Panel: 545 watt Inverter Details: (Make, Type, efficiency) (MEGAREVO, off-grid, 98.7%) Maximum output (kW): 80 kW Annual generation (kWh/year): Annual Capacity Utilization Factor: 19.28 %
		100	**Site No.: B** **Basti Kaleem Ullah, Rahim Yar Khan** Solar irradiance at site: 1900.10 kwh/m^2 Manufacturer/Make PV: Tiger Pro 72 HC 545 Watt Technology: Fixed Tilt

			Solar Cell Type: Mono crystalline Total Number of PV Panels: 184 Nominal Power of each PV Panel: 545 watt Inverter Details: (Make, Type, efficiency) (150kW, MEGAREVO, off-grid, 98.7%) Maximum output (kW): 150kW Annual generation (kWh/year): Annual Capacity Utilization Factor: 19.28 %
		100	**Site No.: C** **Basti Buzdar Wali, Muzaffargarh** Solar irradiance at site: 2000 kwh/m^2 Manufacturer/Make PV: Tiger Pro 72 HC 545 Watt Technology : Fixed Tilt Solar Cell Type: Mono crystalline Total Number of PV Panels: 184 Nominal Power of each PV Panel: 545 Watt Inverter Details: (Make, Type, efficiency) (150kW, MEGAREVO, off-grid, 98.7%) Maximum output (kW): 150 kW Annual generation (kWh/year): Annual Capacity Utilization Factor: 19.28 %
		100	**Site No.: D** **Chak No. 129 ML, Muzaffargarh** Solar irradiance at site: 2000 kwh/m^2 Manufacturer/Make PV: Canadian Solar 450 Watt Technology: Fixed Tilt Solar Cell Type: Mono crystalline Total Number of PV Panels: 222 Nominal Power of each PV Panel: 450 Watt

			Inverter Details: (Make, Type, efficiency) (InfiniSolar TX-PA, 30 kW*4, Off-Grid, 91%) Maximum output (kW): 30kW Annual generation (kWh/year): Annual Capacity Utilization Factor: 19.28%
		100	**Site No.: E** **<u>Azafi Abadi 322/HR, Bahawalnagar</u>** Solar irradiance at site: 2000 kwh/m^2 Manufacturer/Make PV: Canadian Solar 450 Watt Technology : Fixed Tilt Solar Cell Type: Mono crystalline Total Number of PV Panels: 222 Nominal Power of each PV Panel: 450 Watt Inverter Details: (Make, Type, efficiency) (InfiniSolar TX-PA, 30 kW*4, Off-Grid, 91%) Maximum output (kW): 30kW Annual generation (kWh/year): Annual Capacity Utilization Factor: 19.28%
		100	**Site No.: F** **<u>Basti Jam Rafiq Jhaloo, Multan</u>** Solar irradiance at site: 2156 kwh/m^2 Manufacturer/Make PV: Tiger Pro 72 HC 545 Watt Technology : Fixed Tilt Solar Cell Type: Mono crystalline Total Number of PV Panels: 184 Nominal Power of each PV Panel: 545kW Inverter Details: (Make, Type, efficiency) (150kW, MEGAREVO, off-grid, 98.7%) Maximum output (kW): 150kW Annual generation (kWh/year):

			Annual Capacity Utilization Factor: 19.28 %
	☐ Wind		N/A
	☐ Biomass/Bagasse		N/A
	☐ Hydro		N/A
	☐ Generator set (diesel or other)		N/A
	☐ Other (state): _____		N/A
		TOTAL:	**600 kWp**
☐ Storage			Manufacturer/Make:N/A Technology/Chemistry: N/A Maximum output (kW): N/A Capacity (kWh): N/A
☐ Storage Inverter			Manufacturer/Make/efficiency MEGAREVO, off-grid, 98.7%) Maximum Output (kW): For 150kW Inverter Max Output(kW): 150 kW For 30kW Inverter Max Output(kW) : 30 kW

6.7 Location of the microgrid system(s) (Approximate if not known):

Site No.	Site Location	Latitude	Longitude	Coordinate System
A	Basti Chawli Mouza Machka, Rajanpur	28.854856	70.33537	28.854856, 70.33537
B	Basti Kaleem Ullah, Rahim Yar Khan	28.8078893	70.3772551	28.8078893, 70.3772551

C	Basti Buzdar Wali, Muzaffargarh	30.670668	71.349523	30.670668, 71.349523
D	Chak No. 129 ML, Muzaffargarh	30.703649	71.376574	30.703649, 71.376574
E	Azafi Abadi 322/HR, Bahawalnagar	29.250127	72.316834	29.250127, 72.316834
F	Basti Jam Rafiq Jhaloo, Multan	29.419908	71.258263	29.419908, 71.258263

6.8 Is the microgrid system(s) new? If no, please state number of years the mini-grid system(s) has been in operation: Yes

6.9 Expected Annual Production: (Rated Generation Capacity)

Site No.	Site Location	Minimum	Maximum
A	Basti Chawli Mouza Machka, Rajanpur	150,000 kWh	160,000 kWh
B	Basti Kaleem Ullah, Rahim Yar Khan	150,000 kWh	160,000 kWh
C	Basti Buzdar Wali, Muzaffargarh	150,000 kWh	160,000 kWh
D	Chak No. 129 ML, Muzaffargarh	150,000 kWh	160,000 kWh
E	Azafi Abadi 322/HR, Bahawalnagar	150,000 kWh	160,000 kWh
F	Basti Jam Rafiq Jhaloo, Multan	150,000 kWh	160,000 kWh

6.10 Total Connected Load of System: 300 kW approximately

6.11 Average Hours of Operation (daily): 8.5 Hours

(If less than 24hours detail a typical service availability schedule).

6.12 Distribution

	Type of system	Size of system
Type of Distribution System	☐ **Overhead**	

Voltage level of distribution system	380/440	
Lines / Feeders	N/A	N/A
Grid Stations	N/A	N/A
Poles	☐ **Structure/Stainless Steel**	20 Poles per Site
Power Transformers	N/A	
Distribution Transformers	N/A	
Specification of Distribution System	☐ _____ Specify name of host DISCO from which specification for distribution network have been obtained	

Description of distribution network (indicate geographical coordinates of four reference points, general length, or other important features):

_____

_____

_____

_____

_____

_____

6.13 Number of Consumers:

- ☐ **Residential: 280-320**
- ☐ Commercial: 0
- ☐ Industrial: 0
- ☐ Agricultural 0
- ☐ Special (Governmental): 0
- ☐ Any other: 0

6.14 Summary of Revenue and Sources of Funding

- ☐ **Expected Electricity Sales by Customer Category**

- Residential [kWh/year]: 930,000 kWh approximately
- Commercial [kWh/year]: _____
- Industrial [kWh/year]: _____
- Agricultural [kWh/year]: _____
- Special (Governmental) [kWh/year]: _____

☐ **Electricity tariff [kWh or flat rate per W] as agreed mutually:**
Initially Free of Cost, the tariff shall be determined later

☐ **Capital contribution (specify foreign or local):** PKR 228,855,630 (Local)

☐ Loan capital (specify source and provide evidence):
_____

☐ **Grant by Federal/Provincial Government:** Fully Funded by Government of Punjab

☐ Others (specify): _____

☐ Project Internal Rate of Return: _____

☐ Project Internal Rate of Return on Equity: _____

7.0 BANKERS AND FINANCIAL REFERENCES

☐ In Pakistan: ADP-2021-22

☐ Outside of Pakistan: N/A

8.0 DECLARATION BY THE APPLICANT

I/we hereby declare that the details stated above are, to the best of my/our knowledge, true and correct.

Dates this 14th day of October, 2022.

SIGNATURE OF APPLICANT
Name: **Muhammad Badar-Ul-Munir**
Title: **Chief Executive Officer**

QA SOLAR

QUAID-E-AZAM
Solar Power (Pvt) Ltd.

POWER OF ATTORNEY

We, **QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED**, (the **"Company"**), hereby appoint and constitute **Mr. Muhammad Saqlain Arshad** Advocate High Court to appear and act for us as our advocates in connection with the Licensee Application (the **"Application"**) filed in respect of seeking Microgrid System License under NEPRA laws with the National Electric Power Regulatory Authority (NEPRA).

I/We also authorize the said Advocate or any one of them to do all acts and things necessary for the processing, completion and finalization of the Application with NEPRA.

For and on behalf of
QUAID-E-AZAM SOLAR POWER (PRIVATE) LIMITED

CHIEF EXECUTIVE OFFICER

ACCEPTED

MUHAMMAD SAQLAIN ARSHAD
ADVOCATE HIGH COURT
65/3 FCC, GULBERG IV
LAHORE.

ECPAK

Quaid-e-Azam Solar Power (Pvt) Ltd

FEASIBILITY STUDY, AND PREPARATION OF PC-1 FOR "*OFF-GRID VILLAGE ELECTRIFICATION PROJECT IN PUNJAB THROUGH SOLAR POWER*"

Final report is adopted

Environconsult Pakistan (Pvt.) Ltd. ECPAK Lahore - Pakistan

MARCH 2021

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ECPAK

Euroconsult Pakistan (Pvt.) Ltd. ECPAK Lahore - Pakistan

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B. CAPEX & OPEX Details

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LIST OF ABBREVIATIONS

MW	**Mega Watt**
PV	Photo Voltaic
W/m²	**Watt per meter squared**
kWh/m²/day	Kilo Watt hour per meter squared per day
kWh/m²/year	**Kilo Watt hour per meter squared per year**
NREL	National Renewable Energy Laboratory
kW	**Kilo Watt**
AC	Alternating Current
DC	**Direct Current**
HOMER	Hybrid Optimization of Multiple Energy Resources
COE	**Cost Of Electricity**
NPC	Net Present Cost
GWh	**Giga Watt hour**
CFL	Compact Fluorescent Lamp
NASA	**National Aeronautics and Space Administration**
V	Voltage
A	**Ampere**
Voc	Open Circuit Voltage
Isc	**Short Circuit Current**
Vpm	Maximum Power Voltage
Ipm	**Maximum Power Current**
Li-ion	Lithium Ion
Ah	**Ampere hour**
LCA	Life-Cycle Assessment
LCOE	**Levelized Cost Of Electricity**

INTRODUCTION

1.1 PROJECT BACKGROUND

Energy is the backbone for the socio-economic stability of a country. The current demand of energy is increasing gradually due to growing population, the aspiration for improved living standards and industrialization. Pakistan is meeting its energy needs mainly through conventional sources of energy. It is worldwide accepted that renewable energy technologies (such as wind, solar thermal, solar photovoltaic (PV), geothermal, tidal, biomass, waste to energy, etc.) play a tactical role in the accomplishment of the goals of sustainable and economic development as well as environmental protection. Out of these renewable sources of energy; wind and solar are being widely used, due to their commercial acceptance, ease of installation, maintenance, and operation; and competitive capital and maintenance costs

Quite large percentages of population of remote villages in South Punjab have no access to electricity. The lifestyle & social status of this population is poor due to lack of basic facilities of this modern age. The economic condition of this population and villages is also bleak. These villages are distant from the grid area due to which, the DISCOs are not finding it economically feasible to extend their grid networks into these areas.

The Government of Punjab, realizing its responsibility for provision of electricity to households in remote villages, has decided to undertake the challenge for provision of electricity to the off-grid population. For this reason, Quaid-e-Azam Solar Power Pvt. Ltd is working on the pilot project. ***"Installation of Micro-Grid Solar Solutions of remote villages of capacity range 0.5 to 1.5 MWp"*** to provide electricity through renewable resources

This feasibility asses the viability of renewable energy source for the selected villages.

1.2 LOCATION AND POPULATION

1.2.1 Geographical Location and Climate

Punjab is Pakistan's second largest province by area after Baluchistan with an area of 205,344 square kilometers (79,284 square miles). It occupies 25.8% of the total landmass of Pakistan. Punjab's landscape consists mostly of fertile alluvial plains of the Indus River and its four major tributaries in Pakistan, the Jhelum, Chenab, Ravi, and Sutlej rivers which traverse Punjab north to south.

Most areas in Punjab experience extreme weather with foggy winters, often accompanied by rain. By mid-February the temperature begins to rise; springtime weather continues until mid-April, when the summer heat sets in.

The province's temperature variation:

- Punjab's region temperature ranges from −2° to 45 °C
- The maximum temperature can reach up to 50 °C (122 °F) in summer
- The minimum temperature can touch down to −10 °C (14) in winter.

Climatically, Punjab has three major seasons:

- Hot weather (April to June) when temperature rises as high as 110 °F (43 °C).
- Rainy season (July to September). Average rainfall annual ranges between 96 cm sub-mountain region and 46 cm in the plains.
- Cooler/ Foggy / mild weather (October to March). Temperature goes down as low as 40 °F (4 °C).

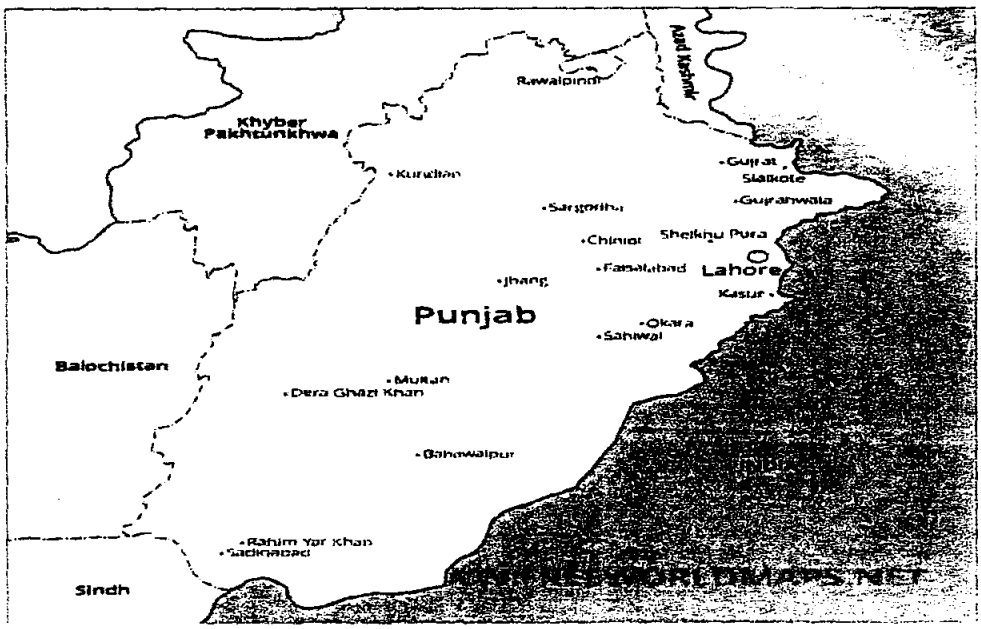


Figure 1. Map of Punjab Province

Punjab has one of the lowest rural electrification rates in Pakistan. Most of the un-electrified villages exist in southern part of the Punjab. In order to eradicate the power deficit and issues related to village electrification, survey of the 47 villages pointed out by the DCOs of relevant districts was conducted. Out of these 47 villages, 07 villages were shortlisted on the basis of their population, socio-economic conditions, availability of land and distance from the grid. Electrification via grid network to these areas is inconceivable because of impassable routes through the rough Terrain, forests and dispersion of the settlements. The majority of the population in these areas suffers from poverty and cannot afford expenses of conventional electrical generation.

Sr. No.	Name of Village	Village Code	Tehsil	District	GPS Coordinates	
					Latitude	Longitude
1	Basti Haider Abad Mouza Machka Pakka	A1	Rajanpur	Rajanpur	28.862000	70.335070
2	Basti Mud Saindad Mouza Saindad	A2	Rajanpur	Rajanpur	28.848000	70.320400
3	Basti Chaappu U/C Db Cholistan	B1	Yazman	Bahawalpur	29.147330	72.269206
4	Basti Kheersar, Cholistan Yazman, Bahawalpur	B2	Yazman	Bahawalpur	29.074536	72.286180
5	**Bharti Shumali / Bharti Janubi / Dilo Dingo,**	**C1-1,**	**Koh-e-Suleman**	**Dera Ghazi Khan**	30.568450	70.373497

		C1-2, C1-3				
6	Pughla Shumali/Janubi, Bhanwar, Nala Sharqi and Hanaso	C2-1, C2-2, C2-3	Koh-e-Suleman	Dera Ghazi Khan	30.823389	70.272719
7	Lophani Daf / Gata Raikh	C3	Koh-e-Suleman	Dera Ghazi Khan	30.433130	70.318667

Table 1 Shortlisted Villages in Punjab for Feasibility Study

The regions with lack of access to electricity grid and the short-listed communities within these regions are demonstrated in Fig. 2. Rajanpur is Punjab's southernmost region with very small population due to its remote location in Bahawalpur is situated in the southern highlands of Punjab with a tropical climate which is characterized by mild and sunny days. Dera Ghazi Khan is located in south-east of Punjab at high elevation which results in harsh climate conditions compared to the other selected communities. Table 1 summarizes the geographic and demographic information of these villages.

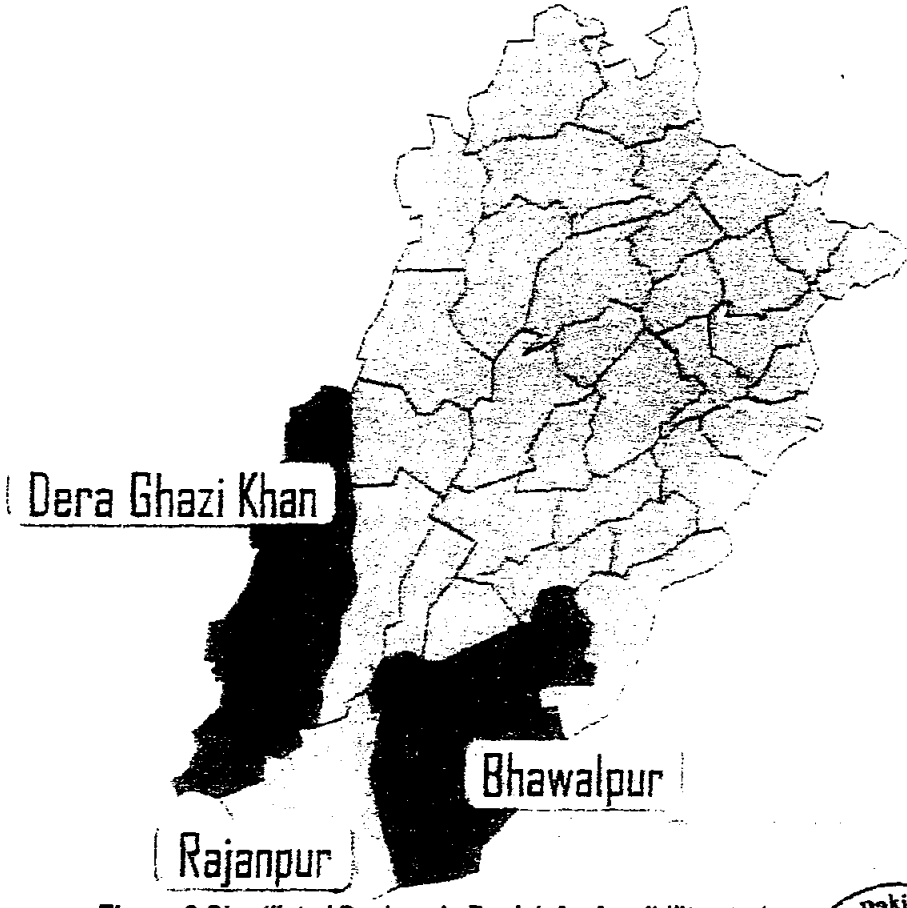


Figure 2 Shortlisted Regions in Punjab for feasibility study

2 LITERATURE REVIEW

2.1 ENERGY RESOURCES

2.1.1 Solar Irradiation

Solar irradiance is the power per unit area received from the Sun in the form of electromagnetic radiation as measured in the wavelength range of the measuring instrument. The solar irradiance is measured in watt per square meter (W/m^2) in SI units. Solar irradiance is often integrated over a given time period in order to report the radiant energy emitted into the surrounding environment (joule per square meter, J/m^2) during that time period. This integrated solar irradiance is called solar irradiation, solar exposure, solar insolation, or insolation.

Solar energy can be used in various ways. Most common method is to generate electricity using PV solar panels, followed by solar collector to exchange heat usually to heat water. These methods are applied in various ways in commercial, industrial and public places.

2.1.2 Wind Speed

In meteorology, wind speed, or wind flow speed, is a fundamental atmospheric quantity caused by air moving from high to low pressure, usually due to changes in temperature. Wind speed is now commonly measured with an anemometer.

Wind speed affects weather forecasting, aviation and maritime operations, construction projects, growth and metabolism rate of many plant species, and has countless other implications. It is to be noted that wind direction is usually almost parallel to isobars (and not perpendicular, as one might expect), due to Earth's rotation.

Wind energy is mainly used to generate electricity with the help of wind turbine. Other applications include transportation through wind

2.1.3 Biomass Resource:

Biomass is a plentiful and oldest source of energy in the world, composed of the organic matter of including agricultural residues, wood, animal and human wastes. It is a mixture of the gases such as carbon dioxide (CO_2) and methane (CH_4), which is produced by microorganisms in the absence of oxygen.

Utilization of biomass for the power generation purpose is becoming very popular by the time and is the easily available source of energy in the rural areas of Pakistan. Moreover, it is a clean source of energy as compared to fossil fuels in the world. That's why biomass can be used as potential source of energy for the electricity generation in the country by using animal manure through digestion process or residues through combustion process.

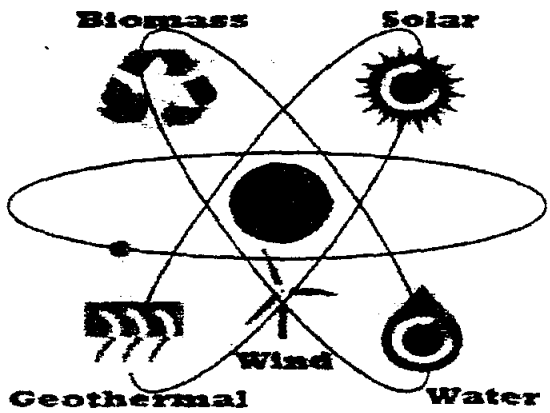


Figure 3 Renewable Energy Resources

2.2 EVALUATION OF RENEWABLE ENERGY RESOURCES

Solar or Wind power generation does not supply electricity to the load continuously, due to its intermittent character, preventing it from meeting a steady constant demand at different times. Therefore, both sources need to be considered as variable forms of energy output. Their separate utilization should always account for the variability and unpredictability of the resource. In order to minimize the influence of intermittency of these resources, batter backup is required.

2.2.1 Solar Radiation and Wind Regime, Distribution and Its Potential

a) **Solar Radiation Resource:**

Punjab has great unexploited solar radiation potential. According to a study, the availability of solar radiation across the country varies between 5.2 and 6 kWh/m²/day with the annual daily average value of 5.7 kWh/m²/day. However, the most recent studies done by FUNAE confirm that in Punjab, the global horizontal irradiation varies between 1785 and 1920 kWh/m²/year. Figure 4 below shows the solar radiation distribution in Punjab.

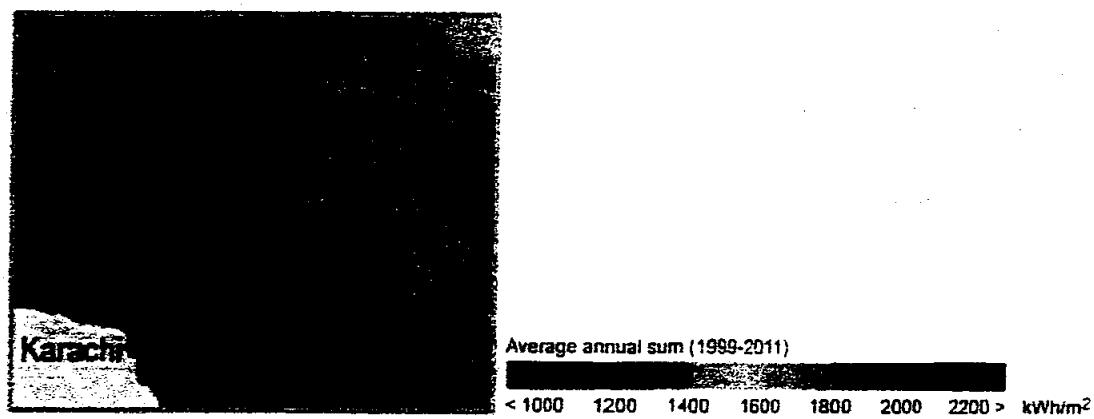


Figure 4. Solar Radiation Resource of Punjab

3 SURVEY DATA AND SATELLITE IMAGERY

07 villages out of 47 villages in Punjab have been short listed for pilot project to perform the techno economic feasibility study and develop a technical solution.

3.1 GENERAL SURVEY DATA OF THE 7 SHORTLISTED VILLAGES:

Sr. No.	Name of Village	Village Code	No. of Households	Population	Distance from Grid	Estimated length of distribution line
1	Basti Haider Abad Mouza Machka Pakka	A1	100	700	34	1064

2	Basti Mud Saindad Mouza Saindad	A2	65	650	36	548
3	Basti Chaappu U/C Db Cholistan	B1	216	700	30	1800
4	Basti Kheersar, Cholistan Yazman, Bahawalpur	B2	70	500	52	1400
5	**Bharti Shumali / Bharti Janubi / Dilo Dingo,**	**C1-1,** C1-2, C1-3	600	4500	47	4896
6	Pughla Shumali/Janubi, Bhanwar, Nala Sharqi and Hanaso	C2-1, C2-2, C2-3	450	4000	46	2706
7	Lophani Daf / Gata Raikh	C3	70	600	69	2370

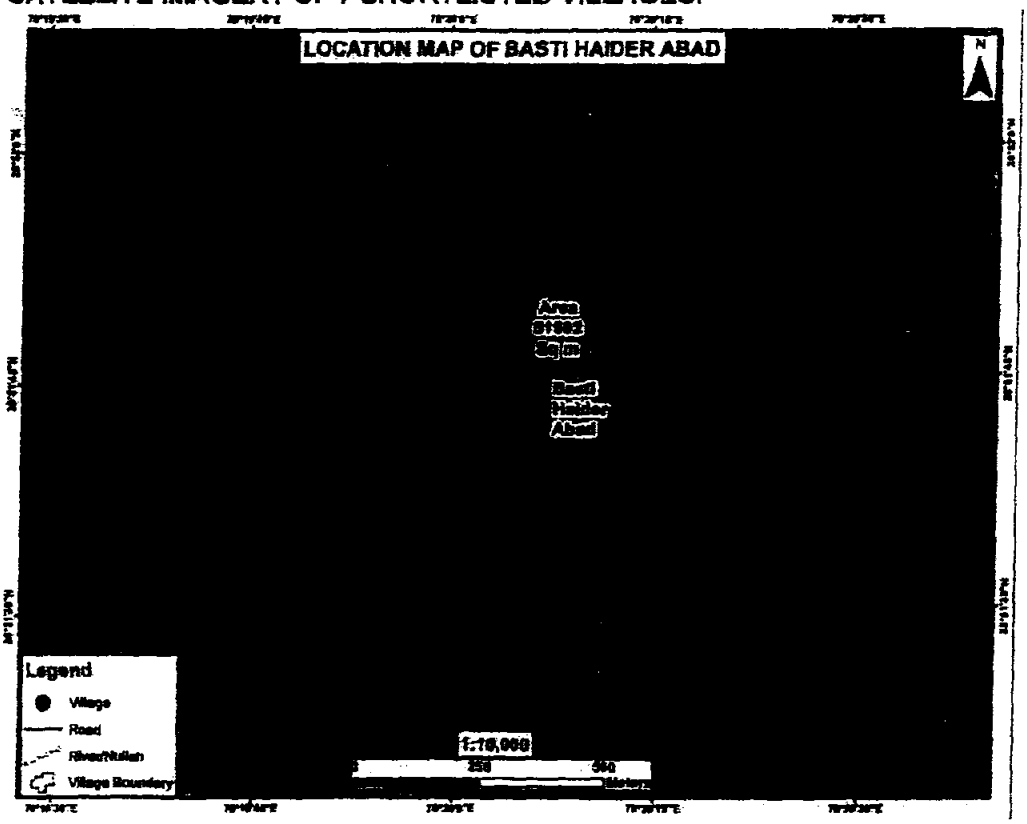
Table 2: Survey Data of Shortlisted Villages

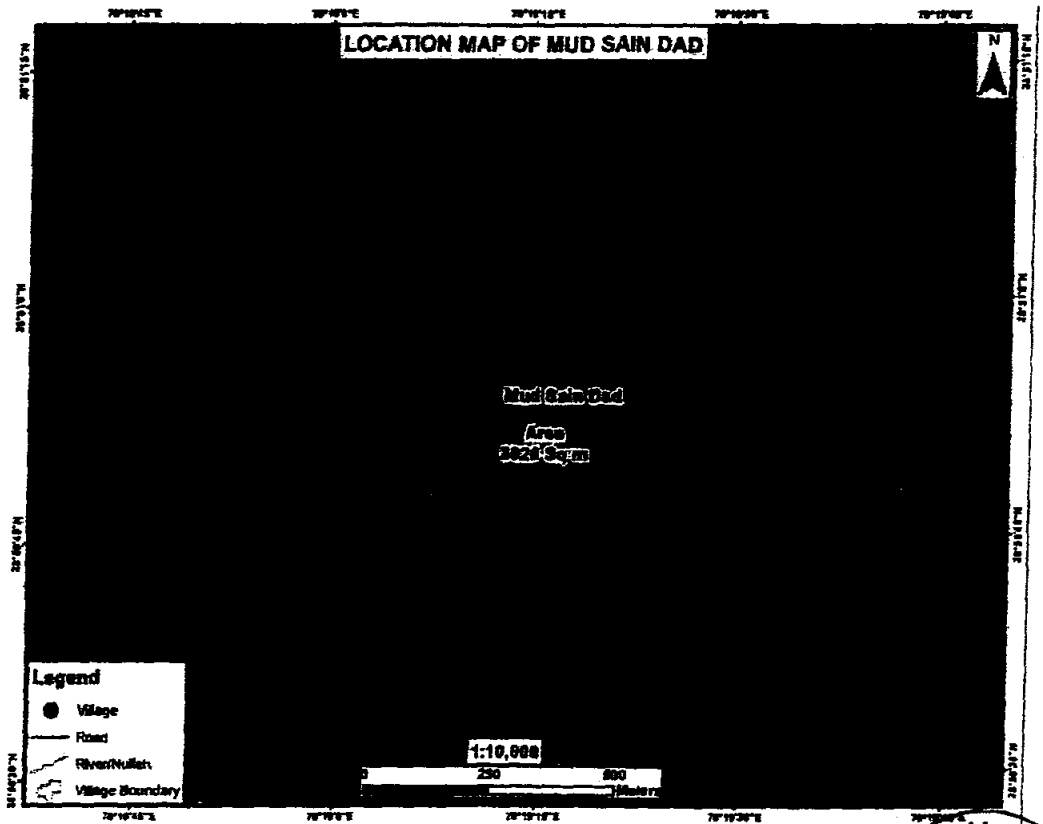
3.2 RESOURCE AVAILABILITY IN THE 7 SHORTLISTED VILLAGES:

Sr. No.	Name of Village	Village Code	Solar Irradiation kWh/m2	Wind Speed (m/s)
1	Basti Haider Abad Mouza Machka Pakka	A1	5.417	2.778
2	Basti Mud Saindad Mouza Saindad	A2	5.419	2.778
3	Basti Chaappu U/C Db Cholistan	B1	5.264	2.932
4	Basti Kheersar, Cholistan Yazman, Bahawalpur	B2	5.273	2.778
5	**Bharti Shumali / Bharti Janubi / Dilo Dingo,**	**C1-1,** C1-2, C1-3	5.189	2.376
6	Pughla Shumali/Janubi, Bhanwar, Nala Sharqi and Hanaso	C2-1, C2-2, C2-3	5.185	2.417
7	Lophani Daf / Gata Raikh	C3	6.5	2.983

Table 3: Resource Availability of Shortlisted Villages

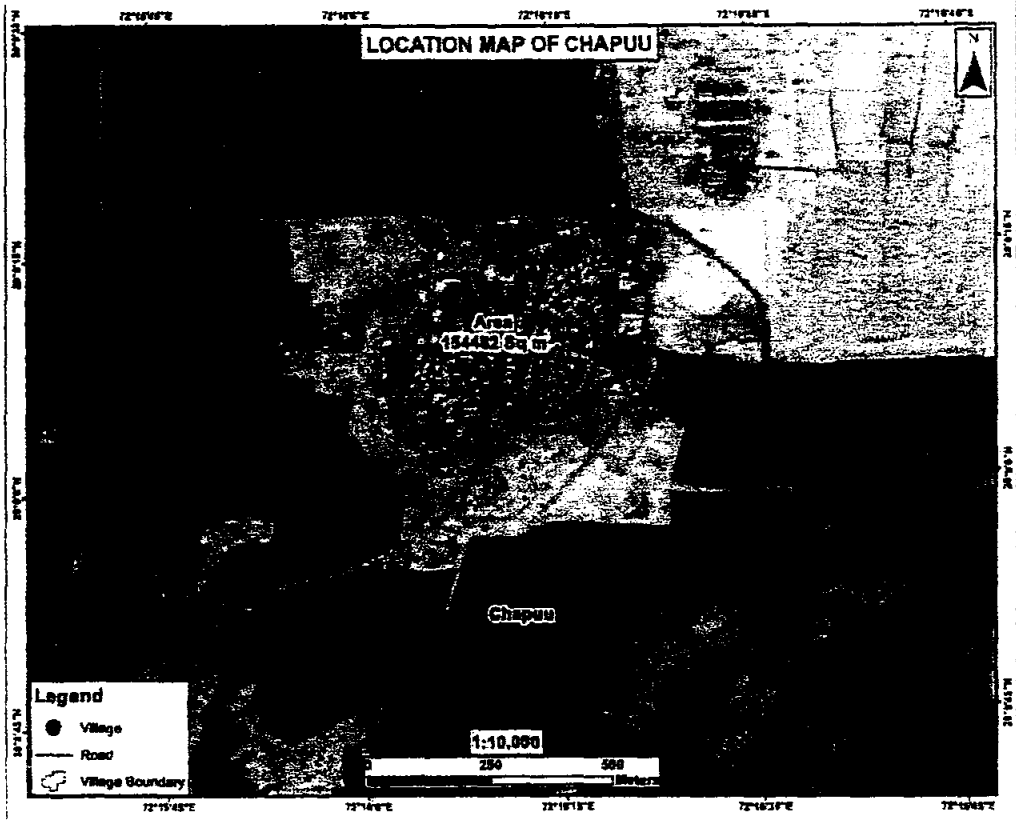
3.3 SATELLITE IMAGERY OF 7 SHORTLISTED VILLAGES:

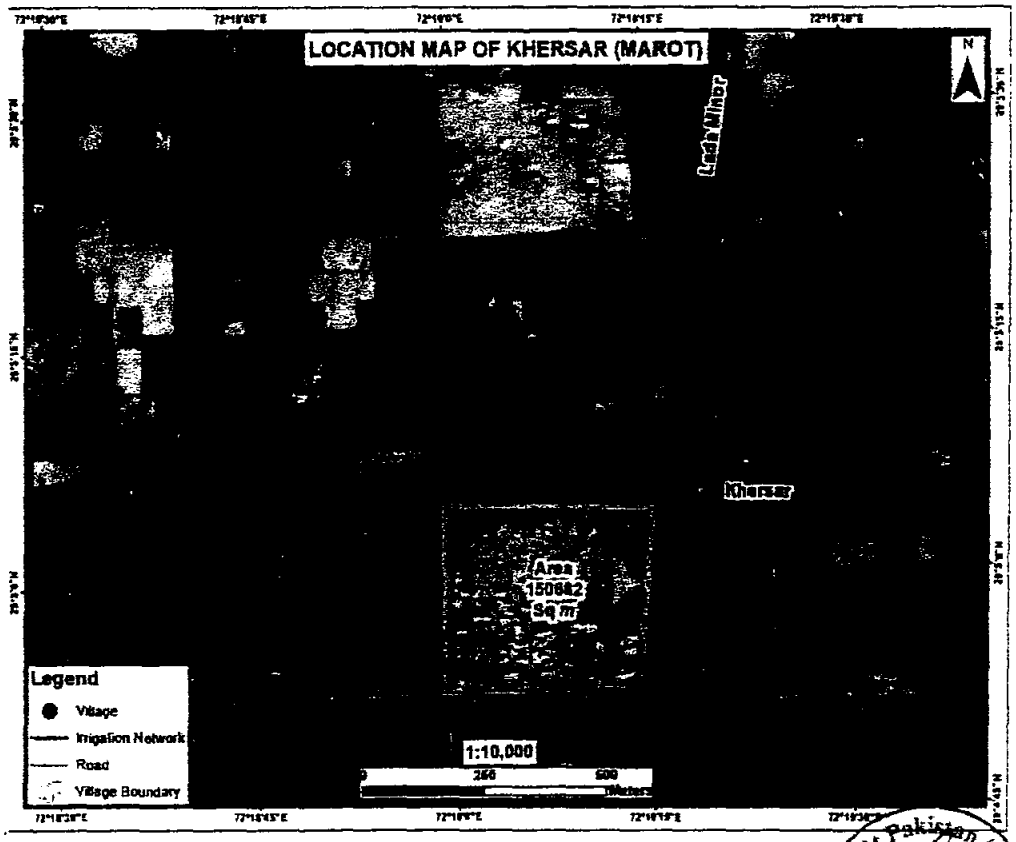




ECPAK

Environconsult Pakistan (Pvt.) Ltd. ECPAK Lahore - Pakistan





ECPAK

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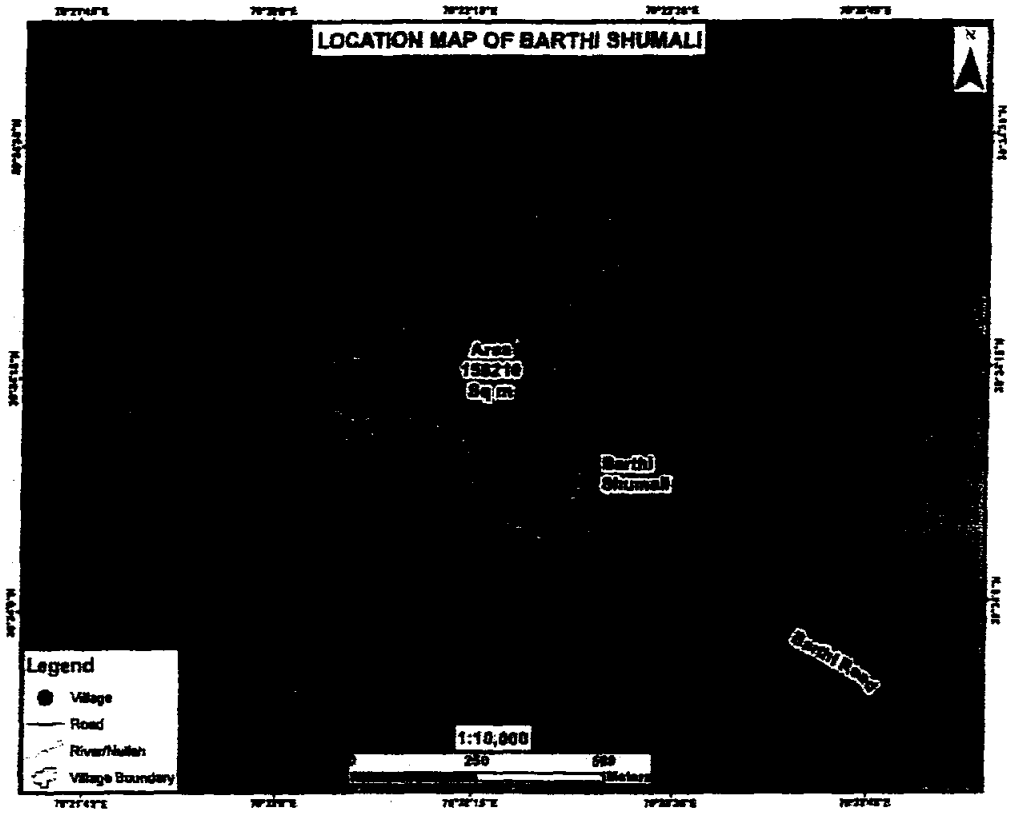
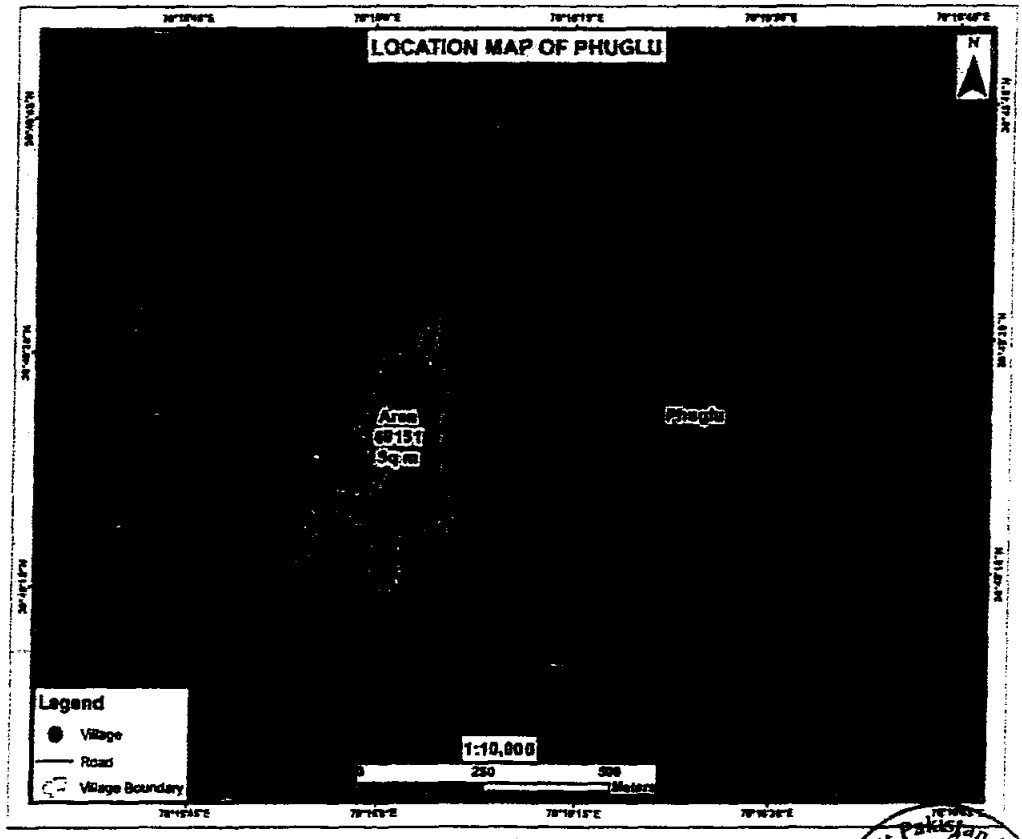
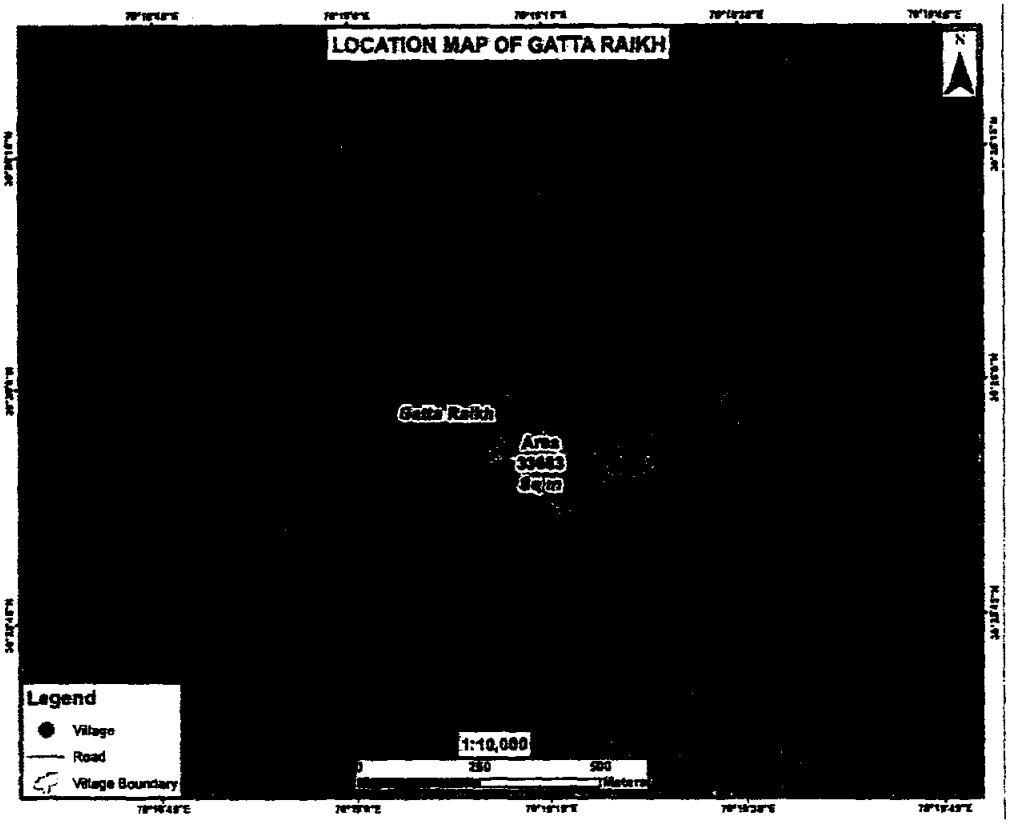

LOCATION MAP OF BARTHI SHUMALI
N
Barthi Shumali
Legend
Village
Road
River/Nullah
Village Boundary
1:10,000
250
Meters


LOCATION MAP OF PHUGLI
N
Phugli
Legend
Village
Road
Village Boundary
1:10,000
250
Meters



4 Overview of Small Solar Hybrid System

Basic Principles of Small-Scale Photovoltaic System

Solar photovoltaic systems rely on the irradiation of the sun and convert its solar energy into electrical energy. For a small scale, PV system that shall be deployed in areas with weak or no grid, typically a hybrid or grid interactive system is suggested. For this study, the term "Solar System" will include the Battery and Grid connection, therefore be equivalent with the term "Solar Hybrid System" or Hybrid System.

Energy of photons in sunlight is converted to DC electricity by the photovoltaic Modules. The DC electricity of a string of PV Modules enters the DC input of an inverter. The inverter converts the DC power provided by the PV Modules into AC power to feed it into the grid and/or to provide the power to connected con- summer loads. The DC power can also be stored in a battery bank which can provide backup power in case of electricity blackouts in areas with unstable grid infrastructure or when solar energy is not available.

Photovoltaic Modules

Photovoltaic technology is based on the photoelectric effect. A photon from light is absorbed in the PN junction of a solar cell. The energy of this photon causes an electron to move out of the depletion region whereby creating an electron-hole pair. This increase in potential results in the generation of current through potential difference (voltage). The electrons on one side of the PN junction then flows through an external circuit and recombines with the holes on the other side. The whole process then gets repeated.

The purity level of the semiconductor material is important as well as the fact that there are no gaps or defects at the molecular and atomic level of the semiconductor material. As a general rule, it can be stated: the lesser the microscopic defects, the higher the efficiency of power conversion.

The efficiency of a solar cell (h) is the percentage of power from solar energy, incident on the solar cell, converted to electrical energy. This term is calculated using the ratio of the maximum power point of the cell, Pm, divided by the light power that reaches the cell, the global irradiance (E, in W / m^2) and the surface area of the solar cell (Ac in m^2).

As this efficiency varies in different irradiance conditions, the PV industry defined certain conditions for the efficiency rating of PV Modules. These are called Standard Test Conditions (STC).

Another important standardized variable is the Normal Operating Cell Temperature (NOCT) for PV Mod- ules. This is a characteristic cell value defined as the temperature of the cells, which they reach at an irradiance of 800 W / m^2, an ambient temperature of 20°C and a wind speed of 1 m/s – typically given at open circuit.

Photovoltaic technologies differ primarily by the type of manufacturing process, which leads to different manufacturing costs, price ranges and performances for the different technologies three main solar cell technologies are commercially available:

- Monocrystalline
- Polycrystalline
- Thin Film

Monocrystalline Technology

The manufacturing process of monocrystalline cells requires more effort in comparison to other technologies. However, these cells offer higher efficiencies in comparison to the polycrystalline or thin film cells typically, within 17 – 20 %.

Advantages:

- Mature and commercially proven technology.
- Long lifetime of PV Modules.
- Low degradation of maximum 0.1 - 0.5 % per year (manufacturer guarantee is 0.7 % of degradation per year; however, reality proves to be less).
- Lower installation costs.
- More environmentally friendly than other technologies, for example, some thin film technologies use cadmium. Monocrystalline cells are not harmful to the environment.

Disadvantages:

- Higher initial investment costs.
- Compared against Thin Film technology: Higher risk of damages (micro-cracks) during transport or during operation at sites with high wind speeds.

Polycrystalline Technology

This technology exists since 1981 and its manufacturing process is simpler in comparison to monocrystal- line technology.

Advantages:

- Lower production costs.

Disadvantages:

- Lower efficiency, due to lower purity of the cell material: 16 – 18 %
- Because of the lower efficiency, slightly more ground surface area is required to reach the same capacity (in comparison to monocrystalline technology).
- Compared against Thin Film technology: Higher risk of damages (micro cracks) during transport or during operation at sites with high wind speeds.

Thin Film Technology

This technology is called Thin Film because only a couple of nanometers of the semiconductor material is placed on a substrate material. Hence, a very low amount of semiconductor material is needed. The main semiconductor materials in use are:

- Cadmium Telluride (CdTe)
- Copper Iridium Gallium Selenium (CIS / CIGS)
- Amorphous Silicon (a-Si)
- Organic photovoltaic cells

Thin Film technologies have a low market share, except of the CdTe material, with the main manufacturer First Solar. But also, CIS / CIGS technologies are having an increasing market, because of their higher efficiency. Depending on the technology, standard thin film module efficiencies have reached 7 - 15%.

Advantages:

- Less affected by high temperatures and shadowing.

Disadvantages:

- Faster degradation rate of up to 0.7 % per year for a-Si.
- Lower efficiency leads to greater surface area requirements and higher installation costs. for the same capacity.

Conclusions

Based on the costs and the availability in the market, it is recommended to opt for standard crystalline PV Modules. These PV Modules provide a very good balance between efficiency and cost while providing better space utilization for areas with limited space for installation.

Mounting Structures

The photovoltaic modules can be installed on fixed structures or on moving structures tracking the sun. Trackers can be implemented either as a single axis system or as a dual axis tracking system.

For this project, keeping in view the economics and complexity, fixed mounting structures will be the most suitable. For the location of Punjab the optimal orientation for the PV modules would be to an azimuth of SSE of 160° or inside the range of ESE – SSW (112.5°- 202.5° N=0°). Within this orientation angle, the highest irradiation on the PV Module plane can be achieved for an unshaded PV Module for the relevant hours of 8am-2pm.

Conclusion

An optimal tilt angle (inclination) of 28° for Punjab has been suggested for the fixed-mounted system in order to deliver a maximum amount of electricity during peak hours of the hot summer months. The assessment of the optimal orientation and inclination for Punjab is based on database for long-term irradiance data: Meteonorm 7.1.

Inverter Technology

Because photovoltaic panels generate electricity in the form of direct current (DC), the electricity must be converted into alternating current (AC) before it can be fed into the grid or used directly with standard AC equipment. This is achieved through use of an inverter.

State of the art inverters offer a broad range of operational stages, which generally fulfill all requirements of the international grid codes in terms of fault-ride-through and reactive power provision. The capacity of inverters widely varies from only a few hundred Wp up to 1.5 MWp of DC PV-Power, depending on the inverter technology.

Electricity Storage System / Batteries

Batteries designed for solar PV system applications have to meet heavy cycling and continuous use. Multiple battery types exist in the market catering to these unique requirements of the application. When considering a battery, the cost of the battery, its usable lifetime and capacity play an important role. The most common battery types available in the market are described as follows.

Lead-acid batteries are the oldest and most common type of storage batteries. The type has long been considered as battery of choice for off-grid power systems due to the relatively low cost, reliability and service life.

A specific type is the deep cycle battery which represents a rechargeable lead-acid battery with very thick active plates and separators made from high quality and high-density alloys. This robust construction enables the battery to be regularly and deeply discharged to 30% of its total capacity. The deep discharge- charge process can be repeated for several hundred times, although if the battery is only discharged to 80-70% of its capacity it can often be repeated several thousand times. Thus, the life of a deep cycle battery is directly proportional to the level of regular discharge. These batteries are further divided into additional types such as flooded lead-acid, valve regulated lead-acid - absorbed glass mat and valve regulated lead-acid – gel electrolyte. Valve regulated batteries are maintenance free, require no water top- ping and often have higher number of cycling times.

4.1 USER LOAD ESTIMATION:

Solar off-grid system is designed to fulfill the electricity need of a Village and the small community consisting of number of households. Community is centered in different small villages in the Punjab province of Pakistan. In current case demand for rural residential electricity is not high as compared to the urban areas, electricity consumption in the residential community is due to the lighting, fans and small water pumps. The main electricity consumption in the current case is due to the basic needs of the household such as Lights, Fans etc. Electric load analysis is performed carefully by considering the load requirements of the households for the summer peak season for the residential needs.

The Load calculation for a typical household in Punjab villages is calculated in the table below:

#	Load Type	Load Rating (W)	Unit	Total Load (W)	Daily Hours	Energy Consumption (kWh/day)
1	Lights (LED)	40	5	200	8	1.6
2	Fan (Energy Efficient)	80	2	160	8	1.28
3	TV (CRT)	150	1	150	4	0.6
4	Power Receptacles	180	1	180	2	0.36

	Total Energy Demand for Household	3.84

Table 4. Electric load calculations for Typical Village Household

4.2 OFF-GRID SOLAR PV SYSTEM SIZING

The following calculation is done to determine the size of the Solar PV systems required in the 7 shortlisted villages of Punjab, The Panel Generation Factor is selected to be at **3.43** and the size of the PV panel is a 330W module. The total size of the Off-Grid system for each village is calculated in the table below:

Panel generation factor (PGF) is used while calculating the size of solar photovoltaic cells. It is a varying factor depending upon the climate of the site location. The constant value of PGF is 3.43

#	Village	Total Energy Consumption (kWh/Day)	Average Power Requirement/household (W)	No. of Houses	Peak Wattage required (KW)
1	A1	384	1000	100	100
2	A2	250		65	65
3	B1	830		216	216
4	B2	269		70	70
5	C1-1	1152		300	300
	C1-2	1152		300	300
6	C2	1728	504	450	450
7	C3	269	79	70	70

Table 5 OFF Grid Solar PV system Sizing of Each Village

4.2.1 Annual Solar System Energy Output

The electricity generated by a solar PV system is governed by its rated power output, but it's also dependent on other factors such as panel efficiency average sunlight hours received, as well as the degree of shading that the system experiences and the tilt angle and azimuth of the roof on which it's installed.

Annual energy production has been obtained from PVSyst simulations attached as ANNEX-A.

#	Village	Proposed Capacity (KW)	PV Panel Rating(W)	No. of PV Modules	*Annual Solar Energy Output (MWh)
1	A1	130	330	394	226.5
2	A2	84.5		256	149.5
3	B1	280		849	484.4
4	B2	91		276	154.4
5	C1-1	260		783	454.8

	C1-2	260		783	454.9
	C1-3	260		783	454.9
6	C2-1	195		594	345.2
	C2-2	195		594	345.2
	C2-2	195		594	345.2
7	C3	71		276	155.8

Table 6 Annual Solar Energy Output of Each Village

4.2.2 Battery Sizing

The Battery Type recommended for using in solar PV system is deep Cycle battery. Deep cycle battery is specially designed for to be discharges to low energy level and rapid recharge or cycle charged and discharged day after day for years.

$$\text{Total Battery Capacity (Ah)} = \frac{(\text{Total Watt hours per day used}) \times \text{DOA}}{0.85 \times 0.5 \times \textit{nominal battery voltage}}$$

$$\text{Total Battery Capacity (Ah)} = \frac{(1536) \times 1}{0.85 \times 0.5 \times 48}$$

$$\text{Total Battery Capacity (Ah)} = 75\text{Ah} \ (80\text{Ah approximately})$$

Battery Bank size is calculated as follows:

#	Village	No. of Houses	Total Energy Consumption (kWh/Day)	Batter Backup required per household (Ah)	Battery Bank Size (Ah)
1	A1	100	384	80	8,000
2	A2	65	250		5,200
3	B1	216	830		17,280
4	B2	70	269		5,600
5	C1-1	300	1152		24,000
	C1-2	300	1152		24,000
6	C2	450	1728		36,000
7	C3	70	269		5,600

Table 7 Battery Bank Sizes for Each Village

4.2.3 Storage Batteries

The main purpose of the batteries is to store the PV output during the day time to be used in the absence of solar radiations, batteries of 80Ah (4 hours Back up) were used in this PV system.

4.2.4 Available Solar Radiation:

Solar radiation data obtained by using PVSyst is in the range of 5 – 6 kWh/m2/day. A profile indicating solar radiation and clearance index is shown in Fig. 06

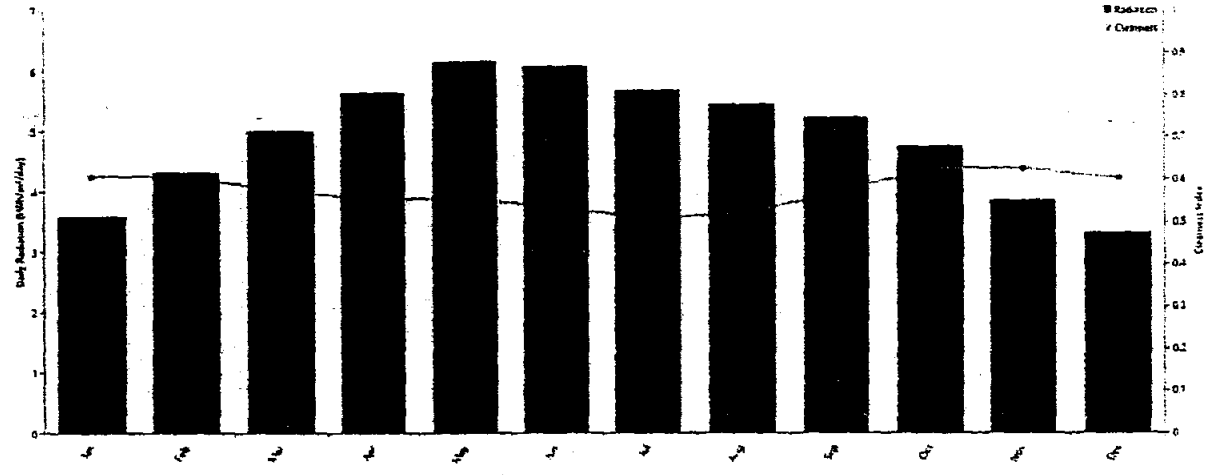


Figure 5. Solar Radiations Profile

4.2.5 System Design & Analysis:

In this PV off-grid electricity generation system, four main components include, the photovoltaic (PV) panels, Inverter, Cables and storage batteries. In order to present feasibility report of the PV system, system was designed consisting of 1000W PV modules and 50 Ah batteries.

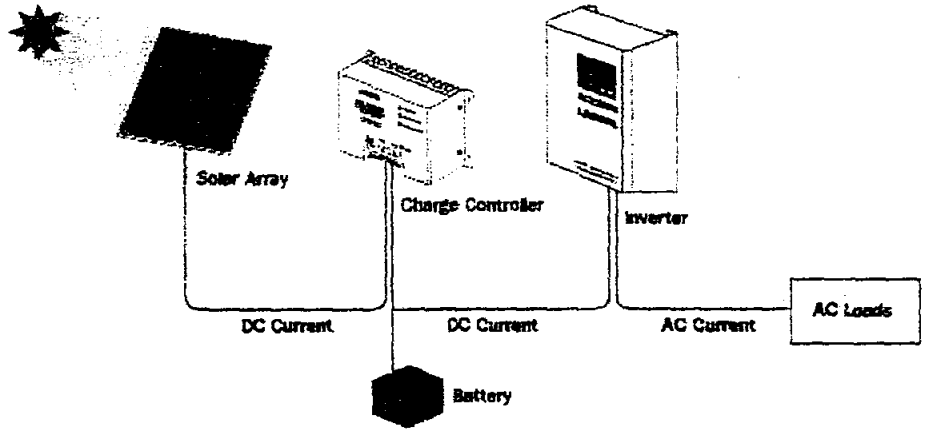


Figure 6 PV- off-grid electricity generation system

4.2.6 Solar Modules:

In this case, solar modules of 330 W capacities have been to meet the load requirement during the day times of maximum load purposes. The tilt angle is 28 Degrees. PV modules are polycrystalline silicon type with maximum rated power of 330 W, nominal voltage of 38.1 V and operating current of 8.7A. Complete details of solar modules used for the current system is listed in Table 5.

Sr. No	Parameters	Units	Values
1	De-rating factor	%	80
2	Lifetime Modules/Batteries	Years	25/05

3	Tilt Angle	Degree	28
4	Rated Power	W	330
5	Open Circuit voltage, Voc	V	45.3
6	Short circuit current Isc	A	8.76
7	Maximum power voltage, Vpm	V	38.1
8	Maximum power current, Ipm	A	8.7

Table 8. Solar Modules technical parameters.

4.3 DECREASE OF EFFICIENCY OF PV PANELS OVER TIME

Solar panel efficiency is affected negatively by temperature increase. Photovoltaic modules are tested at a temperature of 25 degrees C (STC) – about 77 degrees F., and depending on their installed location, heat can reduce output efficiency by 10-25%. As the temperature of the solar panel increases, its output current increases exponentially, while the voltage output is reduced linearly.

25% reduction of efficiency in 10 years will be observed in the Off Grid Solar PV plants.

5 FINANCIAL ANALYSIS

While taking into account the meteorological data and load characteristics of the Punjab village communities along with the diesel fuel's price and the cost of components, the optimal (most economical) sizing of the system is determined. In the optimization procedure, the NPC is considered as the key economic index. The obtained configurations are then compared considering the other state-of-the-art economic indices together with the environmental metrics and the generation fractions.

5.1 INITIAL CAPITAL COST & TOTAL ANNUAL OPERATING COST

The initial capital cost is the total cost of all of the components at the beginning of the operation. In a system composed of batteries, solar panels, Inverters and System hardware.

#	Description	PV System Size	Capital Cost	Annual O&M Cost	Total Cost
	Unit	kW	PKR	PKR	PKR
1	A1	130	16,542,000	1,600,000	18,142,000
2	A2	84.5	11,928,500	1,600,000	13,528,500
3	B1	280	33,087,000	2,000,000	35,087,000
4	B2	91	12,602,000	1,600,000	14,202,000
5	C1-1	260	31,032,424	700,000	31,732,424
	C1-2	260	31,032,424	700,000	31,732,424
	C1-3	260	31,032,424	700,000	31,732,424

6	C2-1	195	23,788,000	2,000,000	25,788,000
	C2-2	195	23,788,000	2,000,000	25,788,000
	C2-3	195	23,788,000	2,000,000	25,788,000
7	C3	71	12,602,000	1,600,000	14,202,000
	Total		**251,222,773**	**16,500,000**	**267,722,773**

Table 9. Total PV System Capital Cost in Each Villages

The operating costs are the expenses corresponding to the operation of all of the components of the system which also includes the salaries of operating personnel.

In addition to the typical focus of thinking about up -front costs of a solar plant, determining a plan and budget for operations and maintenance (O & M) is essential in assessing the business case for a PV facility.

The Operation and Maintenance Cost of each village for one (02) years has been bifurcated in to the following:

The O&M cost includes the following items:

- Salaries Cost of O&M Staff
- Repair & Maintenance
- Cleaning of PV Modules

It is calculated that tariff during O&M period for self-sustainable O&M is **PKR 2.85/kWh** which is way below the current electricity rate in Pakistan. Also, considering the socio-economic conditions of these villages, the financial impact does not cause burden to the government.

6 CONCLUSION AND RECOMMENDATIONS:

6.1 CONCLUSION

This study presents a techno-economic evaluation for Solar PV configurations for the rural remote areas of Punjab. Different system configurations of Solar PV unit were analyzed by calculating a dynamic model. These configurations were assessed through sensitivity analysis using parameters like solar radiations and system sizing and an optimal solution was proposed based on the cost analysis. The results obtained from cost analysis revealed that the combination of Minimum 84.5 kW to a Maximum of 280 kW Solar System Sizes have been generated for this case study. The Minimum & Maximum Initial capital investment ranges from PKR 12M to 33M. The total cost of this project is PKR 276M.

These Solar PV Renewable systems are more effective and reliable source of energy; the government of Pakistan can play a significant role to overcome energy crises by facilitating rural areas with such systems. The Solar PV renewable source-based configuration proposed in this study can be employed in the remote rural area to make them independent of grids.

6.2 RECOMMENDATIONS AND FUTURE WORK

It is recommended that:

- Studies of this nature be transferred and implemented also in other parts of the province, to determine the feasibility for implementation of Solar PV projects using renewables elsewhere in Punjab; and

- This project should be implemented in a pilot phase, so that later on it can be replicated to other regions of the province that yet have not been covered by the national grid.
- Future socio-economic analysis must be made to evaluate the possibility so that the rural communities should pay the regular electricity tariff and the remaining production cost (LCOE) inferred by renewable energy generation should be subsidized by the Government.

SCHEDULE-I:

PROJECT COMMENCEMENT AND COMPLETION SCHEDULE

TPM Consulting

Ref: TPM/QASP/IR/P1/02
Dated: 30th December 2021

To,

ZONERGY (TIANJEN) COMPANY LTD. (LEAD FIRM)
SALEEM BROTHERS (JV)
Lahore

SUBJECT: **LETTER OF COMMENCEMENT FOR THE PROJECT TITLED, "DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-01 (RAJANPUR)"**

Dear Sir,

In pursuance of the Contract Agreement against the total contract price of **PKR 39,100,1000/=** (Pakistani Rupees Thirty-Nine Million One Hundred Thousand Only) signed on 9th December 2021 between **Quad-e-Azam Solar Power (Pvt) Ltd (QASPL)**, Energy Department, Government of the Punjab (The Employer) and **M/S Zonergy (Tianjin) Company Ltd. JV Saleem Brothers** (The Contractor) for the project titled, **"DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-01 (RAJANPUR)"**

We, (**M/s TPM Consulting JV Frontier Engineering Consultants** "Engineer of the Project") on behalf of the Employer issues the Letter of Commencement to perform the work with immediate effect in accordance with the Contract Agreement Terms and Conditions.

Regards,

TPM Consulting

Engr. Shahzad Gul
Project Manager
M/S TPM Consulting JV Frontier Engineering Consultants

30-12-2021

CC.
1. *CEO (QASPL)*
2. *All Managers (QASPL)*

Project Milestones Activities:

PROVISION OF ELECTRICITY TO COMMUNITIES USING INDEGINOUS RESOURCES PACKAGE - 01		
Sr. No.	**Milestones**	**Percentage**
1	Design Approval	10%
2	Site Preparation (clearance/leveling of site, Civil Work for PV Mounting Structure, Earthing)	10%
3	Delivery of Solar Modules at Site	40%
4	Delivery and Installation of PV Mounting Structure	10%
5	Delivery of Inverter, AC Cable, DC Cable and Earthing	10%
6	Complete Installation and Commissioning	15%
7	Upon Rectification of Punch List	5%
	Total	**100%**

Project Timeline with Activities:

"Provision of Electricity to Communities using Indigenous Resources Package-01" (Rajanpur)			
Commencement Date	31st Dec 2021	Project Completion Date	28th June 2022
SR.	[redacted]	ACTIVITY START	ACTIVITY END
1	VERIFICATION OF DRAWINGS	2nd Week of January	2nd Week of January
2	DRAWING APPROVAL AND AMENDMENTS	2nd Week of January	2nd Week of January
3	PROCUREMENT (LOCAL AND IMPORTED)	2nd Week of January	3rd Week of March
5	TEAM MOBILIZATION PLUS MARTERIAL DELIVERY	2nd Week of February	3rd Week of February
6	SITE MARKING FOR MECHANICAL WORK	4th Week of February	1st Week of March
7	CIVIL WORK (Civil Pad)	1st Week of March	3rd Week of March
8	CIVIL WORK (Control Room)	1st Week of March	3rd Week of March
9	CIVIL WORK(Fencing)	1st Week of March	3rd Week of March
10	MECHANICAL WORK (STRUCTURE INSTALLATION)	4th Week of March	3rd Week of April
11	MECHANICAL WORK(PANELS ERECTION)	3rd Week of April	4th Week of April
12	ELECTRICAL WORK	4th Week of April	3rd Week of May
13	ERECTION OF LETTICE POLES	3rd Week of April	3rd Week of May
14	POWER DISTRIBUTION NETWORK INSTALLATION	1st Week of May	4th Week of May
15	INSTALLATION OF CCTV CAMERAS	4th Week of April	2nd Week of May
16	INVERTER PLACEMENT AND TERMINATION	1st Week of June	2nd Week of June
17	COMMISSIONING AND TESTING	3rd Week of June	3rd Week of June
18	TESTING AND HANDOVER TO CLIENT	4th Week of June	4th Week of June

SCHEDULE-II:

DETAILS OF GENERATION FACILITY/SOLAR POWER PLANT

Details of

Generation Facility/Solar Power Plant

(A). General Information

(i).	Name of the Company/Licensee	Quaid e Azam Solar Power (Pvt) Ltd.-QASPL
(ii).	Registered/ Business office of the Company/Licensee	83 A,E/1, 83-D/1, Main Boulevard, Gulberg, Lahore, Pakistan. Main Blvd Gulberg, Block D 1 Gulberg III, Lahore, Punjab
(iii).	Type of the generation facility/Solar Power Plant/Roof Top Solar	Photovoltaic (PV) Cell
(iv).	Location(s) of the generation facility Solar Power Plant/ Roof Top Solar	Basti Chawli Mouza Machka PACKAGE-01(RAJANPUR)

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) Cell	
(ii).	System Type	On-Grid	
(iii).	Installed Capacity of the generation facility Solar Power Plant/ Roof Top Solar	100kW$_P$	
(iv).	No. of Panel/Modules	184 x 545 Watt	
(v).	PV Array	Nos. of Strings	4
		Modules in a string	19
		Nos. of Strings	6
		Modules in a string	18

(vi).	Invertor(s)	Quantity	1
		Make	MEGAREVO
		Capacity of each unit	150 kW

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	Tiger Pro 72 HC 545 Watt
(ii).	Type of Cell	Mono crystalline
(iii).	Dimension of each Module	2274x1134x35mm(89.53x44.65x1.38 inch)
(iv).	Total Module Area	3.5750 m^2
(v).	Frame of Panel	Anodized aluminium alloy
(vi).	Weight of one Module	28.9 kg
(vii).	No of Solar Cells in each module	144 (6×24)
(viii).	Efficiency of module	21.13%
(ix).	Maximum Power (P_{max})	545 W_P
(x).	Voltage @ P_{max}	40.80 V
(xi).	Current @ P_{max}	13.36 A
(xii).	Open circuit voltage (V_{oc})	49.52V
(xiii).	Short circuit current (I_{sc})	13.94A

(xiv).	Maximum system open Circuit Voltage	1500VDC (IEC)	
(b).	**Inverters**		
(i).	Type of Module	150 kW	
(ii).	Type of Cell	MPS0150	
(iii).	Input Operating Voltage Range	320v-480v	
(iv).	Efficiency of inverter	98.7 %	
(v).	Rated voltage	400V	
(vi).	Rated Current	217 A	
(vii).	Max. Power Point Tracking Range	200 V to 850 V	
(viii).	Output electrical system	3 Phase AC	
(ix).	Rated Output Voltage	320 to 460	
(x).	Power Factor (adjustable)	0.8 Lagging-0.8 Leading	
(xi).	Power control	MPP tracker	
(xii).	Rated Frequency	50 Hz	
(xiii).	Environmental Enclosures	Relative Humidity	0-100%
		Audible Noise	50 DB @ 1m
		Operating Elevation	5000m (derate over 3000m)
		Operating temperature	-25 to +60°C

(xiv).	Grid Operating protection	A	DC circuit breaker
		B	AC circuit breaker
		C	DC overload protection (Type 2)
		D	Overheat protection
		E	Grid Protection
		F	Ground fault Protection
		G	
(c).	**Data Collecting System**		
(i).	System Data	Continuous online logging with data logging software to portal.	
(d).	**Unit Transformer**		
(i).	Not Applicable		

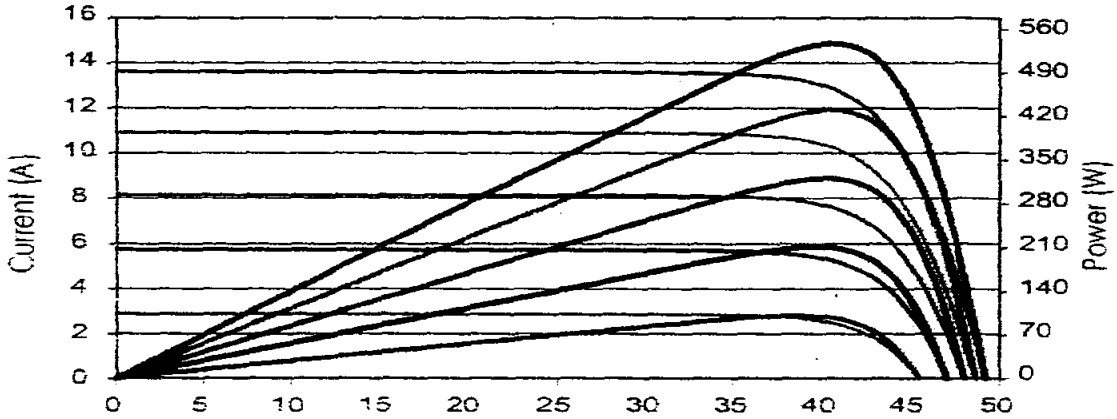
(D). Other Details

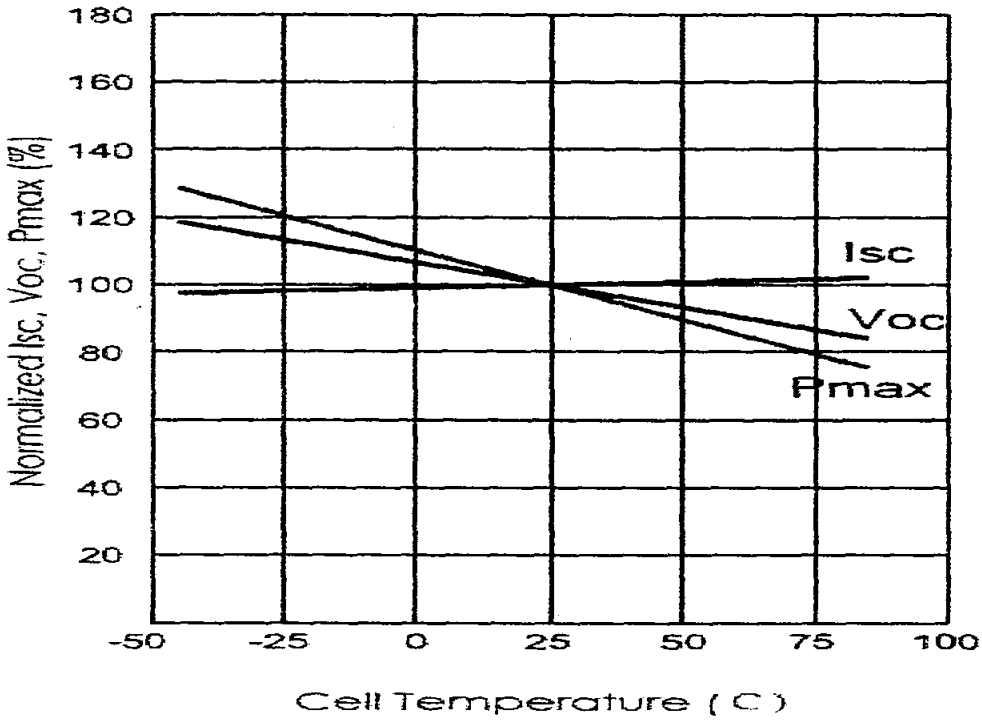
(i).	Expected COD of the generation facility Solar Power Plant/ Roof Top Solar	June 28, 2022 (Expected)
(ii).	Expected useful Life of the generation facility Solar Power Plant/ Roof Top Solar from the COD	25 years

V-I Curve

Generation Facility/Solar Power Plant/Roof Top Solar

of the Licensee





Information Regarding Consumer i.e. QASPL to be Supplied by the Licensee i.e. Off-Grid Village

(i).	No. of Consumers		40-50 Households
(ii).	Location of consumers (distance and/or identity of premises)		Basti Chawli Mouza Machka (RAJANPUR), Punjab
(iii).	Contracted Capacity and Load Factor for consumer		100kW$_P$/ 19.28%
(iv).	Specify Whether		
	(a).	The consumer is an Associate undertaking of the Licensee -If yes, specify percentage ownership of equity;	QASPL
	(b).	There are common directorships:	-
	(c).	Either can exercise influence or control over the other.	-
(v).	Specify nature of contractual Relationship		
	(a).	Between each consumer and the Licensee	Zonergy will construct and operate solar plant and provide electricity to Off-Grid Villages for its operations.
	(b).	Consumer and DISCO.	Off-Grid Villages
(vi)	Any other network information deemed relevant for disclosure to or consideration of the Authority.		NA

Information Regarding Distribution Network for Supply of Electric Power Consumer in the name of QASPL

(i).	No. of Feeders		01
(ii).	Length of Each Feeder (Meter)		300ft
(iii).	Length of Each Feeder to each Consumer		Will be Defined As per Consumers Need
(iv).	In respect of all the Feeders, describe the property (streets, farms, Agri land, etc.) through, under or over which they pass right up to the premises of customer, whether they cross-over.		N/A
(v).	Whether owned by QASPL, Consumer or DISCO-(deal with each Feeder Separately)		QASPL
	(a).	If owned by DISCO, particulars of contractual arrangement	N/A.
	(b).	Operation and maintenance responsibility for each feeder	Zonergy
(vi).	Whether connection with network of DISCO exists (whether active or not)- If yes, provide details of connection arrangements (both technical and contractual)		N/A.
(vii).	Any other network information deemed relevant for disclosure to or consideration of the Authority.		N/A.

Expected Annual Generation of Plant:

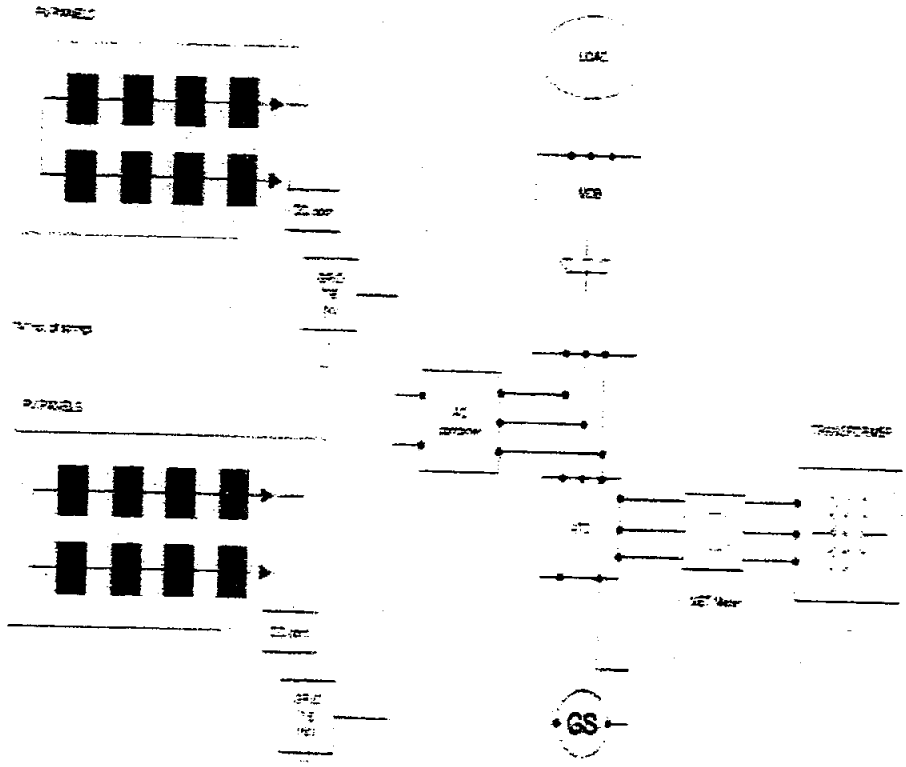
Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	113.1	133.8	133.2	12,535.8	11,327.6
February	121.6	137.0	136.3	12,870.9	11,415.3
March	166.0	178.8	177.8	16,830.2	14,509.4
April	182.1	187.9	186.8	17,692.1	14,969.2
May	203.2	203.6	202.4	19,148.1	16,032.0
June	194.8	192.8	191.5	18,111.6	15,269.7
July	187.7	186.9	185.7	17,540.7	14,934.7
August	178.6	181.6	180.4	17,056.8	14,581.8
September	170.7	180.6	179.6	17,008.4	14,445.2
October	145.8	161.2	160.3	15,157.8	12,945.1
November	122.1	143.7	143.0	13,476.4	11,814.3
December	102.0	121.6	120.8	11,345.5	10,189.5
Total Generation					1631.7

Expected Annual Accumulative Irradiance of Plant:

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,887.6	
	POA Irradiance	2,009.5	6.5%
	Shaded Irradiance	1,997.6	-0.6%
	Irradiance after Reflection	1,934.6	-3.2%
	Irradiance after Soiling	1,895.9	-2.0%
	Total Collector Irradiance	**1,895.9**	**0.0%**
	Output at Irradiance Levels	188,245.3	-0.3%
	Output at Cell Temperature Derate	172,798.8	-8.2%
	Output After Mismatch	167,551.1	-3.0%
	Optimal DC Output	166,868.4	-0.4%
	Constrained DC Output	166,868.1	0.0%
	Inverter Output	163,250.1	-2.2%
	Energy to Grid(kWh)	**162,433.9**	**-0.5%**

SCHEDULE-III:
INTERCONNECTION STUDY

SINGLE LINE DRAWING



TPMConsulting

SCHEDULE-IV:

INFORMATION RELATING TO LOCATION (LOCATION MAPS, SITE MAP, LAND ETC.)

Information Relating To Location (Location Maps, Site Map, Land Etc.)

Serial Number	Location	Site Coordinates	
1.	Basti Chawli Mouza Machka PACKAGE-01(RAJANPUR)	Latitude	28.863707
		Longitude	70.335823

SITE NO. B

[TECHNICAL SCHEDULES I, II, III, IV & V]

SCHEDULE-I:

PROJECT COMMENCEMENT AND COMPLETION SCHEDULE

OFFICE COPY

TPM Consulting

Ref: TPM/QASP/IR/P2/02
Dated: 10th November 2021

To.

ZONERGY (TIANJIN) COMPANY LTD. (LEAD FIRM)
SALEEM BROTHERS (JV)
Lahore

SUBJECT: **LETTER OF COMMENCEMENT FOR THE PROJECT TITLED, "DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-02 (RAHIM YAR KHAN)"**

Dear Sir

In pursuance of the Contract Agreement against the total contract price of **PKR 36,334,754.00** (Pakistani Rupees Thirty-Six Million Three Hundred Thirty-Four Thousand Seven Hundred Fifty-Four Only) signed on 28th October 2021 between **Quad-e-Azam Solar Power (Pvt) Ltd** (QASPL), Energy Department, Government of the Punjab (The Employer) and **M/S Zonergy (Tianjin) Company Ltd. JV Saleem Brothers** (The Contractor) for the project titled, **"DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-02 (RAHIM YAR KHAN)"**

We, (**M/s TPM Consulting JV Frontier Engineering Consultants** "Engineer of the Project") on behalf of the Employer issues the Letter of Commencement to perform the work with immediate effect in accordance with the Contract Agreement Terms and Conditions

Regards,

TPM Consulting

11/11/21

Engr. Shahzad Gul
Project Manager
M/S TPM Consulting JV Frontier Engineering Consultants

Received
Sahir
11/11/2021

CC:
1. *CEO (QASPL)*
2. *All Managers (QASPL)*

Project Milestones Activities:

PROVISION OF ELECTRICITY TO COMMUNITIES USING INDEGINOUS RESOURCES PACKAGE - 02		
Sr. No.	**Milestones**	**Percentage**
1	Survey and Design Approval	20%
2	Delivery of Solar Modules and Inverters at Central Warehouse	40%
3	Complete Installation at 50% Sites	20%
4	Complete Installation at 50% Sites	20%
	Total	**100%**

Project Timeline with Activities:

"Provision of Electricity to Communities using Indigenous Resources Package-02" (Rahim Yar Khan)			
Commencement Date	10th Nov 2021	Project Completion Date	30th June 2022
SR.	ACTIVITY	ACTIVITY START	ACTIVITY END
1	VERIFICATION OF DRAWINGS	3rd Week of December	4th Week of December
2	DRAWING APPROVAL AND AMENDMENTS	1st Week of January	1st Week of January
3	PROCUREMENT (LOCAL AND IMPORTED)	4th Week of November	1st Week of May
5	TEAM MOBILIZATION PLUS MARTERIAL DELIVERY	2nd Week of April	3rd Week of April
6	SITE MARKING FOR MECHANICAL WORK	3rd Week of April	3rd Week of April
7	CIVIL WORK (Civil Pad)	2nd Week of April	3rd Week of April
8	CIVIL WORK (Control Room)	2nd Week of April	3rd Week of April
9	CIVIL WORK(Fencing)	2nd Week of April	3rd Week of April
10	MECHANICAL WORK (STRUCTURE INSTALLATION)	2nd Week of April	1st Week of May
11	MECHANICAL WORK(PANELS ERECTION)	2nd Week of April	1st Week of May
12	ELECTRICAL WORK	1st Week of May	2nd Week of March
13	ERECTION OF LETTICE POLES	2nd Week of May	3rd Week of June
14	POWER DISTRIBUTION NETWORK INSTALLATION	2nd Week of May	3rd Week of June
15	INSTALLATION OF CCTV CAMERAS	2nd Week of May	3rd Week of May
16	INVERTER PLACEMENT AND TERMINATION	3rd Week of May	2nd Week of June
17	COMMISSIONING AND TESTING	3rd Week of June	3rd Week of April
18	TESTING AND HANDOVER TO CLIENT	4th Week of June	4th Week of June

SCHEDULE-II:

DETAILS OF GENERATION FACILITY/SOLAR POWER PLANT

Details of

Generation Facility/Solar Power Plant

(A). General Information

(i).	Name of the Company/Licensee	Quaid e Azam Solar Power (Pvt) Ltd.-QASPL
(ii).	Registered/ Business office of the Company/Licensee	83 A, E/1, 83-D/1, Main Boulevard, Gulberg, Lahore, Pakistan. Main Blvd Gulberg, Block D 1 Gulberg III, Lahore, Punjab
(iii).	Type of the generation facility/Solar Power Plant/Roof Top Solar	Photovoltaic (PV) Cell
(iv).	Location(s) of the generation facility Solar Power Plant/ Roof Top Solar	Basti Kaleem Ullah PACKAGE-02(RAHIM YAR KHAN)

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) Cell	
(ii).	System Type	On-Grid	
(iii).	Installed Capacity of the generation facility Solar Power Plant/ Roof Top Solar	100kW$_P$	
(iv).	No. of Panel/Modules	184 x 545 Watt	
(v).	PV Array	Nos. of Strings	4
		Modules in a string	19
		Nos. of Strings	6
		Modules in a string	18

(vi).	Invertor(s)	Quantity	1
		Make	MEGAREVO
		Capacity of each unit	150 kW

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	Tiger Pro 72 HC 545 Watt
(ii).	Type of Cell	Mono crystalline
(iii).	Dimension of each Module	2274x1134x35mm(89.53x44.65x1.38 inch)
(iv).	Total Module Area	3.5750 m^2
(v).	Frame of Panel	Anodized aluminium alloy
(vi).	Weight of one Module	28.9 kg
(vii).	No of Solar Cells in each module	144 (6×24)
(viii).	Efficiency of module	21.13%
(ix).	Maximum Power (P_{max})	545 W_P
(x).	Voltage @ P_{max}	40.80 V
(xi).	Current @ P_{max}	13.36 A
(xii).	Open circuit voltage (V_{oc})	49.52V
(xiii).	Short circuit current (I_{sc})	13.94A

(xiv).	Maximum system open Circuit Voltage	1500VDC (IEC)	
(b).	**Inverters**		
(i).	Type of Module	150 kW	
(ii).	Type of Cell	MPS0150	
(iii).	Input Operating Voltage Range	320v-480v	
(iv).	Efficiency of inverter	98.7 %	
(v).	Rated voltage	400V	
(vi).	Rated Current	217 A	
(vii).	Max. Power Point Tracking Range	200 V to 850 V	
(viii).	Output electrical system	3 Phase AC	
(ix).	Rated Output Voltage	320 to 460	
(x).	Power Factor (adjustable)	0.8 Lagging-0.8 Leading	
(xi).	Power control	MPP tracker	
(xii).	Rated Frequency	50 Hz	
(xiii).	Environmental Enclosures	Relative Humidity	0-100%
		Audible Noise	50 DB @ 1m
		Operating Elevation	5000m (derate over 3000m)
		Operating temperature	-25 to +60°C

(xiv).	Grid Operating protection	A	DC circuit breaker
		B	AC circuit breaker
		C	DC overload protection (Type 2)
		D	Overheat protection
		E	Grid Protection
		F	Ground fault Protection
		G	
(c).	**Data Collecting System**		
(i).	System Data	Continuous online logging with data logging software to portal.	
(d).	**Unit Transformer**		
(i).	Not Applicable		

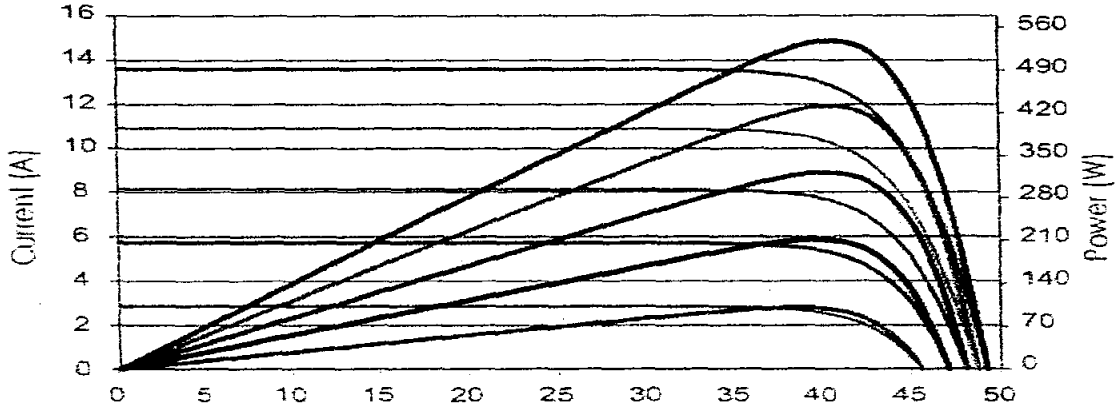
(D). Other Details

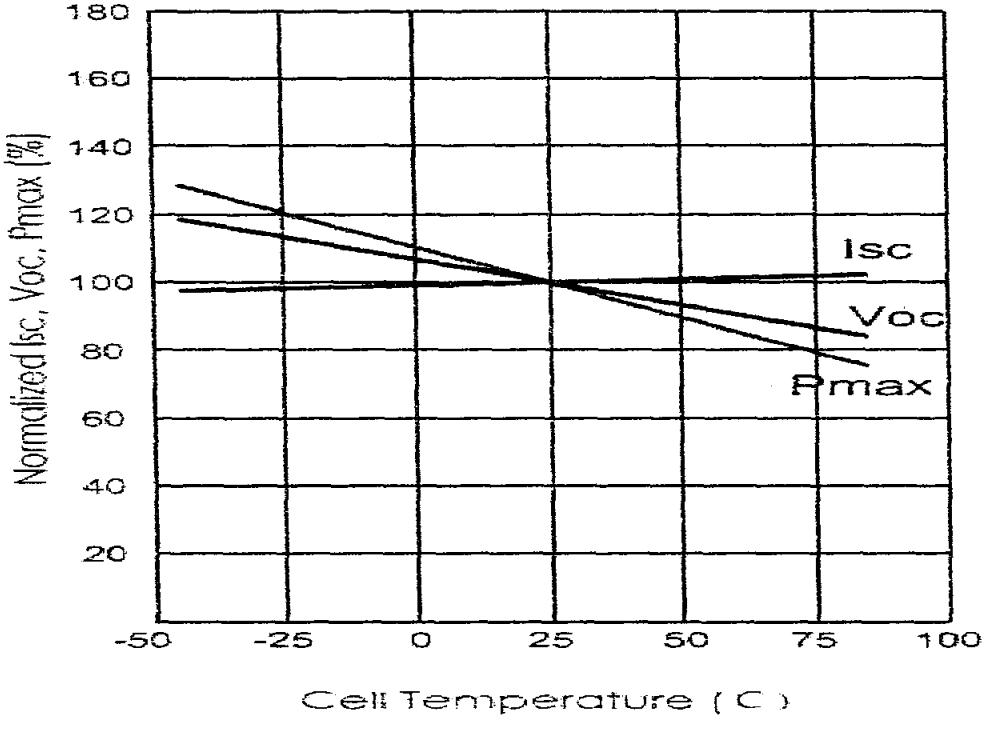
(i).	Expected COD of the generation facility Solar Power Plant/ Roof Top Solar	June 28, 2022 (Expected)
(ii).	Expected useful Life of the generation facility Solar Power Plant/ Roof Top Solar from the COD	25 years

V-I Curve

Generation Facility/Solar Power Plant/Roof Top Solar

Of the Licensee





Information

Regarding Consumer i.e. QASPL to be Supplied by the Licensee i.e. Off-Grid Village

(i).	No. of Consumers		70-80 Households
(ii).	Location of consumers (distance and/or identity of premises)		Basti Kaleem Ullah PACKAGE-02 (RAHIM YAR KHAN), Punjab
(iii).	Contracted Capacity and Load Factor for consumer		100kW$_P$ / 19.28%
(iv).	Specify Whether		
	(a).	The consumer is an Associate undertaking of the Licensee -If yes, specify percentage ownership of equity;	QASPL
	(b).	There are common directorships:	-
	(c).	Either can exercise influence or control over the other.	-
(v).	Specify nature of contractual Relationship		
	(a).	Between each consumer and the Licensee	Zonergy will construct and operate solar plant and provide electricity to Off-Grid Villages for its operations.
	(b).	Consumer and DISCO.	Off-Grid Villages
(vi)	Any other network information deemed relevant for disclosure to or consideration of the Authority.		NA

Information

Regarding Distribution Network for Supply of Electric Power Consumer in the name of QASPL

(i).	No. of Feeders		01
(ii).	Length of Each Feeder (Meter)		300ft
(iii).	Length of Each Feeder to each Consumer		Will be Defined As per Consumers Need
(iv).	In respect of all the Feeders, describe the property (streets, farms, Agri land, etc.) through, under or over which they pass right up to the premises of customer, whether they cross-over.		N/A
(v).	Whether owned by QASPL, Consumer or DISCO-(deal with each Feeder Separately)		QASPL
	(a).	If owned by DISCO, particulars of contractual arrangement	N/A.
	(b).	Operation and maintenance responsibility for each feeder	Zonergy
(vi).	Whether connection with network of DISCO exists (whether active or not)- If yes, provide details of connection arrangements (both technical and contractual)		N/A.
(vii).	Any other network information deemed relevant for disclosure to or consideration of the Authority.		N/A.

Expected Annual Generation of Plant:

Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	113.1	133.8	133.2	12,535.8	11,327.6
February	121.6	137.0	136.3	12,870.9	11,415.3
March	166.0	178.8	177.8	16,830.2	14,509.4
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June	194.8	192.8	191.5	18,111.6	15,269.7
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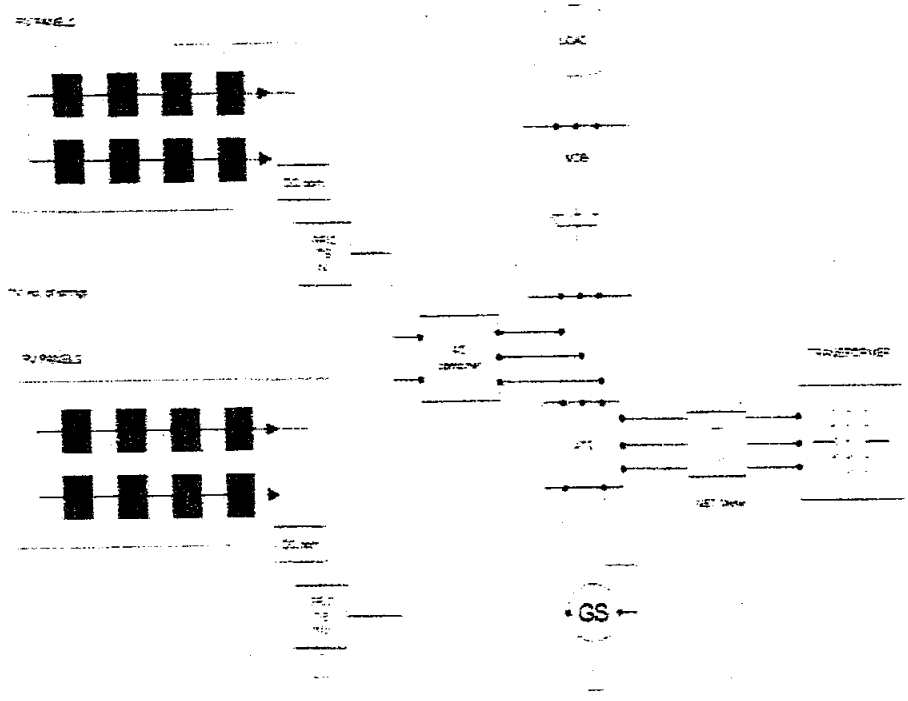
September	170.7	180.6	179.6	17,008.4	14,445.2
October	145.8	161.2	160.3	15,157.8	12,945.1
November	122.1	143.7	143.0	13,476.4	11,814.3
December	102.0	121.6	120.8	11,345.5	10,189.5
Total Generation					1631.7

Expected Annual Accumulative Irradiance of Plant:

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,887.6	
	POA Irradiance	2,009.5	6.5%
	Shaded Irradiance	1,997.6	-0.6%
	Irradiance after Reflection	1,934.6	-3.2%
	Irradiance after Soiling	1,895.9	-2.0%
	Total Collector Irradiance	**1,895.9**	**0.0%**
	Output at Irradiance Levels	188,245.3	-0.3%
	Output at Cell Temperature Derate	172,798.8	-8.2%
	Output After Mismatch	167,551.1	-3.0%
	Optimal DC Output	166,868.4	-0.4%
	Constrained DC Output	166,868.1	0.0%
	Inverter Output	163,250.1	-2.2%
	Energy to Grid(kWh)	**162,433.9**	**-0.5%**

SCHEDULE-III:
INTERCONNECTION STUDY

SINGLE LINE DRAWING



TPM Consulting

SCHEDULE-IV:

INFORMATION RELATING TO LOCATION (LOCATION MAPS, SITE MAP, LAND ETC.)

Information Relating To Location (Location Maps, Site Map, Land Etc.)

Serial Number	Location	Site Coordinates	
1.	Basti Kaleem Ullah PACKAGE-02(RAHIM YAR KHAN)	Latitude	28.423542
		Longitude	70.456133

SITE NO. C

[TECHNICAL SCHEDULES I, II, III, IV & V]

SCHEDULE-I:

PROJECT COMMENCEMENT AND COMPLETION SCHEDULE

OFFICE COPY

TPM Consulting

Ref: TPM/QASP/IR-P3/02
Dated: 10th November 2021

To,

ZONERGY (TIANJIN) COMPANY LTD. (LEAD FIRM)
SALEEM BROTHERS (JV)
Lahore

SUBJECT: **LETTER OF COMMENCEMENT FOR THE PROJECT TITLED, "DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-03 (MUZAFFARGARH)"**

Dear Sir

In pursuance of the Contract Agreement against the total contract price of **PKR 36,334,754.00** (Pakistani Rupees Thirty-Six Million Three Hundred Thirty-Four Thousand Seven Hundred Fifty-Four Only) signed on 28th October 2021 between **Quaid-e-Azam Solar Power (Pvt) Ltd** (QASPL), Energy Department, Government of the Punjab (The Employer) and **M/S Zonergy (Tianjin) Company Ltd. JV Saleem Brothers** (The Contractor) for the project titled, **"DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-03 (MUZAFFARGARH)"**

We, (**M/s TPM Consulting JV Frontier Engineering Consultants** "Engineer of the Project") on behalf of the Employer issues the Letter of Commencement to perform the work with immediate effect in accordance with the Contract Agreement Terms and Conditions

Regards.

TPM Consulting

4/11/2021

Engr. Shahzad Gul
Project Manager
M/S TPM Consulting JV Frontier Engineering Consultants

CC
1. *CEO (QASPL)*
2. *All Managers (QASPL)*

10/11/2021

Project Milestones Activities:

PROVISION OF ELECTRICITY TO COMMUNITIES USING INDEGINOUS RESOURCES PACKAGE - 03		
Sr. No.	**Milestones**	**Percentage**
1	Survey and Design Approval	20%
2	Delivery of Solar Modules and Inverters at Central Warehouse	40%
3	Complete Installation at 50% Sites	20%
4	Complete Installation at 50% Sites	20%
	Total	**100%**

Project Timeline with Activities:

Comparison between Timeline Provided By The Contractor Of "Provision of Electricity to Communities using Indigenous Resources Package-XII (MUZAFFARGARH)			
Commencement Date	10th Nov 2021	Project Completion Date	30th June 2022
SR.	[redacted]	ACTIVITY START	ACTIVITY END
1	VERIFICATION OF DRAWINGS	3rd Week of December	4th Week of December
2	DRAWING APPROVAL AND AMENDMENTS	1st Week of January	1st Week of January
3	PROCUREMENT (LOCAL AND IMPORTED)	4th Week of November	1st Week of May
5	TEAM MOBILIZATION PLUS MARTERIAL DELIVERY	2nd Week of April	3rd Week of April
6	SITE MARKING FOR MECHANICAL WORK	3rd Week of April	3rd Week of April
7	CIVIL WORK (Civil Pad)	2nd Week of April	3rd Week of April
8	CIVIL WORK (Control Room)	3rd Week of April	3rd Week of April
9	CIVIL WORK(Fencing)	2nd Week of April	3rd Week of April
10	MECHANICAL WORK (STRUCTURE INSTALLATION)	3rd Week of April	1st Week of May
11	MECHANICAL WORK(PANELS ERECTION)	3rd Week of April	1st Week of May
12	ELECTRICAL WORK	3rd Week of May	3rd Week of May
13	ERECTION OF LETTICE POLES	3rd Week of May	3rd Week of June
14	POWER DISTRIBUTION NETWORK INSTALLATION	3rd Week of May	4th Week of June
15	INSTALLATION OF CCTV CAMERAS	2nd Week of May	3rd Week of May
16	INVERTER PLACEMENT AND TERMINATION	4th Week of May	3rd Week of June
17	COMMISSIONING AND TESTING	3rd Week of June	3rd Week of June
18	TESTING AND HANDOVER TO CLIENT	4th Week of June	4th Week of June

SCHEDULE-II:

DETAILS OF GENERATION FACILITY/SOLAR POWER PLANT

Details of

Generation Facility/Solar Power Plant

(A). General Information

(i).	Name of the Company/Licensee	Quaid e Azam Solar Power (Pvt) Ltd.-QASPL
(ii).	Registered/ Business office of the Company/Licensee	83 A,E/1, 83-D/1, Main Boulevard, Gulberg, Lahore, Pakistan. Main Blvd Gulberg, Block D 1 Gulberg III, Lahore, Punjab
(iii).	Type of the generation facility/Solar Power Plant/Roof Top Solar	Photovoltaic (PV) Cell
(iv).	Location(s) of the generation facility Solar Power Plant/ Roof Top Solar	Basti Buzdar Wali PACKAGE-03(Muzaffargarh)

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) Cell	
(ii).	System Type	On-Grid	
(iii).	Installed Capacity of the generation facility Solar Power Plant/ Roof Top Solar	100kW$_P$	
(iv).	No. of Panel/Modules	184 x 545 Watt	
(v).	PV Array	Nos. of Strings	2
		Modules in a string	20
		Nos. of Strings	8
		Modules in a string	18

(vi).	Invertor(s)	Quantity	1
		Make	MEGAREVO
		Capacity of each unit	150 kW

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	Tiger Pro 72 HC 545 Watt
(ii).	Type of Cell	Mono crystalline
(iii).	Dimension of each Module	2274x1134x35mm(89.53x44.65x1.38 inch)
(iv).	Total Module Area	3.5750 m^2
(v).	Frame of Panel	Anodized aluminium alloy
(vi).	Weight of one Module	28.9 kg
(vii).	No of Solar Cells in each module	144 (6×24)
(viii).	Efficiency of module	21.13%
(ix).	Maximum Power (P_{max})	545 W_P
(x).	Voltage @ P_{max}	40.80 V
(xi).	Current @ P_{max}	13.36 A
(xii).	Open circuit voltage (V_{oc})	49.52V
(xiii).	Short circuit current (I_{sc})	13.94A

(xiv).	Maximum system open Circuit Voltage	1500VDC (IEC)	
(b).	**Inverters**		
(i).	Type of Module	150 kW	
(ii).	Type of Cell	MPS0150	
(iii).	Input Operating Voltage Range	320v-480v	
(iv).	Efficiency of inverter	98.7 %	
(v).	Rated voltage	400V	
(vi).	Rated Current	217 A	
(vii).	Max. Power Point Tracking Range	200 V to 850 V	
(viii).	Output electrical system	3 Phase AC	
(ix).	Rated Output Voltage	320 to 460	
(x).	Power Factor (adjustable)	0.8 Lagging-0.8 Leading	
(xi).	Power control	MPP tracker	
(xii).	Rated Frequency	50 Hz	
(xiii).	Environmental Enclosures	Relative Humidity	0-100%
		Audible Noise	50 DB @ 1m
		Operating Elevation	5000m (derate over 3000m)
		Operating temperature	-25 to +60°C

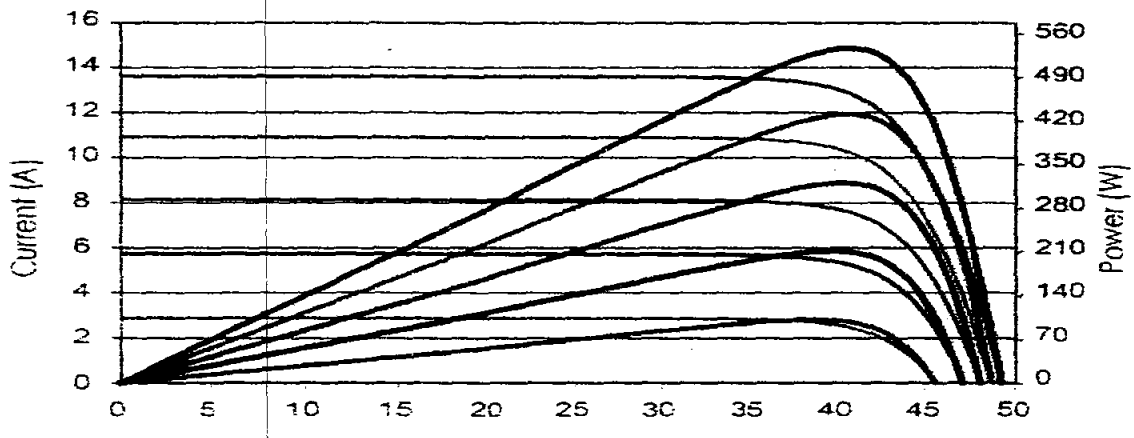
(xiv).	Grid Operating protection	A	DC circuit breaker
		B	AC circuit breaker
		C	DC overload protection (Type 2)
		D	Overheat protection
		E	Grid Protection
		F	Ground fault Protection
		G	
(c).	**Data Collecting System**		
(i).	System Data	Continuous online logging with data logging software to portal.	
(d).	**Unit Transformer**		
(i).	Not Applicable		

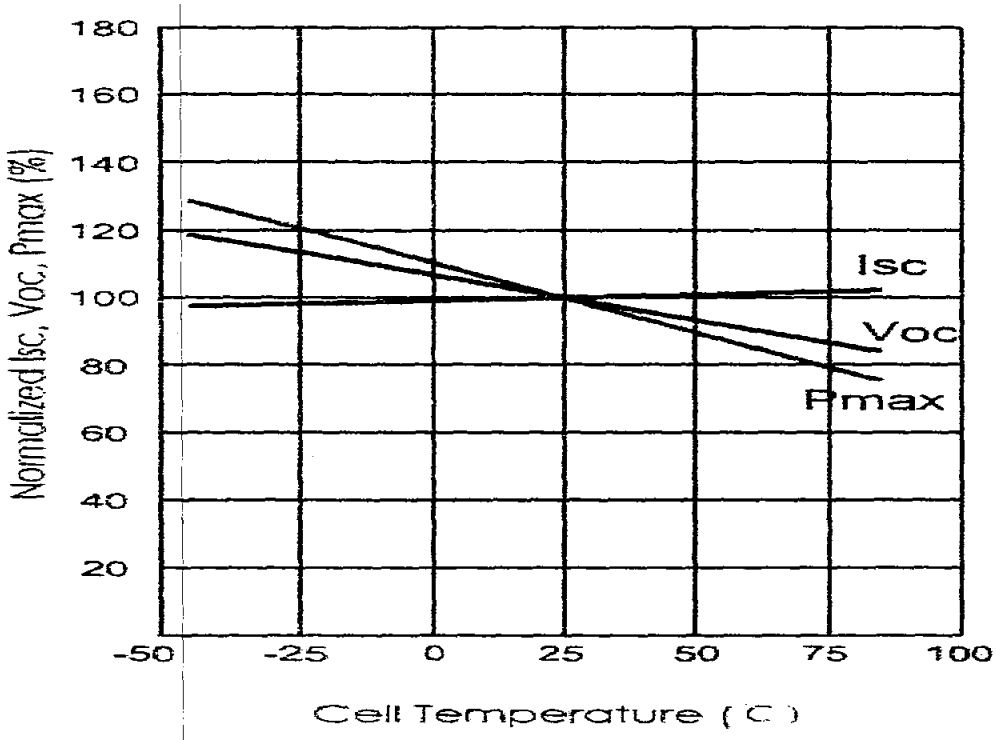
(D). Other Details

(i).	Expected COD of the generation facility Solar Power Plant/ Roof Top Solar	June 28, 2022 (Expected)
(ii).	Expected useful Life of the generation facility Solar Power Plant/ Roof Top Solar from the COD	25 years

V-I Curve

Generation Facility/Solar Power Plant/Roof Top Solar of the Licensee





Information

Regarding Consumer i.e. QASPL to be Supplied by the Licensee i.e. Off-Grid Village

(i).	No. of Consumers		40-45 Households
(ii).	Location of consumers (distance and/or identity of premises)		Basti Buzdar Wali (Muzaffargarh), Punjab
(iii).	Contracted Capacity and Load Factor for consumer		100kW$_P$/ 19.28%
(iv).	Specify Whether		
	(a).	The consumer is an Associate undertaking of the Licensee -If yes, specify percentage ownership of equity;	QASPL
	(b).	There are common directorships:	-
	(c).	Either can exercise influence or control over the other.	-
(v).	Specify nature of contractual Relationship		
	(a).	Between each consumer and the Licensee	Zonergy will construct and operate solar plant and provide electricity to Off-Grid Villages for its operations.
	(b).	Consumer and DISCO.	Off-Grid Villages

(vi)	Any other network information deemed relevant for disclosure to or consideration of the Authority.	NA

Information Regarding Distribution Network for Supply of Electric Power Consumer in the name of QASPL

(i).	No. of Feeders		01
(ii).	Length of Each Feeder (Meter)		300ft
(iii).	Length of Each Feeder to each Consumer		Will be Defined As per Consumers Need
(iv).	In respect of all the Feeders, describe the property (streets, farms, Agri land, etc.) through, under or over which they pass right up to the premises of customer, whether they cross-over.		N/A
(v).	Whether owned by QASPL, Consumer or DISCO-(deal with each Feeder Separately)		QASPL
	(a).	If owned by DISCO, particulars of contractual arrangement	N/A.
	(b).	Operation and maintenance responsibility for each feeder	Zonergy
(vi).	Whether connection with network of DISCO exists (whether active or not)- If yes, provide details of connection arrangements (both technical and contractual)		N/A.
(vii).	Any other network information deemed relevant for disclosure to or consideration of the Authority.		N/A.

Expected Annual Generation of Plant:

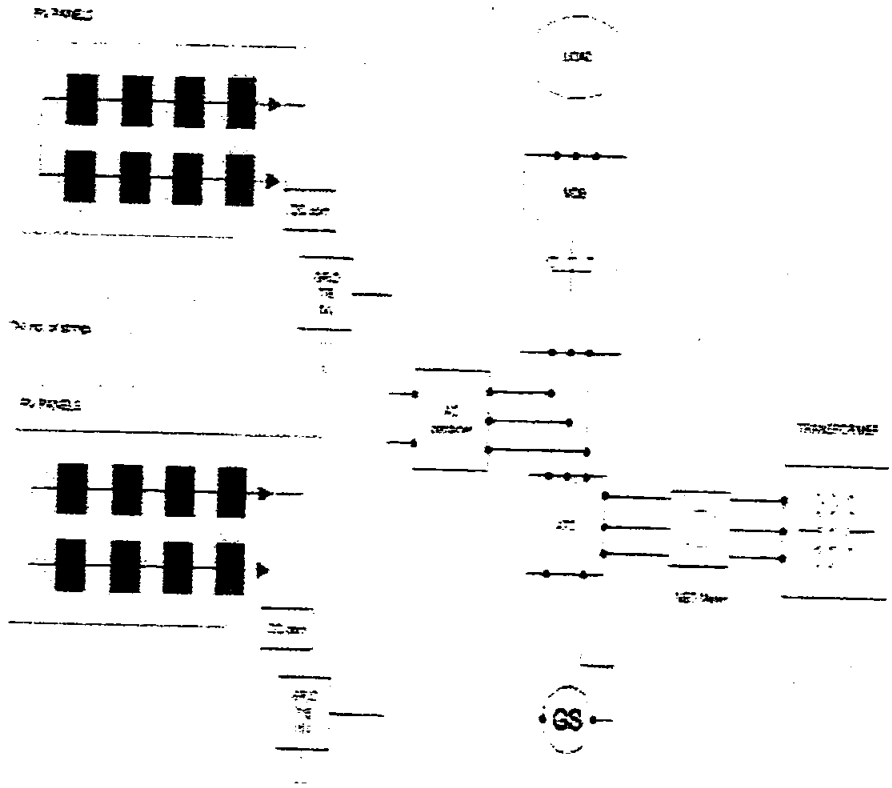
Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	113.1	133.8	133.2	12,535.8	11,327.6
February	121.6	137.0	136.3	12,870.9	11,415.3
March	166.0	178.8	177.8	16,830.2	14,509.4
April	182.1	187.9	186.8	17,692.1	14,969.2
May	203.2	203.6	202.4	19,148.1	16,032.0
June	194.8	192.8	191.5	18,111.6	15,269.7
July	187.7	186.9	185.7	17,540.7	14,934.7
August	178.6	181.6	180.4	17,056.8	14,581.8
September	170.7	180.6	179.6	17,008.4	14,445.2
October	145.8	161.2	160.3	15,157.8	12,945.1
November	122.1	143.7	143.0	13,476.4	11,814.3
December	102.0	121.6	120.8	11,345.5	10,189.5
Total Generation					1631.7

Expected Annual Accumulative Irradiance of Plant:

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,887.6	
	POA Irradiance	2,009.5	6.5%
	Shaded Irradiance	1,997.6	-0.6%
	Irradiance after Reflection	1,934.6	-3.2%
	Irradiance after Soiling	1,895.9	-2.0%
	Total Collector Irradiance	**1,895.9**	**0.0%**
	Output at Irradiance Levels	188,245.3	-0.3%
	Output at Cell Temperature Derate	172,798.8	-8.2%
	Output After Mismatch	167,551.1	-3.0%
	Optimal DC Output	166,868.4	-0.4%
	Constrained DC Output	166,868.1	0.0%
	Inverter Output	163,250.1	-2.2%
	Energy to Grid(kWh)	**162,433.9**	**-0.5%**

SCHEDULE-III:
INTERCONNECTION STUDY

SINGLE LINE DRAWING



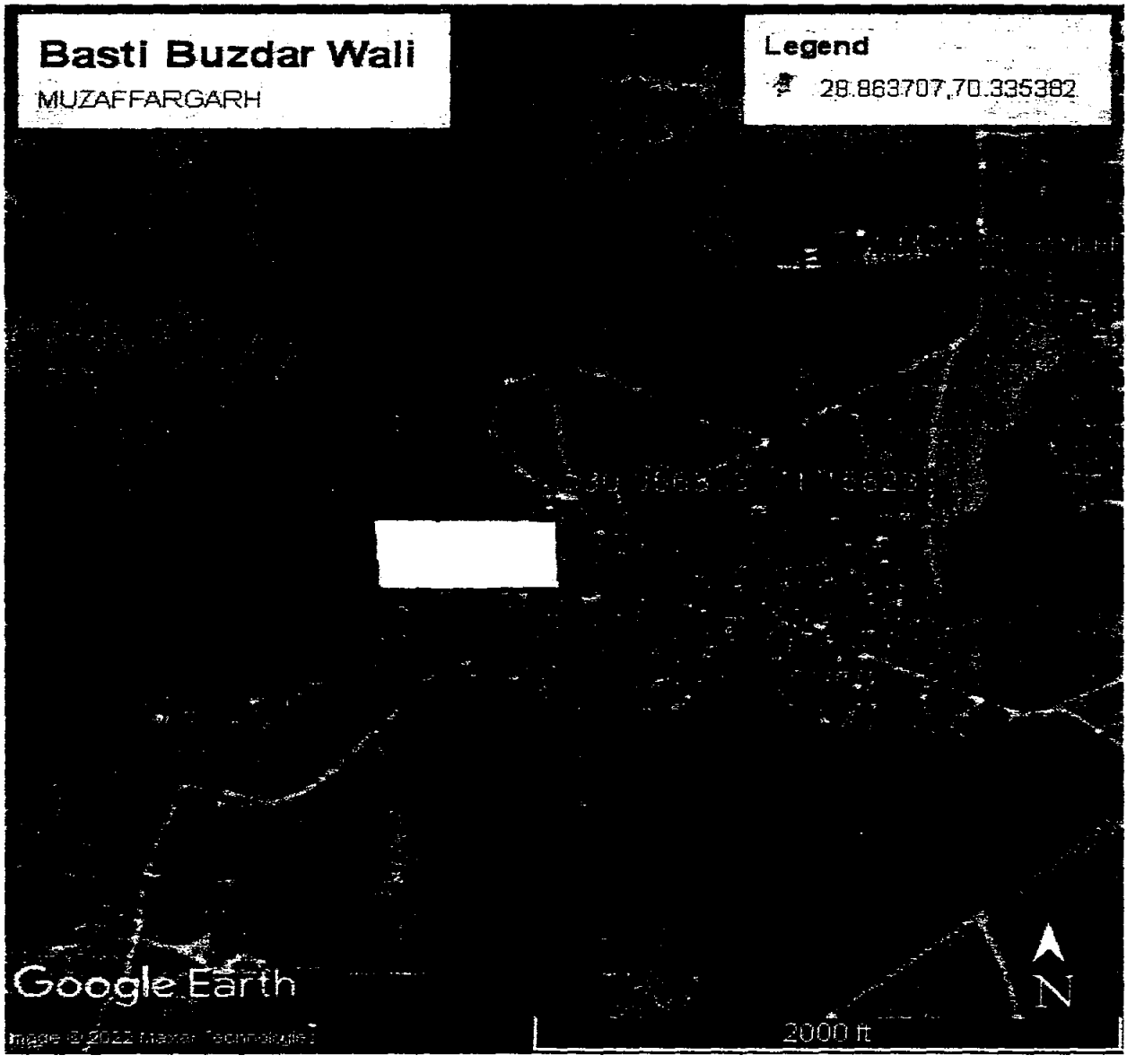
TPM Consulting

SCHEDULE-IV:

INFORMATION RELATING TO LOCATION (LOCATION MAPS, SITE MAP, LAND ETC.)

Information Relating To Location (Location Maps, Site Map, Land Etc.)

Serial Number	Location	Site Coordinates	
1.	Basti Buzdar Wali PACKAGE-03(Muzaffargarh)	Latitude	28.863707
		Longitude	70.335382



SITE NO. D

[TECHNICAL SCHEDULES I, II, III, IV & V]

SCHEDULE-I:

PROJECT COMMENCEMENT AND COMPLETION SCHEDULE

TPM Consulting

Ref: TPM/QASP/IND/P4/02
Dated: 14th December 2021

To,

M/S SKY BLUE BUILDERS (LEAD FIRM)
SKY BLUE RENEWABLE ENERGIES(PVT) LTD - GCL (JV)
Lahore.

SUBJECT: **LETTER OF COMMENCEMENT FOR THE PROJECT TITLED, DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-04 (MUZAFFARGARH)**

Dear Sir,

In pursuance of the Contract Agreement against the total contract price of **PKR 38,973,630.00** (Pakistani Rupees Thirty-Eight Million Nine Hundred Seventy-Three Thousand Six Hundred Thirty Only) signed on 30th November 2021 between **Quad-e-Azam Solar Power (Pvt) Ltd (QASPL)**, Energy Department, Government of Punjab (The Employer), and **M/S Sky Blue Builders - Sky Blue Renewable Energies (Pvt) Ltd - GCL (JV)** (The Contractor) for the project titled, **"SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR "PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES" PACKAGE-04 (MUZAFFARGARH)"**

We, (**M/s TPM Consulting JV Frontier Engineering Consultants** "Engineer of the Project") on behalf of the Employer issue the Letter of Commencement to perform the work with immediate effect in accordance with the Contract Agreement Terms and Conditions.

Regards.

TPM Consulting

Engr. Shahzad Gul
Project Manager
M/S TPM Consulting JV Frontier Engineering Consultants

CC:
1. *CEO (QASPL)*
2. *All Managers (QASPL)*

Received
14.12.2021

15/12

Project Milestones Activities:

PROVISION OF ELECTRICITY TO COMMUNITIES USING INDEGINOUS RESOURCES PACKAGE - 04		
Sr. No.	**Milestones**	**Percentage**
1	Design Approval	10%
2	Site Preparation (Clearance/Leveling of site, Civil Work for PV Mounting Structure, Earthing)	10%
3	Delivery of Solar Modules at Central Warehouse	30%
4	Delivery of Inverters at Central Warehouse	10%
5	Delivery of PV Mounting Structure	5%
6	Complete Installation of PV Mounting Structure	5%
7	Completion of Fencing and Control Room Building	10%
8	Complete Installation and Commissioning	15%
9	Upon Rectification of Punch List	5%
Total		**100%**

Project Timeline with Activities:

"Provision of Electricity to Communities using indigenous Resources Package-04" (MUZAFFARGARH)			
Commencement Date	14th Dec 2021	Project Completion Date	12th June 2022
SR.	ACTIVITY	ACTIVITY START	ACTIVITY END
1	VERIFICATION OF DRAWINGS	2nd Week of December	2nd Week of December
2	DRAWING APPROVAL AND AMENDMENTS	2nd Week of December	2nd Week of December
3	PROCUREMENT (LOCAL AND IMPORTED)	2nd Week of December	3rd Week of February
5	TEAM MOBILIZATION PLUS MARTERIAL DELIVERY	2nd Week of January	3rd Week of January
6	SITE MARKING FOR MECHANICAL WORK	4th Week of January	1st Week of February
7	CIVIL WORK (Civil Pad)	1st Week of February	3rd Week of February
8	CIVIL WORK (Control Room)	1st Week of February	3rd Week of February
9	CIVIL WORK(Fencing)	1st Week of February	3rd Week of February
10	MECHANICAL WORK (STRUCTURE INSTALLATION)	4th Week of February	3rd Week of March
11	MECHANICAL WORK(PANELS ERECTION)	3rd Week of February	4th Week of March
12	ELECTRICAL WORK	4th Week of March	3rd Week of April
13	ERECTION OF LETTICE POLES	3rd Week of March	3rd Week of April
14	POWER DISTRIBUTION NETWORK INSTALLATION	1st Week of April	4th Week of April
15	INSTALLATION OF CCTV CAMERAS	4th Week of March	3rd Week of April
16	INVERTER PLACEMENT AND TERMINATION	1st Week of May	2nd Week of May
17	COMMISSIONING AND TESTING	3rd Week of May	3rd Week of May
18	TESTING AND HANDOVER TO CLIENT	4th Week of May	4th Week of May

SCHEDULE-II:

DETAILS OF GENERATION FACILITY/SOLAR POWER PLANT

Details of Generation Facility/Solar Power Plant

(A). General Information

(i).	Name of the Company/Licensee	Quaid e Azam Solar Power (Pvt) Ltd.-QASPL
(ii).	Registered/ Business office of the Company/Licensee	83 A, E/1, 83-D/1, Main Boulevard, Gulberg, Lahore, Pakistan. Main Blvd Gulberg, Block D 1 Gulberg III, Lahore, Punjab
(iii).	Type of the generation facility/Solar Power Plant/Roof Top Solar	Photovoltaic (PV) Cell
(iv).	Location(s) of the generation facility Solar Power Plant/ Roof Top Solar	Chak No. 291 ML PACKAGE-04 (Muzzafargarh)

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) Cell	
(ii).	System Type	On-Grid	
(iii).	Installed Capacity of the generation facility Solar Power Plant/ Roof Top Solar	100kW$_P$	
(iv).	No. of Panel/Modules	222 x 450 Watt	
(v).	PV Array	Nos. of Strings	18
		Modules in a string	12
(vi).	Invertor(s)	Quantity	4
		Make	InfiniSolar TX-PA
		Capacity of each unit	30 kW

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	Canadian Solar 450 Watt
(ii).	Type of Cell	Mono crystalline
(iii).	Dimension of each Module	2108x1048x35mm(83.0x41.3x1.38 inch)
(iv).	Total Module Area	3.5750 m^2
(v).	Frame of Panel	Anodized aluminium alloy
(vi).	Weight of one Module	24.3 kg
(vii).	No of Solar Cells in each module	144 (2*(12*6))
(viii).	Efficiency of module	20.4%
(ix).	Maximum Power (P_{max})	450 W_P
(x).	Voltage @ P_{max}	41.1 V
(xi).	Current @ P_{max}	10.96 A
(xii).	Open circuit voltage (V_{oc})	49.1 V
(xiii).	Short circuit current (I_{sc})	11.66 A
(xiv).	Maximum system open Circuit Voltage	1500VDC (IEC)
(b).	**Inverters**	

(i).	Type of Module	120 (30*4) KW	
(ii).	Type of Cell	InfiniSolar TX-PA 30 KW	
(iii).	Input Operating Voltage Range	720 VDC-950 VDC	
(iv).	Efficiency of inverter	91%	
(v).	Rated voltage	400V	
(vi).	Rated Current	72 A	
(vii).	Max. Power Point Tracking Range	460 V to 900 V	
(viii).	Output electrical system	3 Phase AC	
(ix).	Rated Output Voltage	195.5-253	
(x).	Power Factor (adjustable)	0.8 Lagging-0.8 Leading	
(xi).	Power control	MPP tracker	
(xii).	Rated Frequency	49-51 Hz	
(xiii).	Environmental Enclosures	Relative Humidity	0-100%
		Audible Noise	50 DB @ 1m
		Operating Elevation	5000m (derate over 3000m)
		Operating temperature	-25 to +60°C
(xiv).	Grid Operating protection	A	DC circuit breaker
		B	AC circuit breaker

		C	DC overload protection (Type 2)
		D	Overheat protection
		E	Grid Protection
		F	Ground fault Protection
		G	
(c).	**Data Collecting System**		
(i).	System Data	Continuous online logging with data logging software to portal.	
(d).	**Unit Transformer**		
(i).	Not Applicable		

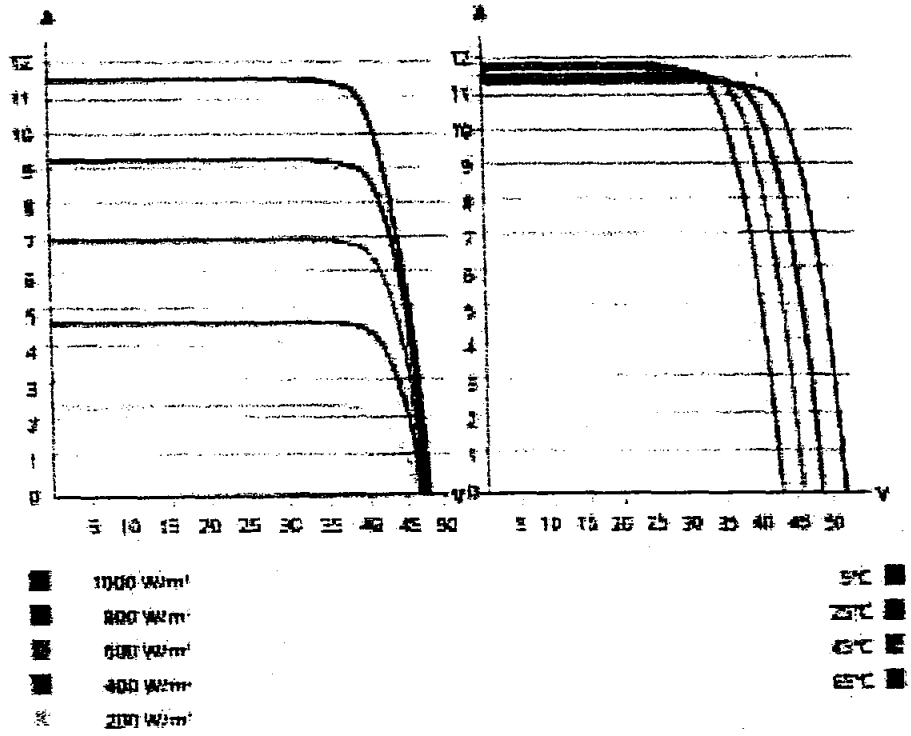
(D). Other Details

(i).	Expected COD of the generation facility Solar Power Plant/ Roof Top Solar	June 12, 2022 (Expected)
(ii).	Expected useful Life of the generation facility Solar Power Plant/ Roof Top Solar from the COD	25 years

V-I Curve

Generation Facility/Solar Power Plant/Roof Top Solar

of the Licensee



Information

Regarding Consumer i.e. QASPL to be Supplied by the Licensee i.e. Off-Grid Village

(i).	No. of Consumers		40-45 Households
(ii).	Location of consumers (distance and/or identity of premises)		Chak No. 291 ML (Muzzafargarh) Punjab
(iii).	Contracted Capacity and Load Factor for consumer		100kWp/ 19.28%
(iv).	Specify Whether		
	(a).	The consumer is an Associate undertaking of the Licensee -If yes, specify percentage ownership of equity;	QASPL
	(b).	There are common directorships:	-
	(c).	Either can exercise influence or control over the other.	-
(v).	Specify nature of contractual Relationship		
	(a).	Between each consumer and the Licensee	SkyBlue Pvt. Ltd. will construct and operate solar plant and provide electricity to Off-Grid Villages for its operations.
	(b).	Consumer and DISCO.	Off-Grid Villages
(vi)	Any other network information deemed relevant for disclosure to or consideration of the Authority.		NA

Information

Regarding Distribution Network for Supply of Electric Power Consumer in the name of QASPL

(i).	No. of Feeders		1
(ii).	Length of Each Feeder (Meter)		300ft
(iii).	Length of Each Feeder to each Consumer		Will be Defined As per Consumers Need
(iv).	In respect of all the Feeders, describe the property (streets, farms, Agri land, etc.) through, under or over which they pass right up to the premises of customer, whether they cross-over.		N/A
(v).	Whether owned by QASPL, Consumer or DISCO-(deal with each Feeder Separately)		QASPL
	(a).	If owned by DISCO, particulars of contractual arrangement	N/A.
	(b).	Operation and maintenance responsibility for each feeder	Skyblue Pvt. Ltd.
(vi).	Whether connection with network of DISCO exists (whether active or not)- If yes, provide details of connection arrangements (both technical and contractual)		N/A.
(vii).	Any other network information deemed relevant for disclosure to or consideration of the Authority.		N/A.

Expected Annual Generation of Plant:

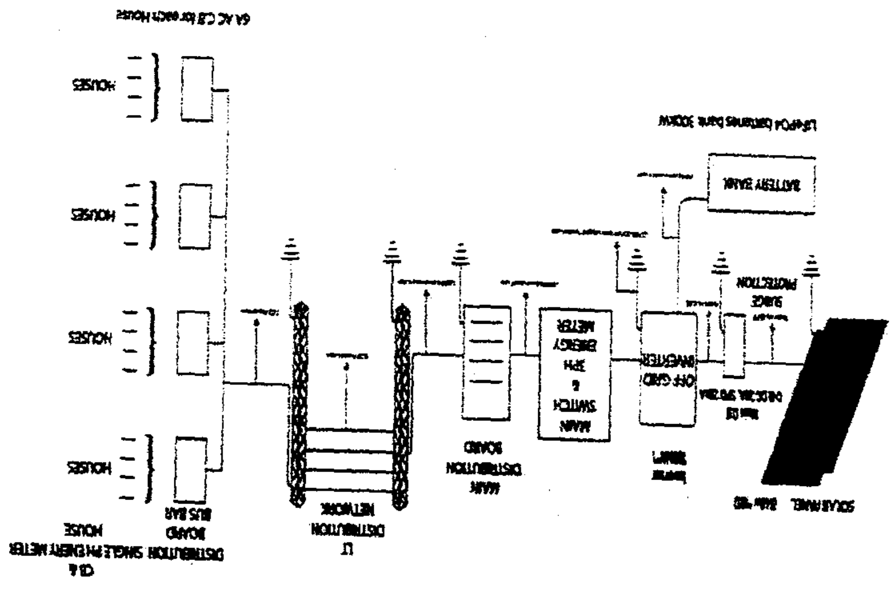
Month	GHI (kWh/m^2)	POA (kWh/m^2)	Shaded (kWh/m^2)	Nameplate (kWh)	Grid (kWh)
January	113.1	133.8	133.2	12,535.8	11,327.6
February	121.6	137.0	136.3	12,870.9	11,415.3
March	166.0	178.8	177.8	16,830.2	14,509.4
April	182.1	187.9	186.8	17,692.1	14,969.2
May	203.2	203.6	202.4	19,148.1	16,032.0
June	194.8	192.8	191.5	18,111.6	15,269.7
July	187.7	186.9	185.7	17,540.7	14,934.7
August	178.6	181.6	180.4	17,056.8	14,581.8
September	170.7	180.6	179.6	17,008.4	14,445.2
October	145.8	161.2	160.3	15,157.8	12,945.1
November	122.1	143.7	143.0	13,476.4	11,814.3
December	102.0	121.6	120.8	11,345.5	10.189.5
Total Generation					1631.7

Expected Annual Accumulative Irradiance of Plant:

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,887.6	
	POA Irradiance	2,009.5	6.5%
	Shaded Irradiance	1,997.6	-0.6%
	Irradiance after Reflection	1,934.6	-3.2%
	Irradiance after Soiling	1,895.9	-2.0%
	Total Collector Irradiance	**1,895.9**	**0.0%**
	Output at Irradiance Levels	188,245.3	-0.3%
	Output at Cell Temperature Derate	172,798.8	-8.2%
	Output After Mismatch	167,551.1	-3.0%
	Optimal DC Output	166,868.4	-0.4%
	Constrained DC Output	166,868.1	0.0%
	Inverter Output	163,250.1	-2.2%
	Energy to Grid(kWh)	**162,433.9**	**-0.5%**

SCHEDULE-III:
INTERCONNECTION STUDY

Single line Diagram



APPROVED
with Comments

TPM Consulting

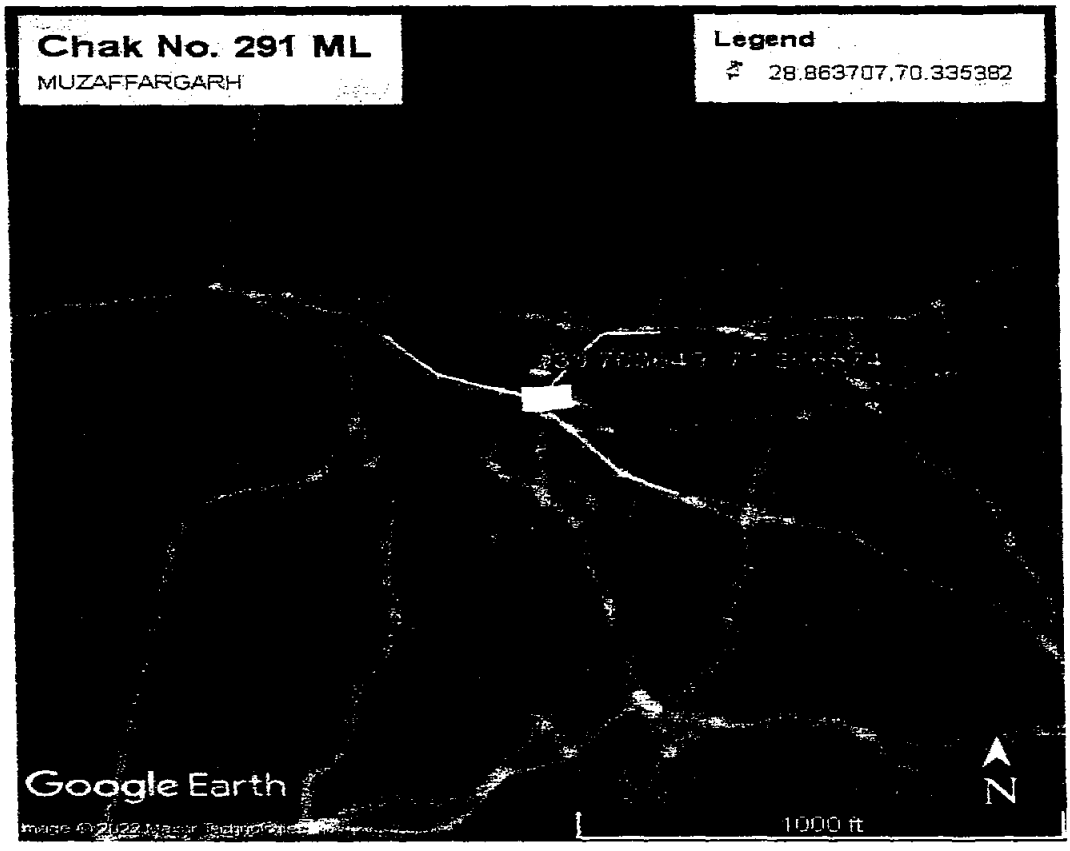
LAHORE

SCHEDULE-IV:

INFORMATION RELATING TO LOCATION (LOCATION MAPS, SITE MAP, LAND ETC.)

Information Relating To Location (Location Maps, Site Map, Land Etc.)

Serial Number	Location	Site Coordinates	
1.	Chak No. 291 ML PACKAGE-04 (Muzaffargarh)	Latitude	30.703649
		Longitude	71.376574



SITE NO. E

[TECHNICAL SCHEDULES I, II, III, IV & V]

SCHEDULE-I:

PROJECT COMMENCEMENT AND COMPLETION SCHEDULE

TPM *Consulting*

Ref: TPM/QASP/IND/P5/02
Dated: 14th December 2021

To,

M/S SKY BLUE BUILDERS (LEAD FIRM)
SKY BLUE RENEWABLE ENERGIES(PVT) LTD - GCL (JV)
Lahore.

SUBJECT: **LETTER OF COMMENCEMENT FOR THE PROJECT TITLED, DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-05 (BAHAWALNAGAR)**

Dear Sir,

In pursuance of the Contract Agreement against the total contract price of **PKR 39,123,630.00** (Pakistani Rupees Thirty-Nine Million One Hundred Twenty-Three Thousand Six Hundred Thirty Only) signed on 30th November 2021 between **Quad-e-Azam Solar Power (Pvt) Ltd (QASPL)**, Energy Department, Government of Punjab (The Employer), and **M/S Sky Blue Builders - Sky Blue Renewable Energies (Pvt) Ltd - GCL (JV)** (The Contractor) for the project titled, **"SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR "PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES" PACKAGE-05 (BAHAWALNAGAR)"**

We, **(M/s TPM Consulting JV Frontier Engineering Consultants** "Engineer of the Project") on behalf of the Employer issue the Letter of Commencement to perform the work with immediate effect in accordance with the Contract Agreement Terms and Conditions.

Regards,

TPMConsulting

Engr. Shahzad Gul
Project Manager
M/S TPM Consulting JV Frontier Engineering Consultants

CC:
1. *CEO (QASPL)*
2. *All Managers (QASPL)*

Recieved
14.12.2021

Project Milestones Activities:

PROVISION OF ELECTRICITY TO COMMUNITIES USING INDEGINOUS RESOURCES PACKAGE - 05		
Sr. No.	**Milestones**	**Percentage**
1	Design Approval	10%
2	Site Preparation (Clearance/Leveling of site, Civil Work for PV Mounting Structure, Earthing)	10%
3	Delivery of Solar Modules at Central Warehouse	30%
4	Delivery of Inverters at Central Warehouse	10%
5	Delivery of PV Mounting Structure	5%
6	Complete Installation of PV Mounting Structure	5%
7	Completion of Fencing and Control Room Building	10%
8	Complete Installation and Commissioning	15%
9	Upon Rectification of Punch List	5%
	Total	**100%**

Project Timeline with Activities:

"Provision of Electricity to Communities using Indigenous Resources Package-05" (BAHAWALNAGAR			
Commencement Date	14th Dec 2021	PROJECT COMPLETION DATE	12th June 2022
SR.	[redacted]	ACTIVITY START	ACTIVITY END
1	VERIFICATION OF DRAWINGS	2nd Week of December	2nd Week of December
2	DRAWING APPROVAL AND AMENDMENTS	2nd Week of December	2nd Week of December
3	PROCUREMENT (LOCAL AND IMPORTED)	2nd Week of December	3rd Week of February
5	TEAM MOBILIZATION PLUS MARTERIAL DELIVERY	2nd Week of January	3rd Week of January
6	SITE MARKING FOR MECHANICAL WORK	4th Week of January	1st Week of February
7	CIVIL WORK (Civil Pad)	1st Week of February	3rd Week of February
8	CIVIL WORK (Control Room)	1st Week of February	3rd Week of February
9	CIVIL WORK(Fencing)	1st Week of February	3rd Week of February
10	MECHANICAL WORK (STRUCTURE INSTALLATION)	4th Week of February	3rd Week of March
11	MECHANICAL WORK(PANELS ERECTION)	3rd Week of February	4th Week of March
12	ELECTRICAL WORK	4th Week of March	3rd Week of April
13	ERECTION OF LETTICE POLES	3rd Week of March	3rd Week of April
14	POWER DISTRIBUTION NETWORK INSTALLATION	1st Week of April	4th Week of April
15	INSTALLATION OF CCTV CAMERAS	4th Week of March	2nd Week of April
16	INVERTER PLACEMENT AND TERMINATION	1st Week of May	2nd Week of May
17	COMMISSIONING AND TESTING	3rd Week of May	3rd Week of May
18	TESTING AND HANDOVER TO CLIENT	4th Week of May	4th Week of May

SCHEDULE-II:

DETAILS OF GENERATION FACILITY/SOLAR POWER PLANT

Details of

Generation Facility/Solar Power Plant

(A). General Information

(i).	Name of the Company/Licensee	Quaid e Azam Solar Power (Pvt) Ltd.-QASPL
(ii).	Registered/ Business office of the Company/Licensee	83 A, E/1, 83-D/1, Main Boulevard, Gulberg, Lahore, Pakistan. Main Blvd Gulberg, Block D 1 Gulberg III, Lahore, Punjab
(iii).	Type of the generation facility/Solar Power Plant/Roof Top Solar	Photovoltaic (PV) Cell
(iv).	Location(s) of the generation facility Solar Power Plant/ Roof Top Solar	Azafi Abadi 322/HR PACKAGE-05 (Bahawalnagar)

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) Cell	
(ii).	System Type	On-Grid	
(iii).	Installed Capacity of the generation facility Solar Power Plant/ Roof Top Solar	100kW$_P$	
(iv).	No. of Panel/Modules	222 x 450 Watt	
(v).	PV Array	Nos. of Strings	18
		Modules in a string	12
(vi).	Invertor(s)	Quantity	4
		Make	InfiniSolar TX-PA
		Capacity of each unit	30 kW

(C). **Technical Details of Equipment**

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	Canadian Solar 450 Watt
(ii).	Type of Cell	Mono crystalline
(iii).	Dimension of each Module	2108x1048x35mm(83.0x41.3x1.38 inch)
(iv).	Total Module Area	3.5750 m^2
(v).	Frame of Panel	Anodized aluminium alloy
(vi).	Weight of one Module	24.3 kg
(vii).	No of Solar Cells in each module	144 (2*(12*6))
(viii).	Efficiency of module	20.4%
(ix).	Maximum Power (P_{max})	450 W_P
(x).	Voltage @ P_{max}	41.1 V
(xi).	Current @ P_{max}	10.96 A
(xii).	Open circuit voltage (V_{oc})	49.1 V
(xiii).	Short circuit current (I_{sc})	11.66 A
(xiv).	Maximum system open Circuit Voltage	1500VDC (IEC)
(b).	**Inverters**	
(i).	Type of Module	120 (30*4) KW

(ii).	Type of Cell	InfiniSolar TX-PA 30 KW	
(iii).	Input Operating Voltage Range	720 VDC-950 VDC	
(iv).	Efficiency of inverter	91%	
(v).	Rated voltage	400V	
(vi).	Rated Current	72 A	
(vii).	Max. Power Point Tracking Range	460 V to 900 V	
(viii).	Output electrical system	3 Phase AC	
(ix).	Rated Output Voltage	195.5-253	
(x).	Power Factor (adjustable)	0.8 Lagging-0.8 Leading	
(xi).	Power control	MPP tracker	
(xii).	Rated Frequency	49-51 Hz	
(xiii).	Environmental Enclosures	Relative Humidity	0-100%
		Audible Noise	50 DB @ 1m
		Operating Elevation	5000m (derate over 3000m)
		Operating temperature	-25 to +60°C
(xiv).	Grid Operating protection	A	DC circuit breaker
		B	AC circuit breaker
		C	DC overload protection (Type 2)

		D	Overheat protection
		E	Grid Protection
		F	Ground fault Protection
		G	
(c).	**Data Collecting System**		
(i).	System Data	Continuous online logging with data logging software to portal.	
(d).	**Unit Transformer**		
(i).	Not Applicable		

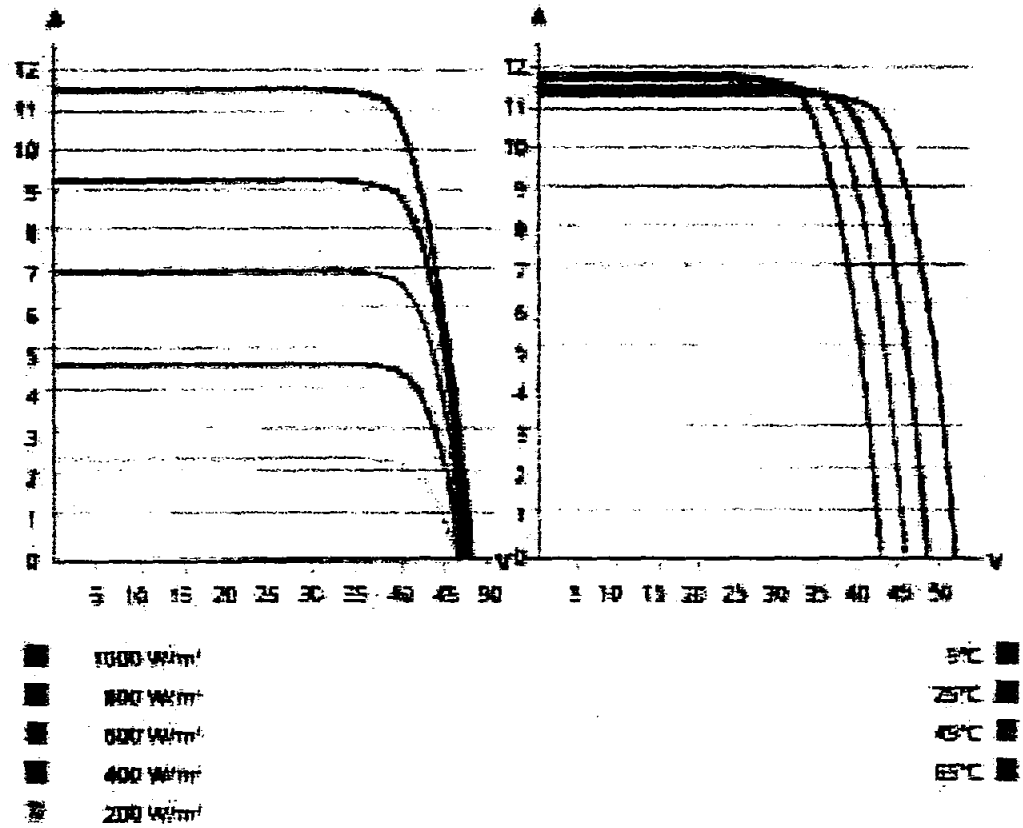
(D). Other Details

(i).	Expected COD of the generation facility Solar Power Plant/ Roof Top Solar	June 12, 2022 (Expected)
(ii).	Expected useful Life of the generation facility Solar Power Plant/ Roof Top Solar from the COD	25 years

V-I Curve

Generation Facility/Solar Power Plant/Roof Top Solar

of the Licensee



Information

Regarding Consumer i.e. QASPL to be Supplied by the Licensee i.e. Off-Grid Villages

(i).	No. of Consumers		50-55 Households
(ii).	Location of consumers (distance and/or identity of premises)		Azafi Abadi 322/HR (Muzaffargarh) Punjab
(iii).	Contracted Capacity and Load Factor for consumer		100kWp/ 19.28%
(iv).	Specify Whether		
	(a).	The consumer is an Associate undertaking of the Licensee -If yes, specify percentage ownership of equity;	QASPL
	(b).	There are common directorships:	-
	(c).	Either can exercise influence or control over the other.	-
(v).	Specify nature of contractual Relationship		
	(a).	Between each consumer and the Licensee	SkyBlue Pvt. Ltd. will construct and operate solar plant and provide electricity to Off-Grid Villages for its operations.
	(b).	Consumer and DISCO.	Off-Grid Villages

(vi)	Any other network information deemed relevant for disclosure to or consideration of the Authority.	NA

Information

Regarding Distribution Network for Supply of Electric Power Consumer in the name of QASPL

(i).	No. of Feeders		1
(ii).	Length of Each Feeder (Meter)		300ft
(iii).	Length of Each Feeder to each Consumer		Will be Defined As per Consumers Need
(iv).	In respect of all the Feeders, describe the property (streets, farms, Agri land, etc.) through, under or over which they pass right up to the premises of customer, whether they cross-over.		N/A
(v).	Whether owned by QASPL, Consumer or DISCO-(deal with each Feeder Separately)		QASPL
	(a).	If owned by DISCO, particulars of contractual arrangement	N/A.
	(b).	Operation and maintenance responsibility for each feeder	Skyblue Pvt. Ltd.
(vi).	Whether connection with network of DISCO exists (whether active or not)- If yes, provide details of connection arrangements (both technical and contractual)		N/A.
(vii).	Any other network information deemed relevant for disclosure to or consideration of the Authority.		N/A.

Expected Annual Generation of Plant:

Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	113.1	133.8	133.2	12,535.8	11,327.6
February	121.6	137.0	136.3	12,870.9	11,415.3
March	166.0	178.8	177.8	16,830.2	14,509.4
April	182.1	187.9	186.8	17,692.1	14,969.2
May	203.2	203.6	202.4	19,148.1	16,032.0
June	194.8	192.8	191.5	18,111.6	15,269.7
July	187.7	186.9	185.7	17,540.7	14,934.7
August	178.6	181.6	180.4	17,056.8	14,581.8
September	170.7	180.6	179.6	17,008.4	14,445.2
October	145.8	161.2	160.3	15,157.8	12,945.1
November	122.1	143.7	143.0	13,476.4	11,814.3
December	102.0	121.6	120.8	11,345.5	10,189.5
Total Generation					1631.7

Expected Annual Accumulative Irradiance of Plant:

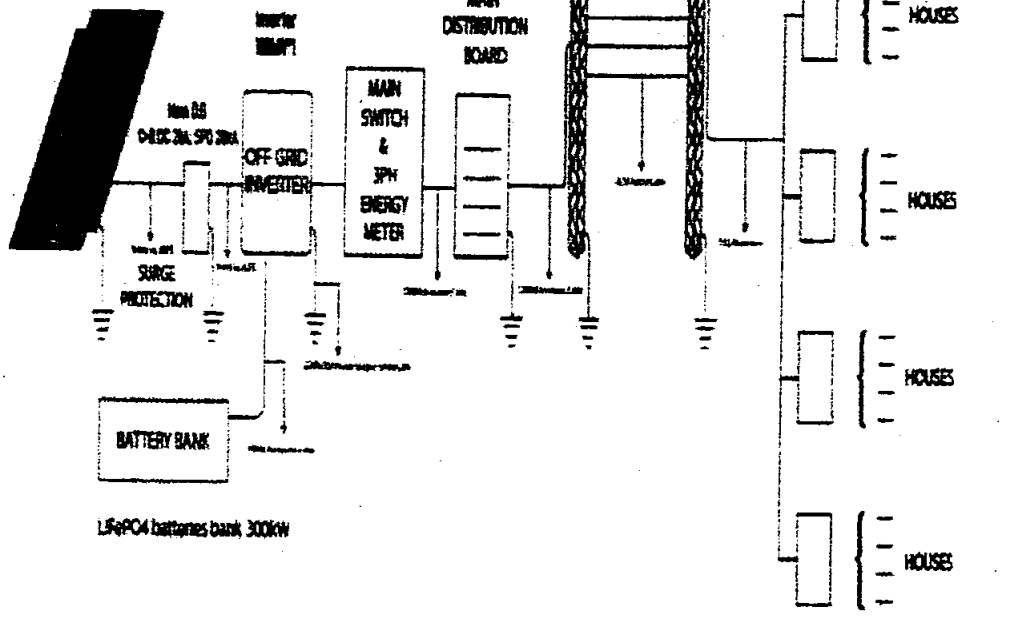
	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,887.6	
	POA Irradiance	2,009.5	6.5%
	Shaded Irradiance	1,997.6	-0.6%
	Irradiance after Reflection	1,934.6	-3.2%
	Irradiance after Soiling	1,895.9	-2.0%
	Total Collector Irradiance	**1,895.9**	**0.0%**
	Output at Irradiance Levels	188,245.3	-0.3%
	Output at Cell Temperature Derate	172,798.8	-8.2%
	Output After Mismatch	167,551.1	-3.0%
	Optimal DC Output	166,868.4	-0.4%
	Constrained DC Output	166,868.1	0.0%
	Inverter Output	163,250.1	-2.2%
	Energy to Grid(kWh)	**162,433.9**	**-0.5%**

SCHEDULE-III:
INTERCONNECTION STUDY

APPROVED
with Comments

TPM Consulting

Single line Diagram



SCHEDULE-IV:

INFORMATION RELATING TO LOCATION (LOCATION MAPS, SITE MAP, LAND ETC.)

Information Relating To Location (Location Maps, Site Map, Land Etc.)

Serial Number	Location	Site Coordinates	
1.	Azafi Abadi 322/HR PACKAGE-05 (Bahawalnagar)	Latitude	29.250127
		Longitude	72.316834

SITE NO. F

[TECHNICAL SCHEDULES I, II, III, IV & V]

SCHEDULE-I:

PROJECT COMMENCEMENT AND COMPLETION SCHEDULE

OFFICE COPY

TPM Consulting

Ref: TPM/QASP/IR/P6/02
Dated: 30th December 2021

To,

ZONERGY (TIANJIN) COMPANY LTD. (LEAD FIRM)
SALEEM BROTHERS (JV)
Lahore

SUBJECT: **LETTER OF COMMENCEMENT FOR THE PROJECT TITLED, "DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-06 (MULTAN)"**

Dear Sir,

in pursuance of the Contract Agreement against the total contract price of **PKR 38,988,862/=** (Pakistani Rupees Thirty-Eight Million Nine Hundred Eighty Eight Thousand Eight Hundered and Sixty Two Only) signed on 9th December 2021 between **Quad-e-Azam Solar Power (Pvt) Ltd (QASPL)**, Energy Department, Government of the Punjab (The Employer) and M/S **Zonergy (Tianjin) Company Ltd. JV Saleem Brothers** (The Contractor) for the project titled, **"DESIGN, SUPPLY, INSTALLATION, TESTING AND COMMISSIONING INCLUDING 2 YEARS O&M FOR PROVISION OF ELECTRICITY TO COMMUNITIES USING INDIGENOUS RESOURCES PACKAGE-01 (RAJANPUR)"**

We, (**M/s TPM Consulting JV Frontier Engineering Consultants** "Engineer of the Project") on behalf of the Employer issues the Letter of Commencement to perform the work with immediate effect in accordance with the Contract Agreement Terms and Conditions.

Regards,

TPM Consulting

Engr. Shahzad Gul
Project Manager
M/S TPM Consulting JV Frontier Engineering Consultants

30-12-2021

CC:
1. *CEO (QASPL)*
2. *All Managers (QASPL)*

Project Milestones Activities:

PROVISION OF ELECTRICITY TO COMMUNITIES USING INDEGINOUS RESOURCES PACKAGE - 06		
Sr. No.	**Milestones**	**Percentage**
1	Design Approval	10%
2	Site Preparation (clearance/leveling of site, Civil Work for PV Mounting Structure, Earthing)	10%
3	Delivery of Solar Modules at Site	40%
4	Delivery and Installation of PV Mounting Structure	10%
5	Delivery of Inverter, AC Cable, DC Cable and Earthing	10%
6	Complete Installation and Commissioning	15%
7	Upon Rectification of Punch List	5%
Total		**100%**

Project Timeline with Activities:

"Provision of Electricity to Communities using Indigenous Resources Package-05" (MUTAH)			
Commencement Date	14th Dec 2021	Project Completion Date	28th June 2021
SR.	ACTIVITY	ACTIVITY START	ACTIVITY END
1	VERIFICATION OF DRAWINGS	2nd Week of January	2nd Week of January
2	DRAWING APPROVAL AND AMENDMENTS	2nd Week of January	2nd Week of January
3	PROCUREMENT (LOCAL AND IMPORTED)	2nd Week of January	3rd Week of March
5	TEAM MOBILIZATION PLUS MARTERIAL DELIVERY	2nd Week of February	3rd Week of February
6	SITE MARKING FOR MECHANICAL WORK	4th Week of February	1st Week of March
7	CIVIL WORK (Civil Pad)	1st Week of March	3rd Week of March
8	CIVIL WORK (Control Room)	1st Week of March	3rd Week of March
9	CIVIL WORK(Fencing)	1st Week of March	3rd Week of March
10	MECHANICAL WORK (STRUCTURE INSTALLATION)	4th Week of March	3rd Week of April
11	MECHANICAL WORK(PANELS ERECTION)	3rd Week of April	4th Week of April
12	ELECTRICAL WORK	4th Week of April	3rd Week of May
13	ERECTION OF LETTICE POLES	2nd Week of April	3rd Week of May
14	POWER DISTRIBUTION NETWORK INSTALLATION	1st Week of May	4th Week of May
15	INSTALLATION OF CCTV CAMERAS	4th Week of April	2nd Week of May
16	INVERTER PLACEMENT AND TERMINATION	1st Week of June	2nd Week of June
17	COMMISSIONING AND TESTING	2nd Week of June	2nd Week of June
18	TESTING AND HANDOVER TO CLIENT	4th Week of June	4th Week of June

SCHEDULE-II:

DETAILS OF

GENERATION FACILITY/SOLAR POWER PLANT

Details of

Generation Facility/Solar Power Plant

(A). General Information

(i).	Name of the Company/Licensee	Quaid e Azam Solar Power (Pvt) Ltd.-QASPL
(ii).	Registered/ Business office of the Company/Licensee	83 A, E/1, 83-D/1, Main Boulevard, Gulberg, Lahore, Pakistan. Main Blvd Gulberg, Block D 1 Gulberg III, Lahore, Punjab
(iii).	Type of the generation facility/Solar Power Plant/Roof Top Solar	Photovoltaic (PV) Cell
(iv).	Location(s) of the generation facility Solar Power Plant/ Roof Top Solar	Basti Jam Rafiq Jhaloo PACKAGE-06(Multan)

(B). Solar Power Generation Technology & Capacity

(i).	Type of Technology	Photovoltaic (PV) Cell	
(ii).	System Type	On-Grid	
(iii).	Installed Capacity of the generation facility Solar Power Plant/ Roof Top Solar	100kW$_P$	
(iv).	No. of Panel/Modules	184 x 545 Watt	
(v).	PV Array	Nos. of Strings	2
		Modules in a string	20
		Nos. of Strings	8
		Modules in a string	18

(vi).	Invertor(s)	Quantity	1
		Make	MEGAREVO
		Capacity of each unit	150 kW

(C). Technical Details of Equipment

(a).	**Solar Panels – PV Modules**	
(i).	Type of Module	Tiger Pro 72 HC 545 Watt
(ii).	Type of Cell	Mono crystalline
(iii).	Dimension of each Module	2274x1134x35mm(89.53x44.65x1.38 inch)
(iv).	Total Module Area	3.5750 m^2
(v).	Frame of Panel	Anodized aluminium alloy
(vi).	Weight of one Module	28.9 kg
(vii).	No of Solar Cells in each module	144 (6×24)
(viii).	Efficiency of module	21.13%
(ix).	Maximum Power (P_{max})	545 W_P
(x).	Voltage @ P_{max}	40.80 V
(xi).	Current @ P_{max}	13.36 A
(xii).	Open circuit voltage (V_{oc})	49.52V
(xiii).	Short circuit current (I_{sc})	13.94A

(xiv).	Maximum system open Circuit Voltage	1500VDC (IEC)	
(b).	**Inverters**		
(i).	Type of Module	150 kW	
(ii).	Type of Cell	MPS0150	
(iii).	Input Operating Voltage Range	320v-480v	
(iv).	Efficiency of inverter	98.7 %	
(v).	Rated voltage	400V	
(vi).	Rated Current	217 A	
(vii).	Max. Power Point Tracking Range	200 V to 850 V	
(viii).	Output electrical system	3 Phase AC	
(ix).	Rated Output Voltage	320 to 460	
(x).	Power Factor (adjustable)	0.8 Lagging-0.8 Leading	
(xi).	Power control	MPP tracker	
(xii).	Rated Frequency	50 Hz	
(xiii).	Environmental Enclosures	Relative Humidity	0-100%
		Audible Noise	50 DB @ 1m
		Operating Elevation	5000m (derate over 3000m)
		Operating temperature	-25 to +60°C

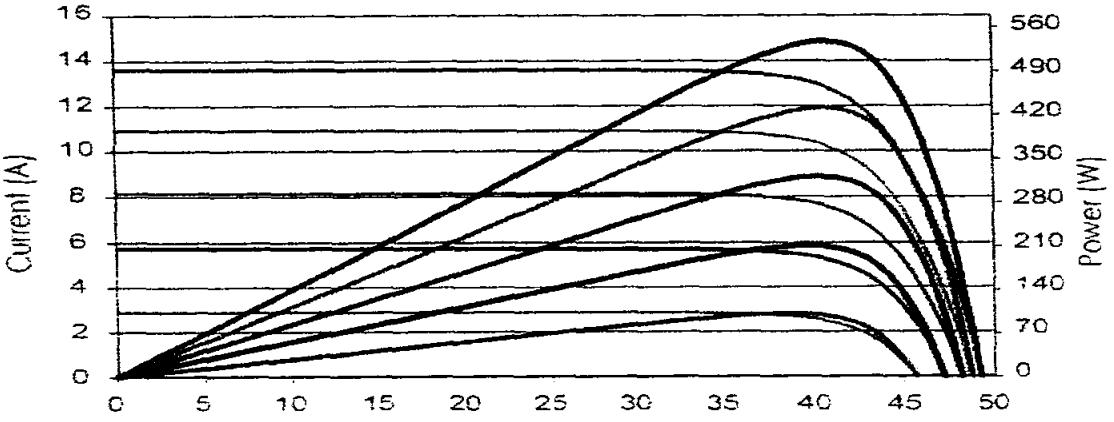
(xiv).	Grid Operating protection	A	DC circuit breaker
		B	AC circuit breaker
		C	DC overload protection (Type 2)
		D	Overheat protection
		E	Grid Protection
		F	Ground fault Protection
		G	
(c).	**Data Collecting System**		
(i).	System Data	Continuous online logging with data logging software to portal.	
(d).	**Unit Transformer**		
(i).	Not Applicable		

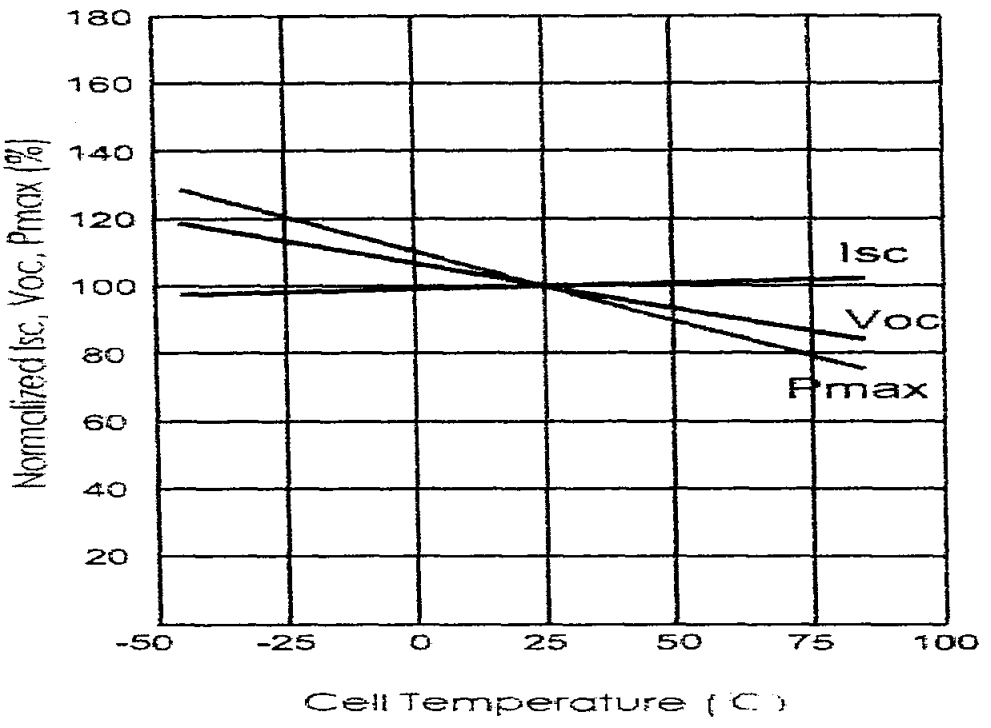
(D). Other Details

(i).	Expected COD of the generation facility Solar Power Plant/ Roof Top Solar	June 28, 2022 (Expected)
(ii).	Expected useful Life of the generation facility Solar Power Plant/ Roof Top Solar from the COD	25 years

V-I Curve

Generation Facilitv/Solar Power Plant/Roof Top Solar of the Licensee





Information

Regarding Consumer i.e. QASPL to be Supplied by the Licensee i.e. Off-Grid Village

(i).	No. of Consumers		40-45 Households
(ii).	Location of consumers (distance and/or identity of premises)		Basti Jam Rafiq Jhaloo (Multan), Punjab
(iii).	Contracted Capacity and Load Factor for consumer		100kW$_P$/ 19.28%
(iv).	Specify Whether		
	(a).	The consumer is an Associate undertaking of the Licensee -If yes, specify percentage ownership of equity;	QASPL
	(b).	There are common directorships:	-
	(c).	Either can exercise influence or control over the other.	-
(v).	Specify nature of contractual Relationship		
	(a).	Between each consumer and the Licensee	Zonergy will construct and operate solar plant and provide electricity to Off-Grid Villages for its operations.
	(b).	Consumer and DISCO.	Off-Grid Villages

(vi)	Any other network information deemed relevant for disclosure to or consideration of the Authority.	NA

Information

Regarding Distribution Network for Supply of Electric Power Consumer in the name of QASPL

(i).	No. of Feeders		1
(ii).	Length of Each Feeder (Meter)		300ft
(iii).	Length of Each Feeder to each Consumer		Will be Defined As per Consumers Need
(iv).	In respect of all the Feeders, describe the property (streets, farms, Agri land, etc.) through, under or over which they pass right up to the premises of customer, whether they cross-over.		N/A
(v).	Whether owned by QASPL, Consumer or DISCO-(deal with each Feeder Separately)		QASPL
	(a).	If owned by DISCO, particulars of contractual arrangement	N/A.
	(b).	Operation and maintenance responsibility for each feeder	Zonergy
(vi).	Whether connection with network of DISCO exists (whether active or not)- If yes, provide details of connection arrangements (both technical and contractual)		N/A.

(vii).	Any other network information deemed relevant for disclosure to or consideration of the Authority.	N/A.

Expected Annual Generation of Plant:

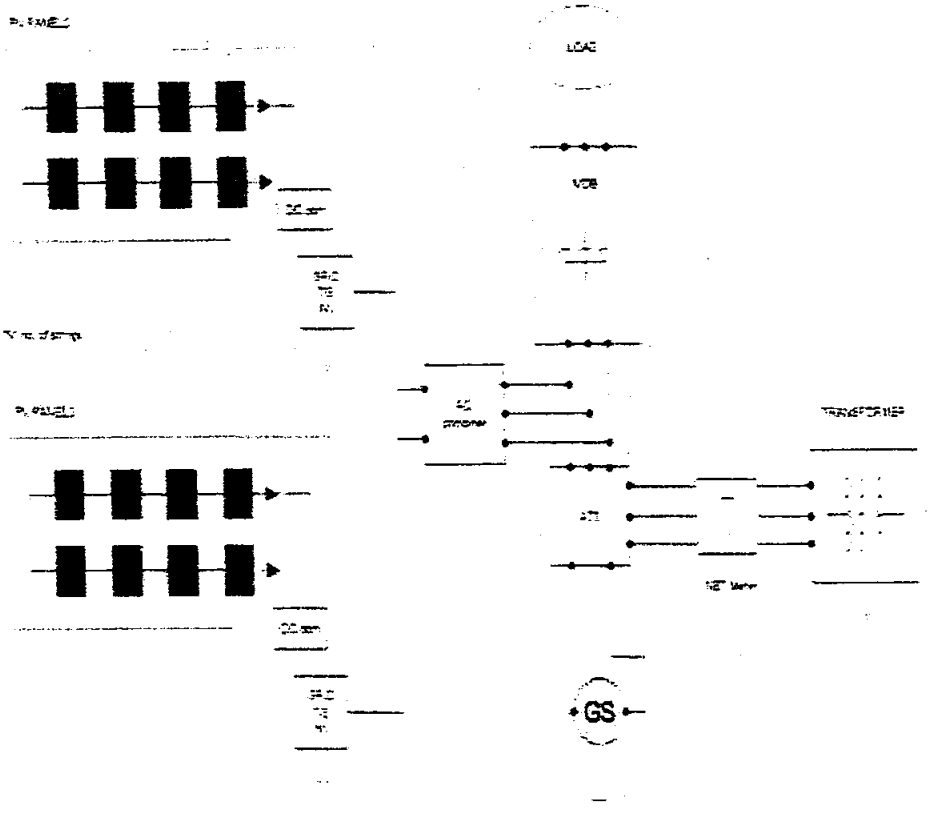
Month	GHI (kWh/m²)	POA (kWh/m²)	Shaded (kWh/m²)	Nameplate (kWh)	Grid (kWh)
January	113.1	133.8	133.2	12,535.8	11,327.6
February	121.6	137.0	136.3	12,870.9	11,415.3
March	166.0	178.8	177.8	16,830.2	14,509.4
April	182.1	187.9	186.8	17,692.1	14,969.2
May	203.2	203.6	202.4	19,148.1	16,032.0
June	194.8	192.8	191.5	18,111.6	15,269.7
July	187.7	186.9	185.7	17,540.7	14,934.7
August	178.6	181.6	180.4	17,056.8	14,581.8
September	170.7	180.6	179.6	17,008.4	14,445.2
October	145.8	161.2	160.3	15,157.8	12,945.1
November	122.1	143.7	143.0	13,476.4	11,814.3
December	102.0	121.6	120.8	11,345.5	10,189.5
Total Generation					1631.7

Expected Annual Accumulative Irradiance of Plant:

	Description	Output	% Delta
Irradiance (kWh/m^2)	Annual Global Horizontal Irradiance	1,887.6	
	POA Irradiance	2,009.5	6.5%
	Shaded Irradiance	1,997.6	-0.6%
	Irradiance after Reflection	1,934.6	-3.2%
	Irradiance after Soiling	1,895.9	-2.0%
	Total Collector Irradiance	**1,895.9**	**0.0%**
	Output at Irradiance Levels	188,245.3	-0.3%
	Output at Cell Temperature Derate	172,798.8	-8.2%
	Output After Mismatch	167,551.1	-3.0%
	Optimal DC Output	166,868.4	-0.4%
	Constrained DC Output	166,868.1	0.0%
	Inverter Output	163,250.1	-2.2%
	Energy to Grid(kWh)	**162,433.9**	**-0.5%**

SCHEDULE-III:
INTERCONNECTION STUDY

SINGLE LINE DRAWING



TPM Consulting

SCHEDULE-IV:

INFORMATION RELATING TO LOCATION (LOCATION MAPS, SITE MAP, LAND ETC.)

Information Relating To Location (Location Maps, Site Map, Land Etc.)

Serial Number	Location	Site Coordinates	
1.	Basti Jam Rafiq Jhaloo PACKAGE-06 (Multan)	Latitude	29.419908
		Longitude	71.258263

ANNEXURE-VII

Intended Table of Tariff

TARIFF APPLICATION TABLE

Year	1	2	3	4	5	6	7	8	9	10
Number of consumers (#)	280-320	280-320	280 - 320	280 - 320	280 - 320	280 - 320	280 - 320	280 - 320	280 - 320	280 - 320
Total generation capacity of power system (kW)	600	600	600	600	600	600	600	600	600	600
Total connected load (kW)	1.5-2 kW	1.5-2 kW	1.5-2 kW	1.5-2 kW	1.5-2 kW	1.5-2 kW	1.5-2 kW	1.5-2 kW	1.5-2 kW	1.5-2 kW
Expected load growth (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Expected revenue from electricity sale										
Expected other revenue										
Estimated capital cost (actual or loan payment)										
Expected fixed maintenance costs										
Expected variable maintenance costs										
Estimated fuel Cost										
Estimated O&M Cost										
Estimated Replacement Cost										
Other cost (Please specify) _____										
Annual Profit/Loss										

DESCRIPTION OF INTENDED TARIFF SCHEME AND SERVICE AVAILABILITY

As mentioned in the Application, the Applicant intends to initially provide the electric supply services to the Consumers of the locality free of any charge. Subsequently, the tariff shall be charged to the Consumers as per mutually agreed between the Applicant and the Consumers in accordance with the principles of fairness and equity as provided under Regulation 6 of the NEPRA Licensing (Microgrid) Regulations, 2022.

Tariff Category	**Number of consumers in this category**	**Tariff**	**Days of the week and time of the day that this service is to be provided**							**Total hours per week**
		Per [unit]	M	T	W	T	F	S	S	