ZERO CARBON SOLAR

APPLICATION

FOR

THE GRANT OF DISTRIBUTED GENERATION LICENSE FOR 3.12 MW SOLAR POWER PLANT AT PACKAGES CONVERTER LIMITED, WALTON ROAD, GULSHAN COLONY, LAHORE

To,

The Registrar,

National Electric Power Regulatory Authority,

NEPRA Tower, Ataturk Ave, G-5, Islamabad, Islamabad Capital Territory

Applicant's Details;

Zero Carbon Power Pvt. Limited

63 E-1 Gulberg-III Lahore, Pakistan

Tel # 03-111-111-926 / 0333-4496883 | Website: www.zerocarbon.com.pk

Email: info@zerocarbon.com.pk

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To

The Registrar,

National Electric Power Regulatory Authority,

NEPRA Tower, Ataturk Ave, G-5, Islamabad, Islamabad Capital Territory

Subject: Application for the grant of Distributed Generation License for 3.12 MW Solar Power Plant at Packages Converter Limited, Walton Road, Gulshan Colony, Lahore.

I, Bilal Afzal being duly authorized representative of Zero Carbon Power Private Limited by virtue of act of memorandum dated 8th September, 2020 hereby apply to the National Electric Power Regulatory Authority for the grant of distributed Generation License of Zero Carbon's On-Grid Power Plant under compliance of section 15 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 Application and Modification Procedure Regulations, 1999, 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. A bank draft in the sum of Rupees 186,944/- (One hundred and eighty six thousand, nine hundred and forty four rupees) being the non-refundable license application fee calculated in accordance with the schedule II of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached with this application.

Dated: November 2nd, 2020

Signature

Bilal Afzal

Zero Carbon Power (Pvt) Ltd

REGISTRAR
Dy. No. 1622
Dated: 03/11/20

ZERO CARBON SOLAR

Application Details

Subject: Application for the Grant of Generation License on 3.12 MW Grid-Tied Solar Power Plant

1. Zero Carbon Power's introduction

Zero Carbon Power Private Limited was incorporated on September 16th, 2020 with corporate universal identification no 0157971 (documents attached as Annexures).The business office is registered at 63 E1, Gulberg III, Lahore. Zero Carbon Private Limited having a dynamic profile for providing Turkey Solutions. The aim is to make Pakistan's energy sector more independent of the national grid and to proliferate the use of green energy into the Pakistan's energy mix for combating climate change and energy crisis by accelerating the use of solar energy, our expert team is committed to provide sustainable solar designing, construction and operations & maintenance.

Zero Carbon Power will supply the whole range of solar energy services to ensure project's efficiency and reliability including civil works, installation, commissioning and monitoring of Solar Power Plant. The services also includes the entire financial, technology and engineering design evaluation of the project.

2. Project overview

Packages Converter Limited intends to install a Grid-Tied Solar PV Power Plant at different locations in their premises, by which they can reduce the electricity consumption from the conventional grid and use the solar generated units for running their daily load. The high electricity consumption is met by various resources, but the use of sustainable energy has remarkable benefits and greater environment impact. To decrease electricity utilization from national grid for the cost-saving, it has decided to switch the maximum load on Solar PV System that will produce the electricity units at lower cost than the conventional grid units. Zero Carbon Power Private Limited is found to be very much suitable among different EPC contractors technically as well as financially, therefore Packages Converter Private Limited has awarded the 3.12 MWp Grid-Tied Solar Power Plant project to Zero Carbon Power Private Limited.

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3. Power Purchase Agreement

The scope of this project is under Power Purchase Agreement (PPA) between Packages Converter Private Limited declared as the "Buyer" and Zero Carbon Power Private Limited as the "Seller". The PPA between the two entities is settled for 15 years on an agreed tariff after that asset will be transferred to buyer. The Solar Power Plant has the DC capacity of 3.12 MW_p to be installed at the rooftops of Packages Converter's vicinity, with an AC capacity of 2.82 MW_p. The solar panel to be utilized is JA Solar JAM72S30 535/MR Mono crystalline Photovoltaic modules Half Cell PERC technology, connected to the Huawei Fusion Solar inverters including SUN 2000-60KTL-M0 and SUN 2000-100KTL-M1 to attain the DC/AC ratio of 1.11. The plant has the net capacity factor of 16.00 % estimated to generate 4327 GWh of green energy during the first operational year, further details are elaborated in the Section III of application and annexures of datasheets in Section IV.

4. Project timeline

The project will be in installation phase right after the grant of Generation License by the authorities. The timeline agreed will be followed accordingly. The Commercial Operation Date COD is expected to be October 15th, 2021 and generic overview of major activities is as follows.

- Detailed feasibility analysis of engineering design 2-3 weeks
- Procurement of equipment/materials 6-8 weeks
- Civil works/ construction activities 10-12 weeks
- Installation of Solar PV accessories 8-10 weeks
- Commissioning of inverters and Plants performance analysis 2-3 weeks

The tentative timeline for the project will be 6-8 months for installation and commissioning, after procurement.

Hence, Zero Carbon Power Private limited requests the authority to grant the generation license for 3.12 MW_p Grid-Tied Solar Power Plant at Packages Converters Private Limited. Situated at Gulshan Colony, Walton Road Lahore.

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RESOLUTION OF THE BOARD OF DIRECTORS OF ZERO CARBON POWER (PRIVATE) LIMITED

A meeting of the Board of Directors of M/s. Zero Carbon Power (Pvt.) Limited (the **Company**) was held on November 2nd, 2020 at its office, at 11:00 am to discuss the procurement of a Generation License by the Company from the National Electric Power Regulatory Authority (**NEPRA**). The Meeting was attended by all the directors of the Company and the following resolutions were unanimously passed:-

1. **RESOLVED THAT** the Company would file an application, for obtaining generation License for setting up a 3.12 MW solar power generation project, to NEPRA.

2. **RESOLVED THAT** in respect of submitting an application for the Generation License (including any modification thereto) to NEPRA, **Mr. Bilal Afzal, Director** CNIC # 35202-8489452-5 would be authorized to do the following acts for and on behalf of the Company:

i) To review, execute, submit and deliver the generation License application (including any modification thereto) for the generation License along with all related documents required by NEPRA for the grant of the Generation License including any contract, affidavits, statements, documents, powers of attorney, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, communications, notices, certificates, requests, statements and any other required document/instrument of any nature;

ii) To represent the company in all negotiations, representations, presentations, hearings, conferences, and/or meetings of any nature whatsoever with any entity (including but not limited to NEPRA, any private parties, companies, partnerships, individuals, governmental and/or semi-governmental authorities and agencies, ministers, boards, departments, regulatory authorities and/or any other entity of any nature whatsoever);

iii) To sign and execute the necessary documentations, pay the necessary fee, appear before the NEPRA as needed, and do all acts necessary for completion and processing of the generation license application (including any modification thereto) and procuring the generation license;

iv) To appoint or nominate any one or more officers of the Company or any other person or persons, singly or jointly, in his discretion to communicate with, make presentations to and attend the NEPRA hearings;

v) To delegate all or any of these powers to any other officials of the Company as deemed appropriate by him;

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vi) To do all such acts, matters and things as may be necessary for carrying out the aforesaid purposes and giving full effect to the Resolutions contained herein.

IT WAS FURTHER RESOLVED THAT the Company, through its Board of Directors, would validate and ratify all the actions taken by the duly authorized Director, Mr. Bilal Afzal, under the authority granted herein.

CERTIFIED TO BE A TRUE COPY OF THE RESOLUTION OF THE BOARD OF DIRECTORS OF THE COMPANY PASSED IN ITS MEETING DATED November 2nd, 2020

Director
Mian Amer Mahmood

Dated: _____

A081581

SECP

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE
LAHORE

Registration Office Lahore — Securities and Exchange Commission of Pakistan

CERTIFICATE OF INCORPORATION

[Under section 16 of the Companies Act, 2017 (XIX of 2017)]

Corporate Universal Identification No. **0157971**

I hereby certify that **ZERO CARBON POWER (PRIVATE) LIMITED** is this day incorporated under the Companies Act, 2017 (XIX of 2017) and that the company is **limited by shares.**

Given under my hand at **Lahore** this **Sixteenth** day of **September,** Two **Thousand** and **Twenty.**

CERTIFIED TO BE TRUE COPY
DEPUTY REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

Incorporation fee Rs. **2010500/-** only

Z. Haider

(Syed Zargham Haider)
Joint Registrar

No. ARL/INC 6235

Dated: 16-9-2020

THE COMPANIES ACT, 2017 (XIX of 2017)

(COMPANY LIMITED BY SHARES)

MEMORANDUM

OF

ASSOCIATION

OF

Zero Carbon Power (Private) Limited

THE COMPANIES ACT, 2017 (XIX of 2017)

(COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

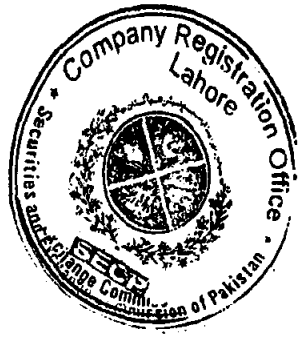
1. The name of the company is Zero Carbon Power (Private) Limited.

2. The registered office of the Company will be situated in the Province of Punjab.

3. (i) The principal line of business of the company shall be to generate and sell electricity. To carry on all or any ancillary businesses relating to generation, production, sale, storage, supply and distribution of electricity. To provide such services as are associated with or required for the said business activities and completion/installation of projects of generation and sale of electricity. To perform all other acts which are necessary or incidental to the business of electricity generation, installation, storage, transmission, distribution, supply and sale subject to permission of concerned authorities. To establish, construct, install, equip, operate, use, manage and maintain electricity generation power plants of all types and capacities subject to permission of the relevant authorities.

(ii) Except for the businesses mentioned in sub-clause (iii) hereunder, the company may engage in all the lawful businesses and shall be authorized to take all necessary steps and actions in connection therewith and ancillary thereto.

(iii) Notwithstanding anything contained in the foregoing sub-clauses of this clause nothing contained herein shall be construed as empowering the Company to undertake or indulge, directly or indirectly in the business of a Banking Company, Non-banking Finance Company (Mutual Fund, Leasing, Investment Company, Investment Advisor, Real Estate Investment Trust management company, Housing Finance Company, Venture Capital Company, Discounting Services, Microfinance or Microcredit business), Insurance Business, *Modaraba* management company, Stock Brokerage business, forex, managing agency, business of providing the services of security guards or any other business restricted under any law for the time being in force or as may be specified by the Commission.



(iv) It is hereby undertaken that the company shall not:

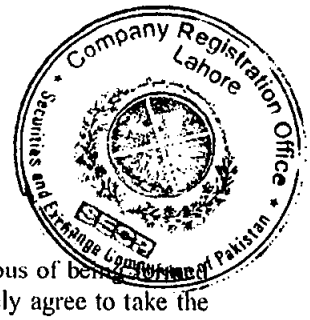
(a) engage in any of the business mentioned in sub-clause (iii) above or any unlawful operation;

(b) launch multi-level marketing (MLM), Pyramid and Ponzi Schemes, or other related activities/businesses or any lottery business;

(c) engage in any of the permissible business unless the requisite approval, permission, consent or licence is obtained from competent authority as may be required under any law for the time being in force.

4. The liability of the members is limited.

5. The authorized capital of the company is Rs: 500,000,000/- (Rupees Five Hundred Million only) divided into 50,000,000 (Fifty Million only) ordinary shares of Rs.10/- (Rupees Ten only) each.



We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a company, in pursuance of this memorandum of association, and we respectively agree to take the number of shares in the capital of the company as set opposite our respective names:

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality (ies) with any former Nationality	Occupation	Usual residential address in full or the registered/ principal office address for a subscriber other than natural person	Number of shares taken by each subscriber (in figures and words)	Signatures
Mian Amer Mahmood	35202-1967706-3	Mian Zahoor-ul-Haq	Pakistan	Business	36-E, Model Town, Lahore	750,000/- (Seven Hundred Fifty Thousand Only)	
Bilal Afzal	35202-8489452-5	Sohail Afzal	Pakistan	Engineer	28-C, Model Town, Lahore	250,000/- (Two Hundred Fifty Thousand Only)	
Zero Carbon (Private) Limited Through Its Authorized Representative /Nominee Director Mian Amer Mahmood	Company Registration # 0131610 CNIC # 35202-1967706-3	Mian Zahoor-Ul-Haq	Pakistan	Holding Company	63-E/1, Gulberg III, Lahore	9,000,000/- (Nine Million Only)	
		Total number of shares taken (Ten Million Only)				10,000,000/-	

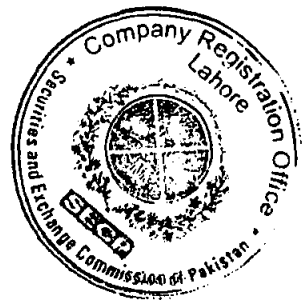
Dated the 8th day of September, 2020

CERTIFIED TO BE TRUE COPY

16-9-20

JOINT REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

THE COMPANIES ACT, 2017 (XIX of 2017)



(Private Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

ZERO CARBON POWER (PRIVATE) LIMITED

1. The Regulations contained in Table 'A' to the First Schedule to the Companies Act, 2017 (the "Act") shall be the regulations of **Zero Carbon Power (Private) Limited** (the "Company") so far as these are applicable to a private company.

PRIVATE COMPANY

2. The Company is a "Private Company" within the meaning of Section 2(1)(49) of the Act and accordingly:

(1) No invitation shall be made to the public to subscribe for the shares or debentures of the Company.

(2) The number of the members of the Company (exclusive of persons in the employment of the Company), shall be limited to fifty, provided that for the purpose of this provision, where two or more persons hold one or more shares in the company jointly, they shall be treated as single member; and

(3) The right to transfer shares of the Company is restricted in the manner and to the extent herein appearing.

TRANSFER OF SHARES

3. A member desirous to transfer any of his shares shall first offer such shares for sale or gift to the existing members and in case of their refusal to accept the offer, such shares may be transferred to any other person, as proposed by the transferor member, with the approval of the Board of Directors.

DIRECTORS

4. The number of directors shall not be less than two or a higher number as fixed under the provisions of the Act. The following persons shall be the first directors of the Company and shall hold the office upto the date of First Annual General Meeting:

1. Mian Amer Mahmood (Nominee of Zero Carbon (Private) Ltd.)
2. Bilal Afzal

We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a company, in pursuance of this memorandum of association, and we respectively agree to take the number of shares in the capital of the company as set opposite our respective names:

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's / Husband's Name in full	Nationality (ies) with any former Nationality	Occupation	Usual residential address in full or the registered/ principal office address for a subscriber other than natural person	Number of shares taken by each subscriber (in figures and words)	Signatures
Mian Amer Mahmood	35202-1967706-3	Mian Zahoor-ul-Haq	Pakistan	Business	36-E, Model Town, Lahore	750,000/- (Seven Hundred Fifty Thousand Only)	
Bilal Afzal	35202-8489452-5	Sohail Afzal	Pakistan	Engineer	28-C, Model Town, Lahore	250,000/- (Two Hundred Fifty Thousand Only)	
Zero Carbon (Private) Limited Through Its Authorized Representative /Nominee Director Mian Amer Mahmood	Company Registration # 0131610 CNIC # 35202-1967706-3	Mian Zahoor-Ul-Haq	Pakistan	Holding Company	63-E/1, Gulberg III, Lahore	9,000,000/- (Nine Million Only)	
		Total number of shares taken (Ten Million Only)				10,000,000/-	

Dated the 8th day of September, 2020

CERTIFIED TO BE TRUE COPY

16-9-20

JOINT REGISTRAR OF COMPANIES
COMPANY REGISTRATION OFFICE
LAHORE.

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Power Purchase Agreement (PPA)

ZERO CARBON SOLAR

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POWER PURCHASE AGREEMENT DESCRIPTION

POWER SELLER

Zero Carbon Power Pvt. Ltd, a company registered and existing under the laws of Pakistan having its registered office 63 Block E1, Gulberg III, Hali Road, Lahore, Pakistan (the "Seller"). The Seller desires to design, install, commission and operate the Grid-Tied Solar Power Plant of 3.12 MW_p. The Seller intends to an agreement of power purchase by The Packages Converters Limited (Buyer), the energy will be generated by the Solar Power Plant for the period of 25 years.

DISCO	Location	Plant Capacity (MW_p)	District	Province	Coordinates
LESCO	Walton Road, Gulshan Colony	3.12	Lahore	Punjab	31°28'07.0"N 74°21'02.2"E

POWER PURCHASER

Packages Convertors Limited a company incorporated and existing under the laws of Pakistan and having its registered office located at Shahrah-e-Roomi, P.O Amer Sidhu, Lahore. (The "Purchaser").

The Purchaser shall provide land on rent to the Seller for the construction, operation and maintenance of a Grid-Tied Solar PV Plant of 3.12 MW_p aggregated for the period of 15 years. The Seller shall invest, design, construct, install, own, operate, and maintain the Plant located at the land provided on rent by the Purchaser to the Seller for duration of the Power Purchase Agreement and the Purchaser shall purchase all of the power generated or available by the Plant from the Seller under the agreed terms and conditions. The Purchaser will provide facilitation to the Seller in early achievement of commercial operation date defined in the contract.

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OVERVIEW OF THE PROJECT

Packages Converter Limited intends to install a Grid-Tie Solar PV Power Plant at different locations in their premises, by which they can reduce the electricity consumption from the grid and use the solar generated units for running the load. The buyer wants to decrease the electricity utilization from conventional generation for cost-saving, under these circumstances, buyer has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional generation.

Zero Carbon Power Pvt. Limited is found to be very much suitable among different EPC contractors technically as well as financially, therefore The Packages Converters Limited has awarded the 3.12 MW Grid-Tied Solar Power project to Zero Carbon Power Private Limited.

TECHNOLOGY DESCRIPTION

- Solar PV Grid-tied system with all necessary protection, instrumentation, monitoring, control and synchronizing with grid.
- Customized civil structures along with efficient protective coating to prevent any structural damage along the tenure of 25 years.
- Tier-1 manufactured JA Solar JAM72S30 535/MR Mono crystalline Half Cell PERC technology PV modules with 20.7 % panel efficiency.
- Grid-tied smart string inverters Fusion Solar Huawei SUN2000 series with all necessary protections.
- Dual string DC combiner box to isolate the DC part when required.
- LV panel containing the energy meter, AC breakers and necessary indications.
- All the electrical installations and wiring for the PV system in accordance with the codes and standard.

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TECHNOLOGY USED

NO.	PARAMETERS	DESCRIPTION
1	Plant Type	Grid-tied, Solar PV Power Plant
2	System Capacity	3.12 MW_p
3	Solar Modules	Tier 1-Mono crystalline PERC Half Cell Solar PV Modules
4	Solar Inverters	On-Grid Smart String Inverter, Huawei SUN2000 series
5	Monitoring	Zero Carbon Power Pvt. Ltd real time cloud based monitoring.

TECHNICAL SUMMARY

- Tier-1 manufactured JA Solar Mono crystalline PERC Half Cell technology PV modules with 20.7 % panel efficiency.
- Grid connected smart string HUAWEI Fusion Solar Inverters, three phase, 98.9% have been considered.
- System will be synchronized with the low voltage panels.
- DC/AC ratio of 1.11 for inverters has been considered.
- Maximum AC output of the system is assumed to be 2.82 MVA.
- Output of the system is based on the instantaneous irradiation value of solar energy.

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SR. NO	ITEMS	DESCRIPTION	QUANTITY
1	Solar Panels	535 Wp , JA Solar JAM78S10 445/MR Mono-PERC Half Cell	5840 Pcs
2	Solar Inverters	Grid-Tied String inverter-SUN2000-60 KTL-M0	12 Pcs
		Grid-Tied String inverter--SUN2000-100 KTL-M1	21 Pcs
3	Structure Type	Customized Galvanized Iron	5841 Pcs
4	DC Cables	6 mm^2 1C/2C	Lot
5	AC Cables	As per requirement	Lot
6	Safety Equipment	ABB/SCH/TSK as required	Pcs
7	Data Logging	Huawei/Zero Carbon Power Cloud based monitoring	1 Job

ZERO CARBON SOLAR

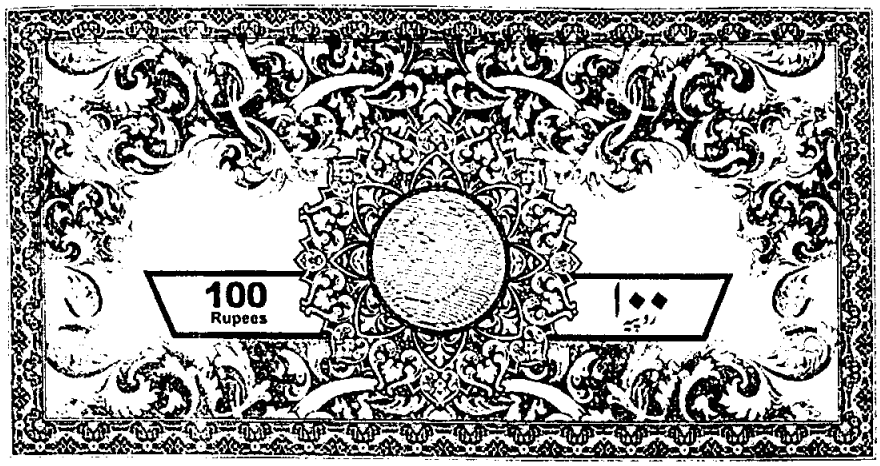
ENERGY GENERATION

Sr. No	Efficiency Parameters	
1	Capacity Utilization Factor	16.00%
2	Energy Generation Units	4.48 Million kWh

Project cost, information regarding sources and amounts of equities and debt.

This document states the project cost, information regarding sources and amounts of equity and debt.

DISCRIPTION	PROJECT COST PKR
EPC	243,139,470
Insurance during Construction	400,000
CAPEX	243,539,470
Financing Fee	-
Interest During Construction	12,000,000
Total cost of project	**255,539,470**
Equity	12,776,974
Debt	242,762,497



POWER PURCHASE AGREEMENT

ZERO CARBON POWER PVT LTD
(Seller)

AND

PACKAGES CONVERTORS LIMITED
(Purchaser)

POWER PURCHASE AGREEMENT

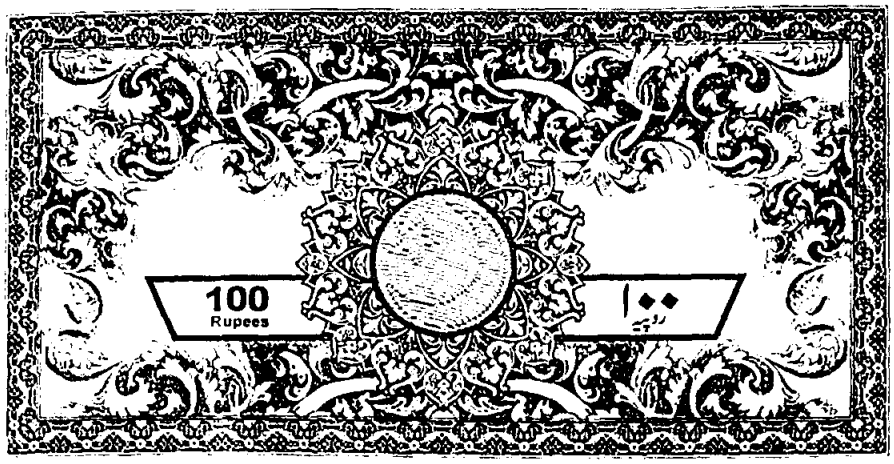
FOR

ELECTRICITY PRODUCED FROM
SOLAR POWERED 3.12 MW CAPACITY POWER GENERATION PLANT

Zero Carbon Power (Private) Limited

Packages Convertors Limited
Shahdrah Road
PO Amersidhu Lahore

AG593068



POWER PURCHASE AGREEMENT

This Power Purchase Agreement (hereinafter "**this Agreement**") is made at Lahore on the 16th day of October 2020 (hereinafter "**the Effective Date**") by and between:

Zero Carbon Power (Private) Limited, a company incorporated and existing under the laws of Pakistan, having its registered office at 63, Block E/1, Hali Road, Gulberg III, Lahore (hereinafter "**the Seller**", which expression shall, wherever the context so permits, means and includes its successors-in-interest and permitted assigns)

AND

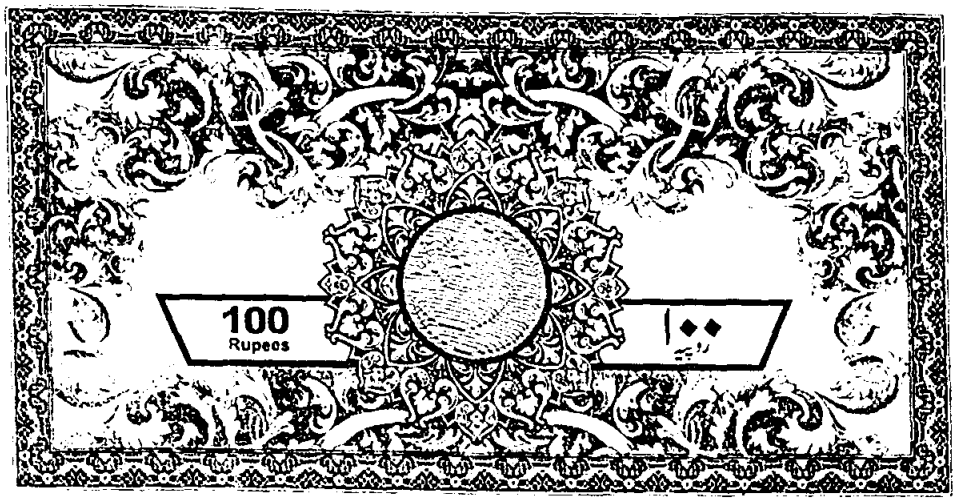
Packages Convertors Limited a company incorporated and existing under the laws of Pakistan and having its registered office located at Shahrah-e-Roomi, P.O Amer Sidhu, Lahore (hereinafter "**the Purchaser**", which expression shall, wherever the context so permits, means and includes its successors-in-interest and permitted assigns).

(The Purchaser and the Seller shall, where the context so permits, hereinafter be collectively referred to as the "**Parties**" and each individually as a "**Party**").

Zero Carbon Power (Private) Limited

Packages Convertors Limited
Shahrah-e-Roomi
PO Amersidhu, Lahore

AB593069



WHEREAS:

A. The Purchaser is in the business of the manufacture and marketing of a large number of domestic and consumer products at Shahrah-e-Roomi, P.O Amer Sidhu, Lahore (the "**Factory**") and requires energy for its operation. The Factory is connected to the distribution and transmission system maintained and operated by the Lahore Electric Supply Company Limited.

B. The Seller is in the business of developing clean energy solutions for corporate customers on a build, own, operate and transfer basis.

C. The Purchaser intends to engage the Seller for the designing, engineering, construction, installation, operation and maintenance of the Project at the Project Site for the purposes of generating solar power to meet the electricity requirements of the Purchaser at the Factory, and the Seller is desirous of selling the electricity so generated to the Purchaser

D. The Parties have agreed to execute this Agreement whereby the Seller shall sell and the Purchaser shall purchase all of the Net Delivered Energy or the Net Energy (as applicable) in accordance with the terms and conditions of this Agreement. The Net Delivered Energy shall be delivered to the Purchaser at the Interconnection Point pursuant to the terms and conditions contained herein.

Zero Carbon Power (Pvt) Ltd.

Packages Convertors Limited
Shahrah-e Roomi
PO Amersidhu, Lahore

SECTION III

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Schedule I

The Location, Size (i.e. Capacity in MW), Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facilities of the Licensee are described in this Schedule.

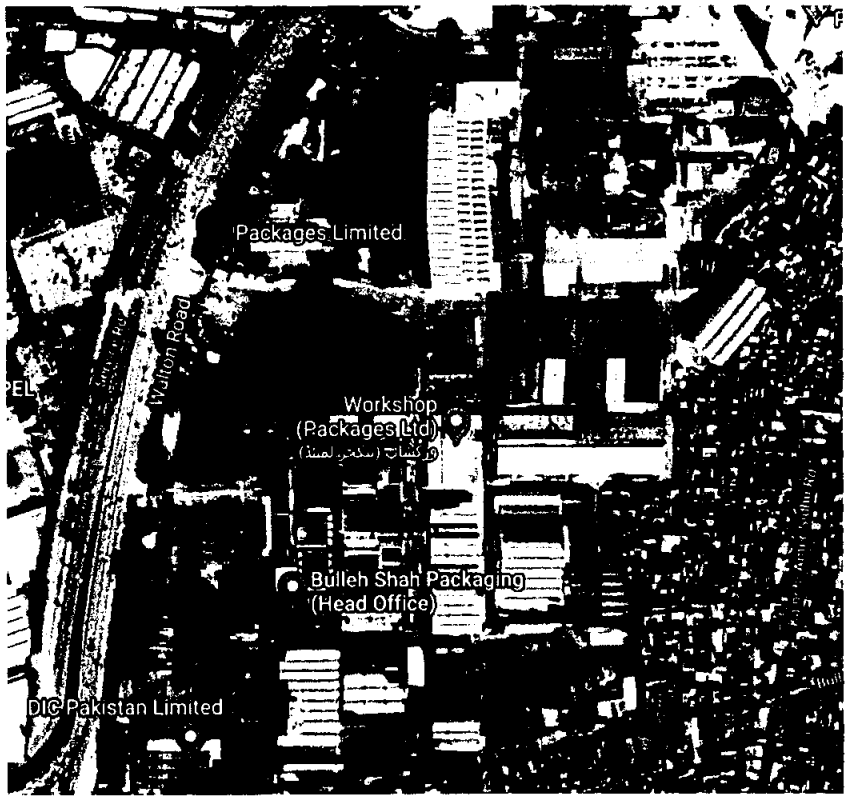
Location Coordinates of the Generation Facility/Solar Power Plant of the Licensee

Generation facility: Zero Carbon Power's 3.12 MW Grid-Tied Solar Power Plant

Address: Packages Converters Limited, Walton Road, Gulshan Colony, Lahore, Punjab, Pakistan.

Location coordinates

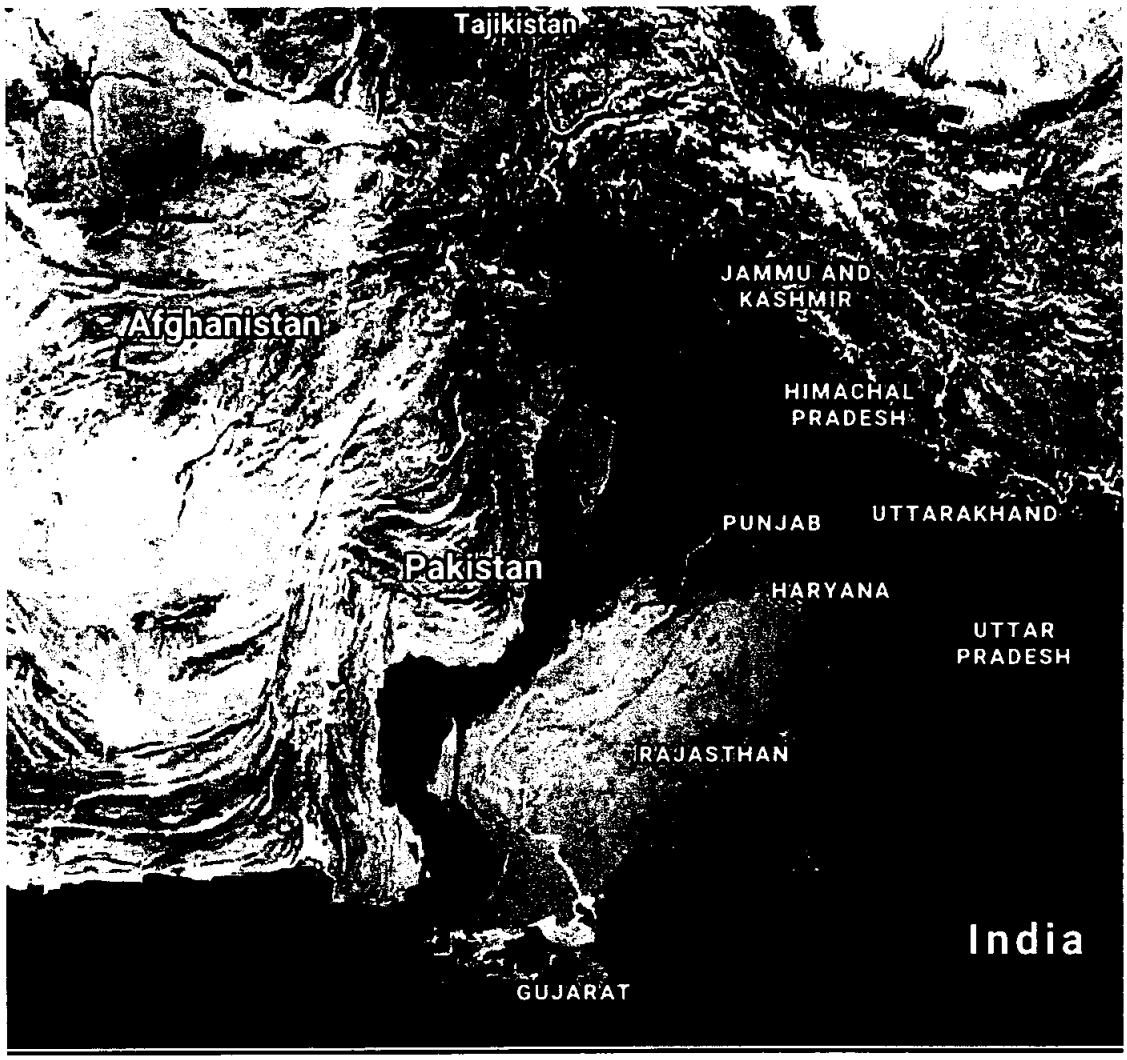
Latitude (North)	Longitude (East)
31°28'07.0"N	74°21'02.2"E



Site Location: Packages Converters Limited, Lahore

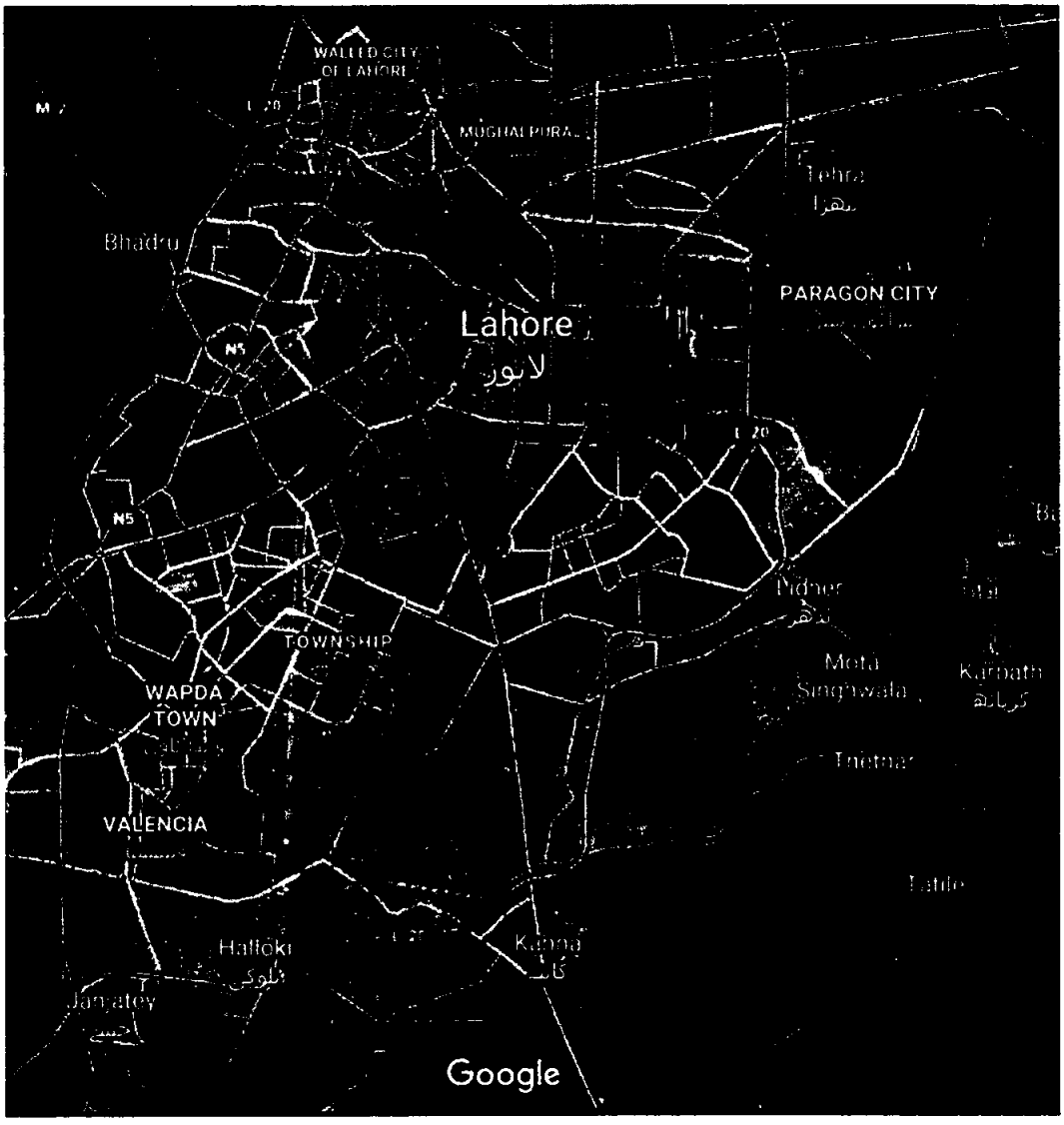
Location of Packages Converters Limited, Generation Facility/ Solar Power Plant of the Licensee on

Map of Pakistan

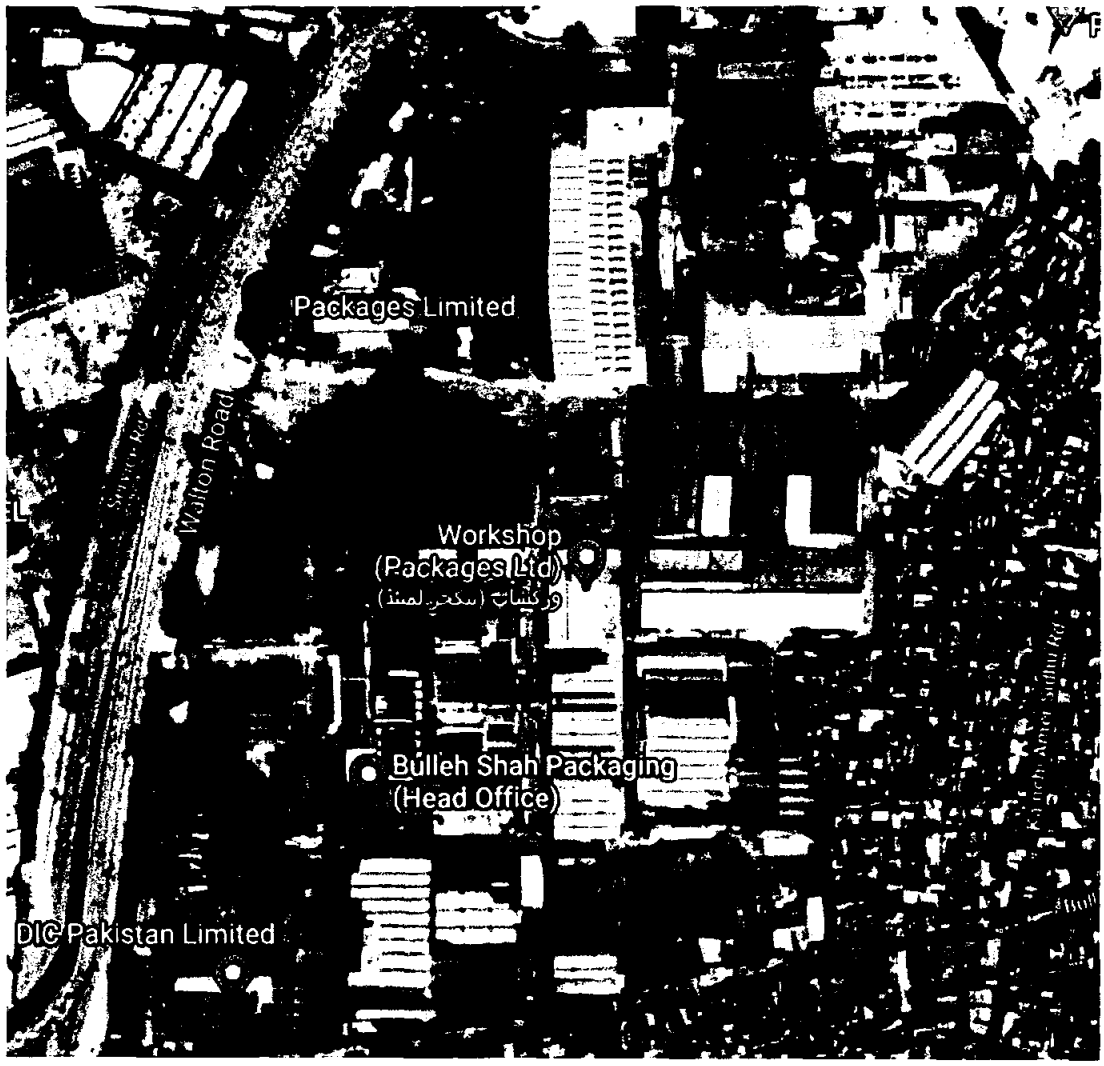


Location of the Packages Converters Limited, Lahore, Generation Facility /Solar Power Plant of the Licensee on

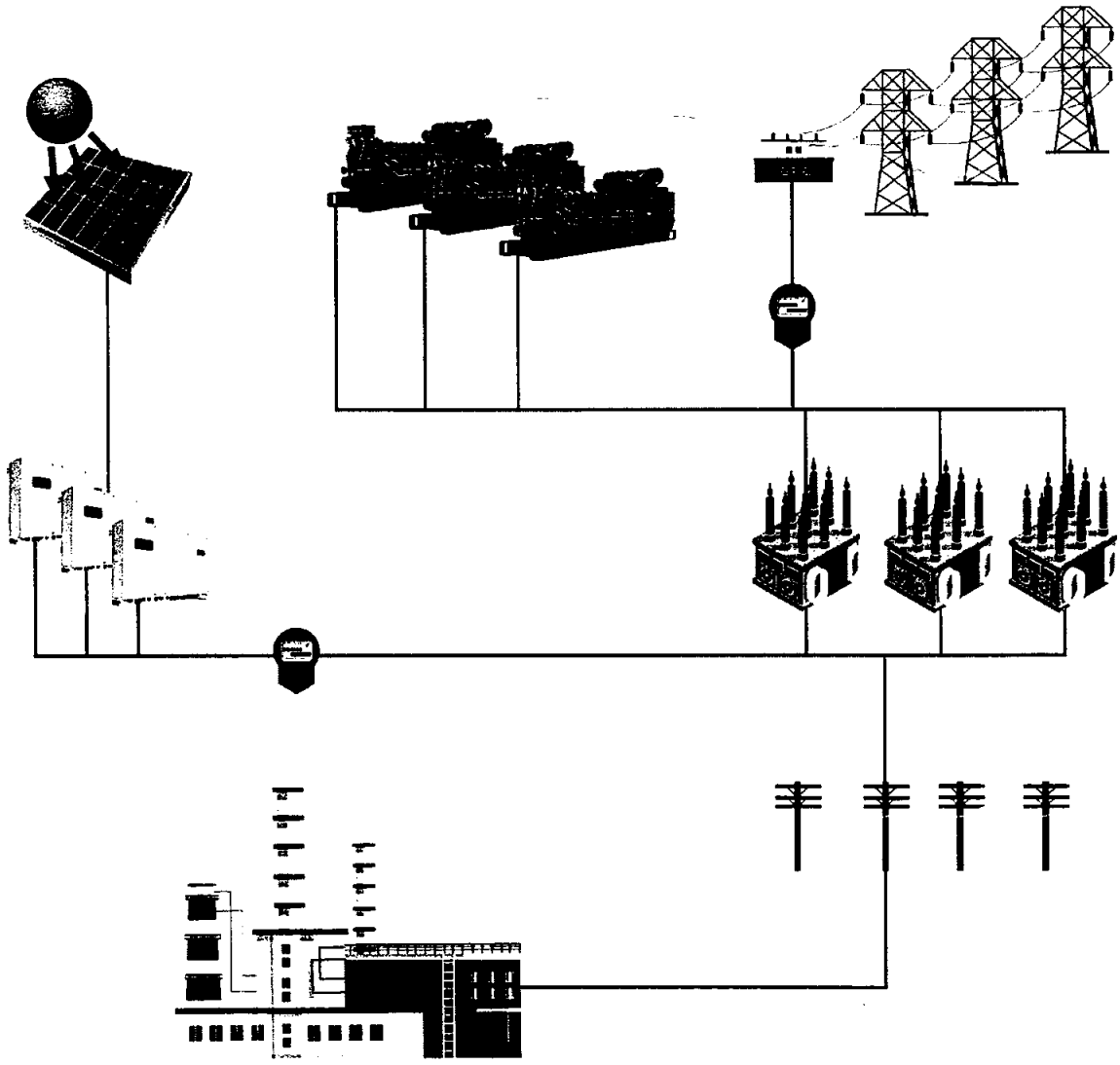
Map of Lahore



Location of the Packages Converter Limited, Generation Facility/Solar Power Plant of the Licensee



Process Flow Diagram of the Generation Facility/Solar Farm/ Solar Power Plant of the Licensee



Single Line Diagrams of the Generation Facility/Solar Farm/ Solar Power Plant of the Licensee

- Single Line diagrams of the power plant have been attached as Annexure III of Schedule II under this application.

Interconnection of the Generation Facility/ Solar Power Plant of the Licensee

1. The power generated from the Zero Carbon Power's 3.12 MW On-Grid Solar Power Plant, installed at the Packages Converter Private Limited, rooftops/ Shell roofs of the vicinity located at Walton Road, Gulshan Colony, Lahore will be dispersed for in-house utilization.
2. The AC side of Solar Power Plant will be terminated at the Low voltage panel of the Packages vicinities at 230/400 V.
3. Any change in the above Interconnection Arrangement duly agreed by Zero Carbon Power (Private) Limited and Packages Converter (Private) Limited shall be communicated to the authority in due course of time.

Technical Details of Generation Facility/ Solar Power Plant

(A)	**General Information**	
(i)	**Name of the Company/Licensee**	Zero Carbon Power Private Limited
(ii)	**Registered office of the Licensee**	63 E-1, Gulberg III, Lahore
(iii)	**Principle Office**	63 E-1, Gulberg III, Lahore
(iv)	**Plants Location**	Walton Road, Gulshan Colony, Lahore, Punjab, Pakistan
(v)	**Field Type**	Fixed Tilted Roof top Plane/Shell Roofs/Carport Sheds
(vi)	**Field Parameters**	Fixed Tilt Angle : 15° , Azimuth Angle 180°
(vii)	**Type of Generation Facility**	Solar Photovoltaic (PV)

(B)	**Solar Power Generation Technology & Capacity**	
(i)	**Type of Technology**	Photovoltaic Half Cell
(ii)	**Type of Cell**	Multi busbar Mono crystalline PERC Cells
(iii)	**Type of System**	Grid Tied
(iv)	**Installed Capacity of the Generation facility**	3.12 MWp DC

(C)	**Technical Details of Equipment**	
(a).	**Solar Panels-PV Modules**	JA Solar, JAM72S30 – 535 W
(i).	**Type of Module**	Mono Crystalline
(ii).	**Surface Area of Module**	Roof top ,Shell roof, Carport Sheds
(iii).	**Dimension of each Module**	2279 ± 2mm x 1135 ±2mm x 35 ± 1 mm

(iv).	**Total area incorporated**	Approx 29,288 m^2	
(v)	**No.of Modules**	5841	
(vi)	**Frame of Module**	Galvonized Iron alloy	
(vii).	**Weight of one Module**	28.5 kg ± 3%	
(viii).	**Module output Warranty**	For 1st Year 97.5 % or above	For 2nd Year till 25 th year 0.7 % /yr Reduction
(ix).	**Number of Solar Cells in each Module**	144 (6×24)	
(x).	**Efficiency of Module**	20.7%	
(xi).	**Environment Protection System**	Encapsulation and sealing arrangement	
(xii).	**Maximum Power (Pmax)**	535 Wp	
(xiii).	**Power Tolerance at STC**	0 ~ + 5 W	
(xiv).	**Operating Voltage at Pmax (Vmp)**	41.93 V	
(xv).	**Operating current at Pmax (Imp)**	12.76 A	
(xvi).	**Open Circuit Voltage (Voc)**	49.78 V	
(xvii).	**Short Circuit Current (Isc)**	13.52 A	
(xviii).	**Optimum Operating voltage at NOCT**	38.78 V	
(xix).	**Optimum Operating Current at NOCT**	10.43 A	
(xx).	**Open Circuit voltage (Voc) at NOCT**	46.31 V	
(x)	**Maximum system Open circuit voltage**	1500 V(IEC/UL) or 1000V (IEC/UL)	
(xi)	**Short circuit current (Isc)**	11.05 A	

(b).	PV Array	
(i)	**Modules in a String**	15-19 (5 Arrangements)
(ii)	**Total No of inverters**	31
(iii)	**Total No of Modules**	5841

(c).	PV Capacity	
(i)	**Total Capacity**	3.12 MWp DC
(ii)	**Net Capacity Factor**	16.0 % (w.r.t AC)

(d).	Inverters	
i.	Inverter make: Huawei Fusion Solar SUN2000-60-KTL-M0	
(i).	**Maximum DC Power Output**	60000 Wp
(ii).	**Inverter Model**	SUN2000-60-KTL-M0
(iii).	**Manufacturer**	HUAWEI
(iv).	**Maximum DC Input Voltage**	DC 1100 V
(v)	**Start Voltage**	DC 200 V
(vi)	**Number of Inverters**	10
(vii).	**Efficiency**	98.70%
(viii).	**Max.Input Current**	DC 132 A
(ix).	**MPPT Voltage Range**	200-1000 V
(x).	**Output Electrical System**	3 Phase 4 Wire
(xi).	**Rated Output Voltage**	230/400 AC
(xii).	**Rated Frequency**	50 Hz
(xiii).	**Power Factor**	Adjustable-0.8 lag to 0.8 lead
(xiv).	**Power Control**	MPP Tracker (6 MPPT/Tracker)
(xv).	**Environmental Enclosure**	Operating Temperature Range -25°C to + 65°C

		Relative Humidity	100 % Non-Condensing
		Protection Class	IP65
		Audible Noise	NA
		Operating Elevation	< 4000 m
(xvi).	**Protection Devices**	(a).	DC Disconnect Switch
		(b).	Anti-Islanding
		(c).	DC SPD
		(d).	DC Reverse Polarity Protection
		(e).	AC SPD
		(f).	Residual Current Monitoring Unit
(e).	**Junction boxes**	NA	Strings directly connected to inverter
(f).	**Data Collecting System**		
(i).	**Weather Data**	(a).	Meteo Control WS501-UMB Temperature, Air Pressure, Wind Speed, Relative Humidity
(ii).	**System Data**	(a).	DC Input Voltage V & current A of each Inverter (Phase, Line)
		(b).	Total DC Power (kW) generated by PV Array
		(c).	AC Output Voltage(V) & current(A) of each Inverter (Phase, Total)
		(d).	AC Output Power kW and energy

		(kwh) of each inverter
	(e).	Frequency (Hz)
	(f).	Power Factor (PF)

(i).	Maximum DC Power Output		100000 W_p
(ii).	Inverter Model		SUN2000-100-KTL-M1
(iii).	Manufacturer		HUAWEI
(iv).	Maximum DC Input Voltage		DC 1100 V
(v)	Start Voltage		DC 200 V
(vi)	Number of Inverters		21
(vii).	Efficiency		98.60%
(viii).	Max.Input Current per MPPT		DC 26 A
(ix).	MPPT Voltage Range		200-1000 V
(x).	Output Electrical System		3 Phase 4 Wire
(xi).	Rated Output Voltage		230/400 AC
(xii).	Rated Frequency		50 Hz
(xiii).	Power Factor		Adjustable-0.8 lag to 0.8 lead
(xiv).	Power Control		MPP Tracker (10 MPPT/Tracker)
(xv).	Environmental Enclosure	Operating Temperature Range	-25°C to + 65°C
		Relative Humidity: 100 % Non-Condensing	
		Protection Class	IP66
		Audible Noise	NA
		Operating Elevation	< 4000 m

(xvi).	Protection Devices	(a).	DC Disconnect Switch
		(b).	Anti-Islanding
		(c).	DC SPD
		(d).	DC Reverse Polarity Protection
		(e).	AC SPD
		(f).	Residual Current Monitoring Unit
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		(c).	AC Output Voltage(V) & current(A) of each Inverter (Phase, Total)
		(d).	AC Output Power kW and energy (kwh) of each inverter
		(e).	Frequency (Hz)
		(f).	Power Factor (PF)

Metering and protection

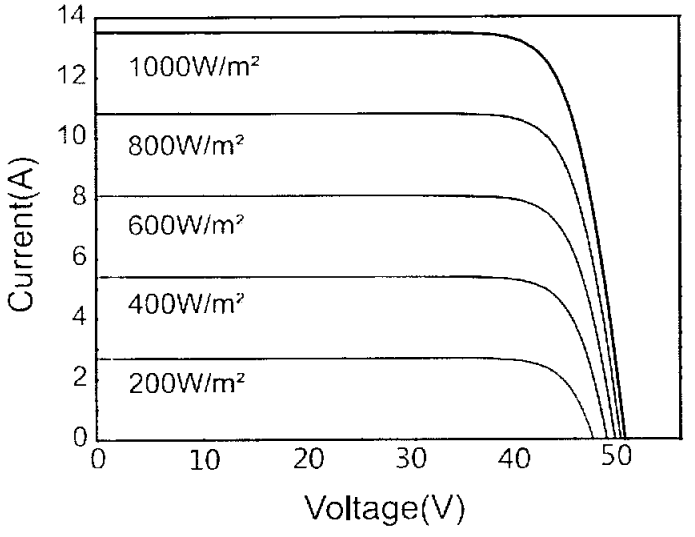
The power produced by the Grid-Tied Solar Power Plant will be limited to inverters and a separate CT meter will be installed for the monitoring at the site, by which instantaneous power, units generated daily and monthly will be recorded.

The following protection will be placed for inverters and some features are built in.

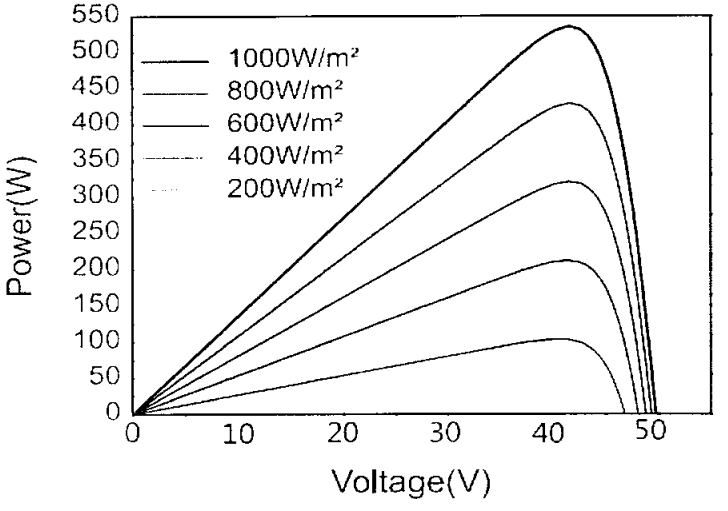
- DC reverse protection device
- AC short circuit protection
- Grid monitoring
- Leakage current protection
- Anti-PID function
- Overvoltage protection

VI Curve of Solar Panel at STC for the Generation Facility/ Solar Power Plant of Licensee

Current-Voltage Curve JAM72S30-535/MR



Power-Voltage Curve JAM72S30-535/MR



ZERO CARBON SOLAR

SECTION 4:
SCHEDULE II

ZERO CARBON
SOLAR

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SCHEDULE-II

The Total Installed Gross ISO Capacity of the Generation Facility/Power Plant/Solar Plant (kW), Total Annual Full Load (Hours), Average Sun Availability, Total Gross Generation of the Generation Facility /Solar Farm (kWh), Annual Energy Generation (25 years Equivalent Net Annual Production-AEP) kWh and Net Capacity Factor of the Generation Facility/Power Plant/Solar Farm of Licensee is given in this Schedule.

ZERO CARBON SOLAR

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SCHEDULE-II

Zero Carbon Power's 3.12 MW On-Grid Solar Plant Generation Facility/Solar Power Plant/SPPL

(1).	Total PV Installed Capacity of Generation facility	3.12 MWp DC 2.71 MWp AC
(2).	Average Sun Availability/Day (Irradiation on inclined Surface)	3.8 hrs
(3).	Days per Year	365
(4).	PV Plant Generation Capacity Annually (as per simulation)	4.320 GWh
(5).	Expected Total Generation in 25 years life span	97.67 GWh
(6).	Generation per year from plant keeping 24 Hours Working	27.33GWh
(7).	Net Capacity factor	16.0 %

Note :

All the above figures are indicative as provided by the applicant. The Net Energy available to power purchaser for dispatch will be determined through procedures contained in the Power Purchase Agreement.

SECTION V

FEASIBILTY STUDY

3.12 MW GRID-TIED SOLAR POWER PLANT

PACKAGES CONVERTER PRIVATE LIMITED

ZERO CARBON SOLAR

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EXECUTIVE SUMMARY

The feasibility study examines the financial, technical, practical and cost effective outcome of the proposed Solar Photovoltaic (PV) installation on the rooftop and parking sheds of Packages Converters Private Limited for the generation of electricity. All the relevant factors including topographical, legal and economic influencing the performance of the power plant are taken into account. The main outcomes of the feasibility report are given below:

Technical Site Analysis: The project site is an adequate site for a Solar PV energy system installation. For the purpose of estimation. The annual average mean daily solar irradiation in Lahore considered to be 5.2 kWh/ m^2, orientation azimuth angle of solar panels is 180 ◦ and panel tilt 15◦ for fixed rooftops. The condition of rooftop location is considered satisfactory for load bearing. The DC/AC ratio is kept 1.15 with the AC side being 2.71 MW.

Anticipated System Information: The project will accommodate a 3.12 MW_p (DC) Solar PV System with a projected annual production of 4320GWh/year.The Solar panel used are of PV panel as a basis for design will result in an acceptable system weight density of 5.00lbs/SF. The inverters incorporated are of Huawei String Inverters SUN 2000 series. The system will offset approximately sixmillion tonnes of carbondioxide annually.

Financial Analysis: Zero Carbon Power Private Limited is an initiative of The Punjab group having a strong financial bench strenght. The project under consideration will be funded by State Bank's loan under category III.The total estimated project cost is PKR 255,539,470.

In conclusion the technical and financial analysis propose that installation of a 3.12 MWp Solar PV System at the proposed location is deemed feasible.

INTRODUCTION

Description of the Project

The project is being installed under reservations by Zero Carbon Power (Pvt) Ltd. The sponsors of the company are interested to install the Solar PV plant to generate electricity. Zero Carbon Power intends to install a Grid-Tied Solar PV Power Plant at different location in their premises, by which they can reduce the electricity consumption from the conventional grid for Packages Converters Pvt. Ltd and use the solar generated units for running the load.

A 3.12 MW Solar PV Plant has been designed for Packages Converters Private Limited, which will get synchronize with the LV termination panel of the proposed site located at Walton Road, Gulshan Colony, Lahore. The total area of the project is around 7.23 Acres (29,288 m^2) for the installation of Solar PV panels. The project area is already cleared and the solar PV panels will be installed with customized structures according to the rooftop and vicinities requirement. The mounting of panels will be done on concrete roofs, shell roofs and carport shed structures.

Location of the Project

The project site is the rooftops and parking lot of Packages Limited, Walton Road, Gulshan Colony, Lahore.

The proposed project site lies between 31°28'07.0"N and 74°21'02.2"E located in Lahore. The land area of project site is around 7.23 Acres (29,288 m^2) located at Walton Road, Gulshan Colony, Lahore. The project land is owned by the buyers as specified in the Power Purchase Agreement for the installation of 3.12 MW Solar PV plant. The location of site can be viewed in Figure.1 and overview of the project site is highlighted and shown in Figure.2

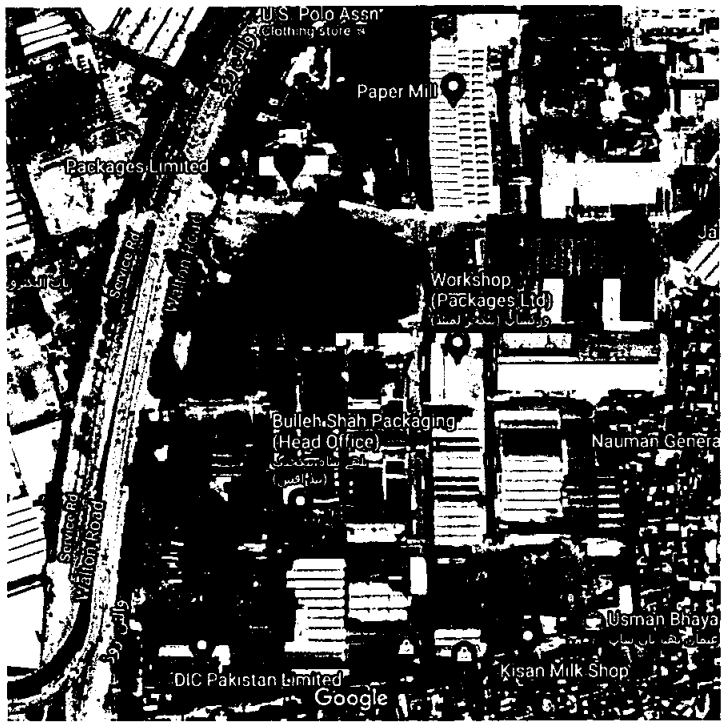
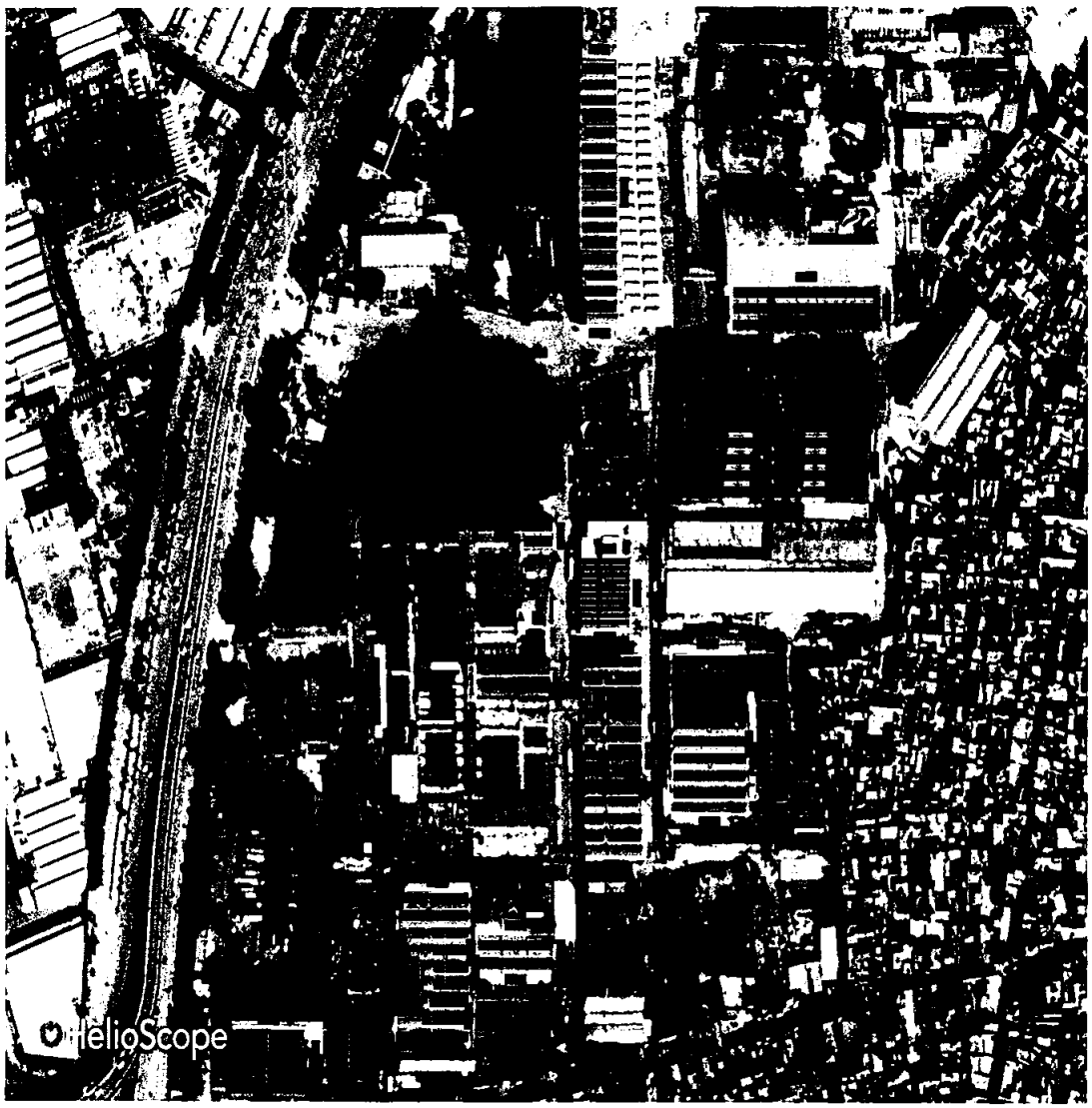


Figure.1- Overview of the site location

Figure.2- Project site to be utilized

Site Overview

The clear rooftops and carport structures are to be installed at the packages Limited vicinity. The site is clear from any obstructions and deems viable for installation. The major hindrances were removed to make a parallel base for mounting the PV panel frames. Irradiance level were measured by pyranometer and wind speed data was gathered byPakistan Meteorological Department to analyse the wind stresses.



CLIMATE AND WEATHER IN LAHORE

Topography

For the purposes of this report, the geographical coordinates of Lahore are 31.550° latitude, 74.344° longitude, and 735 ft elevation.The topography within two miles of Lahore contains only modest variations in elevation, with a maximum elevation change of 135 ft and an average elevation above sea level of 710 ft. Within10 miles also contains only modest variations in elevation 249 ft. Within fifty miles also contains only modest variations in elevation (292ft).

The area within 2 miles of Lahore is covered by artificial surfaces (100 %) within 10 miles by artificial surface (*51%*) and cropland (*43%*), and within 50 miles by cropland *(90%*).

Solar Impact

Pakistan is blessed with immense solar potential, a study conducted by National Renewable Energy Laboratory (NREL), stated that solar energy potential of 2.9 Million MW exists in Pakistan. That accounts to a 5.5 Wh /m^2d^1 solar insolation with annual mean sunshine duration of 8–10 h d^{-1} throughout the country. On an average solar global insulation 5–7 kWh m^2 exists in most parts of the country. The average solar energy available is nearly 5.5 kWh m^2, having annual mean sunshine duration between 8–10 h and 300 days (1500–3000 h) per year. The month with the least sunshine in Lahore, Pakistan, is January, with an average of 7.1h of sunshine. With an average of 9.9h of sunshine, May has the most sunshine of the year. With an average of 14.2h of daylight, June has the longest days of the year in Lahore. Months with the highest UV index in Lahore, Pakistan, are June and July, with an average maximum UV index of 12. The month with the shortest days in Lahore is December, with an average of 10.1h of daylight.

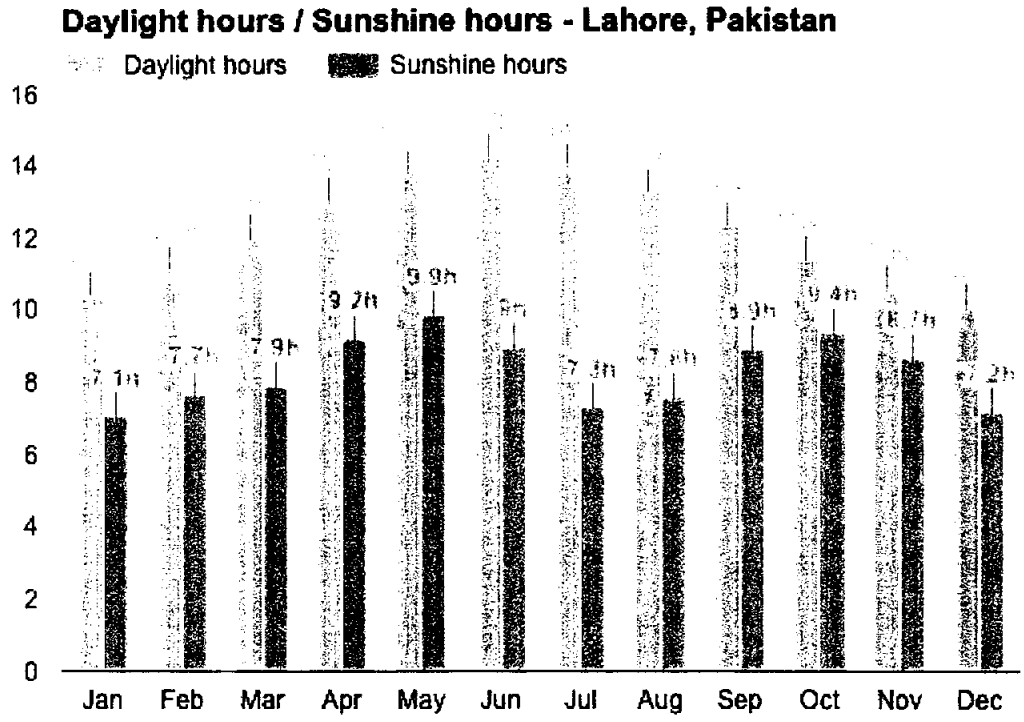


Figure-4. Distribution of solar hours per day annually

According to the Alternative Energy Development Board (AEDB), the mean global solar irradiance falling on a horizontal surface is about 200–250 W/m^2 amounting 6840–8280 MJ/m^2 in a year. For daily global radiation up to 23MJ/m^2, 24 (80%) consecutive days are available in this area for solar energy. Such conditions are ideal for solar thermal applications. Pakistan has potential of producing 92% of its electricity requirements from solar energy, at a rate that's amongst the highest in the world. Solar PV plants can produce 58.1% and concentrated solar plants (CSP) can produce 15% of electricity production. Study of the different solar potential co-ordinates of Pakistan is worth for forth coming planning to utilize solar potential properly and meet power demand of the country.

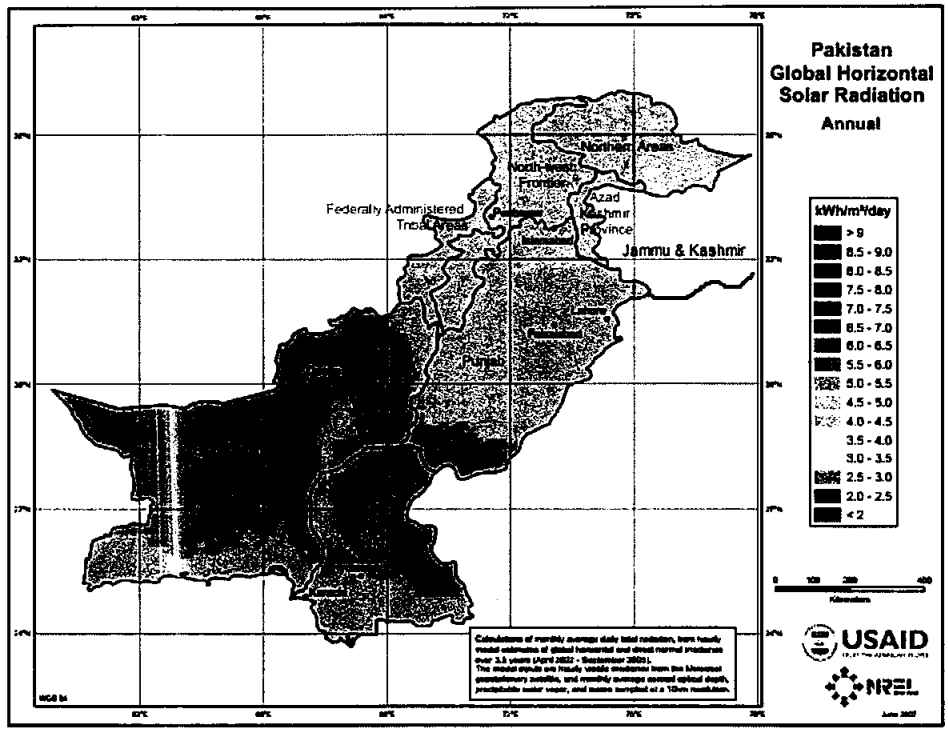


Figure-5: Global horizontal Solar Radiation in Pakistan, mapping done by NREL

Temperature variation in Lahore

As Pakistan is also facing the change in its climatic conditions, especially in the temperature which seems to be risen considerably. Climate has intrinsic variability and has been changing in past few decades, even, before we started measuring the climate parameters. The uniqueness of this issue in modern world is that human activities are now playing significant role in causing the climate to change. This is evident from the recent rise in carbon dioxide (CO_2) concentration in the atmosphere and in response the rise of global temperatures on land and ocean's surface. Lahore experiences significant seasonal variations in temperature with the average monthly temperature varying from 15.9°Cin January to 40 °C in June.

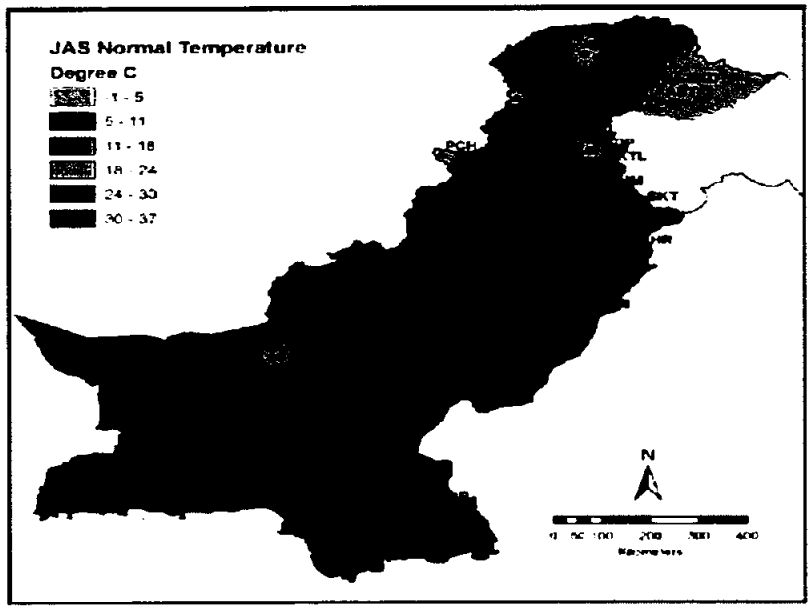


Figure-6. Average temperature distribution over Pakistan.

There are two weather stations near enough to contribute to our estimation of the temperature and dew point in Lahore.For each station, the records are corrected for the elevation difference between that station and Lahore according to the International Standard Atmosphere, and by the relative change present in the MERRA-2 satellite era reanalysis between the two locations. The estimated value at Lahore is computed as the weighted average of the individual contributions from each station, with weights proportional to the inverse of the distance between Lahore and a given station.

1. Temperature and Dew Point

January is the coldest month in Lahore, with an average high-temperature of 19.8°C (67.6°F) and an average low-temperature of 5.9°C (42.6°F). June is the warmest month, with an average high-temperature of 40.4°C (104.7°F) and an average low-temperature of 27.4°C (81.3°F).

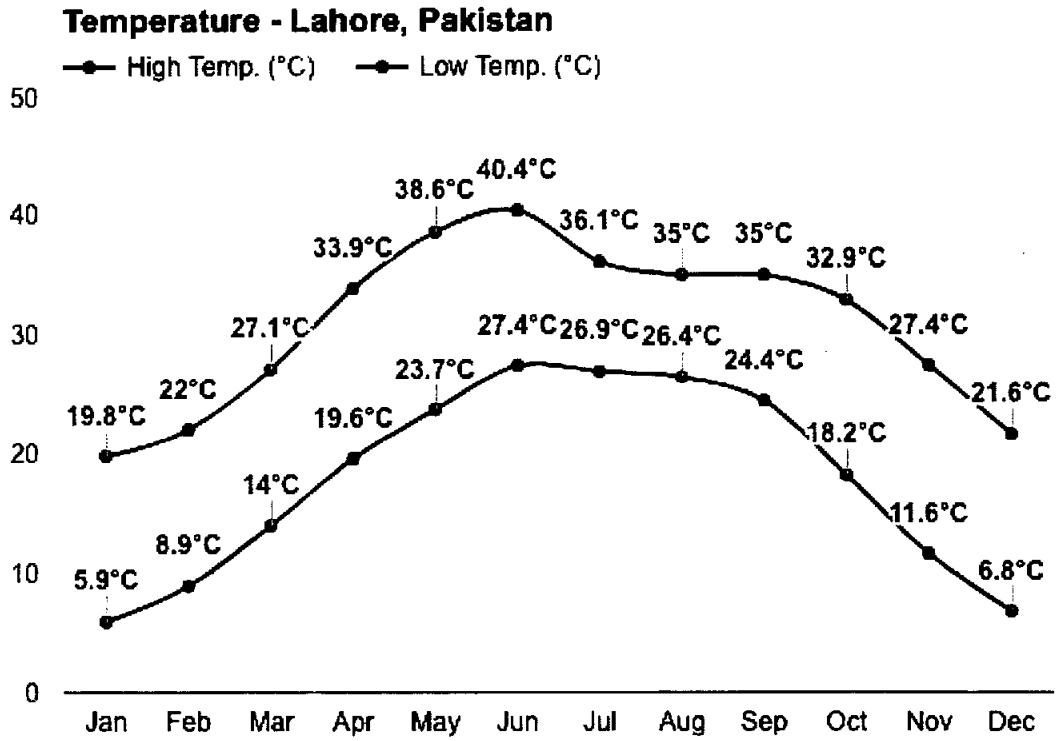


Figure-7. Temperature distribution over maximum average temperature and minimum average temperature over past 30 years.

The red line shows the mean daily maximum shows the maximum temperature of an average day of a month for Lahore. The blue line indicates the minimum temperature variation. The overall graph indicates the average of the hottest day and coldest night of each of the month over the last 30 years.

Rainfall statistics of Lahore

Throughout the year, in Lahore, there are 63 rainfall days, and 628.8mm (24.8") of precipitation is accumulated. January and December, with an average maximum UV index of 3, are months with the lowest UV index in Lahore. July is the month with the most rainfall in Lahore, Pakistan. Rain falls for 11 days and accumulates 202.1mm (8") of precipitation. November is the month with the least rainfall in Lahore. Rain falls for 1 days and accumulates 4.2mm (0.2") of precipitation.

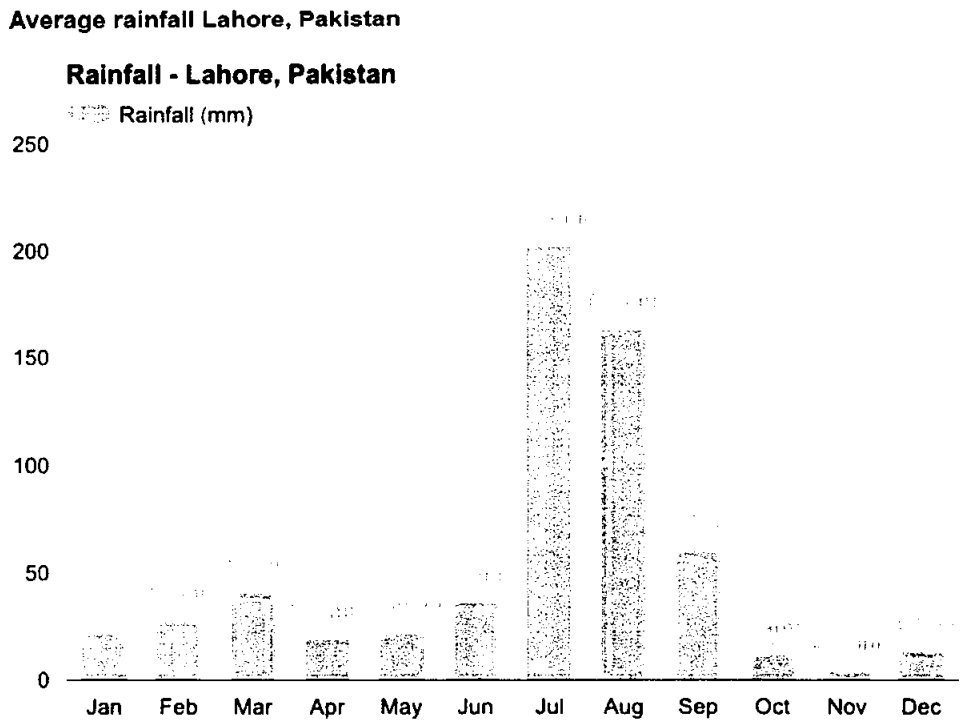


Figure-8. Annual rainfall statistics of Lahore

Percipitation

At least 0.04 inches of liquid or liquid-equivalent precipitation is required to be considered a wet day. The chances of wet days in Lahore varies significantly throughout the year. The wetter season lasts for about 2.5 months, from June 22 to September 8, with a greater than 26 % chance of a given day being a wet day. The chance of a wet day peaks at 51 % on July 22. The drier season lasts 9.5 months, from September 8 to June 22. The smallest chance of a wet day is 2% on November 5. Among wet days, we distinguish between those that experience rain alone, snow alone, or a mixture of the two. Based on this categorization, the most common form of precipitation throughout the year is rain alone, with a peak probability of 51% on July 22.

Wind speed in Lahore

This section discusses the wide-area hourly average wind vector (speed and direction) at10 meters over the ground. The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than

hourly averages. The average hourly wind speed in Lahore experiences mild seasonal variation over the course of the year.

The windier part of the year lasts for 5.9 months from January 21 to January 27, with average wind speeds of more than5.3 miles per hour. The windiest part of the year is April 16, with an average hourly wind speed of 6.3 miles per hour.

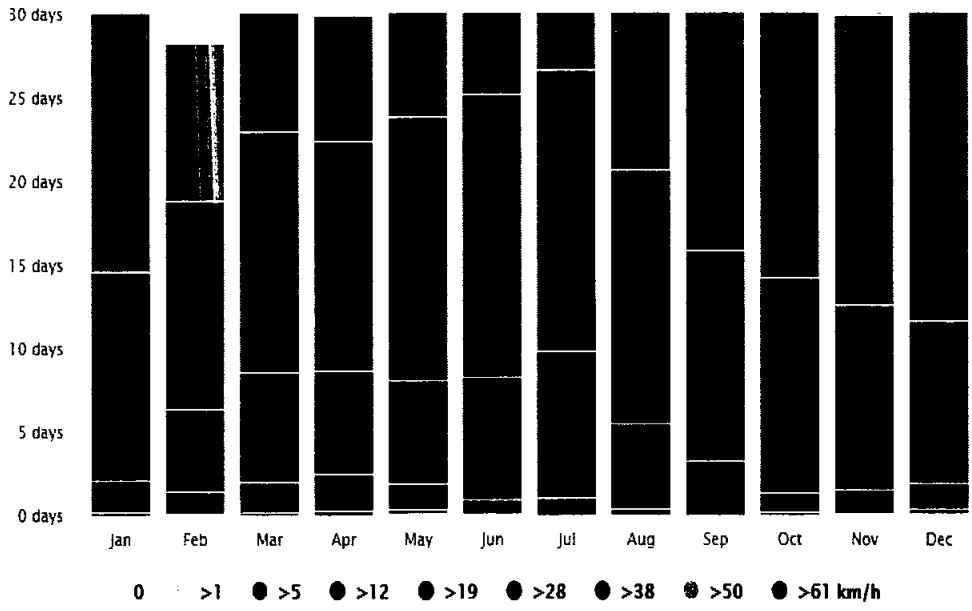


Figure-9. Monthly wind distribution in Lahore.

The above figure represents the day per month during which the wind reaches a certain speed in Lahore. The monsoon creates steady strong winds from December to April, and calm winds in October. The calmer time of year lasts for 6.1 months, from July 17 to January 21. The calmest day of the year is September 23, with an average hourly wind speed of 4.3 miles per hour.

The wind rose for Lahore shows the hours per year the wind blows from the indicated direction. For example SW: Wind is blowing from South-West (SW) to North-East (NE).

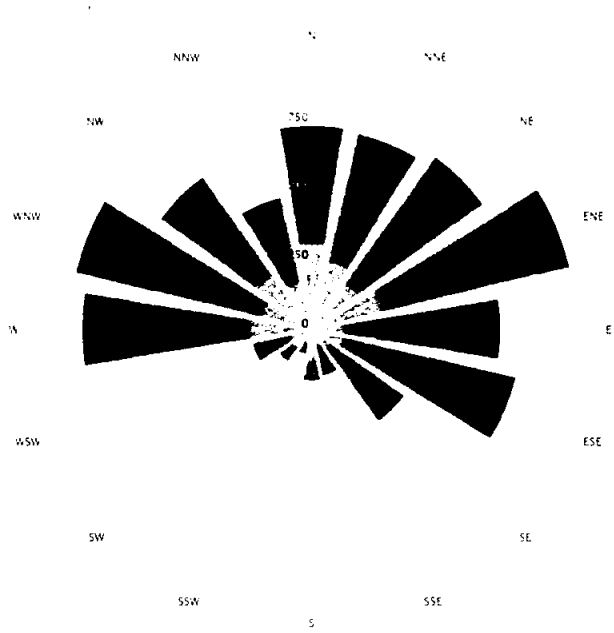


Figure-10. Wind rose diagram indicating the direction of wind in Lahore

Relative Humidity

The humidity comfort level is based on the dew point, as it determines whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid. Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night. Lahore experiences extreme seasonal variation in the perceived humidity.

The muggier period of the year lasts for 4.2 months from June 3rd to October 10th, during which time the comfort level is muggy, oppressive or miserable at least 25 % of the time. The muggiest day of the year is August 11, with muggy conditions 99% of the time. The least muggy day of the year is December 19, when muggy conditions are essentially unheard of.

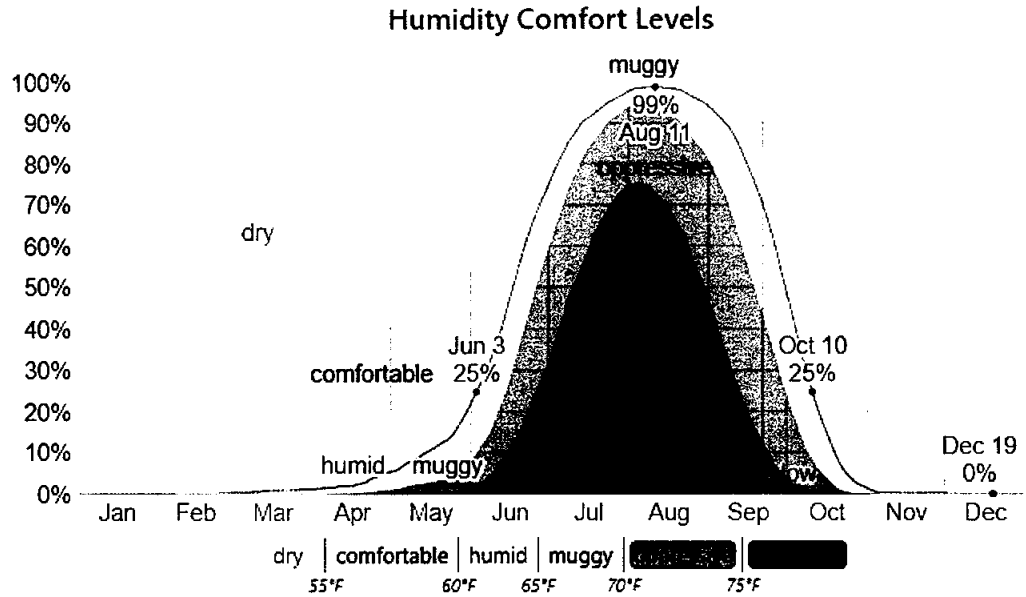


Figure-11.Annual Humidity distribution in Lahore.

Ecology

Although Lahore has expanded in area, alongside modern additions to the city are the ancient monuments, old gardens, graveyards, traditional bungalows with attached gardens, large expanses of lawn and old roadside trees.

Ornithologists have documented the number of bird species in Lahore to be 240 bird species. In another study (1992) only 101 bird species from the parks of Lahore were recorded. However, with an increase in the rate of urbanization, the ecology of Lahore has been considerably affected and bird population reduced to 85, including both residents and migrants. Resident species include Indian grey hornbill, yellow-footed green pigeon, parakeets, bulbuls, doves, spotted owlet, Old World babblers, Old World flycatchers, mynas, woodpeckers, crows, black kites, ashy prinia, redstarts, warblers, red-wattled lapwing, kingfishers, and the Indian white-eye.

As for the birds, there is no impact on the birds due to the solar panels; the panels that are used in the project are lined with anti-reflection coating which helps to reduce the reflection of the panels to almost zero. When the Solar PV panels will be installed on the ground mounted structure, there is a minor disturbance of flora and fauna due to execution of this project.

TECHNICAL ANALYSIS

Site Conditions

The following tasks were carried out:

- Global Horizontal Irradiation, annual and inter-annual variation was assessed.
- Near shading objects were taken into account for placement of PV modules.
- Area required for selected module technology was calculated, keeping in view available area and minimum inter row shading, tilt angle and appropriate spacing was calculated from near shading objects.

Technology Review and Selection

Zero Carbon Power has been recognized for utilizing Tier-1 brands only. The following is the details of technology rendered within this project.

Table-1. Solar PV Modules

Sr. #	Specifications	Data
1	Type of Module	JA Solar, JAM72S30 – 535 W
2	Type of Cell	Mono Crystalline
3	Type of Technology	Half cell PERC technology
3	Dimensions of each module	2279 ± 2mm x 1135 ±2mm x 35 ± 1 mm
4	Weight	28.5 kg
5	Number of Modules	5840
7	Total Land Area Used	Approx.29,288 m^2
8	Module Frame	Galvanized Iron
9	Nominal Max. Power (Pmax)	535 Wp
10	Opt. Operating Voltage (Vmp)	41.93 V

11	Opt. Operating Current (Imp)	12.76 A
12	Open Circuit Voltage (Voc)	49.78 V
13	Short Circuit Current (Isc)	13.52 A
14	Module Efficiency	20.7 %
15	Operating Temperature	-40°C ~ +85°C
16	Max System Voltage	1500V (IEC/UL) or 1000V (IEC/UL)
17	Module Fire Performance	TYPE 1 (UL 1703) or CLASS C (IEC 61730)

Table-2. PV Capacity

1	Total Size	3.12 MW_p
2	Net Capacity Factor	16.0%

Table-3. Solar Inverters

3.1 Model : HUAWEI SUN 2000-60KTL-M0

1	Manufacturer	Huawei
2	Capacity of Each Inverter	60,000 Watts
3	NO of Inverters	39
4	MPPT Input Voltage Range	200-1000V
5	Rated Input Voltage	680V
6	Max input Voltage	1100V
7	Total Power AC	60,000 Watts
8	Max Input Current Per MPPT	22A

9	Max Output Current	95.3A
10	Output Electrical System	3 Phase 4 Wire
11	AC Nominal Voltage	230/400 V
12	Rated Power Frequency	50Hz
13	Efficiency	98.7%
14	Relative Humidity (Non Condensing)	0 ~ 100%
15	Degree of Protection	IP 65

3.2 Model : HUAWEI SUN 2000 -100 KTL-M1

1	Manufacturer	Huawei
2	Capacity of each Inverter	100,000 Watts
3	No of Inverters	3
4	MPPT Input Voltage Range	200~1000 V
5	Rated Input Voltage	600 V
6	Max input Voltage	1100 V
7	Total Power AC	110,000 Watts
8	Max Input Current Per MPPT	26 A
9	Max Output Current	40 A
10	Output Electrical System	3 Phase 4 Wire
11	AC Nominal Voltage	230/400 V
12	Rated Power Frequency	50 Hz

13	Efficiency	98.7%
14	Relative Humidity (Non Condensing)	0 ~ 100%
15	Degree of Protection	IP 66

Table-4. PV Mounting Structure

Sr. #	Specifications	Data
1	Structure	GI Based Roof Mounted and Car Port Sheds
2	Tilt For Roof arrays	15°

Table-5. Data Logging and Monitoring System

Sr. #	Specifications	Data
1	System Data Logging	Continuous Data logging and monitoring through web portal.

Solar PV Yield Estimation and Simulation

The aim of yield estimation is to predict the average annual energy output of the site. Helioscope software is used for simulation and near shading analysis. The land was cleared earlier to place the Solar Panels, any remaining hindrance is considered as keepout in the simulation process.

Working Conditions

The solar system will have automatic mechanism to ensure that PV power currently generated by the inverters always matches the current power consumption of the site load. A closed loop control system of inverter AC output is implemented in reference to energy flow at grid connection point which will reduce inverter AC output of the inverter if site load will be less than the solar production under load shedding conditions.

Plant Characteristics

Generation Voltage: 230/400 V three phase four wire system

Power Factor at rated power: 1

Frequency: 50 Hz

Generation characteristic: Inverter has built-in features of controllable active power ramp following grid disturbance or normal connection, voltage regulation and frequency response. There are no additional control metering and instrumentations.

Design Parameters

The following tasks were carried out for PV layout and shading.

•Assessment of shading (horizon and nearby building)

•Outline layout of area suitable for PV development

•Designing row spacing to reduce inter-row shading and associated shading losses.

•Designing the layout to minimize cable runs and associated electrical losses

•Creating access routes and. sufficient space to allow movement for maintenance purposes

•Choosing a tilt angle that optimizes the annual energy yield according to the latitude of the site and the annual distribution of solar resource.

•Module cleaning strategy

•Simulating the annual energy losses associated with various configurations of tiltt angle, orientation and row spacing. The optimized configuration and simulation results are given in section "Energy Yield Prediction"

Energy Yield Estimation

The energy yield prediction provides the basis for calculating project revenues. The aim is to predict the average annual energy output for the lifetime of the proposed power plant. To estimate accurately the energy produced from a PV power plant, information is needed on the solar resource and temperature conditions of the site. Also required are the layout and technical specifications of the plant components.

A number of solar energy yield prediction software packages are available in the market. These packages use time step simulation to model the performance of a project over the course of a year.

Helioscope software has been used for energy yield prediction for this site and its results are given below.

Details of the simulation steps are presented in the technical schedule.

Layout

The detailed layout (2D) of the solar panels is given 'below' PV layout may change depending upon site constraints before or during installation. Helioscope simulation. Is also performed as per following layout:

Figure-12. 2D layout of project site to be utilized.

Electrical Design

The electrical system comprises the following components:

- Array(s) of Solar Photovoltaic modules
- DC cables for string connections and AC cables for inverters interconnections.

- DC connectors (plugs and sockets)
- Disconnects/switches
- Protection devices e.g. fuses, surge protective devices, beakers
- Smart Energy Meters/ Bi directional meters.
- To ground the Solar Power plant, earthing and boring.

Protections DC Side: Surge Protective Device and DC Disconnect Switches

Protections AC Side: MCBs, Main Breaker and Surge Protective Device

Single Line Diagram

The single line diagrams of the 3.12 MW On-Grid Solar Power Plants has been attached as **Annexures** in **Section IV** of **Schedule II**. The detailed description is that various rooftops, shell roofs and sheds have been used with separate termination points along the vicinity.

OPERATION AND MAINTENANCE SERVICES

1. Operations and Maintenance services involve three basic functions: rapid problem identification and resolution, minimization of downtime due to faults, and comprehensive reporting and transparency of the operational solar PV plant.
2. The real time cloud based data monitoring will be done by the O&M team as a part of preventive maintenance.
3. The maintenance and servicing tasks will be carried out under the supervision of designated Zero Carbon's Operations & Maintenance (O&M) manager, only qualified and trained individuals will comprise of the O&M team who will be allowed to do undertake the required tasks.
4. The O& M team will wear appropriate Personal Protective Equipment PPE, including a safety harness to restrain from falling off the roof.
5. The PPE will include sturdy shoes that will have thick rubber soles to provide electrical insulation, good grip and appropriate clothing, including a hat, sunglasses, gloves and long pants.
6. Lock out and tag out procedures will be used before commencement of maintenance tasks.

7. On-going operation and maintenance concerns for solar power systems will be addressed properly. These systems are exposed to outdoor weather conditions that enhance the aging process, and the infrastructure needs to be in place for the on-going maintenance of these systems to assure their safe operation.
8. Properly grounded or double insulated power tools will be used for maintenance tasks. Tools will be maintained in good condition.
9. Working on electrical equipment and circuits will be carried out in non-operational state after shut down.
10. Proper pathways will be available for operation, maintenance and fire fighting.
11. Fire protection and suppression will be placed at site.

HEALTH AND SAFETY POLICY

Zero Carbon Power Private Limited considers safety as an integral part of its vision and mission, to comply with best international practices, its Health and Safety Policy ensures safe working environment for every individual on field. Working safely is as important as the skills and techniques used with typical construction tools. Good safety practices are considered a more valuable skill. Safe installations are more efficient and cost effective. Using equipment properly and working safely results in less time lost to injuries and the delays on the working end. Thus, saving time and efficiency. We commit to offering a safe and healthy working environment for our employees and additional workforce, eliminating hazards and reducing occupational health and safety risks in all our operations.

Personal Protective Equipment (PPE)

Using personal protective equipment is often essential, but it is generally the last line of defense, after engineering controls, work practices, and administrative controls. Solar energy workers can be exposed to many hazards that may require the use of personal protective equipment.

- The On-site PPE mandatory for all workers include, PPE jackets, Hard hats and glasses while working on welding and electrical operations.
- Workers exposed to potential electrical hazards must utilize the appropriate electrical protective equipment provided by Zero Carbon's HSE or site supervisor.

- HSE Supervisor should enforce the use of PPE necessary to execute the task that poses a potential threat to workers.
- Electrical protective equipment must be maintained in a safe and reliable condition.

Emergency Response Plan

To describe responsibilities in preparation for, response to and recovery from any reasonably foreseeable incident.

Team Leader

- Secure the Health and Safety of all personnel involved Minimize any impact on the environment. Minimize any impact on property and assets.
- The person is responsible to manage the execution of emergency response. The main responsibilities include.
- Lead the team in case of emergency.
- Ensuring that appropriate emergency response teams are defined and prepared for the various emergency response in different cases.
- Notification to Project Manager of any emergency incident.
- Emergency should be notify via radio, telephone or messenger.

2.Site Engineer (HSE)

Site Engineer is responsible for ensuring at site that provisions are in place for emergency response, including:

- In the event of any emergency, following actions shall be taken by Site Engineer.
- Maintenance and overlooking of the equipment regularly.
- Identification & mobilization of Fire Team in case of emergency.
- Analyse the situation and issue direction to the concerned parties and to the Fire Team.
- To make sure that the emergency situation is properly communicated to ERT leader.
- Analyse the intensity of the incident and raise the requirement of any additional equipment if necessary.
- Communicate with site supervisor for withdrawing any permits and for mobilization of any plant and equipment necessary for dealing with emergency.

They personal protective equipment must be periodically inspected for wear and tear or any other damage.

TRAINING AND CAPACITY DEVELOPMENT

Trained and qualified personnel will be available at site 24/7 with proper safety and fire fighting training. Training program will focus on but not limited to Solar Resource Assessment, Site Survey, Technology, Engineering Design, Regulation, Policy, Metering & Billing and Project Management of Rooftop Solar System. The following components will include in training and Development program.

a) Collection of Resource Data
b) Variability and uncertainty of resource data
c) Site evaluation for installation purposes.
d) The technology comparison of PV Modules.
e) Rooftop solar system components
f) Module mounting structure and material selection
g) Selection of inverter based on the design.
h) Design of PV Array (stringing)
i) Shadow Analysis via simulations in different softwares.
j) DC cable sizing
k) DC cable layout
l) Protection equipment including circuit breakers, DC switches and switchgears.
m) Installation and testing standards for solar PV plants
n) Solar Module testing standards
o) Economy of Roof top Solar System
p) Detailed Project Report
q) Operation and maintenance of rooftop and carport solar system
r) Safety and fire fighting training.

Environmental Aspects

Every energy generation and transmission method affects the environment. Conventional generating options can damage air, climate, water, land and wildlife, landscape as well as raise the levels of harmful radiation. PV technology is substantially safer offering a solution to-many environmental and social problems associated with fossil and nuclear fuels: Solar PV energy technology provides obvious environmental advantages in comparison to the conventional energy sources thus contributing to the sustainable development of human activities. Not counting the depletion of the exhausted natural resources, their main advantage is related to the reduced CO2 emissions and normally absence of any air emissions or waste products during their operation.
The use of solar power has additional positive implications such as:

- Reduction of the emissions of the greenhouse gases (mainly CO_2, NO_x) and prevention of toxic gas emissions (SO_2 particulates).
- Reduction of the required transmission lines of the electricity grids.

Socio-Economic Aspects

In regard to the socio-economic viewpoint, the benefits of generating electricity from solar PV system comprise of:

- Increase of the regional/national energy independency
- Provision of significant work opportunities
- Diversification and security of energy supply
- Support of the deregulation of energy markets

CONCLUSION

This feasibility study is conducted to ascertain the technical feasibility and commercial viability of installation of 3.12 MWp rooftop and carport PV system installations at Packages Converter Private Limited, Walton Road, Gulshan Colony,Lahore.
Installation of the PV system will result in annual power generation of 4327 GWh, The results of the financial analysis indicate that the project is feasible. Based on the outcomes of both the technical and financial analysis, the project is deemed viable.

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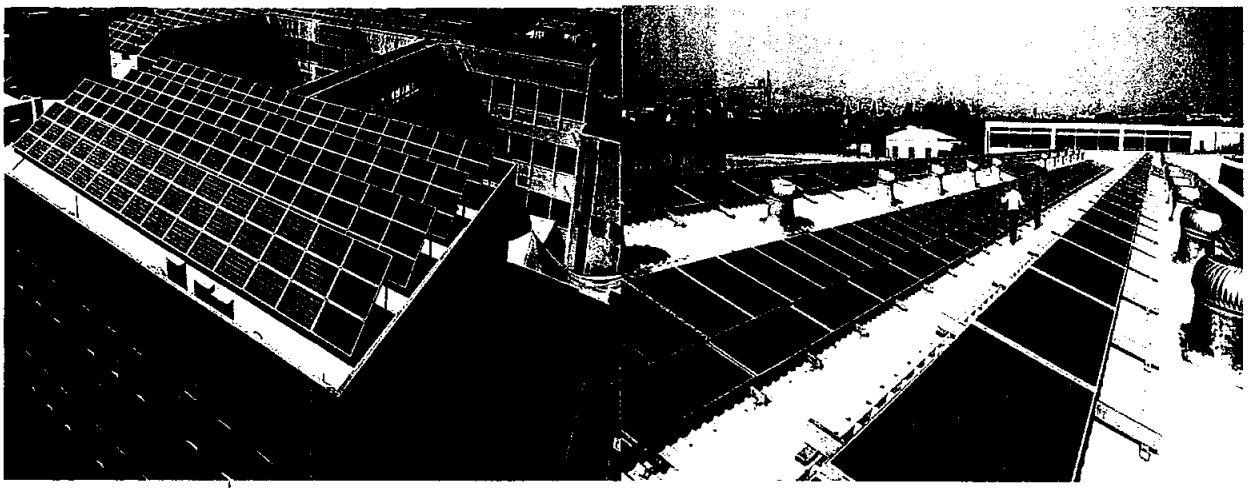
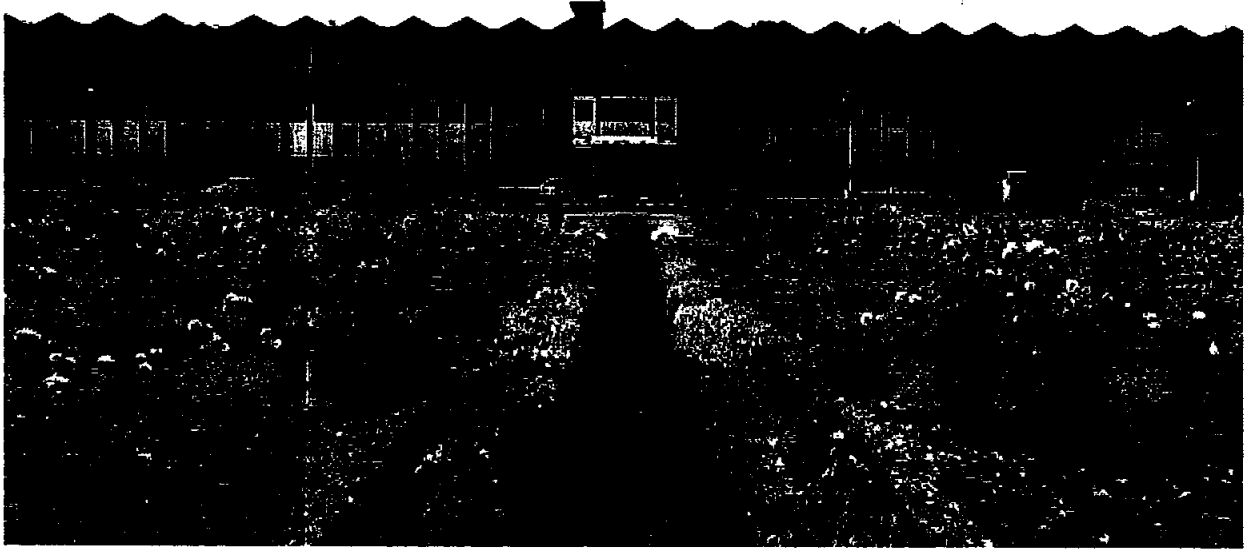
Grid Study

In context to 3.12MW Power Purchase Agreement with Packages Limited located at Walton Road, Gulshan Colony, Lahore, the system studies, load flow, short circuit stability & reliability are not applicable since the energy generation from the solar power plant is being 100% utilized by the consumer.

Zero Carbon (Private) Limited

PREMILINARY ENVIRONMENTAL REPORT OF LAHORE PACKAGES CONVERTORS PRIVATE LIMITED





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EXECUTIVE SUMMARY

Packages Convertors Private Limited (PCPL) is interested to install Solar PV Panels on the rooftop and parking sheds of the factory with capacity of 3.12 MW in Lahore. Around 5841 monocrystalline (Tier 1 Manufactured) PV panels will be installed with power rated of 535 Watts and the capacity factor is approximately 16.0%. the total energy generation will around 4.32 GWh.

The Packages Convertors Private Limited (PCPL) wants to decrease the electricity utilization from conventional grid due to cost-saving. Under these circumstances, PCPL has decided to switch the maximum load on Solar PV System that will produce the cheaper units than the conventional grid units.

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1 PROJECT BACKGROUND AND JUSTIFICATION

The project is financed by Standard Chartered Bank (SBP). The sponsors of the company will be interested to install the solar PV plant to generate electricity. Zero Carbon Power Pvt. Ltd (The Seller)intends to install a Grid-Tie Solar PV Power Plant at Packages Convertors Private Limited (PCPL) (The Purchaser) in Lahore in the factory premises (rooftop and Parking sheds), by which they can reduce the electricity consumption from the conventional grid and use the Solar generated units for running the load of 3.12 MW Solar PV Plant has been designed for PCPL which will get synchronize with the LV termination panel of the proposed site located at Walton Road, Gulshan Colony, Lahore. The site is located at Gulshan Colony, Lahore in the province of Punjab.

1.2 Description of the Project

The project company will be installed 3.12 MW of Solar PV plant in Packages Convertors Private Limited, Lahore to produce electricity. The total area of the project is around 7.23 acres for the installation of PV panels. The project area is already a developed area and cleared area at rooftop and parking sheds of the factory.

1.3 Project Location

The proposed project site lies between 31°28'5.50"N and 74°21'5.00"E 31°32'54.94"N and located in Gulshan Colony, Lahore -Punjab. It is around 10.5 kilometers away from Lahore City. The land area of project site is 7.23 acres located in Gulshan Colony at Walton Road. The project land is owned by the Project Company (The Purchaser) for the installation of 3.12 MW Solar PV plant. The location of site can be viewed in **Figure 1.1** and overview of the project site is shown in **Figure 1.2.**

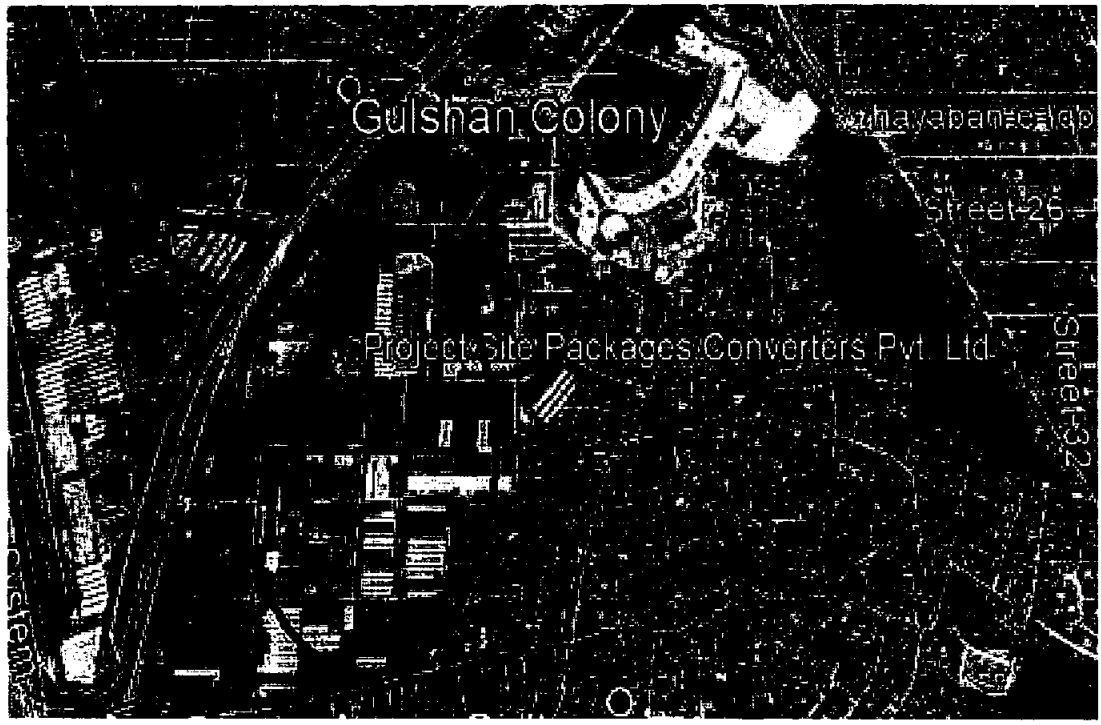

Figure 1.1: Location of Project Site

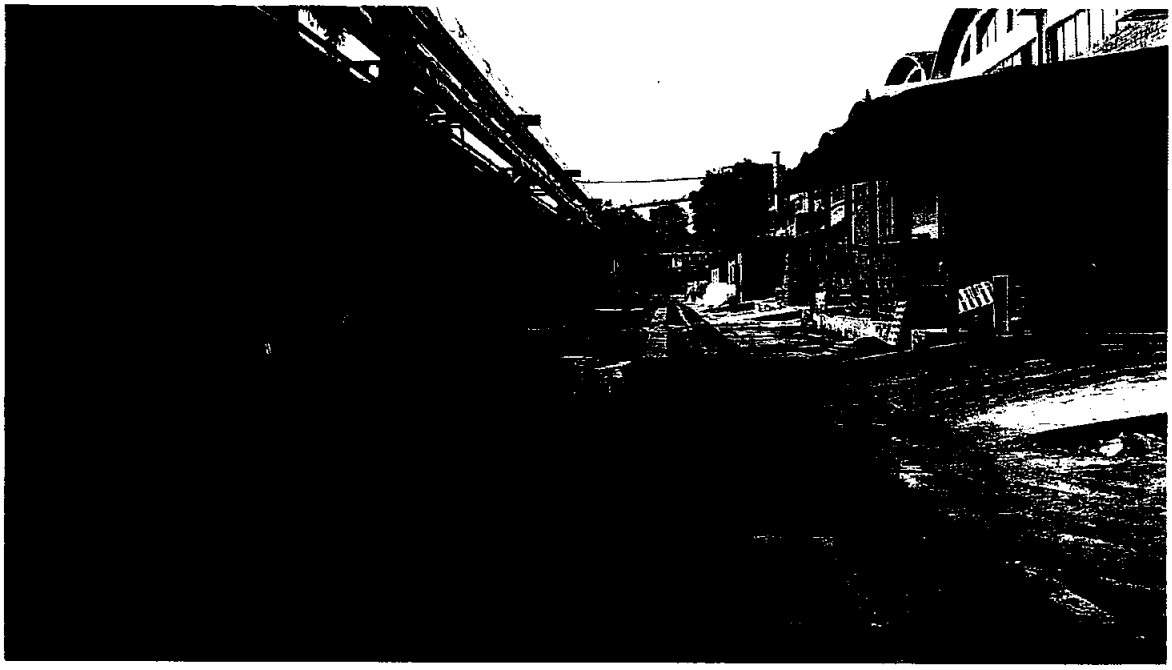

Figure 1.2: Overview of Project Site (Picture-I)

Figure 1.3: Overview of Project Site (Picture-II)

CHAPTER 2

SOLAR ENERGY IN PAKISTAN

2 PROSPECTS OF SOLAR ENERGY IN PAKISTAN

Solar energy has excellent potential in areas of Pakistan that receive high levels of solar radiation throughout the year. Every day, for example, the country receives an average of about 19 Mega Joules per square meter of solar energy. Pakistan being in the Sun Belt is ideally located to take advantage of solar energy technologies. This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200-250 watt per sq.m in a day. This amounts to about 2500-3000 sun shine hours and 1.9 - 2.3 MWh per sq.met in a year. It has an average daily global insolation of 19 to 20 MJ/sq.met per day with annual mean sunshine duration of 8 to 8.5 hours (6-7hrs in cold and 10-12 hrs in hot season) and these values are among the highest in the world. For daily global radiation up to 23MJ/m2, 24 (80%) consecutive days are available in this area for solar energy. Such conditions are ideal for solar thermal applications.

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hour of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar thermal power plants. A quick potential of solar energy in Pakistan can be obtained from the map of solar energy resource released by World Bank Group from 1999 to 2016 as shown in **Figure 2.1.**

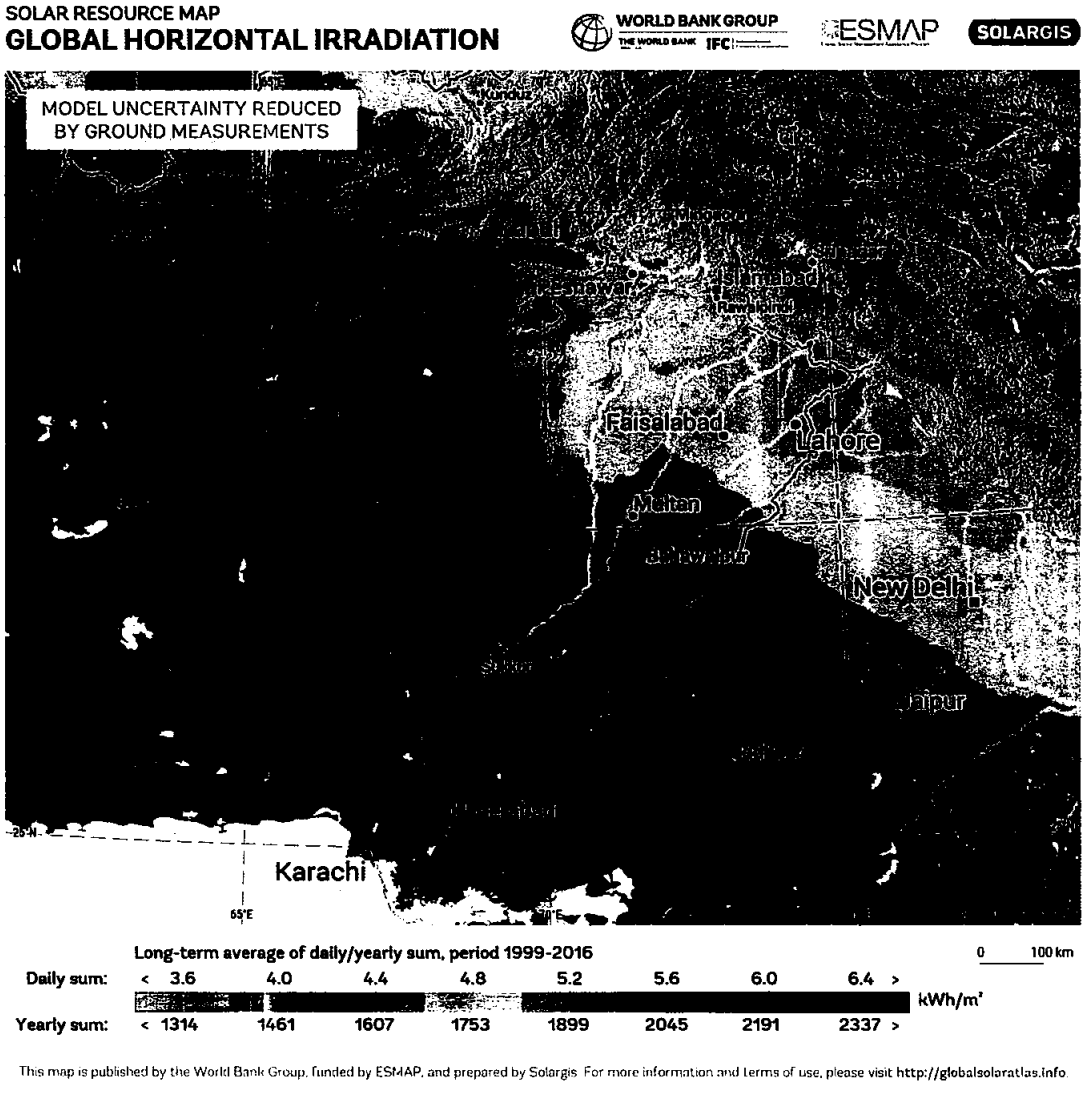

Figure 2.1: Solar Resource Potential Map of Pakistan

2.1 Road Access to the Project Site

The Project site is easily accessible throughout the year. The Lahore-Islamabad motorway (M2) and N-5 G.T Road are the major connecting roads to the Project site, and also the Lahore Ring Road is connected to the project site. The total distance from Lahore to the project site through Main Blvd Gulberg road then turn towards Ferozpur road & Lahore Kasur Road towards Walton Road is approximately 10.5km to the project site as shown in **Figure 2.2 & Figure 2.3**.

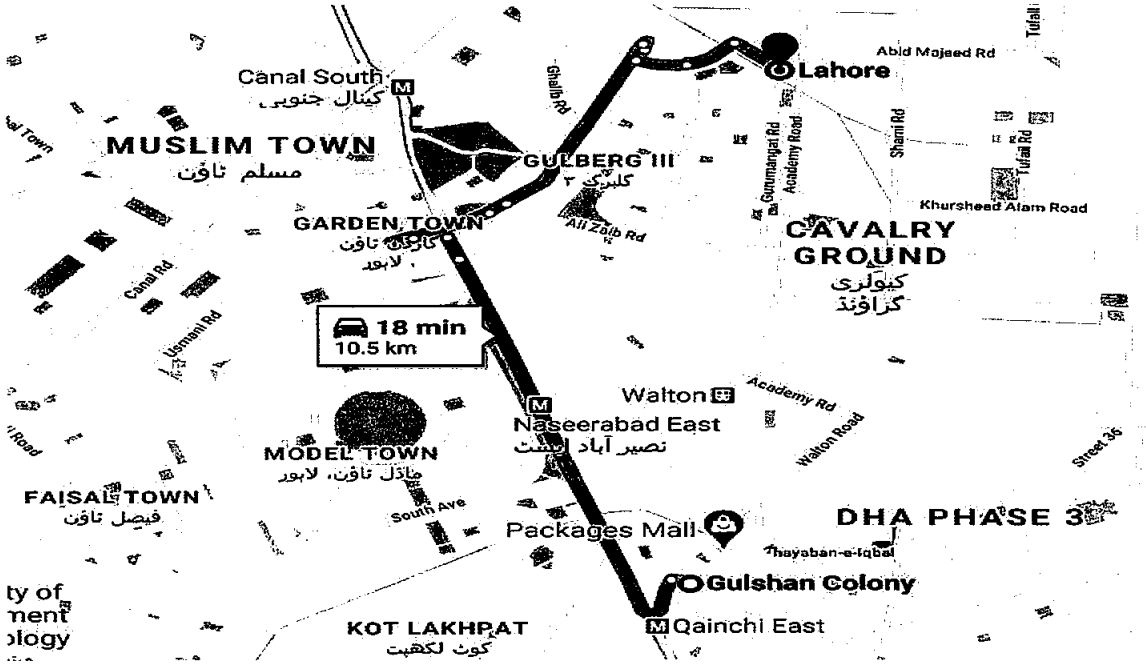

Figure 2.2: Orientation of Project Site from Lahore

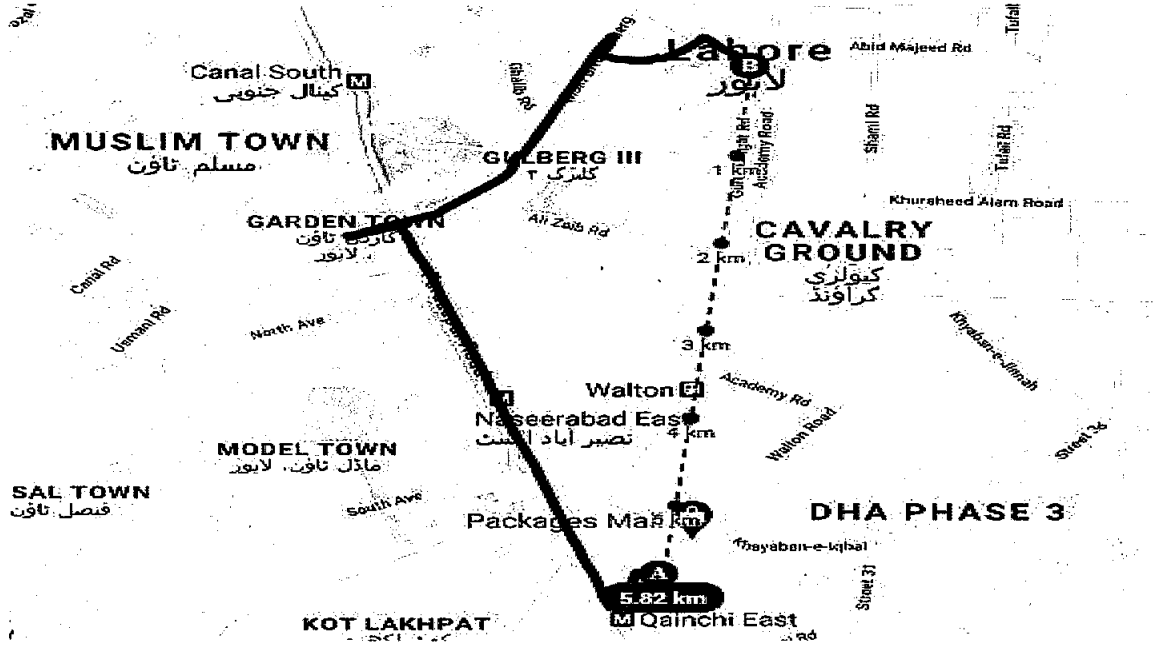

Figure 2.3: Orientation of Project Site from Lahore (Arial Distance)

The planned movement from Port Qasim to the site will be through the National and Super highways. The major section of the track from Karachi to the site is a multi-lane road, having a relatively flat terrain. The distance from port Qasim to the site is approximately 1206km and the Arial distance is around 1018km as shown in figure **Figure 2.4**.

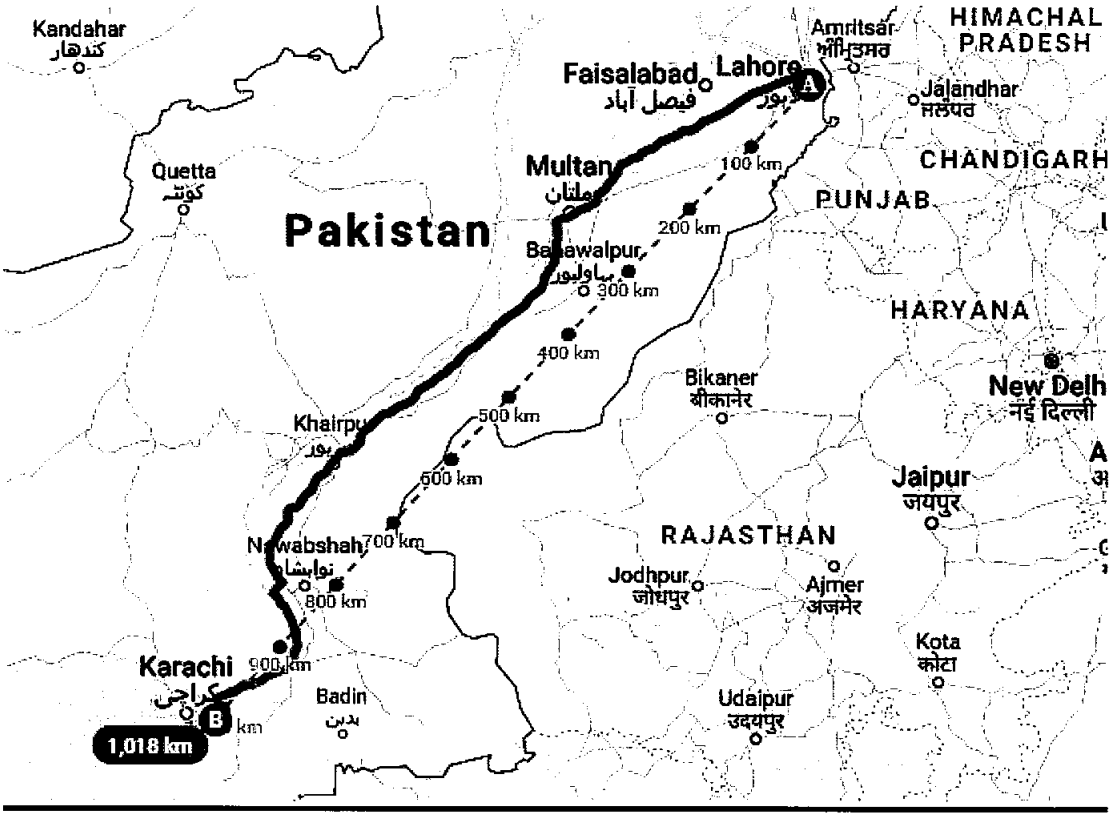

Figure 2.4: Distance from Site to Port Qasim (Arial Distance)

CHAPTER 3

BASELINE CONDITIONS

3 Baseline Conditions

The Baseline condition includes the different parameters which covers under this study are topography, climatic conditions, hydrology, biological conditions, socio-economic environment and seismic hazards.

3.1 Topography

Lahore city lies between 31°15′-31°45′ N and 74°01′-74°39′ E, the second largest city of Pakistan and the capital of Punjab province. It lies 811 miles (1,305 km) northeast of Karachi in the upper Indus plain on the Ravi River, a tributary of the Indus. Lahore is bounded on the north and west by the Sheikhupura District, on the east by Wagah, and on the south by Kasur District. The Ravi River flows on the northern side of Lahore. Lahore city covers a total land area of 404 square kilometres (156 sq mi). at 213.97 meters (702 ft) above sea level.

Lahore is generally flat and slopes towards south and south-west at an average gradient of 1:3000. It can be divided into two parts i.e. the low-lying area along River Ravi and the comparatively upland area in the east away from Ravi. The low lands are generally inundated by the river water during monsoon floods. River Ravi flows in the west of Lahore District forming a boundary with Sheikhupura District. Lahore city lies on the alluvial plain soil called Bari Doab. Doab is a local word for area between rivers. Bari Doab is a part of the Indo-Gangatic alluvial plain formed by the Indus river and its tributaries. It is bounded by Ravi and Chanab rivers in the northwest and west and by Sutlej river in the southeast. Northeastern boundaries of Doab lie near the foothills of the Himalayan Ranges. Lahore city is situated at an average elevation of 210 meters above mean sea level. The alluvial subsoils are of late Pleistocene and were formed by the flood plains of river Ravi. These consist of clay, silt and sand. The thickness of clay increases with distance from the river bed. Topographic map of Lahore derived from satellite mapping is shown in **Figure 3.1.**

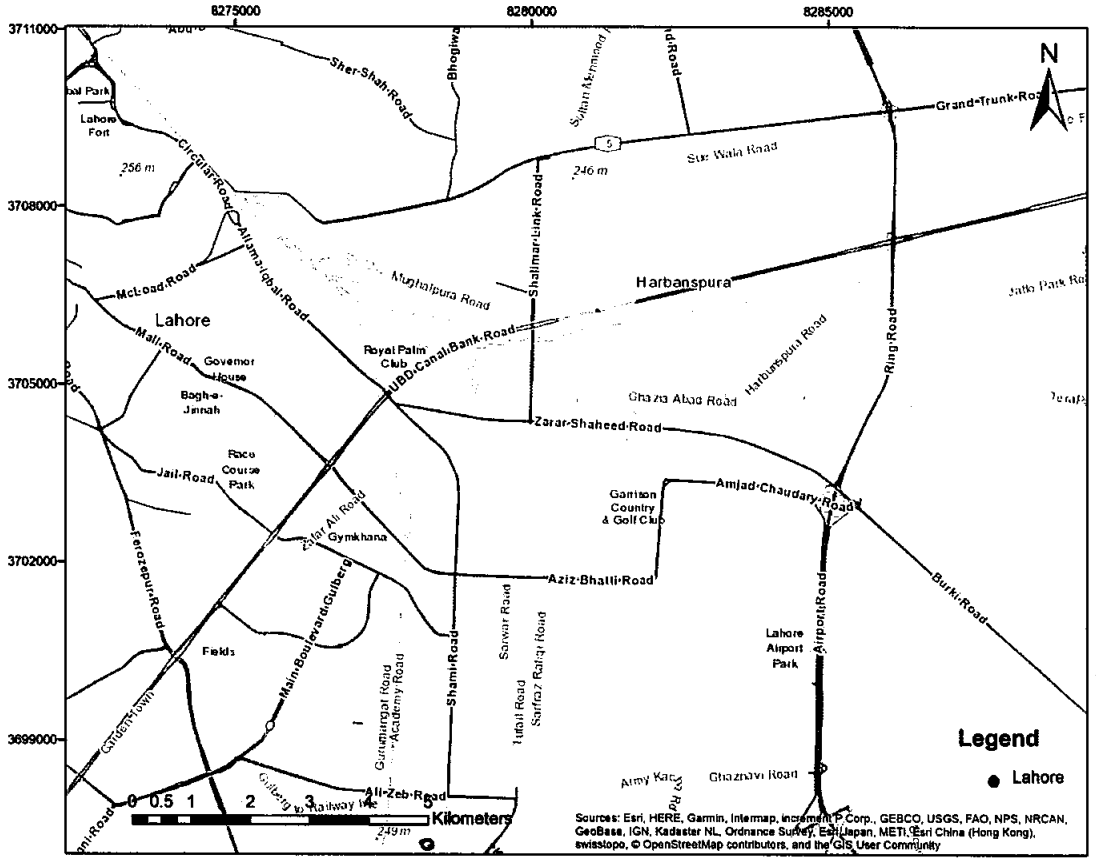

Figure 3.1: Topographic Map of Project Area

3.2 Climatic Conditions

3.2.1 Temperature & Rainfall

Lahore has a semi-arid climate, with extremely hot summers and cool winters. There is a monsoon season between July and September. Lahore's spring season is between February and April, and this is generally considered a very pleasant time. The flowers are in bloom, yet the temperatures are bearable. Daily highs in February begin at a pleasant 22°C, with overnight temperatures of 9°C being a little on the chilly side. The city warms up very quickly, however, and by the end of April daily highs are averaging 34°C with nights already a sultry 20°C. There's very little rainfall during the spring months. The summer season lasts from the month of May to October for almost six months, while the weather is pleasant and cold from November to February. May and June are the hottest months. The monsoon rains hit Lahore in July, August and September, with July being the wettest month. The temperatures are still very high, averaging 37°C during the day and 27°C at night, so the rains come as some relief from the

burning heat. October and November are the autumn months in Lahore, and this is a popular season for tourists. The heat dissipates a little, with average daily highs of around 31°C and the nights are considerably cooler, reaching as low as 11°C by the end of November. In winters, average daily highs are in the region of 23°C in December, January and February, and nights can feel cold at around 6°C. It can be very foggy - and the fog can linger for days or even weeks at a time. The highest rainfall records only in June is about 58.76 millimetres, which is highly seasonal since approximately half of the yearly rainfall takes place also in July and August during the monsoon season.

Lahore has 7-8 hours of sunshine daily on average. As there will be no rise in temperature due to reflections of the panels on the atmosphere because the panels are lined with anti-reflection coating (ARC) on the surface which help to reduce the reflection of the panels to almost zero. Adopted measures during rain and sandstorm are to generate or produce electricity is to be reduced. The detailed temperature data are given in **Table 3.1** taken from metronome 7.7 and graphical presentation in given in **Figure 3.2.**

Table 3.1: Temperature Statistics for Lahore District in 2019

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Temperature(°C)	11.9	15.9	21.5	27.0	32.4	32.2	30.8	30.3	27.9	24.4	17.9	12.9

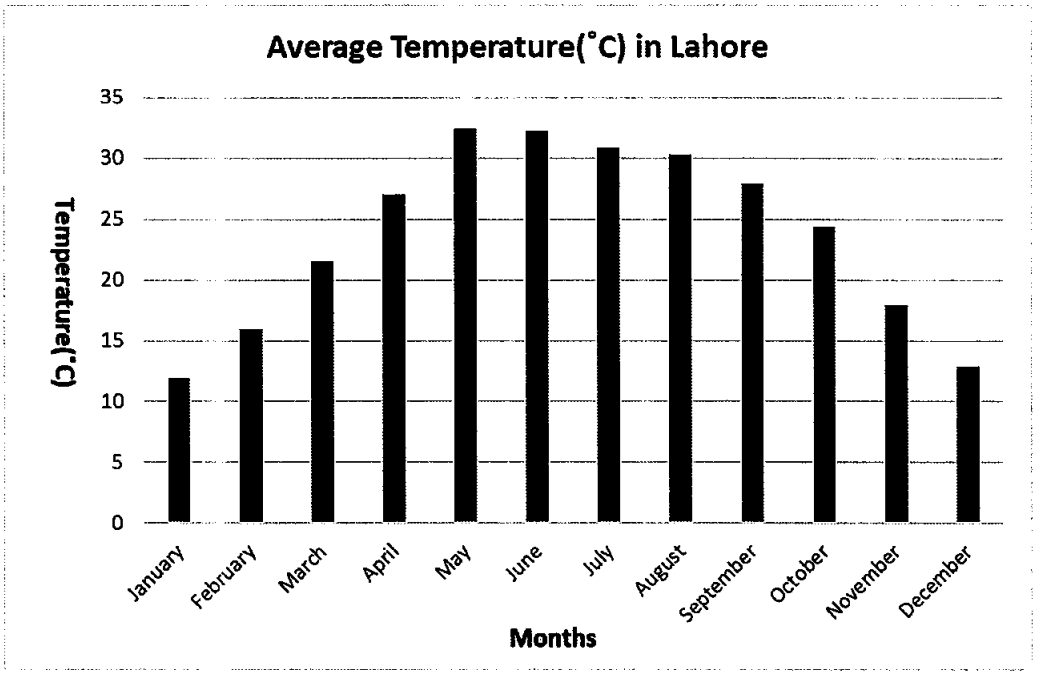

Figure 3.2: Graphical representation of Temperature

The detailed average annual rainfall data are given in **Table 3.2** and graphical presentation in given in **Figure 3.3.**

Table 3.2: Rainfall Statistics for Lahore District in 2019

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Precipation (mm)	36.1	182	35.1	51.2	57.6	21.2	96.3	38.1	24.1	12.6	22.6	27.1
Days	8	13	9	12	14	13	20	13	14	6	11	2

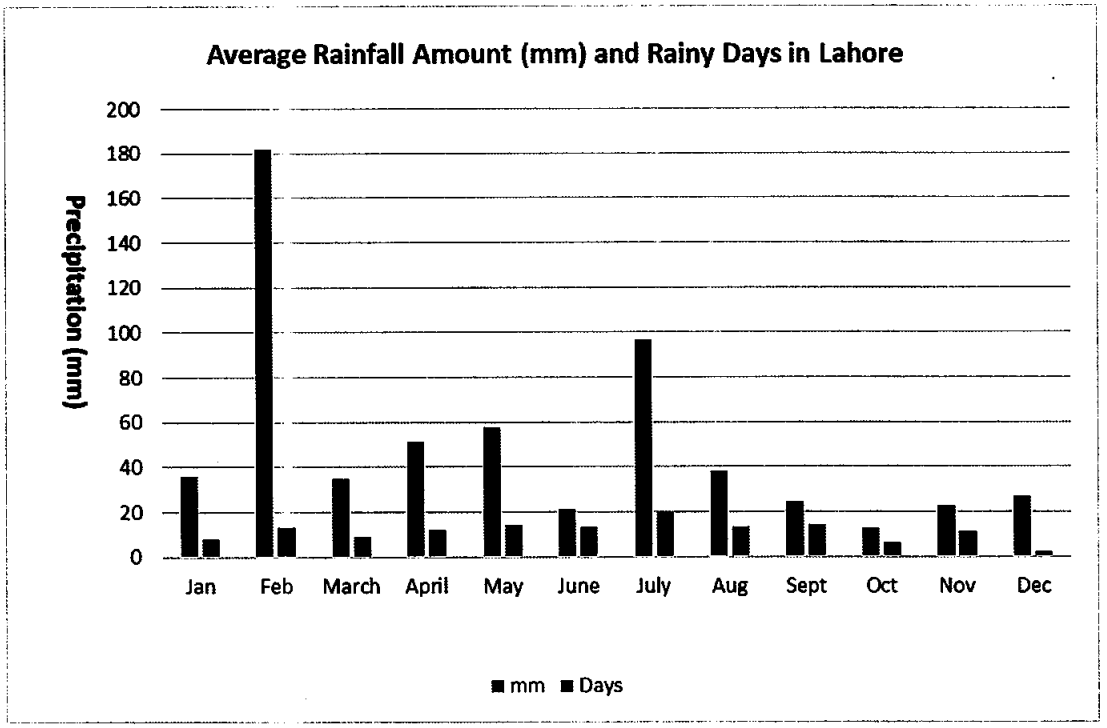

Figure 3.3: Graphical representation of Average Rainfall

Maximum and Minimum Temperature Regime Map of Pakistan is shown in **Figure 3.4**, **Figure 3.5** & **Figure 3.6.**

Figure 3.4: Maximum Temperature Regime Map of Pakistan

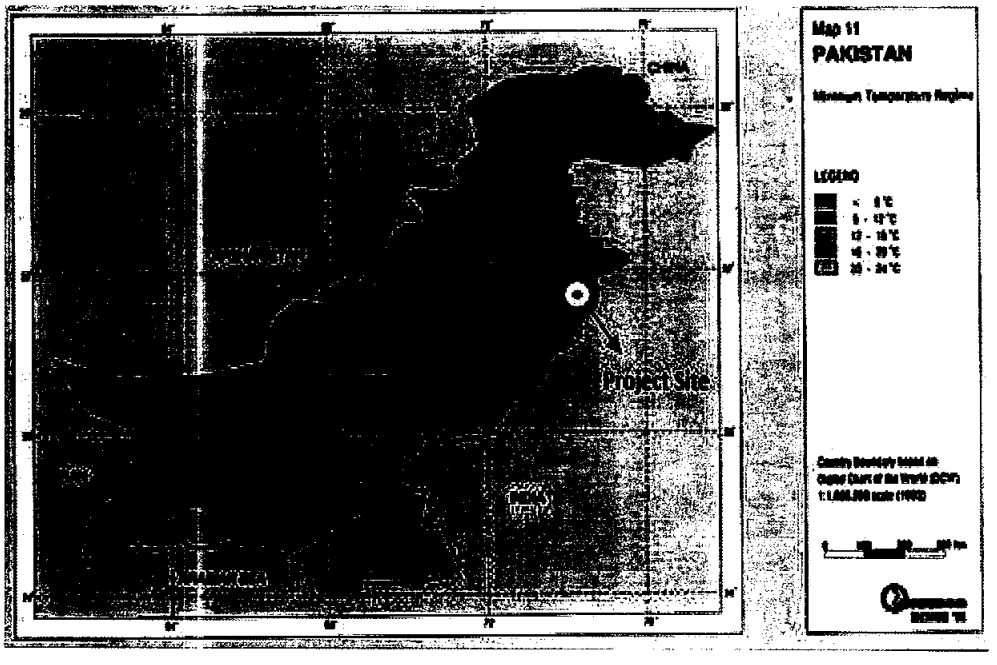

Figure 3.5: Minimum Temperature Regime Map of Pakistan

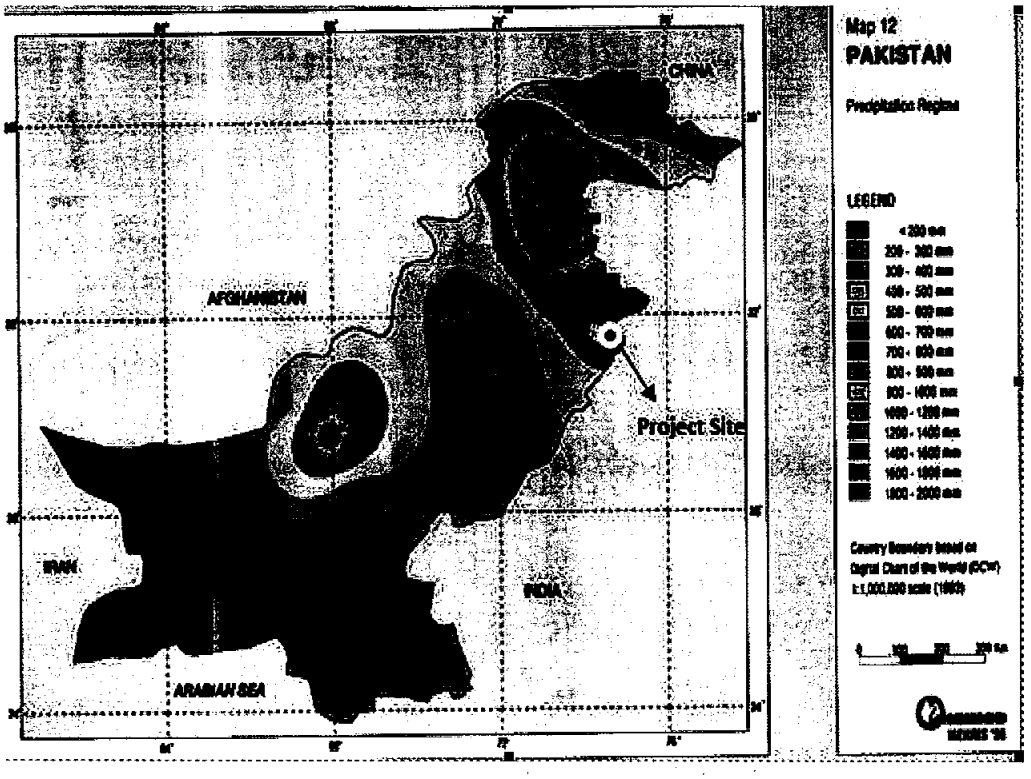

Figure 3.6: Precipitation Map of Pakistan

3.2.2 Wind Speed

The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. The average hourly wind speed in Lahore experiences mild seasonal variation over the course of the year. Westerly breeze dominates the afternoons, while the nights are calm. South east / easterly winds are common here during the monsoon season. Lahore, being in the plains, can experience severe thunderstorms and high wind gusts that can be damaging to its crops.

Wind in Lahore is usually **calm**. The windiest month is June, followed by May and July. June's average wind speed of around 2.11m/s is considered "a light breeze." Maximum sustained winds (the highest speed for the day lasting more than a few moments) are at their highest in late June where average top sustained speeds reach 3.11m/s. The average wind speed on yearly basis are given below in **Figure 3.7**.

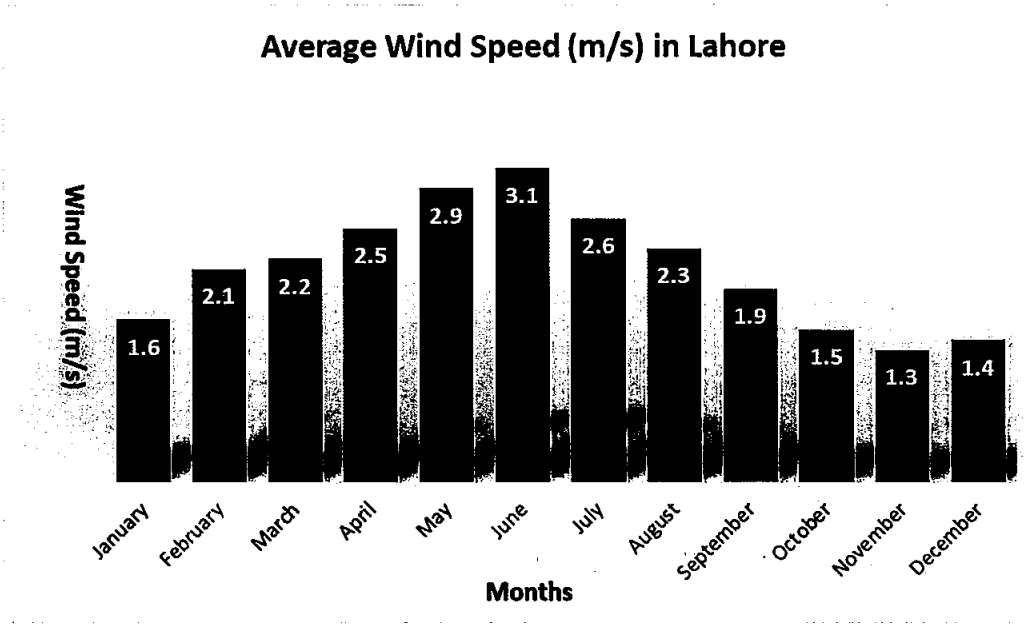

Figure 3.7: Graphical representation of average wind speed in Lahore

3.2.3 Relative Humidity

Lahore experiences extreme seasonal variation in the perceived humidity. Lahore is semi-arid region; the humidity is high. Lahore has some humid months, and dry months in the opposite season. The least humid month is April & May and the most humid month is August (71.3%). Average annual humidity is given in **Figure 3.8.**

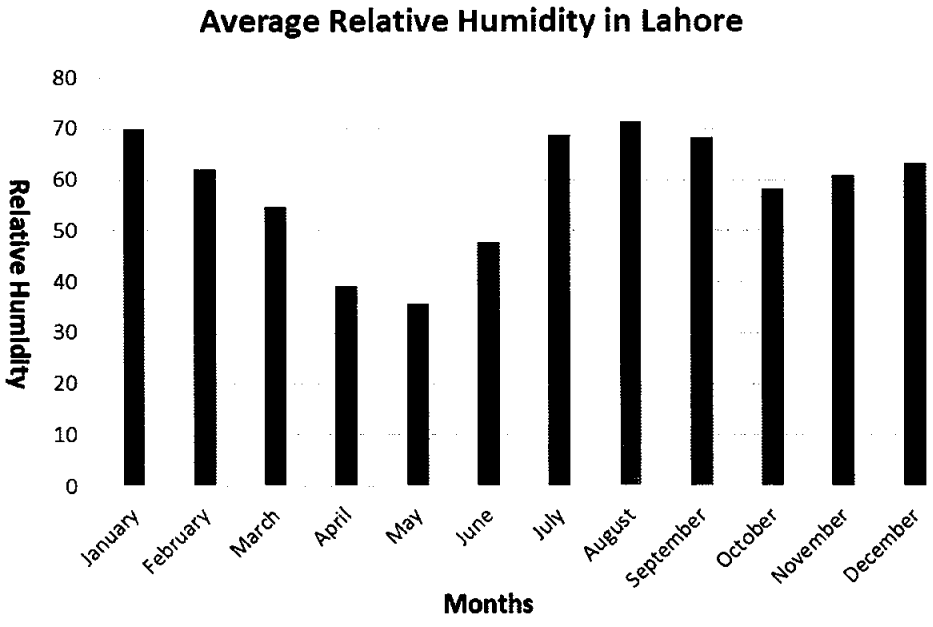

Figure 3.8: Graphical representation of average relative humidity in Lahore

3.3 Hydrology

Lahore area is underlain by unconsolidated alluvial deposits of quaternary age. The aquifer is composed of unconsolidated alluvial complex formed by the contemporaneous filling of a subsiding trough - a foredeep adjacent to the rising Himalayan ranges. Contemporaneous filling and subsidence have given rise to an extensive sedimentary complex of more than 400 meters thickness. The sediments have been deposited by the present and ancestral tributaries of the Indus River during Pleistocene-Recent periods. In accordance with its mode of deposition by large streams in constantly shifting channels, the alluvial complex is heterogeneous and individual strata have little lateral or vertical continuity. However, in spite of their heterogeneity, the alluvial sediments constitute a large aquifer, which on regional basis behaves as a homogeneous aquifer. The individual lenses of silt and clay do not impede the flow of groundwater, considering long-term pumping.

Good quality potable water is a fundamental requirement for human health and survival. Due to fast growth of population, poor town planning and industrialization causing problems in supplying public services, water being one of the most affected. It is becoming difficult for local authorities dealing with water supply to cope with the increasing demands. Lahore is the

second largest city of Pakistan. Its population is increasing at a rapid rate of 3.7 percent per year. In 1901 the population of Lahore was 0.203 million which by 1990 increased to about 4.232 in the Municipal Area (excluding some localities like GOR, Railways, Model Town, colonies in the suburbs etc). At present its population is more than 5.1 million. Water supply of Lahore City has been based on the abstraction of groundwater. Fast growth of population, progressive migration of people to the area and establishment of numerous industries has resulted in rapid increase in water demand. The number of wells and hence, the groundwater abstraction has been increasing in accordance with the growth of population and socio-economic uplift of urban dwellers. On the other hand, urbanization and industrialization has reduced the recharge, as significant proportion of the land has become impermeable. With the increasing number of tube wells, the groundwater, which used to exist at about 4.5 m started declining rapidly. At present, the water table in the central area of the city has deepened to 28 m from the surface level. Due to the continued decline in water table, the groundwater is going out of easy reach for exploitation and the cost of pumping is continuously rising.

The source of water supply for Lahore is only groundwater. Groundwater is abstracted through 300 large capacity tube wells installed at various locations in the Lahore Municipal Area. There are four main well centers, three near the Bund Road (Old Ravi Well Center, National Ravi Park Well Center, Bhogiwal Well Center), and the fourth located at Bund Road to the North of Shalimar Garden. The remaining wells are located throughout the city area, and all wells pump directly to the system, thus eliminating the need for a reservoir. Some more tube wells are being installed to meet maximum day demand. In addition, numerous private owned shallow pumps also exist. The water obtained from deep boreholes is fortunately of good quality. It does not require primary treatment. However, often secondary treatment i.e. chlorination is provided especially in the rainy season. The water produced through these tube wells is fed into Main Grid with pipes having diameters from 40 to 80 cm. The Main Grid feeds water to distribution system with pipes which have diameters ranging from 7.5 to 30 cm. The distribution system supplies the water to citizens through house connections.

3.4 Seismic Hazards

According to Seismic Zoning map of Pakistan, Project area falls in Zone 2A which is minor to moderate damage area. There is no earthquake recorded in the history of region above Richter scale 4.5. Also, no damage to the infrastructure and human settlement is reported in the area. Map is shown in **Figure 3.9.**

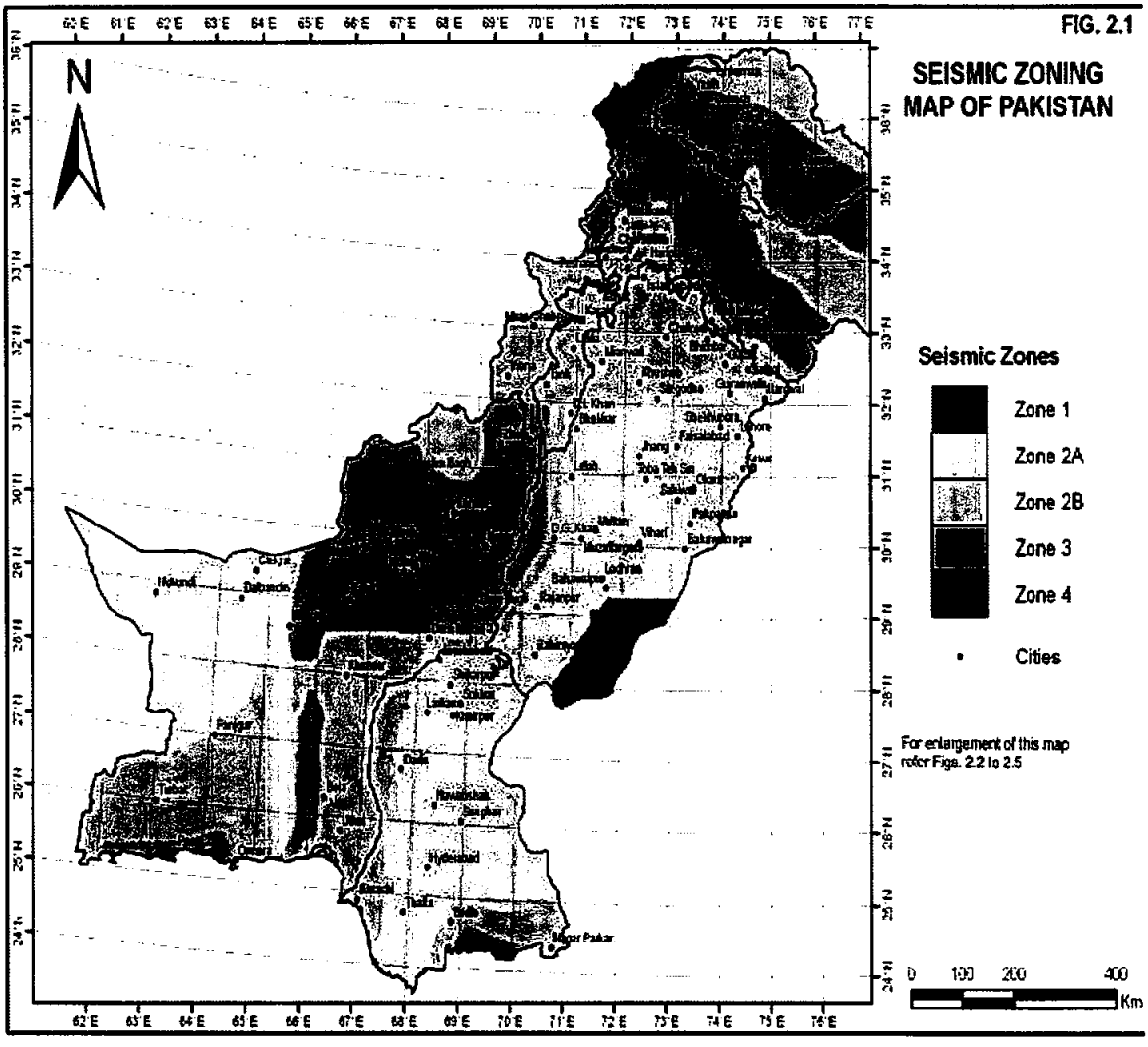

Figure 3.9: Seismic Map of Pakistan

3.5 Socio-Economic Conditions

Lahore is the largest city, and historic cultural center of the Punjab region, and one of Pakistan's most socially liberal, progressive, and cosmopolitan cities. Lahore employs a strong cultural influence over Pakistan. Lahore is a major center for Pakistan's publishing industry, and remains the foremost center of Pakistan's literary scene. The city is also a major center of education in Pakistan, with some of Pakistan's leading universities based in the city. Lahore is also home to Pakistan's film industry. Lahore is the capital of the Pakistani province of Punjab. Lahore is the country's second-most populous city after Karachi and is one of Pakistan's wealthiest cities, with an estimated GDP of $58.14 billion (PPP) as of 2015.

The city also hosts much of Pakistan's tourist industry, with major attractions including the Walled City, the famous Badshahi and Wazir Khan mosques and Sikh shrines. Lahore is also home to the Lahore Fort and Shalimar Gardens, both of which are UNESCO World Heritage Sites. The results of the 2017 Census determined the population to be at 11,126,285, with an annual growth rate of 4.07% since 1998. Gender-wise, 52.35% of the population is male, while 47.64% is female, and transgender people make only 0.01% of the population. Lahore is a young city with over 40% of its inhabitants below the age of 15. The average life expectancy stands at less than 60 years of age.

3.6 Ecology

Although Lahore has expanded in area, alongside modern additions to the city are the ancient monuments, old gardens, graveyards, traditional bungalows with attached gardens, large expanses of lawn and old roadside trees. The main crops are wheat, cotton, rice, sugarcane, maize, oilseeds, pulses, fruits, vegetables, spices, fodders and a large range of other crops. The dominant tree species are Eucalyptus, Poplar, Weeping Willow, Jaman and Mango. The wildlife of the district includes foxes, boars, jackals and wild cats. Among the birds, there are usually Yellow-footed Green Pigeon, Grey Hornbill, Little-brown Dove, Ring Dove, Rose-ringed Parakeet, Alexandrine Parakeet and Little-green bee eater. When the Solar PV panels will be installed on the roof top and parking sheds, there is no Flora and Fauna is going to be disturbed due to execution of this project.

As for the birds, there is no impact on the birds due to the solar panels; the panels that are used in the project are lined with anti-reflection coating which helps to reduce the reflection of the panels to almost zero. When the Solar PV panels will be installed on the rooftop structure, there is no disturbance of flora and fauna due to execution of this project.

CHAPTER 4

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

4 Potential Environmental Impacts and Mitigation Measures

The project may have environmental impact during construction and operation phase of the project. During construction phase, the impacts may be temporary and short term while long term impacts may be observed during the operational phase of the project. The project has positive impacts overall by providing a competitive, pollution free and cost effective. It may also meet the increasing demand of power and reduce the gap between demand and supply of power.

The construction and operation phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. The impacts of the project are envisaged during the design and planning, during pre-construction phase, construction phase.

4.1 Impact on Air Quality

As the proposed project is Solar PV project, the impact during construction of project is expected to be minimal as a Greenfield Project plant. Particulate matter in the form of dust would be the predominant pollutant affecting the air quality during the construction phase. Dust will be generated mainly through the movement of vehicles (transportation activities). No excavation and filling are required because the PV panels will install on rooftop and parking sheds of the factory. The main source of gaseous emission during the construction phase is movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO2, NOX, and particulate matter. The impact is reversible, marginal and temporary in nature.

4.2 Impact on Noise Quality

The major noise generating sources during the construction phase are vehicular traffic, construction equipment like; generators, compressors, vibrators etc. The operation of this

equipment will generate noise ranging between 75 – 90 dB (A). As noise generated during construction phase of the project is low and within the Limits of NEQ's. As there is no human settlements and villages near the project vicinity so overall, the impact of generated noise on the environment during construction period is insignificant, reversible and localized in nature.

4.3 Impact on Water Use and Quality

The construction personnel would be housed in factory premises and compounds provided by the project sponsors. These compounds and TSF would discharge considerable amount of domestic wastewater. Stagnant pools of water would increase breeding of mosquitoes and generally create insanitary conditions. The main pollutants are organic components and microorganisms with the potential to cause contamination of water quality. To address potential impacts on water quality, disinfected washroom (e.g., through regular liming) will be used as main component of the sanitation system. As the PV panels will be installed on rooftop so no use of water during construction phase of the project and overall, no impact on water use and its quality.

4.4 Impact on Groundwater Contamination

There is no harm to the ground water due to construction of PV project because panels will be installed on the rooftop and parking sheds of the factory and there is no require any excavation to fix the structure and the project site is already cleared on the rooftop in premises of factory. There is no impact on the Ground water.

Ground water due to plant operation will be drawn during operation phase for any purpose. There shall be minimal discharge of wastewater from cleaning of Solar PV modules. The wastewater emanating from cleaning operations shall be recycled or used for plantation around the plant. For 01 MW, one vehicle of water is required for the cleaning and duration of the cleaning for 3.1 MW is required approximately 02 or 03 days. For 03.1 MW, approximately 46000 liters of water is required for washing of panels and on monthly basis and the process will be done on monthly basis.

During the operation & maintenance period, natural underground water can be used for cleaning the modules with manual washing. The water for cleaning the module doesn't include any chemical agents, so the untreated underground water will be used for cleaning. Based on our project circumstances, modules shall be cleaned one in every month. The water supply system will be installed along the solar panel array and will be used by the cleaning staff to use the tap water for manual cleaning.

4.5 Impact on Land Use

The mobilization of construction equipment and construction materials will require space for storage and parking of construction vehicles and equipment, construction material storage yards, disposal sites, and labor camps for human resource to avoid environmental impact and public inconvenience. The total land available for the Project is 7.23 acres. At the Project site, there is no any agricultural land or any natural habitat or projected area in the premises of the project. Overall, there will be no impact on the land use. There is no excavation require for the panels installation and no piling required because the PC panels will be installed on the rooftop and parking sheds. Only a small chunk of land is required for the space of storage of equipment, construction material and waste handling which have a no or minor impact and will be temporary only in construction phase.

4.6 Impact on Biological Environment

The project site is already developed area and there is no harm to the biological environment for the installation of PV plant. There will be no impact on flora and fauna of the project area. Thus, the site development works would not lead to any significant loss of important species or ecosystems. The panels will be installed on the rooftop and parking sheds so there is no cutting of trees in the area.

4.7 Impact on Solid Waste

Solid waste during the construction phase consists primarily of excess concrete and cement, rejected components and materials, packing and shipping materials (pallets, crates, Styrofoam, plastics etc.) and human waste. During the construction there will be generation of garbage, for which designated practices of solid waste disposal shall be followed.
Solid waste disposal will be done as follows;

- A waste inventory of various waste generated will be prepared and periodically updated.
- The scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers.

- ❖ Food waste and recyclables viz. paper, plastic, glass etc will be stored in designated waste bins/containers. The recyclables will be periodically sold to local recyclers while food waste will be disposed through proper waste handling mechanism.
- ❖ Hazardous waste viz. waste oil etc will be collected and stored in paved and bounded area and subsequently sold to authorized recyclers.

The complete details of scrap metal details will be given as; scrap metal waste generated from erection of structures and related construction activities will be collected and stored separately in a stack yard and sold to local recyclers as per to manage the solid waste handling team. A separate yard area will be allocated for storing the waste material as per the required industrial practice. Waste handling agency will be hired at the start of project construction to manage the waste generating during the construction and operational phase of the plant and the practices used for handling the waste disposal to manage proper waste management through different mechanisms like, make a proper dumping site for the disposal of waste, handling of waste. The wastes which are recyclable are sold to the external contractors and the non-hazardous waste will be dumped through municipal waste collection system and services. The solid waste will be dumped away from the project site and where nearby no settlements or any other affected environment is present. It may the proper dumping site that is used for local municipality. Although the PV cells will not be disposed but sent back under as warranty is for 25 years.

There are some solid wastes in the project site, including the packing material for the equipment, like the wooden pallets and carton boxes. Solid waste management plan will be followed third party EPA certified contractor will be hired for disposal of solid waste (No Impact).

CHAPTER 5

INSTITUTIONAL REQUIREMENT AND ENVIONMENTAL MONITORING PLAN

5 Institutional Requirement and Environmental Monitoring Plan

During the construction and operation of PV Project, the project company will comply all the rules and regulations of EPA and the standard practices as well as NEQs standards. And implement the environmental mitigation and monitoring plan during construction of the project. Environmental Management and Monitoring Plan provides the mechanism to address the adverse environmental as well as social impacts of the proposed project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works.

The main purpose of Environmental Monitoring Plan is to provide a detailed summary of the predicted impacts associated, mitigating measures and monitoring actions so as to minimize potential negative impacts and enhance positive impacts from the Project.

5.1 Preconstruction Phase

During pre-construction phase of the project, a field survey was conducted by the team to identify the potential impacts and address into the monitoring plan to mitigate their affects to the project and the surrounding environment. Define the roles and responsibilities for those who involved in the implementation of the EMP during construction. Also define the implementation mechanism for the mitigation measures identified during the present study.

5.2 Construction Phase

During construction phase of the project, a solid waste will be handled properly as per the standard industrial practices and dumped into the proper waste disposal sites which are already identified. Provide safety trainings to the workers who works during the construction phase. Provide instructions to project personnel and contractors regarding procedures for

protecting the environment and minimizing environmental impact during construction of the project.

5.3 Operational Phase

During operational phase, the environment and social impact will be minimum as there is no dust and any gaseous emission from the plant. Only the waste water that used for the cleaning mechanism of PV panels will be generated and will be handled properly as per the standards. Also provide trainings and awareness sessions rising on the environmental and social issues related to power transmission projects to the project. Ensure the legal compliance properly during O & M phase of the project. The waste water will be used for plantation purposes.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6 Conclusions and Recommendations

The Project will be the replacement of conventional power generation with renewable energy. Solar energy will replace fossil fuel powered generation, and therefore reduce suspended particulate matter and greenhouse gas emissions into the atmosphere.

The project is cost effectively and environmental impacts are likely to be minimum in result from the proposed Power project. Careful mitigation and monitoring, specific selection criteria and review/assessment procedures have been specified to ensure that minimal impacts will take place. The detailed design would ensure inclusion of any such environmental impacts that could not be specified or identified at this stage are taken into account and mitigated where necessary. Those impacts can be reduced through the use of mitigation measures such as correction in work practices at the construction sites, or through the careful selection of sites and access routes. As proposed land is already the cleared and Solar PV panels will be installed on the rooftop or roof mounted structure and parking sheds and there is no harm to the natural environment or any biological habitat.

Based on the environmental and social assessment and survey conducted for the Project, the potential adverse environmental impacts can be mitigated to an acceptable level by adequate implementation of the mitigation measures identified during visit. Adequate provisions are being made in the Project to cover the environmental mitigation and monitoring requirements, and their associated costs.

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Expression of Interest for Sub-Contractors

Zero Carbon Private Limited will be the contractor for 3.12MW On Grid Solar Power Plant at Packages Limited located at Walton Road, Gulshan Colony, Lahore. There are no subcontractors added to the project.

Zero Carbon (Private) Limited