siddiqsons SOLAR LIMITED
27th Floor, Ocean Tower, G-3, Block-9, Scheme # 5, Main Clifton Road,
Karachi, Pakistan. Ph: +92 21 35166571 (5Lines)

Date: August 24, 2015

THE REGISTRAR
NEPRA Tower Attaturk Avenue (East),
Sector G-5/1,
Islamabad.

SUBJECT: **APPLICATION FOR A GENERATION LICENSE OF SIDDIQSONS SOLAR LIMITED FOR ITS 50 MW SOLAR POWER PROJECT TO BE LOCATED NEAR THE HAASIL VILLAGE, CHAKWAL DISTRICT, PUNJAB**

I, **Mr. Khawaja Bilal Hussain, Chief Executive Officer,** being the duly authorized representative of Siddiqsons Solar Limited by virtue of Board Resolution dated August 21 2015, hereby apply to the National Electric Power Regulatory Authority (**NEPRA**) for the grant of a generation license to Siddiqsons Solar Limited pursuant to Section 7(2)(a) read with 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 pay order no. 10424234, in the sum of PKR 279,952/- (PKR Two Hundred Seventy Nine Thousand Nine Hundred and Fifty Two Only) being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Sincerely,

KHAWAJA BILAL HUSSAIN
CEO

Siddiqsons Solar Limited

Details of the Project as per Schedule III of the Regulation

1. Introduction of the Sponsors/Applicant

1.1. As required under the Section 24 of Act, Siddiqsons Solar Limited (the "**Applicant**" or the "**Company**") is an entity incorporated under the Companies Ordinance, 1984, to act as a special purpose vehicle (the "**SPV**") and develop a 50MW PV Solar Power Plant, near Haasil Village, Chakwal District, Punjab, Pakistan (the "**Project**"), sponsored by Siddiqsons Limited.

1.2. The Applicant is developing a 50 MW PV Solar Power Plant under the upfront tariff regime prescribed by National Electric Power Regulatory Authority ("**NEPRA**") *vide* its decision dated 25th May 2015 (the "**Upfront Tariff**").

1.3. The Company obtained Letter of Intent ("**LOI**") dated 5th December 2015 from the Alternative Energy Development Board ("**AEDB**") and is diligently working towards the early implementation of the Project.

1.4. By way of background and introduction, the Main Sponsor of the Project consist of Siddiqsons Limited, the flagship company of Siddiqsons Group, one of the largest industrial groups in Pakistan. The Financial Statements and Bank Certificates for the Main Sponsor are attached herewith as Annex 11 and Annex 9 respectively.

Siddiqsons Group was initiated in 1959 and is engaged in a diverse portfolio of industry segments including energy, textile, real estate, tinplate, banking, theme parks and dairy.

- **Energy:** Siddiqsons has entered into the energy sector in 2014 with the established of Siddiqsons Energy Limited, the project company for establishing 350 MW Supercritical Coal-Fired Power Plant in Eastern Industrial Zone, PQA, Karachi. NEPRA has approved the Upfront Tariff and Generation License for this project. The Financial Close of this project is expected in first quarter of 2016.

- **Textile**: In textile, Siddiqsons Limited is pioneer in manufacturing of denim in Pakistan. The Company has the largest fully integrated denim manufacturing under one roof in Pakistan.

- **Real Estate**: Siddiqsons' real estate business includes mega projects such as Ocean Towers, the tallest standing building in Pakistan with a height of 491 feet. It also has over 2 million square feet projects in pipeline.

- **Banking**: The Group is also a significant shareholder in MCB, since its privatization in 1991.

- **Theme Park**: Group has a majority share in Theme Park Industry in Pakistan; some of the parks include Aladdin Water Park in Karachi and Joyland Lahore.

- **Dairy**: Siddiqsons Group, in 2013, has diversified into dairy business, with an aim to produce high quality milk through strict quality assurance mechanism. Siddiqsons Dairies (Private) Limited has initially started with a herd size of 2500 animals.

- **Tinplate:** Siddiqsons Tinplate Limited, a company listed on Karachi Stock Exchange, was established in 1999, whereby the Group grew from being the largest denim manufactures and exporters to the first and only tinplate producer in the country. Located in city Baluchistan, it is using cutting edge technology to produce cans and containers for packaging of cooking oil, fruits, beverages etc.

- The Main Sponsor have further collaborated with professional firms that are highly qualified and committed to developing and commissioning the Project on a fast track basis. Collectively, the Main Sponsor along with their professional alliances, presents a vastly experienced team of power sector professionals of international repute.

- The Profile of the Group along with details of Senior Management is enclosed herewith as Annex 7.

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2. Project Company

2.1. Siddiqsons Solar Limited shall be the Project Company for the Project, whereas Siddiqsons Limited shall be the Main Sponsor, *vide* the LOI issued by AEDB, committing at least 20% equity in Siddiqsons Solar Limited till at least for 6 years after the Commercial Operation Date (COD). As submitted above, the Company is developing its Project under the NEPRA Upfront Tariff regime. It is anticipated that the construction of 1x50MW power plant on PV solar technology will take approximately 9-10 months from the issuance of notice to proceed to the project EPC contractors. The plant is targeting its commissioning in the fourth quarter, 2016. The Constitutive Documents of Siddiqsons Solar Limited are enclosed herewith as Annex 4.

3. Power Purchaser

3.1. The entire power generated by the Project will be sold to National Transmission and Despatch Company (the "**Power Purchaser**") for the term of 25 years from the commercial operations date.

3.2. The Project is being developed under the Policy for Development of Renewable Energy for Power Generation, 2006, (the "**AEDB Policy**") on the Build, Operate, Own (BOO) basis.

3.3. The 25 year tariff concession period is in line with the design life of the technology as they are designed to have a very low probability of failure within 25 years life. The Grid and Transmission Lines to evacuate power will be made available by the Power Purchaser.

3.4. The site will be connected to the grid through loop-in-loop-out scheme on Ahmadal-Pindigheb 132 kV circuit, being controlled by IESCO. The Final Interconnection Study Report is enclosed herewith as Annex-16.

4. Site

4.1. The Company has privately acquired land measuring 500 acres near Haasil Village, Chakwal/Attock District Border, in Punjab (the "**Site**").

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4.2. The site for the Project is in the northern region of the Punjab province about 40 km North West of Haasil (33.202 N; 72.547 E). Solar radiations are higher in that area as compared to load centers in central Punjab due to clear air. Seasonal flooding is not a point to be considered as the site is having a higher elevation than the River Soan which is close to the site. Recent events of flooding have had no impact in this specific region. Location map and site map are provided in Annex-18.

5. The Project Progress

5.1. Since its inception, the following milestones have been achieved by the Company:

- Bank guarantee of USD 25,000 has been submitted to AEDB
- Letter of Intent (LOI) received in December 2014
- UBL has been engaged as the Financial Advisor and Lead Arranger for the Project
- 8.2 Ingenieurpartnerschaft Obst & Ziehmann, a German company, has been engaged as technical consultants
- Bankable Feasibility Study, Topography, Geotechnical Survey and IEE have been completed
- Land measuring 500 acres for the project has been acquired
- Solar Irradiation and capacity factor estimates are in place
- Weather station for monitoring on – site irradiation data has been procured
- Haidermota BNR Law has been engaged for legal advisory services
- Grid interconnection study by Power Planners International (PPI) has been completed and submitted to NTDC for approval
- Lockton has been engaged as insurance advisor
- First Solar has been shortlisted as the EPC Contractor (First Solar, OEM for ThinFilm CdTe Photovoltaic solar panels); EPC contract currently under discussion

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6. EPC Contractor and Selection of Technology

6.1. First Solar has been shortlisted as the technology provider for this Project, and the Company is in negotiation stage with the technology provider respectively. The selected contractor shall have turnkey responsibility for designing, delivering, installing and commissioning the plant as per specifications and time schedules agreed in the EPC contract. Furthermore, First Solar will also be providing O&M services for at least first two years after COD. The PV technology employed will be thin film, with fixed mounted structures in place.

6.2. First Solar provides integrated solar solutions with expertise in co-development, EPC and module supply. It is a tier 1 solar PV module manufacturer with over 10 GW installed worldwide and over 4 GW in pipeline. It has the strongest financial stability & bankability in the industry and is the largest manufacturer of Thin Film modules.

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

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

6.4. First Solar used Cadmium Telluride (CdTe) Thin Film modules. Thin film module efficiencies have advanced rapidly. Major advantages of CdTe Thin Film, fixed tilted structures include:

- Easier to manufacture, thus lower costs
- Less affected by high temperatures and shadowing
- Annual degradation expected to be approx. 0.5% , below the 0.7% level allowed by Nepra
- Fixed – tilted modules cost significantly lower than tracker solutions
- Installation costs are lower and the process is less complex
- Maintenance costs are lower
- System has a simpler O&M regime

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- Space requirement is low

7. Plant Details, Technical Details of Equipment and Plant Characteristics

7.1.

i.	Name of Applicant	Siddiqsons Solar Limited
ii.	Registered Office	7th Floor, Siddiqsons Tower, 3 J.C.H. Society, Block 7 & 8, Shahrae Faisal, Karachi, Pakistan
iii.	Business Office	27th Floor, Ocean Tower, Plot G-3, Block-9, Clifton, Karachi, Pakistan
iv.	Plant Location	Around 500 acres near Haasil Village, Chakwal District, Punjab, Pakistan
v.	Type of Generation Facility	Solar PV Power Generation

7.2.

	Technical Details of Equipment	
(a)	**Solar Panels - PV Modules**	
	Type of Module	Thin Film
	Type of Cell	CdTe semiconductor
	Dimension of each Module	1200mmX600mmX6.8mm
	Module Surface Area	0.72 m2
	No. of Panel/Modules	427,200
	Total Module Area	180 Acres
	Total Land Area Used	225 Acres
	Panel's Frame	Aluminium alloy
	Weight of one Module	12 kg
	Module Output Warranty	From year 1 to 25th year
		Not exceeding 0.7% per annum of initial power output)except first year)

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	Number of Solar Cells in each module	216
	Efficiency of module	16.00%
	Environment Protection System	
	Maximum Power (Pmax)	115W
	Voltage @ (Pmax)	70.5 V
	Current @ Pmax	1.63 A
	Open circuit voltage (Voc)	87.8 V
	Short circuit current (Isc)	1.78A
	Maximum system open Circuit Voltage	1500 V
(b)	**PV Array**	
	Nos. of Sub-array	100
	Modules in a string	24
	Total Nos. of Strings	17800
	Modules in Sub-Array	4272
	Total No. of Modules	427200
(c)	**PV Capacity**	
	Total	50 MWp
(d)	**Inverters**	
	Capacity of each unit	1000 MW
	Inverter Model	GEPSC-1000
	Manufacturer	
	Rated Input Voltage	DC900V
	Number of Inverters	45
	Total Power	45 MW
	Efficiency	98.2% Europe efficiency
	Max. Allowable Input voltage	DC1500V
	Max. Current	DC input 1200A
	Max. Power Point Tracking Range	DC900V~DC1300V
	Output electrical system	AC Output range
	Rated Output Voltage	AC 550 V
	Rated Frequency	50HZ/60HZ
	Power Factor	>0.99 (Rated Power)

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	Environmental Enclosure	Operating Temperature Range	-30 C ~ +55 C
		Relative Humidity	0~95%
		Audible Noise	47.4 dBa
		Operating Elevation	Max 6000m, reduce output when higher than 3000m
		Warranty Period	5 years
	Grid Operation Protection	(a).	over voltage protection
		(b).	anti islanding protection
(e)	**Junction Boxes Installed**		
	Number of J/Box units	1400	
	Input circuits in each box	15A*15	
	Max. input voltage of each circuit	15A	
	Max. input voltage	1500V	
	Protection Level	IP65	
	Overcurrent protection	Yes	
	Output switch	Yes	
	Surge protection	Yes	
(f)	**Data Collection System**		
	Weather Data	(i).	Pyranometer - Sets (Incline to record irradiation level) [Yes]
		(ii).	Thermometer - Sets (to record ambient temp) [Yes]

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	System Data	(i).	DC input voltage (V) & current (A) of each Inverter (Phase, Line) [Yes]
		(ii).	Total DC power (kw) generated by PV array. [Yes]
		(iii).	AC output voltage (V) and current (A) of each Inverter (Phase, Total) [Yes]
		(iv).	AC output power (kW) and energy (kWh) of each Inverter [Yes]
		(v).	Frequency (Hz) [Yes]
		(vi).	Power Factor (PF) [Yes]
		(vii).	Temperature inside inverter station [Yes]
(g)	**Isolating Transformer**		
	Rating	KVA	
	Type of Transformer	35KV Box-type transformer	
	Input Voltage	AC315V	
	Output Voltage	AC35KV	
	Efficiency	99.60%	
(h)	**Outdoor Cubicle Control Room**		
	Data record	Continuous logging with	

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		data logging software [Yes]	
	Control Room System	Computerized data acquisition system [Yes]	
	Control Room System Detail	Interfacing Hardware & Software, Industrial Type PC, which will be robust & rugged suitable to operate in the Control Room environment [Yes]	
(i)	**Mounting Structure**		
	Structure	Support structure is formed by vertical purlins and horizontal steel beam.	
	Tilt of Array Frame	25 Degree	
	Array Specification	PV module size is 1200mm 600 mm X 6.8 mm. Support is put in two rows, 2X10 PV module. 19800	

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		supports are needed.	
(j)	**Foundation Pillars/Piling**		
	No. of Foundations	170880	
	Foundation Structure	Reinforced concrete pile or Spiral steel piles.	

8. Power Plant Control System

8.1. Highly integrated technology for control has been finalized to make sure smooth operation of power plant. Skycontrol system is recommended for power plant control, grid stability management and ensuring grid injection both at medium and high voltage levels and in parallel meeting all requirements to grid codes. Its distinguishing feature, the genuine closed-loop control principle, ensures high-precision control by measurement of all relevant physical quantities at grid connection point and their continuous feedback to controller input. Combined with adaptable control algorithm and communication sequences, this makes Skycontrol a highly efficient tool for fast and stable control for large-scale solar power plant.

8.2. Key functions are:

- Active power control (curtailment and grid activity management)
- Reactive power injection
- Reactive power compensation of passive component
- Voltage stabilization
- Frequency stabilization

9. Metering

9.1. Tariff metering shall comply with technical standards defined in power purchase agreement.

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10. Protection

10.1. Electrical and control protections shall comply with International Standards with high precision to ensure safe and reliable operation of all power plant equipment. Electrical protection system for 132Kv grid shall be integrated as per IEC 61850 including SCADA system for control and monitoring of electrical system.

11. Instrumentation

11.1. Instrumentation where required shall be selected according to the site ambient conditions to make sure the reliability of complete power plant during operation and maintenance. Multiple numbers of HMIs shall be installed in centralized control room for overall monitoring of power plant including fault recorders with backup storage to maintain the data historian as per period defined in power purchase agreement.

12. Infrastructure

12.1. Site for the Project is located at an approximate distance of 35 KMs from Chakri Interchange of Lahore-Islamabad Motorway. Total area acquired for installation of 50MW DC solar power plant is approximately 500 Acres (2,020,000 Square Meters) with 132kV power inter-connection facility available at a distance of 8 KMs.

12.2. Site can be accessed through two link roads, one is from Charki Inter-change and second road connecting with Motorway nearby Gandakhas Village which is about 12 KMs from power plant gate. During the project execution, second option will be used for logistics of power plant equipment and for this 12 KMs long road will be widen, compacted and carpeted with bitumen.

12.3. Railway track is not available nearby which could have been another mode of equipment logistics but in case of Siddiqsons 50MW DC solar power plant, road transport is the most viable and safest option.

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12.4. Siddiqsons has planned to build a residential facility for construction staff with basic needs to maintain good standards of living for all personnel. Similarly permanent facilities with all amenities for operation and maintenance personal staying at site from the date of commercial operation will be built within the available land. It will be ensured to protect the plant personnel and equipment by implementing hi-tech security system including deputation of highly skilled patrolling escorts on ground.

13. Training and Development

13.1. First Solar has been selected as the EPC contractor. First Solar is the global leader in production of solar panels and has been in the industry for nearly two decades. The team to be deployed on site will comprise of experienced and trained personnel in the field of solar PV projects. The EPC will also be required to do the O&M of the plant for the first two years, and will simultaneously train personnel on ground through a comprehensive training and development program. The training program will be designed to ensure a smooth transition in the operations and maintenance of the plant post two years from COD. The team dedicated for O&M for the solar plant will go through a comprehensive training program conducted by First Solar.

13.2. For the personnel employed by Siddiqsons Solar Limited, a comprehensive training program has been devised. The training program will comprise:

1) Multiple site visits to select plants installed by First Solar internationally
2) Development of comprehensive SoPs and training manuals
3) Comprehensive training at the OEMs facilities
4) On the Job training at the Project site and plant

14. Financing

14.1. The total cost of the Project is estimated at USD 76.9 million. The debt to equity ratio of the Project shall be 75:25. The United Bank Limited *vide* its letter dated June 08, 2015, enclosed herewith as Annex -10, has provided an in-principal interest in structuring and providing debt arrangement services for the Project debt of approx. USD 57.7 million for funded project finance along with non-funded facilities, such as Letter of Credit etc. At this stage, the entire Project

would be 100% locally financed, however the Company may go for mix of local and foreign financing at a later stage.

14.2. The debt will have a tenor of 10 years after completion of the project. Debt repayments will be on a quarterly basis, and will commence from the first quarter following COD. The project is expected to be completed in 10 months from financial close. The equity required for the project is expected to be injected by the main Sponsor.

14.3. Sources of financing are as under:

	In USD Million
Debt through Local financial Institutions	57.68
Equity injection by Sponsors	19.22
Total	**76.90**

15. Project Cost, information regarding Sources and amounts of Equity and Debt

15.1. The total Project cost is estimated to be USD 76.9 million, and is inclusive of Engineering, Procurement & Construction (EPC) cost of USD 65 million. This project cost is an estimate and will be finalized after finalization and negotiations with the EPC contractors.

15.2. The overall break-up of the project cost us as under:

	In USD million
Total EPC Cost	65.00
Other Costs (including Project Development, non EPC, financing fees and insurance)	10.88
Interest During Construction*	1.02
Total Project Cost	**76.90**

*to be adjusted as per actuals

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16. O&M Costs

16.1. The total annual operating and maintenance costs during the first year following COD are estimated as follows:

Total Costs per MW (USD)	
Foreign O&M	34,400 (indexed to US CPI and USD PKR Exchange Rate)
Local O&M	5,500 (indexed to PAK CPI and USD PKR Exchange Rate)
Insurance	13,000
Total	**52,900**

17. Insurance Costs

17.1. Estimated to be within 1% of Project EPC Cost allowed by NEPRA, this cost will be adjusted at actuals and is subject to the cap allowed.

18. Project Timeline

18.1. The financial close is expected by March, 2016 and the project is expected to start operations by December, 2016. A snapshot of the milestones achieved to date and timeline going forward is as under:

Milestone	Expected Date
Submission of FS to AEDB	August 2015
Submission of GL Application	August 2015
Approval of FS from AEDB	September 2015
Submission of Upfront Tariff Approval	September 2015
Signing of IA/EPA	October 2015
Financial Close	March 2016
COD	December 2016

19. Initial Environment Examination

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19.1. At present, Pakistan Environment Protection Agency (Pak-EPA) has NO regulation for solar power generation in Schedule I or Schedule II (PEPA Regulations 2000). According to S.R.O. 339 (1)/2001, issued by Pakistan environmental protection agency (review of IEE and EIA) regulations-2000, the thermal power generation is the closest energy generation (reference Schedule-I, Category B: Energy) which may be quoted for solar energy generation hence, Punjab-EPA is undergoing a process of amendments in the PEPA Act, 2000 where solar and wind power generation subjects will soon be added by the time the regulations are amended.

19.2. This Initial Environmental Examination (IEE) is to provide information to evaluate the likely environmental, social and health impacts that may potentially be generated from the project. It also aims to make recommendations for minimizing / eliminating negative impacts and maximizing the positive impacts. A field survey of the project site and adjoining area was conducted and environmental aspect & potential impacts of project activities were identified, assessed, and documented. The EIA Team carried out consultations with various stakeholders and community members, particularly lead government agencies and local authorities.

19.3. Both the Pakistani and World Bank's social safeguard policies have been considered during the assessment. The IEE study has been carried out according to requirements of the current EA Regulation of Pakistan Environmental Protection Act (PEPA 1997, clause 11) and the Environmental Assessment Policies and Procedures of the World Bank OP 4.01 Environmental Assessment (Annex B - Content of EA and Annex C - Environmental Management Plan).

19.4. Aim of the IEE study is to meet both the requirements of the PEPA regulations 2000 and World Bank. For this purpose, IEE has been prepared according to the special IEE format regarding the requirements of the World Bank, provincial department of Forest and wildlife and Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2000.

19.5. The IEE study has been conducted by Engineering Consultancy Services Punjab (Pvt.) Limited (ECSP) in accordance with the Punjab-EPA guidelines and have been submitted to Environment Protection Agency (EPA) Punjab. The final IEE Report and the submission receipt is enclosed herewith as Annex-17.

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20. Health, Safety and Emergency Plan

20.1. Detailed Health, Safety and Emergency Plan is enclosed herewith as Annex-18.

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siddiqsons SOLAR LIMITED
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EXTRACT OF THE MINUTES OF THE MEETING OF THE BOARD OF DIRECTORS OF SIDDIQSONS SOLAR LIMITED HELD AT THE REGISTERED OFFICE OF THE COMPANY ON TUESDAY, 18TH AUGUST 2015.

I, Sohail Kassamali, Company Secretary, Siddiqsons Energy Limited do hereby certify that the following resolution was passed by the Board of Directors at the meeting held at the registered office of the Company on 18th August 2015:

"**RESOLVED THAT** SIDDIQSONS SOLAR LIMITED (a company incorporated under the laws of Pakistan with its registered office located at 7th Floor, Siddiqsons Tower, 3 J.C.H Society, Block 7 & 8, Main Shahrah-e-Faisal, Karachi) (the **Company**) be and is hereby authorised to submit an application for the grant of a generation licence (including any modifications thereto) by National Electric Power Regulatory Authority in respect of its 50 MW solar power generation project to be located near Haasil Village (the **Project**) and in relation thereto, enter into and execute all required documents, make all filings and pay all applicable fees, in each case, of any nature whatsoever, as required.

FURTHER RESOLVED THAT in respect of submitting an application for the generation licence (including any modifications thereto) to National Electric Power Regulatory Authority, **MR. ABDUR RAHIM AS DIRECTOR AND MR. KHAWAJA BILAL AS CHIEF EXECUTIVE OFFICER** be and are hereby singly and jointly empowered and authorized for and on behalf of the Company to:

(i) review, execute, submit, and deliver the generation license application (including any modifications thereto) for the generation licence any related documentation required by National Electric Power Regulatory Authority for the grant of the generation licence, including any contracts, affidavits, statements, documents, powers of attorney, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature whatsoever;

(ii) represent the Company in all negotiations, representations, presentations, hearings, conferences and/or meetings of any nature whatsoever with any entity (including, but in no manner limited to National Electric Power Regulatory Authority, any private parties, companies, partnerships, individuals, governmental and/or semi governmental authorities and agencies, ministries, boards, departments, regulatory authorities and/or any other entity of any nature whatsoever);

(iii) sign and execute the necessary documentation, pay the necessary fees, appear before the National Electric Power Regulatory Authority as needed, and do all acts necessary for

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completion and processing of the generation license application (including any modifications thereto) and procuring the generation license;

(iv) appoint or nominate any one or more officers of the Company or any other person or persons, singly or jointly, in their discretion to make communicate with, make presentations to and attend the National Electric Power Regulatory Authority hearings; and

(vi) do all such acts, matters and things as may be necessary for carrying out the purposes aforesaid and giving full effect to the above resolutions/resolution".

"AND FURTHER RESOLVED THAT MR. ABDUR RAHIM AS DIRECTOR AND MR. KHAWAJA BILAL AS CHIEF EXECUTIVE OFFICER be and is hereby authorized to delegate all or any of the above powers in respect of the foregoing to any other officials of the Company as deemed appropriate."

Company Secretary

Siddiqsons Solar Limited Karachi

A010196

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

[Under section 32 of the Companies Ordinance, 1984 (XLVII of 1984)]

Corporate Universal Identification No. **0093810**

I hereby certify that **SIDDIQSONS SOLAR LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **limited by shares.**

Given under my hand at **Karachi** this **Fourth** day of **June,** Two **Thousand** and **Fifteen**.

Incorporation fee Rs. **322,000/=** only

(Sidney Custodio Pereira)
Joint Registrar of Companies
Karachi

THE COMPANIES ORDINANCE, 1984

--: o : --

(COMPANY LIMITED BY SHARES)

--: o : -

Memorandum of Association

of

SIDDIQSONS SOLAR LIMITED

I. The name of the Company is "**SIDDIQSONS SOLAR LIMITED**".

II. The Registered Office of the Company will be situated in the Province of Sindh.

III. The objects for which the Company is established are to do all or any of the following:

1. To design, finance, insure, build, establish, own, operate, maintain, manage electric power generating plants for the generation, supply & transmission of electric power and in relation thereto, to establish, fix, carry out and maintain without limitation, any ancillary works, cables, wires, meter, lines, interconnect facilities, grid stations, transmission facilities, civil, electrical and mechanical works.

2. To carry out a feasibility study for and to carry on the business of power generation and in relation thereto, to generate, accumulate, transmit, distribute and sell electric power anywhere in Pakistan, to the public sector, including the Water and Power Development Authority, National Transmission and Dispatch Company, Government and Government bodies, and the private sector subject to any permission required under the Law.

3. To manufacture, purchase, import or otherwise acquire, construct, own, process, operate and maintain buildings, apparatus, fixtures, fittings, plants, machinery, materials, and things as may be necessary, incidental to or convenient in connection with power generating plant for the generation of electric power and or in connection with supply, transmission and distribution of electric power.

4. To enter into any agreement or agreements with any government or other authority, supreme, municipal, local or otherwise, that may seem conducive to all or any of the objects of the Company and/or to obtain from such government or authority including the State Bank of Pakistan or National Electric Power Regulatory Authority (NEPRA) any rights, concessions or privileges, licenses which the Company may think desirable to obtain and to carry out, exercise and comply with any such arrangements, rights, privileges, concessions and licenses.

5 To buy, sell, manufacture, repair, alter, improve, exchange or let out, import, export and deal in all works legally permitted, plant, machinery, engines, tanks, cylinders, valves, regulators, testing equipment, tools, utensils, appliances, cookers, stoves, heaters, apparatus, products, materials, substances, raw materials, chemicals, natural gas, liquefied petroleum gas, fuel oil, coal, lubricants, articles and things and to manufacture, experiment with, render marketable and deal in all products legally permitted, incidental to or obtained in the business carried on by the Company.

6. To purchase, take on lease or tenancy or in exchange, hire, take options over or otherwise acquire for any estate or interest whatsoever and to hold, develop, work, cultivate, deal with and turn to account concessions, grants, decrees, licenses, privileges, claims, options, leases, property, real or personal or rights or powers of any kind which may appear to be necessary or convenient for the business of the Company but not to act as a leasing company or property developer.

7. To sell, exchange, mortgage, let on royalty or tribute, grant licenses, easements, options and other rights over and in any manner deal with or dispose of the Company's property or any part thereof for such consideration as may be thought fit and in particular for stocks, shares or securities of any company but in any event not to act as an investment company or leasing company.

8. To establish laboratories and to employ and promote scientific research and invention, patronize such invention and enter into manufacture in collaboration with outside parties for transfer of technology from abroad and to promote transfer of technology from Pakistan abroad, and to carry on business in all other allied fields permissible by law.

9. To invest and deal with any moneys of the Company not immediately for the time being required for any of the purposes of the Company in such investments as may be thought proper and to hold, sell or otherwise deal with such investments but in any event not to act as an investment company.

10. For the purposes of the business of the Company only, to advance money upon such terms as the Company may approve, and to guarantee the obligations and contracts of customers and others but not to act as a banking company.

11. To apply for, purchase or otherwise acquire and protect, prolong and renew whether in Pakistan or elsewhere any patents, patent rights, brevets d'invention, trademarks, design licenses, protections, concessions and the like conferring any exclusive or non-exclusive or limited right to use any secret or other information as to any invention, process or privilege which may seem capable of being used for any of the purposes of the Company or the acquisition of which may seem calculated directly or indirectly to benefit the Company and to use, exercise, develop, manufacture under grant, licenses, privileges in respect of, or otherwise turn to account the property, rights and information so acquired and to carry on any business in any way connected therewith.

12. To get insured against losses, damages, risks, accidents and liabilities of all kinds which may affect the company whether in respect of its contracts, agreements, advances, securities or in respect of servants or employees of the company, or in respect of

property belonging to or leased to or hired by the company, either by setting apart funds of the company or by effecting such insurance and in later case to pay the premium thereon.

13. To train personnel and workers, in Pakistan and/or abroad, to obtain technical proficiency in various specialties connected with the business of the Company.

14. To undertake and execute any project the undertaking whereof may seem desirable, and either gratuitously or otherwise.

15. To procure the Company to be registered or recognized in any foreign country or place.

16. To acquire and undertake all or any part of the business, property, goodwill and liabilities of any person or company carrying on any business which the Company is authorized to carry on or possessed of property suitable for the purposes of the Company.

17. To adopt such means of making known the business and/or services of the Company as may seem expedient and in particular by advertising in the press, or in the other media or by way of participation in exhibitions.

18. For the purposes of the Company, to purchase, manage, acquire by lease, mortgage, dispose of, sell, exchange, turn to account any part of the property and rights of the Company.

19. To employ or appoint any persons, experts, consultants, advisers, contractors (including O&M contractors), brokers in connection with the business of the Company.

20. To pay for any property or rights acquired by the Company, either in cash or fully paid shares or by the issue of securities, or partly in one mode and partly in another and generally on such terms as may be determined.

21. Only in connection with the business of the Company to open and operate any current, overdraft, loan, fixed or savings bank accounts for the Company, and draw, make, accept, discount, endorse, execute and issue promissory notes, bills of exchange, bills of lading and other negotiable or transferable instruments or securities and to deposit money, securities or property with any persons, firm or company and on any terms with or without security and to advance money to the Company's executives, officers and employees/agents/customers and others having dealings with the company but in any event not to act as an investment, banking or finance company.

22. In connection with the business of the Company only, to give guarantees and indemnities for the payment of money or the performance of contracts or obligations by this Company but in any event not to act as an investment, banking or finance company.

23. In connection with the business of the Company only, to borrow and where required, to secure the payment of money in such manner as the Company shall think fit and in particular by the creation of mortgages and charges over the present and future property, assets and/or undertaking of the Company and/or by issue of debentures;

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participation term certificates, term finance certificates and other securities charged upon all or any of the Company's property both present and future, and to purchase, redeem and pay off any such securities.

24. To lawfully raise moneys in such manner as the Company shall think fit and in particular by the issue of such securities, bonds and instruments payable to bearer or otherwise, and either permanent or redeemable or repayable convertible into shares and collaterally to secure the repayment of any such moneys so raised or any such securities or instruments of the Company by means of a trust deed or otherwise.

25. To take, or otherwise acquire, and hold shares in any other company having objects altogether or in part similar to those of this Company or carrying on any business capable of being conducted so as directly or indirectly to benefit this Company but in any event not to act as an investment company.

26. To issue all or any part of the original or enhanced share capital of the Company at par or at a premium or discount subject to any permission required under the law.

27. To enter into partnership or into any agreement or agreements for sharing profits, union of interests, cooperation, joint venture, reciprocal concession and/or facilities with any person or company whether or not having objects similar to those of this Company but in any event not to act as managing agents.

28. So far as is permissible in law, to offer stock option schemes to employees, to grant funds, donations, annuities, pensions, allowances, gratuities, bonuses to any employees or Directors or employees of the Company or any dependent thereof or to any charitable, religious, social, scientific, educational, industrial institutions or organization and to establish provident, gratuity and/or superannuation funds for the benefit of present or ex-employees or Directors or former directors of the Company

29. To pay all or any costs charges and expenses preliminary and incidental to the promotion, formation, establishment and registration of the Company and to pay any development costs incurred (whether before or after the incorporation of the Company) by the sponsors of the Company in connection with any project of the Company.

30. To pay brokerage or commission to any person or persons in consideration of his/their subscribing, or agreeing to subscribe, whether absolutely or conditionally, for any shares or debentures of the Company, or for procuring or agreeing to procure subscriptions whether absolute or conditional for the same which brokerage or commission may be paid either in cash or shares of the Company, credited as fully paid up.

31. To distribute any of the Company's property among the members in the event of winding up of the Company.

32. To amalgamate, consolidate, or merge, either in whole or in part, with or into any other companies, associations, firms or persons carrying on any trade or business of a similar nature to that which this Company is authorized to carry on.

33. To resolve, settle disputes by negotiation, conciliation, mediation, arbitration, litigation,

or other means. judicial or extra judicial, and to enter in compromise agreement with creditors. members and any other persons in respect of a difference or dispute with them and to exercise the power to sue and be sued and to initial or oppose all actions. steps. proceedings or application which may seem calculated directly or indirectly to benefit or prejudice. as the case may be, the interest of the Company or of its members.

34. To do all or any of the things herein in any part of the world either as principals, agents, contractors or otherwise. and either alone or in conjunction with others but in any event not to act as managing agents.

35. To provide engineering, construction, consultancy and design services and radio and other communication systems and services, and any facilities, equipment and installations whether related to such services and systems or otherwise.

36. To carry on any other business whether manufacturing or otherwise that may seem to the Company capable of being conveniently carried on in connection with the above objects or calculated directly or indirectly to enhance the value of or render profitable any of the Company's property or rights or which it may be advisable to undertake with a view to improving , developing, rendering or turning to account any property real or personal belonging to the Company or in which the Company may be interested and to do all or any of the above things either as principals. agents, contractors or otherwise. and either alone or in conjunction with others and either by or through agents, sub-contractors. trustees or otherwise. and to do all such things as are incidental or conducive to the attainment of the above objects but in any event not to act as managing agents.

37. To do all and everything necessary, suitable or proper or incidental or conducive to the accomplishment of any of the purposes or the attainment of any of the objects or the furtherance of any of the powers hereinbefore set forth, either alone or in association with other corporate bodies, firms or individuals or with any Government authority or public or quasi-public authority or any other authority, and to do every other act or thing incidental or impertinent to or arising out of or connected with the business or powers of the Company or part thereof, provided the same be lawful.

38. It is expressly declared that all the powers expressed therein are to be cumulative but in no case unless the context expressly so requires is the generality of any one sub-clause to be narrowed or restricted by the name of the Company or by the particularity of expression in the same sub-clause or by the application of any rule of construction such as the ejusdem generis rule, and accordingly none of such sub-clauses or the objects therein specified or the power thereby conferred shall be deemed subsidiary or auxiliary merely to the objects mentioned in any other sub-clause of this clause, and the Company shall have full power to exercise all or any of the powers conferred by any part of this clause in any part of the world.

39. IT IS HEREBY UNDERTAKEN that the Company shall not engage in the banking business. business of a finance. investment. leasing or insurance company, or as a Modaraba Management Company. or the business of land development or a managing agent or any unlawful business and that nothing in the objects clause shall be construed to entitle it to engage in such business.

40. AND that none of such-clauses or the objects therein specified or the powers thereby conferred shall be or be deemed to be subsidiary or ancillary or ancillary merely to the objects mentioned in any of the other sub clause of this clause or any of them but the Company have full power to exercise all or any of the power conferred by any part of this clause in any part of the world, notwithstanding that the business undertaking property rights or acts proposed to be transacted, acquired, dealt with or performed do not fall within the objects of the earlier or any other sub-clauses of this clause or any of them.

41. It is declared that notwithstanding anything contained in the foregoing object clauses of this Memorandum of Association nothing contained therein shall be construed as empowering the Company to undertake or to indulge in business of banking company, leasing and investment, real estate business, deposit taking, managing agency or insurance business directly or indirectly as restricted under the law or any unlawful operation. The Company shall not launch multi-level marketing (MLM), Pyramid and Ponzi Schemes.

IV. The liability of the Members is limited.

V. The authorized capital of the Company is Rs.100,000,000 (Rupees: One Hundred Million Only) divided into 10,000,000 (Ten Million only) shares of Rs.10 (Rupees Ten only) each, with power of the Company, specifically, to increase the authorized share capital to include a further issue including of preference shares and generally, to increase or reduce the capital and to divide the shares in the capital for the time being into several classes in accordance with the provisions of the Companies Ordinance, 1984 and any rules made there-under, and to attach thereto respectively such preferential, deferred, qualified or special rights, privileges or conditions as may be determined by or in accordance with the Articles of Association of the Company for the time being, and to vary, modify or abrogate any such rights, privileges or conditions in such manner as may for the time being be provided by the Articles of Association of the Company in accordance with law.

We, the several persons whose name 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 indicated herein below against our respective names:

S. No	Name & Surname (Present & Former) / Father / Husband Names In Full Block Letters	NIC No (In Case Of Foreigner, Passport No)	Nationality With Any Former Nationality And Occupation	Residential Address In Full	Number Of Shares Taken By Each Subscriber	Signature of the Subscriber
1	Mr. Abdur Rahim S/O Muhammad Tariq Rafi	42201-0409988-5	PAKISTAN Business	House No. 34-H-1, Block-6, PE.C.H.S., Karachi.	10,000 (Ten Thousand Shares)	
2	Ibrahim Shamsi S/O Aftab Ahmed Shamsi	42301-4652147-5	PAKISTAN Business	House No. 59, Street 19, Khayaban-e-Badban, Phase-V, DHA, Karachi.	10,000 (Ten Thousand Shares)	
3	Mr Muhammad Tariq Rafi S/O Muhammad Rafi	42000-8453226-9	PAKISTAN Business	House No. 34-H-1, Block-6, PE.C.H S., Karachi.	10,000 (Ten Thousand Shares)	
4	Mrs Nighat Tariq W/O Muhammad Tariq Rafi	42201-9906534-6	PAKISTAN Business	House No 34-H-1, Block-6, PE C.H.S., Karachi.	10,000 (Ten Thousand Shares)	
5	Mrs Anum Abdur Rahim W/O Abdur Rahim	42201-8648714-6	PAKISTAN Business	House No. 34-H-1, Block-6, PE.C.H.S., Karachi.	10,000 (Ten Thousand Shares)	
6	Mrs. Alia Sajjad W/O Sajjad Ahsan	42000-7241258-4	PAKISTAN Business	House No 19, Khayaban-e-Hilal, Phase-VI, DHA, Karachi.	10,000 (Ten Thousand Shares)	
7	Mrs. Rahma Ibrahim W/O Ibrahim Shamsi	42301-0468767-6	PAKISTAN Business	House # 59, Street 19, Khayaban-e-Badban, Phase-V, DHA, Karachi.	10,000 (Ten Thousand Shares)	
				Total Number of Shares.	70,000 (Seventy Thousand Shares)	

Dated the 23rd day of May 2015

Witness to above signatures.

Name: National Institutional Facilitation Technologies (Pvt.) Ltd.

Nationality: Pakistani

Address: 5th Floor, AWT Plaza, I. I. Chundrigar Road, Karachi

Company Registration Office Karachi

THE COMPANIES ORDINANCE, 1984

--: o : --

(COMPANY LIMITED BY SHARES)

--: o : -

Articles of Association

of

SIDDIQSONS SOLAR LIMITED

I. PRELIMINARY

1. TABLE "A" Not to Apply

The regulations in Table 'A' in the First Schedule to the Companies Ordinance, 1984 shall not apply to the Company except so far as the same are repeated or contained in these articles.

2. DEFINITIONS

Unless the context otherwise requires, the terms used in these articles shall have the meanings set out below:

(a) **"Articles"** mean these articles of association of the company as originally framed or as from time to time altered by in accordance with the law.

(b) **"Board"** means the group of directors in a meeting duly called and constituted or, as the case may be, the directors assembled at a board.

(c) **"Book and paper"**, "book or paper" or "books of account" mean accounts, deeds, vouchers, writings and documents, maintained on paper or computer network, floppy, diskette, magnetic cartridge tape, CD-Rom or any other computer readable media;

(d) **"Buy-back of shares rules"** mean the Companies (Buy-Back of Shares) Rules, 1999 or any modification or re-enactment thereof.

(e) **"Company"** means **Siddiqsons Solar Limited.**

(f) **"Central depository"** means a central depository as defined in clause (ca) of section 2 of the Securities and Exchange Ordinance, 1969 (XVII of 1969) and registered with the Securities and Exchange Commission of Pakistan under section 32 A of the said ordinance.

(g) **"Central Depositories Act"** means the Central Depository Act, 1997 or any modification or re-enactment thereof.

(h) **"Central Depository Regulations"** mean the central depository company of Pakistan limited regulations made pursuant to section 35(1) of the Central Depository Act, 1997 or any modification or re-enactment thereof.

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(i) "**Central Depository Register**" means a computerized electronic register maintained by a central depository in respect of book-entry securities.

(j) "**Code**" means the code of corporate governance.

(k) "**Commission**" means the Securities and Exchange Commission of Pakistan established under section 3 of the Securities and Exchange Commission of Pakistan Act, 1997.

(l) "**Directors**" mean the directors for the time being of the company including alternate directors and, subsequently elected pursuant to Companies Ordinance, 1984 or as the case may be, the directors assembled at a board.

(m) "**Dividend**" includes cash dividend, dividend in species and bonus shares.

(n) "**Electronic**" includes electrical, digital, magnetic, optical, bio-metric, electro-chemical, wireless or electromagnetic technology.

(o) "**Electronic transactions ordinance**" means the Electronic Transactions Ordinance, 2002 or any modification or re-enactment thereof.

(p) "**In Person**" includes attendance and/or voting at a meeting, personally or by video or telephone-conference or other facility whereby all the participants of the meeting can hear and / or see each other unless expressly stated otherwise by the directors.

(q) "**Instrument of transfer**" includes transfer deeds and any record of transfer of book-entry securities in the central depository register, provided by the central depositories act and the central depository regulations.

(r) "**Issue of capital rules**" means Companies (issue of capital) Rules, 1996 or any modification or re-enactment thereof.

(s) "**Listing requirements**" mean the listing regulations of the stock exchanges.

(t) "**Member**" means a person whose name is for the time being entered in the register of members by virtue of his being a subscriber to the memorandum of association of the company or of his holding by allotment or otherwise any share, scrip or other security which gives him a voting right in the company including but not limited to the account holders of a central depository.

(u) "**Memorandum**" means the memorandum of association of the company as originally framed or as from time to time altered in accordance with law.

(v) "**Month**" means calendar month according to the English calendar.

(w) "**Office**" means the registered office for the time being of the company.

(x) "**Ordinance**" means the Companies Ordinance, 1984 or any modification or re-enactment thereof for the time being in force.

(y) "**Preference shares**" not being ordinary shares mean preference shares whether redeemable or irredeemable, cumulative or otherwise with the rights, privileges and conditions attaching thereto as are provided by the articles

(z) "**Preference shareholders**" not being ordinary shareholders mean in relation to the Company, every person to whom the company has allotted, or who becomes the holder of such shares and whose name is entered in the register of members

Solar Limited Karachi

(aa) "**Proxy**" includes an attorney duly constituted under a power of attorney.

(ab) "**Record**" includes, in addition to a written or printed form, any disc, tape, sound-track, film or other device in which sounds and / or other data is embodied so as to be capable (with or without the aid of some other instrument or machine) of being reproduced there from in audible, legible or visual form.

(ac) "**Register**" means, unless the context otherwise requires, the register of members and include the register of debenture-holders or holders of other securities maintained on paper or computer network, floppy, diskette, magnetic cartridge tape, CD-Rom or any other computer readable media; to be kept pursuant to section 147 of the ordinance and / or central depository register under the central depositories act and the central depository regulations.

(ad) "**Registrar**" means a registrar, defined in section 2 (1) (31), performing the duty of registration of companies under the ordinance.

(ae) "**Regulations**" mean the rules of governance of the company made by the board from time to time.

(af) "**Seal**" means the common or official seal of the company.

(ag) "**Section**" means section of the ordinance.

(ah) "**Share Capital Rules**" mean the companies' Share Capital (Variation in Rights and Privileges) Rules, 2000.

(ai) "**Sign**" **and** "**Signature**" unless otherwise provided in these articles, include respectively lithography, printing facsimile, "advanced electronic signature" which is capable of establishing the authenticity and integrity of an electronic document, as defined by section 2(e) of the electronic transactions ordinance, and names impressed with a rubber or other kind of stamp.

(aj) "**Special Resolution**" means the special resolution of the company as defined in section 2(1) (36) of the ordinance.

(ak) "**Stock Exchanges**" mean the Islamabad, Lahore and Karachi stock exchanges and such other stock exchanges as may be established in Pakistan.

3. INTERPRETATION

In these articles, unless the context otherwise requires:

(a) the singular includes the plural and vice versa and words denoting any gender shall include all genders;

(b) references to any act, ordinance, legislation, the code, the listing requirements, rules or regulations or any provision of the same shall be a reference to that act, ordinance, legislation, the code, the listing requirements, rules or regulations or provisions, as amended, re-promulgated or superseded from time to time;

(c) the terms "include" or "Including" shall mean include or including without limitation;

(d) Expressions referring to writing shall, unless the contrary intention appears, be construed as including references to printing, lithography, photography, and other modes of

representing or reproducing words in a visible form, including but not limited to, electronic transmission such as facsimile, and electronic mail or any other electronic process as prescribed by section 3 of the electronic transactions ordinance.

(e) words importing persons shall include bodies corporate; and

(f) words and expressions contained in these articles shall bear the same meaning as in the ordinance.

REGISTERED OFFICE

4. The registered office of the company shall be in the Province of Sindh as the directors shall from time to time appoint.

PUBLIC LIMITED COMPANY

5. The company is a public limited company within the meanings of section 2(1), Clause (30) of the Companies Ordinance, 1984.

BUSINESS

6. All branches or kind of business which the company is either expressly or by implication authorized to undertake may be undertaken by the directors at such time or times as they shall think fit, and further may be allowed by them to be in abeyance, whether such branch or kind of business may have been actually commenced or not, so long as the directors may deem it expedient not to commence or proceed with such branch or kind of business

II. CAPITAL

SHARES

7. The minimum Subscription upon which the Directors may proceed to make First Allotment is fixed at Rs.700,000/- (Rupees: Seven Hundred Thousand Only).

8. The Authorized Capital of the Company is Rs 100,000,000/- (Rupees One Hundred Million Only) divided into 10,000,000 (Ten Million Only) (ordinary shares of Rs.10/= each, but the Company may from time to time by a Special Resolution increase, consolidate, sub-divide, reduce or otherwise re-organize the share capital of the Company, subject to the provisions of Section 108 of the Companies Ordinance, 1984

9. Subject to section 90 of the ordinance and any rules in that regard made under the ordinance, and without prejudice to any special rights previously conferred on the holders of any existing shares or class of shares, any share in the company may be issued with different rights, restrictions and privileges, including but not limited to the following as may be approved by the company by special resolution:

(1) different voting rights; voting rights disproportionate to the paid-up value of shares

held: voting rights for specific purposes only; or no voting rights at all;

(2) different rights for entitlement of dividend, right shares or bonus shares or entitlement to receive the notices and to attend the general meetings;

(3) rights and privileges for indefinite period, for a limited specified period or for such periods as may from time to time be determined by the company;

(4) different manner and mode of redemption, including redemption in accordance with the provisions of these articles, subject to sections 85 and 95 (4) of the ordinance, including but not limited to, by way of conversion into shares with such rights and privileges as determined by the company in the manner and mode provided in these articles; and

(5) Different rights and privileges for listing or non-listing of any class of shares.

10. Subject to section 95(4)(a) of the ordinance and any rules in that regard made under the ordinance, the company may issue shares which are to be redeemed or any other redeemable security, on such terms and in such manner as may be provided in the said section and rules.

11. Subject to provisions of the ordinance and these articles and subject to any special rights or privileges for the time being attached to any issued shares, the shares in the capital of the company for the time being, including any new shares resulting from an increase in the authorized capital, shall be under the control of the directors who may allot or otherwise dispose of the same or any of them to such persons (subject to article 43), on such terms and conditions, and with such rights and privileges annexed thereto as the resolution creating the same shall direct, and if no direction be given, as the directors shall determine and at such times and in such manner as the directors think fit, either at par or at a premium or subject to section 84 of the ordinance at a discount, with power to the directors to give any person the right to call for and be allotted shares of any class of the company at par or at a premium or, subject as aforesaid, at a discount, such option being exercisable at such time, and for such consideration as the directors think fit. Provided that the shares in the capital of the company shall always be issued as fully paid shares and no shares shall be issued as partly paid shares. The directors shall, as regards any allotment of shares, duly comply with such of the provisions of sections 67 to 73, the central depositories act, the central depository regulations, the issue of capital rules and the share capital rules, as may be applicable to the company.

12. The directors may allot and issue shares in the capital of the company as payment or part payment for any property sold or transferred, or for services rendered, to the company in the ordinary course of its business, and shares so allotted shall be issued as fully paid shall be deemed to be fully paid shares.

Siddiqsons Sohar Limited Karachi

Company Registration Office Karachi Securities and Exchange Commission of Pakistan SECP

13. The board shall, as regards any allotment of shares, duly comply with such provisions of sections 67 to 73 of the ordinance as may be applicable.

14. The company may at any time pay a commission to any person for subscribing or agreeing to subscribe (whether absolutely or conditionally) for any shares, debentures or debenture stock in the company or procuring or agreeing to procure subscriptions (whether absolutely or conditionally) for any shares, debentures or debenture stock in the company: Provided, that, if the commission in respect of shares shall be paid or payable out of capital, the statutory requirements and conditions shall be observed and complied with, and the amount or rate of commission shall not exceed such percentage on the shares, debentures or debenture stock in each case subscribed or to be subscribed, as may be determined by the board subject to any limits required by law. The commission may be paid or satisfied, either wholly or partly, in cash or in shares, debentures or debenture stock. The company may also on any issue of shares pay such brokerage fees as may be lawful. Provided that such brokerage fees shall not exceed such percentage of the shares, debentures or debenture stock paid-up as may be determined by the board, subject to any limits required by law.

15 Subject to section 95A of the ordinance and any rules in that regard made under the ordinance, the company may purchase its own shares on such terms and in such manner as may be provided in the said section and rules

16. Except as permitted in the ordinance and any rules in that regard made under the ordinance, no part of the funds of the company shall be employed in the purchase of its own shares or in giving, whether directly or indirectly and whether by means of a loan, guarantee, security or otherwise, any financial assistance for the purpose of or in connection with a purchase made or to be made by any person of or any shares in the company.

17. Except as required by law, no person shall be recognized by the company as holding any share upon any trust, and the company shall not be bound by or be compelled in any way to recognize (even when having notice thereof) any equitable, contingent, future or partial interest in any share or any interest in any fractional part of a share or (except only as by these Articles or by law otherwise provided or under an order of a court of competent jurisdiction) any other rights in respect of any share except any absolute right to the entirely thereof in the registered an absolute right to the entirely thereof in the registered holder.

18. Save as herein otherwise provided, the company shall be entitled to treat the registered holder of any share as the absolute owner thereof and accordingly shall not, except as ordered by a court of competent jurisdiction or as by statute required, be bound to recognize (even when having notice thereof) any benami, equitable, contingent, future, partial or other claim or right to or interest in such share on the part of any other person.

19 Shares may be registered in the name of persons, any limited company or other corporate body Not more than four persons shall be registered as joint-holders of any share.

20. If any share or shares stand in the name of two or more persons, the person first named in the register shall, as regards receipt of dividend or bonus or service of notices and all or

any other matters connected with the company except voting at the meeting and the transfer of shares, be deemed the sole holder.

RIGHTS PRIVILEGES AND CONDITIONS ATTACHED TO SHARES

21. As regards income, the profits which the company may determine to distribute in respect of any financial year or other period for which the accounts shall be made up, shall be applied in the following order of priority;

(1) In paying the holders of the preferences shares. the right to a cumulative preferential dividend as determined by the board on the capital paid up thereon payable as regards each financial year out of the profits of the company resolved to be distributed in respect of that year. but shall not be entitled to any further participation in profits; and

(2) Subject to the rights of any class of shares for the time being issued. in distributing the balance amongst the holders of the ordinary shares according to the amounts paid up on the ordinary shares held by them respectively.

22. As regards conversion. the company may partly or wholly convert the preference shares at the option of the holders of the preference shares in accordance, respectively, with the terms and conditions of their issue.

22. As regards capital, on a return of capital in a winding up or otherwise (except upon the redemption of shares of any class of preference shares or the purchase by the company of its own shares). the surplus assets of the company remaining after payment of its liabilities shall be applied in the following order of priority:

(1) in paying to the holders of the preference shares, the capital paid up on the same without any further right to participate in profits or assets; and

(2) subject to the rights of any other class of shares for the time being issued, in distributing the balance amongst the holders of the ordinary shares according to the amounts paid up on the ordinary shares held by them respectively.

23. As regards entitlement to bonus or right shares, the holders of preference shares shall not be entitled to bonus or right shares in the event that the company increases its capital by the issue of further shares or otherwise.

24. As regards voting rights. the holders of the preference shares shall not be entitled to receive notice of, attend, or vote at, any general meeting of the company, except as otherwise provided by the ordinance, whereby the holders of such shares would be entitled to vote separately as a class. that is, with respect to voting entitlement of the preference shareholders on matters affecting, respectively, their substantive rights and liabilities. Without prejudices to the foregoing. the holders of preference shares may attend the general meeting of the company as observers with prior permission of the chairman.

CERTIFICATES

25. The Certificates of title to shares and duplicate thereof shall be issued under the seal of the company and signed by two of the directors or by one such director and the secretary provided that such signatures may if necessary be printed lithographed or stamped subject to the approval of the directors.

26. Every member shall be entitled to one certificate for all the shares registered in his name, or, if the directors so approve, to several certificates each for one or more of such shares, but in respect of each certificate for less than one hundred shares, the directors shall be entitled to charge a fee of Rupees 10 or such lesser sum as they may determine. Every certificate of shares shall specify the number and denoting numbers of the shares in respect of which it is issued.

27. The company shall within ninety days after the allotment of any shares, debentures or debenture stock and within forty-five days (or where the transferee is a central depository,

within five (5) days) after receipt by the company of the application for transfer of any such shares, debentures or debenture stock complete and have ready for delivery the certificate (such expression shall hereinafter be deemed to include book-entry security as defined in the central depositories act, and the central depository regulations) of all shares, the debentures and the certificate of all debenture stock allotted or transferred, and unless sent by post or delivered to the person entitled thereto within the period aforesaid the company shall immediately thereafter give notice to that person in the manner prescribed in these articles for the giving of notices to members that the certificate is ready for delivery.

28 If a certificate of shares, debenture or debenture stock is proved to the satisfaction of the company to have been lost or destroyed or, being defaced or mutilated or torn, is surrendered to the company, and the company is requested to issue a new certificate in replacement thereof, the company shall, after making such enquiry as it may deem fit, advise the applicant within thirty days from the date of application the terms and conditions (as to indemnity and otherwise and as to payment of the actual expenses incurred on such enquiry and of a fee not exceeding ten rupees) on which the company is prepared to issue a new certificate and a time for compliance therewith or of the reasons why the company is unable to issue a new certificate, as the case may be, and in the former case if the applicant shall within the time allowed comply with the terms and conditions specified, the company shall issue a new certificate to the applicant within forty five days from the date of application.

29. The company shall not be bound to issue more than one certificate in respect of a share or shares held jointly by two or more persons and delivery of a certificate for a share to any one of joint holders shall be sufficient delivery to all.

TRANSFER AND TRANSMISSION

30.(1) The directors shall not refuse to register the transfer of fully paid shares unless the instrument

of transfer is defective or invalid or is not accompanied by the certificate of the share(s) to which it relates. The directors may also decline to recognise any instrument of transfer unless it is accompanied, in addition to the certificate of the shares to which it relates, by such other evidence as the directors may reasonably required to show the right of the transferor to make the transfer. The directors may waive the production of any certificate upon evidence satisfactory on them of its loss or destruction.

(2) If the directors refuse to register a transfer of any shares they shall, within thirty (30) days (or where the transferee is a central depository, within five (5) days) after the date on which the instrument of transfer was lodged with the company, send to the transferee and the transferor notice of the refusal indicating the reason for such refusal; provided that if the directors refuse to register a transfer of shares on account of a defect in or the invalidity of the instrument of transfer, the transferee shall be entitled, after removal of such defect or invalidity, to re-lodge the instrument of transfer with the company.

31. Shares in the company shall be transferred in accordance with the central depositories act and the central depository regulations. If the shares of the company are not registered in the central depository, the same may be transferred through the instrument of transfer. The instrument of transfer of any share shall be in writing in the usual common form, or in the following form, or as near thereto as circumstances will admit:

"I/We, ... of ....
son/daughter/wife of ..... being a national(s) of
..... in consideration of the sum of Rupees
.... only (Rs. .....) paid to me/us by
.... of ..... son/daughter/wife of
.... being a national(s) of ..... (hereinafter called the 'said transferee(s)') do hereby transfer to the said transferee(s) share(s) numbered standing in my/our name(s) in the books of **SIDDIQSONS SOLAR LIMITED**, to hold onto the said transferee(s) his/her/their executors, administrators and as signs, subject to the several conditions on which I/we hold the same at the time of execution hereof, and I/we the said transferee(s) do hereby agree to take the said share(s) subject to the conditions aforesaid.

As witness our hands the ..... day of ..... thousand and ....."

Signed by the said transferor in the presence of

Transferor's signature.....

Transferor's occupation.....

Witness 1..... ... .

Witness 2 .....

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan
SECP

Siddiqsons Solar Limited Karachi

Occupation	Occupation... ... .
Address	Address...... ....
Signed by the said transferee in the presence of Transferee's occupation	Transferee's signature
Witness 1	Witness 2 ....
Occupation	Occupation
Address	Address.................. ....

32. No transfer shall be made to a minor or person of unsound mind.

33. All registered instruments of transfer shall be retained by the company, but any instrument of transfer which the directors may decline to register shall be returned to the person depositing the same.

34 The instrument of transfer of any share in the company shall be duly stamped and executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the register in respect thereof.

35 On giving seven days previous notice in the manner provided in the ordinance and articles, the transfer books and register may be closed during such time as the directors think fit, not exceeding in the whole forty-five days in each year, but not exceeding thirty days at a time

36 Any member may make and deposit with the Company a nomination in writing specifying one or more eligible persons who or each of whom, in the event of the death of the Member, may be entered in the Register as the holder of such number of shares specified in the nomination for such nominee or each such nominee of which the member remains the registered holder, at the date of his death. A person shall be eligible for nomination for the purposes of this Article only if he is a spouse, parent, brother, sister or child of the member nominating him and the applicable relationship all should be specified in the nomination in respect of each nominee. A member may at any time by notice in writing cancel, or by making and depositing with the company another nomination before his death vary any nomination already made by him pursuant to this Article. In the event of the death of a member any person nominated by him in accordance with this Article may, on written application accompanied by the relative share certificates and evidence establishing the death of the member, request the company to register himself in place of the deceased member as the holder of the number of shares for which the nomination in his favour had been made and deposited with the company, and if it shall appear to the Directors that it is proper so to do, the Directors may register the nominee as the holder of those shares in place of the deceased member.

(a) in the case of the death of a member who was a joint-holder of shares the survivor or survivors shall be the only persons recognized by the company as having any title to his interest in the shares If the deceased member was a sole holder of shares, the nominee or

nominees of the deceased where a nomination under Article 37 is effective, and the legal personal representatives, executors or administrators, of the deceased where no such nomination has been made and deposited with the company, shall be the only persons recognized by the company as having any title to his interest in the shares.

(b) Before recognizing any legal representative or executor or administrator, the Directors may require him to obtain a grant of succession certificate or probate or letters of administration or other legal representation, as the case may be, from some competent Court in Pakistan having effect in Karachi; provided nevertheless that in any case where the Directors in their absolute discretion think fit, it shall be lawful for the Directors to dispense with the production of succession certificates or probates or letters of administration or such other legal representation, upon such terms as to indemnity or otherwise as the Directors, in their absolute discretion, may consider necessary.

37. The executors or administrators or the nominee appointed under section 80 of the ordinance of a deceased member (not being one of several joint-holders) shall be the only person recognized by the company as having any title to the shares registered in the name of such member, and in case of the death of any one or more of the joint-holders of all registered shares (such expression shall hereinafter be deemed to include registration as a sub-account holder of a central depository under the central depositories act and the central depositories regulations) ,the survivors shall be the only persons, recognized by the company as having any title to or interest in such shares, but nothing herein contained shall be taken to release the estate of a deceased joint-holder from any liability on shares held by him jointly with any other person. Before recognizing any executor or administrator, the directors may require him to obtain a grant of probate or nomination as mentioned above or letters of administration or other legal representation, as the case may be, from some competent court in Pakistan having effect in Karachi. Provided nevertheless that in any case where the board in their absolute discretion think fit, it shall be lawful for the directors to dispense with the production of probate or letters of administration or such other legal representation upon such terms as to indemnify or otherwise as the directors, in their absolute discretion, may consider necessary.

38. Any person becoming entitled to a share in consequence of the death or insolvency of a member may upon such evidence being produced as may from time to time properly be required by the Directors and subject as hereinafter provided, elect either to be registered himself as the holder of the share or instead of being registered himself, to make such transfer of the share or instead of being registered himself, to make such transfer of the share as the deceased or insolvent person could have made but the Directors shall, in either case, have the same right to decline or suspend registration as they would have had in the case of a transfer of the share by that member before his death or insolvency as the case may be.

39. Any committee or guardian of a lunatic or minor member or any person becoming entitled to a share in consequence of the death or bankruptcy or insolvency of any member upon producing such evidence that he sustains the characters in respect of which he proposes to act under this article, or of his title, as the directors think sufficient, shall have the right to be registered as a member in respect of such share, or may, subject to the

regulations as to transfer hereinbefore contained, transfer such share.

40. Neither the company nor the directors nor any other officer of the company shall incur any liability for registering or acting upon a transfer of shares apparently made by sufficient parties, although the same may, by reason of any fraud or other cause not known to the company or the directors or any other officer of the company, as aforesaid, be legally inoperative or insufficient to pass the property in the shares proposed or professed to be transferred, and although the transfer may, as between the transferor and transferee, be liable to be set aside, and, notwithstanding that the company may have notice that such instrument of transfer was signed or executed and delivered by the transferor in blank as to the name of the transferee or the particulars of the shares transferred, or otherwise in defective manner. And in every such case the person registered as transferee, his executors, administrators and assigns alone shall be entitled to be recognized as the holder of such shares and the previous holder shall, so far as the company is concerned, be deemed to have transferred his whole title hereto.

ALTERATION OF CAPITAL

41. The company may by ordinary resolution and subject to compliance with the requirements of section 92 of the ordinance increase the authorized share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

42 Subject to the provisions of section 92 (1) (d), 92(3) and 93 and section 13 of the central depositories act, the company may, by ordinary resolution;

(a) consolidate and divide its share capital into shares of larger amount than its existing shares.

(b) by sub-division of its existing shares or any of them, divide the whole or any part of its share capital into shares of smaller amount than is fixed by the memorandum of association;

(c) cancel any shares which, at the date of the passing of the resolution, have not been taken or agreed to be taken by any person.

43. The directors may from time to time increase the issued share capital by such sum as they think fit. Except as otherwise permitted by section 86 of the ordinance , rule 5 of share capital rules, the listing requirements and section 14 of the central depositories act, as are applicable to the company and subject to any special rights or privileges for the time being attached to any issued shares, all shares intended to be issued by the directors shall, before issue, be offered to the members strictly in proportion to the amount of the issued shares held by each member (irrespective of class); provided that fractional shares shall not be offered and all fractions less than a share shall be consolidated and disposed of by the company and the proceeds from such disposition shall be paid to such of the entitled members as may have accepted such offer. Such offer shall be made by notice specifying the number of shares offered, and limiting a time within which the offer, if not accepted, will be deemed to be declined, and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made that he declines to accept the shares offered, the directors may dispose of the same in such manner as they think fit. In respect of each such offer of shares the directors shall comply with the provisions of section 86 of the ordinance and in

particular with the provisions of sub -sections (3), (4) and (5) thereof. Any difficulty in the apportionment of shares amongst the members, such difficulty shall, in the absence of any directions given by the company in general meeting, be determined by the directors.

44. Except so far as otherwise provided by the conditions of issue or by these articles, any capital raised by the creation of new shares shall be considered part of the original capital and shall be subject to the provisions herein contained with reference to transfer and transmission and otherwise.

45. Subject to the provisions of sub-section (2) of section 86 of the ordinance, if, owing to any inequality in the number of new shares to be issued and the number of shares held by a member entitled to have the offer of such new shares, any difficulty shall arise in the apportionment of such new shares or any of them amongst the members, such difficulty shall, in the absence of any direction in the resolution creating the shares or by the company in general meeting, be determined by the directors.

46. The company may, by special resolution, reduce its share capital in any manner, with and subject to, any incident authorized and consent required by law.

47. The share premium account maintained pursuant to section 83(1) of the ordinance may, be applied by the company:

(a) in writing off the preliminary expenses of the company;

(b) in writing off the expenses of, or the commission paid or discount allowed on, any issue of shares or debentures of the company;

(c) in providing for the premium payable on the redemption to any redeemable preference shares or debentures of the company; or

(d) in paying up un-issued shares of the company to be issued as fully paid bonus shares.

48. Subject to the provisions of section 96 to 105 inclusive of the ordinance, the directors may accept from any member the surrender on such terms and conditions as shall be agreed of all or any of his shares.

VARIATION OF SHAREHOLDERS' RIGHTS

49. Whenever the capital is divided into different classes of shares, all or any of the rights and privileges attached to each class may, subject to the provisions of section 108 of the ordinance, be modified, commuted, affected, abrogated or dealt with by agreement between the company and any person purporting to contract on behalf of that class provided such agreement is (a) ratified in writing by the holders of at least three-fourths in nominal value of the issued shares of the class or (b) confirmed by a special resolution passed at an extraordinary general meeting of the holders of shares of the class and all the provisions hereinafter contained as to general meetings, shall, mutatis mutandis, apply to every such meeting. This article shall not by implication curtail the power of

modification which the company would have if this article were omitted.

III. MEETINGS

CONVENING OF GENERAL MEETINGS

50. Except as may be allowed under section 158(1) of the ordinance and listing requirements, the company shall hold a general meeting once at least in every calendar year within a period of four months following the close of its financial year in the town in which the office is situate and at such time and place as may be determined by the directors, provided that no greater interval than fifteen months shall be allowed to elapse between two such general meetings. The company may for any special reason and with permission of the commission, extend the time within which any annual general meeting, not being the first such meeting, shall be held.

51. The company shall hold its annual general meeting in the town in which the registered office is situate: provided that, it may, for any special reason and with permission of the commission. hold the said meeting at any other place. Save as aforesaid, the company may hold its general meeting at two (2) or more venues using any technology that gives the members as a whole a reasonable opportunity to participate in the meetings.

52 All general meetings of the company, other than the statutory meeting or any annual general meeting. shall be called extraordinary general meetings, and shall be subject to listing requirements.

53. The directors may, whenever they think fit, and they shall, on the requisition of the holders of not less than one-tenth of the issued capital of the company. forthwith proceed to convene an extraordinary general meeting of the company. If at any time there are not within Pakistan sufficient directors capable of acting to form a quorum, any director of the company may call an extraordinary general meeting in the same manner as nearly as possible as that in which meetings may be called by the directors, and in the case of such requisition the following provisions shall have effect:

(1) The requisition must state the objects of the meeting and must be signed by the requisitioners and deposited at the office and may consist of several documents in like form each signed by one or more requisitioners.

(2) If the directors do not proceed within twenty-one days from the date of the requisition being so deposited to cause a meeting to be called, the requisitioners or a majority of them in value may themselves convene the meeting, but any meeting so convened shall not be held after three months from the date of the deposit.

(3) Any meeting convened under this article by the requisitioners shall be convened in the same manner as nearly as possible as that in which meetings are to be convened by the directors but shall be held at the office.

(4) A requisition by joint-holders of shares must be signed by all such holders.

54 (1) Notice of a general meeting shall be sent in the manner hereinafter mentioned at least twenty one (21) days before the date on which the meeting is to be convened...

such persons as are under these articles or the ordinance entitled to receive such notices from the company and shall specify the place and the day and hour of the meeting and the nature of the business to be transacted thereat.

(2) In the case of an emergency affecting the business of the company, an extraordinary general meeting may be convened by such shorter notice than that specified in article 54(1) as the registrar may authorize.

(3) Where any special business, that is to say, business other than consideration of the accounts, balance sheet and the reports of the directors and auditors, the declaration of dividend, the appointment and fixation of the remuneration of auditors and, where the notice convening the meeting provides for the election of directors, the election of directors (all such matters being herein referred to as ordinary business) is to be transacted at a general meeting, there shall be annexed to the notice of such meeting a statement setting out all such facts as may be material for the consideration of such business including the nature and extent of the interest (whether direct or indirect) of any director, and where the item of business involves approval of any document, the time and place appointed for inspection thereof, and to the extent applicable such a statement shall be annexed to the notice also in the case of ordinary business to be transacted at the meeting.

(4) Where a resolution is intended to be proposed for consideration at a general meeting in some special or particular form, a copy thereof shall be annexed to the notice convening such meeting.

(5) If a special resolution is intended to be passed at a general meeting, the notice convening that meeting shall specify the intention to propose the resolution as a special resolution.

(6) A notice for a general meeting at which an election of directors is to take place shall state the number of directors to be elected at that meeting and the names of the retiring directors.

(7) The notice of every general meeting shall prominently specify that a proxy may be appointed who shall have the right to attend, demand or join in demanding a poll and vote on a poll and speak at the meeting in the place of the member appointing him and shall be accompanied by a form of proxy acceptable to the company.

(8) The company shall comply with the provisions of section 160(1) and section 50 of the ordinance with regard to giving notices of general meetings.

55. The accidental omission to give any such notice to, or the non-receipt of notice by, any of the members shall not invalidate the proceedings at any such meeting.

PROCEEDINGS AT GENERAL MEETINGS

56. No business shall be transacted at any general meeting unless a quorum of members is present at the time when the meeting proceeds to business; save as herein otherwise, provided ten (10) members present in person or by proxy representing twenty five percent (25%) of the total voting power shall be a quorum.

57. The chairman of the board of directors shall preside as chairman at every general meeting

of the company, or if there is no such chairman, or if he shall not be present in person within fifteen minutes after the time appointed for the holding of the meeting or is unwilling to act, the chief executive shall preside as chairman of the meeting, or if the chief executive is absent or unwilling to act, any one of the directors present in person may be elected to be chairman of the meeting, or if no director be present in person, or if all the directors present in person decline to take the chair, the members present in person shall choose one of their member to be chairman of the meeting.

58. If within half-an-hour from the time appointed for the meeting, a quorum is not present, the meeting if convened upon such requisition as aforesaid shall be dissolved, but in any other case it shall stand adjourned to the same day in the next week at the same time and place, and if at such adjourned meeting a quorum is not present within half an hour from the time appointed for it, the meeting shall be dissolved.

59. The chairman may adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for more than seven days, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.

60 In the case of an equality of votes the chairman shall, both on a show of hands and at the poll, have a casting vote in addition to the vote or votes to which he may be entitled as member

61. (1) At any general meeting a resolution put to the vote of the meeting shall be decided on a show of hands, unless a poll is (before or on the declaration of the result of the show of hands) demanded in accordance with paragraph (2) of this article, and unless a poll is so demanded, a declaration by the chairman of the meeting that a resolution has, on a show of hands, been carried, or carried unanimously, or by a particular majority, or lost, and an entry to that effect in the book or electronic record of the proceeding of the company shall be conclusive evidence of the fact, without proof of the number or proportion of the votes recorded in favour of, or against, the resolution.

(2) Any of the following persons may demand a poll:

(a) The chairman of the meeting; or

(b) Ten members having the right to vote on the resolution and present in person or by proxy; or

(c) Any member or members present in person or by proxy having not less than one-tenth of the total voting power in respect of the resolution.

62. If a poll is demanded, as aforesaid, it shall be taken (subject to section 168 of the ordinance) in such manner and at such time and place as the chairman of the meeting directs, and either at once or after an interval or adjournment of not more than fourteen days from the day on which the poll is demanded, and the result of the poll shall be

deemed to be the resolution of the meeting at which the poll was held. The demand for a poll may be withdrawn at any time by the person or persons who made the demand. In case of any dispute as to the admission or rejection of a vote, the chairman of the meeting shall determine the same, and such determination made in good faith shall be final and conclusive.

63. Any poll duly demanded on the election of a chairman of a meeting or on any question of adjournment shall be taken at the meeting and without adjournment. A poll demanded on any other question shall be taken at such time, not being more than 14 days from the day on which the poll is demanded as the chairman of the meeting directs.

64. The demand of a poll shall not prevent the continuance of a meeting for the transaction of any business other than the question on which a poll has been demanded.

VOTES OF MEMBERS

65. Subject to section 160 and any rights or restrictions for the time being attached to any class or classes of shares, every member present in person (where all the participants of a general meeting can see each other) shall have, whether on a show of hands or on a poll, votes proportionate to the paid up value of the shares or other securities carrying voting rights held by him according to the entitlement of the class of such shares or securities, as the case may be provided that , the provisions of section 178 shall apply in the case of the election of directors.

66. Without prejudice to articles 69 and 79, on a show of hands, every member present in person shall have one vote and upon a poll every member present in person or by proxy shall have one vote in respect of each share held by him. Provided always that in the case of an election or removal of a director, the provisions of articles 91 and 94 respectively shall apply.

67. On a poll a member entitled to more than one vote need not, if he votes, use all his votes or cast all the votes he uses in the same way.

68. Any company or other corporation which is a member of the company may by resolution of its directors or other governing body authorize such person as it thinks fit to act as its representative at any meeting of the company or of any class of members of the company, and the person so authorized shall be entitled to exercise the same powers on behalf of the company or corporation which he represents as that company or corporation could exercise if it were an individual member of the company, present in person. The production before or at the meeting of a copy of such resolution purporting to be signed by a director or the secretary of such company or corporation and certified by him as being a true copy of the resolution shall be accepted by the company as sufficient evidence of the validity of the appointment of such representative.

69. Any person entitled under article 39 to any shares may vote at any general meeting in respect thereof in the same manner as if he were the registered holder of such shares, provided that forty-eight hours at least before the time of holding the meeting or adjourned meeting, as the case may be, at which he proposes to vote he shall satisfy the directors of his right to such

shares, or the directors shall have previously admitted his right to vote at such meeting in respect thereof. If any member be a lunatic, idiot or non compos mentis, he may vote, whether by a show of hands or at a poll, by his committee, curator bonis or other legal curator and such last mentioned persons may give their votes by proxy.

70. Where there are jointly registered holders of any share, any one of such persons may vote at any meeting either in person or by proxy in respect of such share as if he were solely entitled thereto; and if more than one of such joint-holders be present at any meeting, either in person or by proxy, that one of the said persons so present whose name stands first in the register in respect of such share shall alone be entitled to vote in respect thereof. Several executors or administrators of a deceased member in whose name any share stands shall for the purposes of this article be deemed joint holders thereof.

71. On a poll votes may be given either in person (including without limitation a representative of a company duly authorized under article 68) or by proxy.

72. No objection shall be raised to the qualification of any voter except at the meeting or adjourned meeting at which the vote objected to is given or tendered, and every vote not disallowed at such meeting shall be valid for all purposes. Any such objection made in due time shall be referred to the chairman of the meeting, whose decision shall be final and conclusive.

73. The instrument appointing a proxy shall be in writing under the hand of the appointer (such expression shall exclude any reference to the electronic transactions ordinance in accordance with section 31 (1) of the electronic transactions ordinance) or of his attorney duly authorized in writing (such expression shall exclude electronic transmission as prescribed by section 3 of the electronic transactions ordinance) or if such appointer is a corporation under its common seal or signed by an officer or an attorney duly authorized by it (such expression shall exclude any reference to the electronic transactions ordinance in accordance with section 31 (1) of the electronic transactions ordinance). Save as provided by article 80, no person shall be appointed a proxy who is not a member of the company and qualified to vote.

74. Subject to article 73 hereof, the instrument appointing a proxy and the power of attorney or other authority (if any) under which it is signed, or a copy of that power or authority duly notarized, shall be deposited (such expression shall hereinafter include, where permitted by law, receipt in accordance with section 15 of the electronic transactions ordinance) at the office not less than forty-eight hours before the time for holding the meeting at which the person named in the instrument proposes to vote, and in default the instrument of proxy shall not be treated as valid.

75. A vote given in accordance with the terms of an instrument appointing a proxy shall be valid notwithstanding the previous death or insanity of the principal or revocation of the instrument or transfer of the share in respect of which the vote is given, provided no intimation in writing of the death, insanity, revocation or transfer of the share shall have been received at the office before the meeting. Provided nevertheless that the chairman of

Technical/Executive Director and such Technical/Executive Director may be appointed only for a fixed period in such special remuneration as may be determined by the Board. The number of such directors appointed shall not be counted within minimum or maximum fixed for number of directors in these articles. Such Technical/Executive Directors would be the senior executives of the company and will not have any representation on the Board of the company unless specially invited by the members to assist them in the proceedings of the meeting of the Board of Directors of the company.

CHIEF EXECUTIVE AND OTHER PRINCIPAL OFFICERS OF THE COMPANY

82. The company shall have an office of chief executive which shall be filled from time to time by the directors who may appoint a director or (subject to section 201 of the ordinance) any other person to be the chief executive of the company for a period not exceeding three years and on such terms and conditions as the directors may think fit, and such appointment shall be made within fourteen days from the date on which the office of chief executive falls vacant. If the chief executive at any time is not already a director he shall be deemed to be a director of the company notwithstanding that the number of directors shall thereby be increased and he shall be entitled to all the rights and privileges and shall be subject to all liabilities of the office of director. Upon the expiry of his period of office, a chief executive shall be eligible for re-appointment. The chief executive may be removed from office in accordance with the provisions of section 202 of the ordinance notwithstanding anything contained in these articles or in any agreement between the company and the chief executive.

83. No person who is ineligible to become a director of the company shall be appointed or continue as the Chief Executive except as permitted by Section 187.

84. The Chief Executive retiring under Article 82 continue to perform his functions until his successor is appointed unless non-appointment of his successor is due to any fault on his part or his office is expressly terminated.

85. The directors may appoint other principal officers of the company including chief operating officer, chief financial officer, head of internal audit and the company secretary (who is to be a full time employee of the company as required by section 204 A), and give such officer such designations and with such terms and conditions as the directors may determine from time to time.

86. A chief executive of the company shall receive such remuneration as the directors may determine and it may be made a term of his appointment that he be paid a pension and/or gratuity and/or other benefits on retirement from his office.

87. The directors may from time to time entrust to and confer upon the chief executive for the time being such of the powers exercisable under these articles by the directors as they may think fit, and may confer such powers for such time, and to be exercised for such objects and purposes, and upon such terms and conditions, and with such restrictions as they think expedient; and they may confer such powers, either collaterally with, or to the exclusion of, and in substitution for all or any of the powers of the directors in that behalf; and may from

time to time revoke, withdraw, alter or vary all or any of such powers.

QUALIFICATION AND REMUNERATION OF DIRECTORS

88. Any director who serves on any committee or who devotes special attention to the business of the company, or who otherwise performs services which in the opinion of the directors are outside the scope of the ordinary duties of a director, may be paid such extra remuneration as the directors may determine from time to time. The remuneration of a director for attending meetings of the board shall from time to time be determined by the directors.

89. Each director of the company may, in addition to any remuneration receivable by him, be reimbursed his reasonable travelling and hotel expenses incurred in attending meetings of the directors or of the company or otherwise whilst employed on the business of the company.

90. The qualification of an elected director, in addition to his being a member, where required, shall be his holding share of the nominal value of Rs. 10 at least in his own name, but a director representing the interests of a member or members holding share of the nominal value of Rs. 10 at least shall require no such share qualification. A director shall not be qualified as representing the interests of a member or members holding shares of the requisite value unless he is appointed as such representative by the member or members concerned by notice in writing addressed to the company specifying the shares of the requisite value appropriated for qualifying such director. Shares thus appropriated for qualifving a director shall not, while he continues to be such representative, be appropriated for qualifying any other director. A director shall acquire his share qualification within two (2) months from the effective date of his appointment as director.

91. The continuing directors may act notwithstanding any vacancy in their body so long as their number is not reduced below the number fixed by or pursuant to these articles as the necessary quorum of directors.

92. The office of a director shall ipso facto be vacated if:

(a) he ceased to hold the share qualification, if any, necessary for his appointment; or

(b) he is found to be an unsound mind by a court of competent jurisdiction; or

(c) he is adjudged an solvent; or has applied to be adjudicated as an insolvent and his application is pending or is an un-discharged insolvent; or

(d) he has been convicted by a court of law for an offence involving moral turpitude;

(e) he or any firm of which he is a partner or any private company of which he is a director without the sanction of the company in general meeting accepts or holds any office of profit under the company other than that of a chief executive or legal or technical adviser or a banker in contravention of the provisions of section 188 (i) (c) of the ordinance;

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any meeting shall be entitled to require such evidence as he may in his discretion think fit of the due execution of an instrument of proxy and that the same has not been revoked.

76. Every instrument appointing a proxy shall, as nearly as circumstances will admit, be in the form or to the effect following and shall be retained by the Company:

SIDDIQSONS SOLAR LIMITED

I, _____ of _____, being a member of **SIDDIQSONS SOLAR LIMITED**, hereby appoint _____of _____ (or failing him _____ of _____ or failing him _____ of _____) as my proxy in my absence to attend and vote for me and on my behalf at the (Annual or Extraordinary, as the case may be) general meeting of the company to be held on the _____ day of _____and at any adjournment thereof.

As witness my hand this _____ day of _____.

Signed by the said

In the presence of

Provided always that an instrument appointed a proxy may be in the form set out in regulation 39 of table A of the first schedule to the ordinance.

IV. DIRECTORS

NUMBER OF DIRECTORS

77. Subject to the provisions of these articles and the ordinance, all directors shall be elected by the members in general meeting.

78. The company shall have at least six directors. Subject to the said minimum, the directors themselves shall determine from time to time in the manner provided in this article the number of directors that the company shall have. At least thirty-five (35) days before the date of every general meeting at which directors are intended to be elected, the directors shall fix the number of elected directors that the company shall have from the effective date of the election and the number of such directors who shall be elected at the meeting. The number of elected directors so fixed by the directors shall not be changed except

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with the prior approval of the company in general meeting. The following persons shall be the first directors of the Company and shall hold the office up to the date of First Annual General Meeting.

(1) Mr. Abdur Rahim

(2) Mr. Ibrahim Shamsi

(3) Mr. Muhammad Tariq Rafi

(4) Mrs. Nighat Tariq

(5) Mrs. Anum Abdur Rahim

(6) Mrs. Alia Sajjad

(7) Mrs. Rahma Ibrahim

ALTERNATE DIRECTORS

79 When any director intends to be, or is living outside Pakistan, he may with the approval of the directors appoint any person to be his alternate director, and such alternate director during the absence of the appointer from Pakistan, shall be entitled to receive notice of and to attend and vote at meeting of directors and shall be subject to and entitled to the provisions contained in these articles with reference to directors and may exercise and perform all such powers, directions and duties as his appointer could have exercised or performed including the power of appointing another alternate director. An alternate director so appointed shall not be required to hold any qualification. Such appointment shall be recorded in the director minute book. A director may at any time by notice in writing to the company remove an alternate director appointed by him. The alternate director shall cease to be such provided that if any director retires but is re-elected at the meeting at which such retirement took effect any appointment made by him pursuant to this article which was in force immediately prior to this retirement and re-election and which has not otherwise ceased to be effectively shall continue to operate after his re-election as if he had not so retired. An alternate director shall not be deemed to be the agent of the director appointing him but shall be reckoned as one with his appointer. All appointments and removals of alternate directors shall be effected by writing under the hand of the director making or revoking such appointment and left at the office. For the purpose of assessing a quorum in accordance with the provisions of article 99 hereof an alternate director shall be deemed to be director. Any director may act as alternate director for any one or more directors, as well as being able to act as a director in his own right. An alternate director may resign as such upon giving thirty (30) days prior notice to the board to this effect. An alternate director need not be a member of the Company.

80. Notwithstanding article 164, an alternate director, even if not a member, shall, in the absence of a direction to the contrary in the instrument appointing him, be entitled to notice of general meetings of the company and (subject to the provisions of article 75) to vote at such meetings on behalf of his appointer, if his appointer is a member of the company, and generally to represent his appointer.

81. Directors shall have power at any time and from time to time to appoint any person as

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(f) he absents himself from three consecutive meetings of the directors or from all meetings of the directors for a continuous period of three months, whichever is the longer, without leave of absence from the board of directors: or

(g) he or any firm of which he is a partner or any private company of which he is a director accepts a loan or guarantee from the company in contravention of section 195 of the ordinance; or

(h) he acts in contravention of section 214 of the ordinance; or

(i) by notice in writing to the company he resigns his office; or

(j) he is removed from office by resolution of the company in general meeting in accordance with section 181 of the ordinance; or

(k) his appointment is withdrawn by the authority nominating him as director; or

(l) he has betrayed lack of fiduciary behavior and a declaration to the effect has been made by the court under section 217 of the ordinance at any time during the preceding five years.

93. Subject to authorization being given by the directors in accordance with section 196(2)(g) of the ordinance, a director shall not be disqualified from contracting with the company either as vendor, purchaser or otherwise, nor shall any such contract or arrangement entered into by or on behalf of the company with any company or partnership of or in which any director of the company shall be a member or otherwise interested, be avoided, nor shall any such director so contracting or being such member or so interested be liable to account to the company for any profit realized by any such contract or arrangement by reason of such director holding that office or of the fiduciary relationship so established. A director who, or whose spouse or minor child, is in any way, whether directly or indirectly, concerned or interested in any contract or arrangement or proposed contract or arrangement with the company shall disclose the nature of such concern or interest in accordance with section 214 of the ordinance that is to say:

(a) in the case of a contract or arrangement to be entered into, at the meeting of the directors at which the question of entering into the contract or arrangement is first taken into consideration or, if the director was not, on the date of that meeting, concerned or interested in the contract or arrangement, at the first meeting of the directors held after he becomes so concerned or interested; and

(b) in the case of any other contract or arrangement, at the first meeting of the directors held after the director becomes concerned or interested in the contract or arrangement.

A general notice that any director of the company is a director or a member of any other named company or is a member of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall, as regards any such transaction, be sufficient disclosure under this article. Provided, however, that any such general notice shall expire at the end of the financial year in which it was given and may be renewed for a further period of one financial year at a time by giving fresh notice in the last month of the financial year in which it would otherwise expire.

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94. Except as provided in Section 216 of the Ordinance, a Director shall not vote in respect of any contract or arrangement in which he is either directly or indirectly concerned or interested nor shall his presence count for the purpose of forming a quorum at the time of any such vote and if he does so vote, his vote shall not be counted.

95. Whereby any contract or resolution of the directors an appointment or a variation in the terms of an existing appointment is made (whether effective immediately or in the future) of a chief executive, whole time director or secretary of the company, in which appointment of any director of the company is, or after the contract or resolution becomes, in any way, whether directly or indirectly, concerned or interested, or whereby any contract or resolution of the directors, an appointment or a variation in the terms of appointment is made (whether effective immediately or in the future) of a chief executive, the company shall inform the members of such appointment or variation in the manner required by section 218 of the ordinance and shall comply with the requirements of that section in regard to the maintaining of such contracts and resolutions open for inspection by members at the office, the provision of certified copies thereof and extracts there from and otherwise.

96. In accordance with section 219, the company shall maintain at its office a register or electronic record, in which shall be entered separately particulars of all contracts, arrangements or appointments in which the directors are interested Such register or electronic record shall be open to inspection to the members during business hours, subject to any reasonable restriction that may be imposed by the company in general meeting.

97. A director of the company may be or become a director of any other company promoted by the company or in which the company may be interested as a vendor, shareholder or otherwise, and no such director shall be accountable for any benefits received as a director or member of such other company.

ELECTION OF DIRECTORS

98 The number of directors determined by the directors under articles 78 shall be elected to office by the members in general meeting in the following manner, namely:

(a) a member present in person or by proxy shall have such number of votes as is equal to the product of voting shares held by him and the number of directors to be elected,

(b) a member may give all his votes to a single candidate or divide them between more than one of the candidates in such manner as he may choose, and

(c) the candidate who gets the highest number of votes shall be declared elected as director and then the candidate who gets the next highest number of votes shall be so declared, and so on until the total number of directors to be elected has been so elected.

If the number of persons who offer them to be elected as directors is not more than the number of vacancies for which elections are being held, such persons being otherwise eligible shall be deemed to have been elected as directors from the date on which the election was proposed to be effective.

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99. A director elected under article 98 shall hold office for a period of three years unless he earlier resigns or becomes disqualified from being a director, or otherwise ceases to hold office.

100. A retiring director of the company shall be eligible for re-election.

101. The company in general meeting may remove a director from office by a resolution passed with the requisite number of votes determined in accordance with the provisions of section 181 of the ordinance.

102. Any casual vacancy occurring among the directors may be filled up by the directors within a time period prescribed by the code, and the person so appointed shall hold office for the remaining period of the director in whose place he is appointed. Provided that the directors may not fill a casual vacancy by appointing any person who has been removed from the office of a director of the company under article 101.

103. No person including a retiring director of the company shall be eligible for election to the office of director of the company at any general meeting unless he has, not less than fourteen days before the date of the meeting, left at the office, a notice in writing, and duly signed, signifying his candidature for the office.

104. The company shall keep at the office a register of the directors and officers, containing the particulars required by section 205 of the ordinance and the company shall otherwise comply with the provisions of that section as regards furnishing returns to the registrar and giving inspection of the register.

PROCEEDINGS OF DIRECTORS

105. The directors shall meet together at least once in each quarter of a year for the despatch of business, adjourn and otherwise regulate their meetings and proceedings as they may think fit in accordance with the ordinance, the code and the listing requirements. Questions arising at any meeting shall be decided by a majority of votes and in case of an equality of votes the chairman shall have a second or casting vote.

106. The quorum necessary for the transaction of the business of the directors shall be one-third of the number of directors or two directors, whichever is greater, present in person. An alternate director whose appointment is effective shall be counted in a quorum. If all the directors except one are disqualified from voting, the matter should be decided in general meeting.

107. A director may, and the secretary on the requisition of a director shall, at any time summon a meeting of the directors. Such meetings may be held using any technology consented to by all the directors, including but not limited to telephone and video conferencing. The consent may be a standing one, withdrawable by a director only within a reasonable period of time before the meeting. It shall not be necessary to give notice of a meeting of directors to any director for the time being absent from Pakistan.

108. The board of directors of the company shall from time to time elect one of the directors as chairman of the board of directors of the company and determine the period for which he is to hold office and his remuneration. The chairman or in his absence the chief executive shall preside over all meetings of the board of directors. but if at any meeting neither the chairman nor the chief executive is present in person within half an hour of the time appointed for holding the same, the directors present in person may choose one of their member to be chairman of the meeting.

109. A meeting of the directors at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretion by or under these articles for the time being vested in or exercisable by the directors generally.

110 The directors may from time to time delegate of their powers to committees consisting of such two members or more members of their body as they think fit, and may from time to time revoke such delegation. Any committee so formed shall, in the exercise of the powers so delegated, conform to any regulations that may from time to time be imposed upon it by the directors.

111 The meeting and proceedings of any such committee consisting of two or more members shall be governed by the provisions herein contained for regulating the meetings and proceedings of the directors, so far as the same are applicable thereto and are not superseded by any regulations made by the directors under article 110.

112 All acts done by any meeting of the directors or by a committee of the directors or by any person acting as a director of the company shall, notwithstanding that is shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such directors or person acting as aforesaid, or that they or any of them were disqualified or had vacated office, or were not entitled to vote, be as valid as if every such person had been duly appointed or had duly continued in office and was qualified and had continued to be a director and had been entitled to be a director. Provided that nothing in this article shall be deemed to give validity to acts done by any such director after the appointment of such director has been shown to be invalid.

113 A resolution, other than resolution in respect of any matter specified in section 196(2) of the ordinance circulated through fax or email or any form of electronic transmission to all the directors for the time being entitled to receive notice of a meeting of the directors, passed without any meeting of the directors or of a committee of directors and signed or affirmed through fax or email or any form of electronic transmission, by a majority of all directors in writing under the hands of all directors (or in their absence their alternate directors) for the time being in Pakistan, being not less than the quorum required for meetings of the directors, or as the case may be of the members of the committee, shall be valid and effectual as if it had been passed at the meeting of the directors, or as the case may be of such committee, duly called or constituted. The resolution in writing of the company may consist of several copies of a document signed by one or more director(s) and takes effect at the date and time on which the last director, necessary for the resolution to be passed, signs a copy of the resolution: or a record of several signed electronic messages each indicating the identity of the sender, the text of the resolution

and the sender's agreement or disagreement to the resolution, as the case may be and such a resolution takes effect on the date on which the last director's message, necessary for the resolution to be passed, is received.

114. If any director of the company, being willing, shall be called upon to perform extra services or to make any special exertions in going or residing away from his place of business for the time being for any of the purposes of the company or in giving special attention to the business of the company as a member of a committee of the directors, the company may remunerate such director so doing either by a fixed sum or by a percentage of profits or otherwise as may be determined by the directors, and such remuneration may be either in addition to or in substitution for his or their share in the remuneration above provided for the directors.

MINUTES

115. The directors shall cause minutes to be duly entered in books provided for the purpose of or as an electronic record, of;

(a) all appointments of officers;

(b) the names of the directors present in person at each meeting of the directors and of any committee of the directors;

(c) all orders made by the directors and committees of the directors;

(d) all resolutions and proceedings of general meeting and of meetings of the directors and of the committees of the directors;

and any such minutes of any meeting of the directors or of any such committee or of the company, if purporting to be signed by the chairman of such meeting or by the chairman of the next succeeding meeting, shall be prima facie evidence of the matter stated in such minutes.

POWERS AND DUTIES OF DIRECTORS

116. The directors shall duly comply with the provisions of the ordinance, the listing requirements and the code. In particular and without prejudice to the generality of the foregoing, the company shall comply with the provisions of the ordinance in regard to the registration of the particulars of mortgages and charges affecting the property of the company or created by it, to the keeping of a register of the directors, and to the sending to the registrar of an annual list of members and a summary of particulars relating thereto, and notice of any consolidation or increase of share capital, sub-division of shares, and copies of special resolutions and a copy of the register of directors and notifications of any changes therein. All such information may be stored as an electronic record and transmitted accordingly, where possible.

117. The control of the company shall be vested in the directors, and the business of the company shall be managed by the directors who may exercise all such powers of the company and do all such acts and things as may be exercised or done by the company as by the ordinance or by these articles or by a special resolution expressly directed or required to be exercised or done by the company in general meeting, subject nevertheless

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to any regulations of these articles, to the provisions of the ordinance, and to such regulations being not inconsistent with the aforesaid regulations or provisions, as may be prescribed by the company in general meeting; but no regulation made by the company in general meeting shall invalidate any prior act of the directors which would have been valid if that regulation had not been made.

118. Without prejudice to the general powers conferred by article 117 and to any other powers or authorities conferred by these articles on the directors, it is hereby expressly declared that the directors shall have the following powers, that is to say, power:

(1) To purchase or otherwise acquire for the company any property, rights or privileges which the company is authorized to acquire at such price and generally on such terms and conditions as they think fit, and to sell, let, exchange or otherwise dispose of absolutely or conditionally any part of the property, privileges and undertaking of the company upon such terms and conditions, and for such consideration, as they may think fit.

(2) At their discretion to pay for any property, rights, privileges acquired by or services rendered to the company either wholly or partially in cash or in shares (subject to the provisions of section 86 of the ordinance) bonds, debentures or other securities of the company. Any such bonds, debentures or other securities may be either specifically charged upon all or any part of the property of the company or not so charged

(3) To open account with any bank or financial institution and deposit into and withdraw money from such accounts from time to time.

(4) To make, draw, endorse, sign, accept, negotiate and give all cheques, bills of lading, drafts, orders, bills of exchange, and other promissory notes and negotiable instruments required in the business of the company.

(5) To secure the fulfillment of any contracts, agreements or engagements entered into by the company by mortgage or charge of all or any of the property of the company for the time being or in such other manner as they may think fit.

(6) Subject to the provisions of the ordinance, to appoint and at their discretion remove or suspend such agents (other than Managing Agents), managers, secretaries, officers, employees for permanent, temporary or special services as they may from time to time think fit, and to determine their powers and duties and fix their salaries or emoluments and to require security in such instances and to such amount as they think fit.

(7) To appoint any person or persons (whether incorporated or not) to accept and hold in trust for the company any property belonging to the company or in which it is interested or for any other purposes, and to execute and do all such deeds, documents and things as may be requisite in relation to any such trust and to provide for the remuneration of such trustee or trustees

(8) To institute, conduct, defend, compound or abandon any legal proceedings by or against the company or its officers or otherwise concerning the affairs of the company and also to compound and allow time for payment or satisfaction of any debts due and of any claims or demands by or against the Company.

(9) To refer claims or demands by or against the company to arbitration and observe and perform the awards.

(10) To make and give receipts, releases and other discharges for money payable to the company and for the claims and demands of the Company.

(11) To act on behalf of the company in all matters relating to bankrupts and insolvents.

(12) To determine who shall be entitled to sign on the company's behalf bills, notes, receipts, acceptances, endorsements, cheques, releases, contracts and documents.

(13) From time to time to provide for the management of the affairs of the company either in different parts of Pakistan or elsewhere in such manner as they think fit, and in particular to establish branch offices and to appoint any persons to be the attorneys or agents of the company with such powers (including power to sub-delegate) and upon such terms as may be thought fit.

(14) To invest and deal with any of the moneys of the company not immediately required for the purposes thereof upon such securities and in such manner as they may think fit, and from time to time to vary or realize such investments.

(15) To execute in the name and on behalf of the company in favour of any director of the company or other person who may incur or be about to incur any personal liability for the benefit of the company, such mortgages of the company's property (present and future) as they think fit, and any such mortgage may contain a power of sale and such other powers, covenants and provisions as shall be agreed on.

(16) To give to any person employed by the company, a commission on the profits of any particular business or transaction or a share in the general profits of the company, and such commission or share of profits shall be treated as part of the working expenses of the company.

(17) To enter into all such negotiations and contracts and rescind and vary all such contracts and execute and do all such acts, deeds and things in the name and on behalf of the company as they may consider expedient for or in relation to any of the matters aforesaid or otherwise for the purposes of the company.

(18) To establish, maintain, support and subscribe to any charitable or public object, and any institution, society, or club which may be for the benefit of the company or its employees, or may be connected with any town or place where the company carries on business; to give pensions, gratuities, or charitable aid to any person or persons who have served the company or to the wives, children, or dependants of such person or persons, that may appear to the directors just or proper, whether any such person, his widow, children or dependants, have or have not a legal claim upon the company.

(19) Subject to the provisions of section 227 of the ordinance, before recommending any dividends, to set aside portions of the profits of the company to form a fund to provide for such pensions, gratuities, or compensation; or to create any provident or benefit fund in such or any other manner as to the directors may seem fit.

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(20) Subject to the provision of the ordinance to accept from any member on such terms and conditions as shall be agreed a surrender of his shares or any part thereof.

(21) To make advances and loans without security or on such security as they may deem proper and as permissible under the law.

(22) To make and alter rules and regulations concerning the time and manner of payment of the contributions of the employees and the company respectively to any such funds and the accrual, employment, suspension and forfeiture of the benefits of the said fund and the application and disposal thereof, and otherwise in relation to the working and management of the said fund as the directors shall from time to time think fit.

(23) To delegate all or any of the powers hereby conferred upon them to such person or persons as they may from time to time think fit.

(24) Subject o section 213 of the ordinance to authorize the having an official seal of the company for use abroad

REGISTER OF DIRECTORS SHAREHOLDINGS

119. In accordance with section 220, the company shall maintain at its office a register or electronic record of the directors, chief executive officer, chief financial officer (chief accountant), company secretary or head of internal audit who is or has been the beneficial owner of listed securities and every person who is directly or indirectly the beneficial owner of not less than ten percent (10%) of the beneficial interest in the company. This register or electronic record shall be open to inspection during business hours subject to sub-sections (5), (6) and (7) of section 220.

POWER OF ATTORNEY

120. The directors may from time to time and at any time by power of attorney appoint any company, firm or person (including any director or officer of the company) or body of persons, whether nominated directly or indirectly by the directors, to be the attorney or attorneys of the company for such purposes and with such powers, authorities and discretions and for such period and subject to such conditions as they may think fit, and any such powers of attorney may contain such provisions for the protection and convenience of persons dealing with any such attorney to delegate all or any of the powers, authorities and discretions vested in him; and without prejudice to the generality of the foregoing any such power of attorney may authorize the attorney to institute, conduct, defend, compound or abandon any legal proceedings by or against the company whether generally or in any particular case.

AUDIT COMMITTEE

121. The Directors shall establish an Audit Committee which shall comprise not less then three members, including the chairman. Majority of the members of the Committee shall be from among the non-executive directors of the company and the chairman of the Audit Committee shall preferably be a non-executive director. The names of member of the Audit Committee shall be disclosed in each annual report of the company.

MANAGEMENT COMMITTEE

122. The Directors shall establish management committees to comply with the requirements of the code of the corporate governance and their own requirements for effective management and control. The Directors shall nominate members for each committee which may be from the board of directors or outside the board.

BORROWING POWERS

123. (1) The directors may exercise all the powers of the company to borrow money and to mortgage or charge its undertaking, property and assets (both present and future), and to issue debentures, debenture stocks, and other securities, whether outright or as collateral security for any debt, liability or obligation of the company or of any third party.

(2) In exercising the powers of the company aforesaid the directors may, from time to time and on such terms and conditions as they think fit, raise money from banks and financial institutions and from other persons under any permitted system of financing, whether providing for payment of interest or some other form of return, and in particular the directors may raise money on the basis of the mark up on price, musharika, modaraba or any other permitted mode of financing, and without prejudice to the generality of the foregoing the directors may exercise all or any of the powers of the company arising under section 19(2) of the ordinance.

(3) In regard to the issue of securities the directors may exercise all or any of the powers of the company arising under sections 19(2), 87 and 120 of the ordinance and in particular the directors may issue any security as defined in section 2(1)(34) of the ordinance or may issue any instrument or certificate representing redeemable capital as defined in section 2(1)(30A) of the ordinance or participatory redeemable capital as defined in section 2(1)(25) of the ordinance.

124. Debentures, debenture-stock, bonds and other securities may be made assignable free from any equities between the company and the person to whom the same may be issued.

125. Any debentures, debenture-stock, bonds or other securities may be issued at a discount, premium or otherwise and with any special privileges as to redemption, surrender, drawing, allotment of shares, attending and voting at general meetings of the company, appointment of directors of the company or otherwise.

126. The directors shall cause a proper register to be kept in accordance with the provisions of section 135 of the ordinance, of all mortgages and charges specifically affecting the

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property of the company, and shall duly comply with the provisions of the sections of the ordinance, namely, sections 121 and 122 (Registration of mortgages and charges), section 128 (Endorsement of certificates), section 129 (Filing of prescribed particulars), section 130 (Keeping of a copy of every instrument creating any mortgage or charge by the company at the office) and section 132 (Giving of intimation of the payment or satisfaction of any charge or mortgage created by the company).

127. Every register of holders of debentures of the company may be closed for any periods not exceeding in the whole forty five days in any year and not exceeding thirty days at a time Subject as aforesaid, every such register shall be open to the inspection of members or debenture holders. But the company may in general meeting impose any reasonable restrictions, so that at least two hours, in each day when such register is open, for inspection

128 Subject to the provisions of section 76 of the ordinance, no transfer of registered debentures shall be registered unless a proper instrument of transfer duly stamped and executed by the transferor and transferee has been delivered to the company together with the certificate or certificates of the debentures

129 If the directors refuse to register the transfer of any debentures, they shall, within thirty days from the date on which the instrument of transfer was lodged with the company, send or cause to be sent to the transferee and transferor notice of the refusal.

130. The company shall comply with the provisions of section 136 of the ordinance as to allowing inspection of copies kept at the office in pursuance of section 130 of the ordinance, and as to allowing inspection of the register of mortgages to be kept at the office in pursuance of section 135 of the ordinance.

131 The company shall comply with the provisions of sections 113 and 150 of the ordinance as to supplying copies of any register of holders of debentures or of any trust deed for securing any issue of debentures.

LOCAL MANAGEMENT

132. Subject to the provisions of sections 206 and 207 of the ordinance, directors may from time to time provide for the management of the affairs of the company outside Pakistan or in any special locality in Pakistan in such manner as they shall think fit and the following provisions shall operate without prejudice to the general powers hereby conferred.

(1) The directors may from time to time and at any time establish any local boards or agencies for managing any of the affairs of the company outside Pakistan or in any specified locality in Pakistan and may appoint any persons to be members of such local board or any managers or agents and may fix their remuneration.

(2) The directors may from time to time and at any time delegate to any persons so appointed any of the powers, authorities and discretions for the time being vested in the directors and may authorize the members for the time being of any such local board or any of them to fill up any vacancies therein and to act notwithstanding vacancies and any such appointment or delegation may be made on such terms

subject to such conditions as the directors may think fit; and the directors may at any time remove any person so appointed and may annul or vary any such delegation.

(3) The directors may at any time and from time to time, by power of attorney under the seal of the company, appoint any person to be the attorneys of the company for such purposes and with such powers, authorities and discretions (not exceeding those vested in or exercisable by the directors under these articles) and for such period and subject to such conditions as the directors may from time to time think fit; and any such appointment may, if the directors think fit, be made in favour of all or any of the members of any local board established as aforesaid, or in favour of any company or of the members directors, nominees or managers of any company or firm, and any such power of attorney may contain such provisions for the protection or convenience of persons dealing with such attorneys as the directors think fit.

(4) Any such delegates or attorneys as aforesaid may be authorised by the directors to sub-delegate all or any of the powers, authorities and discretions for the time being vested in them.

V. ACCOUNTS AND DIVIDENDS

BOOKS OF ACCOUNT

(References to books of account, balance sheet, profit and loss accounts and auditors' report shall hereinafter mutatis mutandis include all electronic forms of record or storage of the company.)

133 The directors shall cause to be kept proper books of account with respect to the matters set out in section 230 of the ordinance.

134. The books of account shall be kept at the office or at such other place as the directors think fit, and shall be open to inspection by the directors during business hours. If the directors decide to keep the books of account at a place other than the office they shall comply with the directions contained in the proviso to section 230(1) of the ordinance.

135. The company shall preserve in good order the books of account of the company in respect of any financial year for a period of ten years following the close of that year or otherwise as provided in the section 230(6) of the ordinance.

136. The directors shall from time to time determine whether and to what extent and at what times and places and under what conditions or regulations the accounts and books of the company or any of them shall be open to the inspection of the members, and no member (not being a director of the company) shall have any right of inspecting any account or book or document of the company except as conferred by law or authorized by the directors or by the company in general meeting.

137. (1) The directors shall arrange to place before the annual general meeting of the company in every year a duly audited balance sheet and profit and loss account conforming to the requirements of section 234, 237 and 238 of the ordinance and made up to a date not more than four months before the date of such meeting and having the auditor's

report attached thereto, and a report of the directors conforming to the requirements of section 236 of the ordinance.

(2) As required by section 241 of the ordinance the balance sheet and profit and loss account shall first be approved by the directors and when so approved shall be signed by the chief executive and at least one director but if on account of his absence from Pakistan or other reason the signature of the chief executive cannot be obtained, the balance sheet and profit and loss account shall be signed by at least two directors for the time being in Pakistan, and in every such case a statement signed by those two directors shall be subjoined to the balance sheet and profit and loss account stating the reason why the signature of the chief executive was not obtained.

(3) The directors may authorize the chairman or the chief executive to sign the report of the directors which may then be signed accordingly, but in the absence of any such authority the report of the directors shall be signed as required by section 236(3) of the ordinance in the same manner as the balance sheet and profit and loss account.

138 (1) A copy of the balance sheet, profit and loss account and the reports of the directors and auditors shall be sent not less than twenty one (21) days before the date of the annual general meeting to the members and other persons entitled to receive notices of general meetings in the manner in which notices are to be given hereunder and a copy thereof shall be kept for a period of at least fourteen (14) days before the meeting at the office for inspection by members. The company shall send, each stock exchange listing the shares of the company three hundred copies (or such number as may be prescribed from time to time), and to the registrar of companies and to the commission, five copies (or such number as may be prescribed from time to time), each of the balance sheet, profit and loss account and the reports of the directors and auditors at the same as they are dispatched to the members and other persons in accordance with this article.

(2) After the balance sheet, profit and loss account and the reports of the directors and auditors have been laid before the annual general meeting of the company, three copies thereof (or, such larger number as may be prescribed under section 242(1) of the ordinance) signed by the signatories thereto shall be filed with the registrar within thirty days from the date of the meeting and the company shall also comply with the provisions of section 242(2) of the ordinance where applicable.

(3) Subject to provisions of sections 245 and the listing requirements, the company shall, within one month from the close of the first and third quarters and two month from the close of the second quarter, of the year of account of the company, prepare and transmit to the members one copy and to stock exchange listing the shares of the company three hundred copies (or such number as may be prescribed from time to time), each of the profit and loss account for that quarter and of the balance sheet as at the end of that quarter. Such quarterly profit and loss accounts and balance sheets need not to be audited but must be signed in the same manner as the annual profit and loss accounts and balance sheets are required to be signed. The directors shall also send, to the commission and to the registrar three copies (or such number as may be prescribed for the time being under section 245(1) (b) of the ordinance), each of such quarterly profit and loss accounts and balance sheets at the same time as they

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are sent to the members in accordance with this article.

(4) The company may with the consent of shareholders and consultation of respective stock exchange(s), transmit quarterly accounts through web site of the company subject to the approval of the commission.

139. The directors shall in all respects comply with the provisions of sections 230 to 247 of the ordinance, or any statutory modification thereof for the time being in force.

ANNUAL RETURNS

140. The company shall make the requisite annual returns in accordance with the provisions of section 156 of the ordinance.

DIVIDENDS

141. The company in general meeting may declare dividends, but no dividend shall exceed the amount recommended by the directors, provided that the company in general meeting may declare a smaller dividend.

142. No dividend shall be paid otherwise than out of the profits of the year or any other undistributed profits, and in the determination of the profits available for dividends the directors shall have regard to the provisions of the ordinance and in particular to the provisions of sections 83, 235 and 248 of the ordinance.

143. The declaration of the directors as to the amount of the net profits of the company shall be conclusive.

144. The directors may from time to time pay to the members such interim dividends as in their judgment the position of the company justifies.

145. All dividends shall be declared and paid according to the amounts paid on the shares. All dividends shall be apportioned and paid proportionally to the amounts paid or credited as paid on the shares during any portion or portions of the period in respect of which the dividend is paid; but if any share is issued on terms providing that it shall rank for dividend as from a particular date such share shall rank for dividend accordingly.

146. All dividends declared shall be paid within the periods specified in section 251 of the ordinance.

147. No dividend payable in respect of a share shall bear interest against the company.

148. The directors may retain any dividends on which the company has a lien, and may apply the same in or towards satisfaction of the debts, liabilities or engagements in respect of which the lien exists.

149. Any general meeting declaring a dividend may resolve that such dividend be paid and

satisfied wholly or in part in cash or by the distribution of specific assets, and in particular by the distribution of paid-up shares, debentures, debenture-stock or other security of the company, or paid-up shares, debentures, debenture-stock or other security of any other company, or in any one or more of such ways.

150 Any general meeting may resolve that any moneys, investments, or other assets forming part of the undivided profits of the company standing to the credit of the reserve fund referred to in article 157 or in the hands of the company and available for dividend (or representing premiums received on the issue of shares and standing to the credit of the share premium account) be capitalized and distributed amongst such of the members as would be entitled to receive the same if distributed by way of dividend and in the same proportion on the footing that they become entitled thereto as capital and that all or any part of such fund be applied on behalf of such members in paying up in full any un-issued shares, debentures, debenture-stock or other security of the company, which shall be distributed accordingly, and that such distribution or payment shall be accepted by such members in full satisfaction of their interest in the said capitalized sum.

151 For the purpose of giving effect to any resolution under article 149 or article 150, the directors may settle any difficulty which may arise in regard to the distribution as they think expedient and may fix the value for distribution of any specific assets and may determine that cash payments shall be made to any members upon the footing of the value so fixed in order to adjust the rights of all parties and may vest any such cash or specific assets in trustees upon such trusts for the persons entitled to the dividend or capitalized fund as may seem expedient to the directors. Where requisite a proper contract shall be filed in accordance with the provisions of section 73 of the ordinance, and the directors may appoint any person to sign such contract on behalf of the persons entitled to the dividend or capitalized fund, and such appointment shall be effective.

152. A transfer of shares shall not pass the rights to any dividend declared thereon before the registration of the transfer.

153. The directors may retain the dividends payable upon shares in respect of which any person is under article 38 entitled to become a member or which any person under that article is entitled to transfer until such person shall become a member in respect thereof or shall duly transfer the same.

154. Any one of several persons who are registered as the joint-holders of any share may give effectual receipts for all dividend and payments on account of dividends in respect of such share.

155 The dividend in respect of any share shall be paid to the registered holder of such share or to his banker or to a financial institution (as defined in section 2(1) (15A) of the ordinance) nominated by him for the purpose. Unless otherwise directed, any dividend may be paid by cheque or warrant sent through post to the registered address of the member or person entitled thereto, or, in the case of joint-holders, to the registered address of that one whose name stands first on the register in respect of the joint-holding, or to such financial institution or bank as the member or person entitled thereto or such joint-holders, as the case may be.

direct. and every cheque or warrant so sent shall be made payable to the order of the person to whom it is sent, or to the order of the institution or bank, directed as aforesaid.

156. All dividends unclaimed for one year after having been declared may be invested or otherwise made use of by the directors for the benefit of the company until claimed and all dividends unclaimed for three years after having been declared may be forfeited by the directors for the benefit of the company, but the directors may annul the forfeiture wherever they may think proper.

RESERVE AND DEPRECIATION FUNDS

157. The directors may from time to time before recommending any dividend set apart any and such portion of the profits of the company as they think fit as a reserve fund to meet contingencies or for the liquidation of any debentures, debts or other liabilities of the company, for equalization of dividends or for repairing, improving, and maintaining any of the property of the company, and for such other purposes of the company as the directors in their absolute discretion think conducive to the interests of the company; and may invest the several sums so set aside upon such investments (other than shares of the company) as they may think fit, and from time to time deal with and vary such investments, and dispose of all or any part thereof for the benefit of the company, and may divide the reserve fund into such special funds as they think fit, with full power to employ the reserve funds or any part thereof in the business of the company, and that without being bound to keep the same separate from the other assets.

158 The directors may, from time to time before recommending any dividend, set apart any and such portion of the profits of the company, as they think fit, as a depreciation fund applicable at the discretion of the directors, for providing against any depreciation in the investment of the company or for rebuilding, restoring, replacing or for altering any part of the buildings, work, plant, machinery, or other property of the company destroyed or damaged by fire, flood, storm, tempest, earthquake, accident, riot, wear and tear, or any other means whatsoever, and for repairing, altering and keeping in good condition the property of the company, or for extending and enlarging the buildings, machinery and property of the company with full power to employ the assets constituting such depreciation fund in the business of the company, and that without being bound to keep the same separate from the other assets.

159. All moneys carried to the reserve fund and depreciation fund respectively shall nevertheless remain and be profits of the company applicable, subject to due provision being made for actual loss or depreciation, for the payment of dividends and such moneys and all the other moneys of the company not immediately required for the purposes of the company may be invested by the directors in or upon such investment or securities as they may select or may be used as working capital or may be kept at any bank on deposit or otherwise as the directors may from time to time think proper.

160. The directors may also carry forward any profits which they may think prudent not to distribute, without setting them aside as a reserve.

VI. AUDIT

161 Auditors shall be appointed and their duties regulated in accordance with sections 252 to 255 of the ordinance or any statutory modification thereof for the time being in force.

VII. SEAL

162 The directors shall provide a common seal of the company which shall not be affixed to any instrument except by the authority of a resolution of the board or by a committee of directors authorized in that behalf by the directors, and two (2) directors, or one (1) director and the secretary of the company, shall sign every instrument to which the common seal is affixed.

163. The directors may provide for the use in any territory, district or place not situated in Pakistan, of an official seal which shall be a facsimile of the common seal of the Company, with the addition on its face of the name of every territory, district or place where it is to be used. The official seal shall not be affixed to any instrument except by the authority of a resolution of the board or by a committee of directors authorized in that behalf by the directors, and two (2) directors, or one (1) director and the secretary of the company, or such other person as the directors may appoint for the purpose, shall sign every instrument to which the official seal is affixed. The provisions of section 213 shall apply to the use of the official seal.

VIII. NOTICES

164 (1) A notice may be given by the company to any member either personally or by sending it by post to him at his registered address or (if he has no registered address in Pakistan) to the address, if any, within Pakistan supplied by him to the company for the giving of notices to him or in electronic form as prescribed by section 3 of the electronic transactions ordinance.

(2) Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, prepaying and posting a letter containing the notice and, unless the contrary is proved, to have been effected at the time at which the letter would be delivered in the ordinary course of post.

165 In accordance with section 15 of the electronic transactions ordinance, a notice dispatched by electronic transmission shall be deemed to be received by the addressee at his place of business or where he ordinarily resides when it reaches the designated information system of the addressee. If no information system has been so designated, receipt will occur when the electronic notice reaches an information system of the addressee.

166. If a member has no registered address in Pakistan, and has not supplied to the company an address within Pakistan or an electronic address, for the giving of notices to him, a notice addressed to him or to the shareholders generally and advertised in a newspaper circulating in the Province in which the office is situated and in at least one issue each of a daily newspaper in the English language and a daily newspaper in the Urdu language circulating in the province in which the stock exchange on which the company is listed is situate, shall be deemed to be duly given to him on the day on which the advertisement appears.

167. A notice may be given by the company to the joint-holders of a share by giving the notice to the joint-holder named first in the register in respect of the share.

168. A notice may be given by the company to the persons entitled to a share in consequence of the death or insolvency of a member by sending it through the post in a prepaid letter addressed to them by name, or by the title of representatives of the deceased, or assignee of the insolvent or by any like description, at the address (if any) in Pakistan supplied for the purpose by the persons claiming to be so entitled or addressing it in a similar manner and dispatching it to a designed electronic address or until any such address has been so supplied, by giving the notice in any manner in which the same might have been given if the death or insolvency had not occurred.

169. Notice of every general meeting shall be given in same manner hereinbefore authorized to (a) every member of the company except those members who (having no registered address within Pakistan) have not supplied to the company either a postal address within Pakistan or electronic address for the giving of notices to them, and also to (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting. Subject to the provisions of articles 80 and section 255(6), no other person shall be entitled to receive notices of general meetings

170. Any notice required to be given by the company to the members or any of them and not expressly provided for by these articles shall be sufficiently given, if given by advertisement.

171. Any notice required to be or which may be given by advertisement shall be advertised once in a newspaper circulating in the province in which the office is situate and in at least one issue each of a daily newspaper in the English language and a daily newspaper in the Urdu language circulating in the province in which the stock exchange on which the company is listed is situate.

172. Any notice given by advertisement shall be deemed to have been given on the day on which the advertisement shall first appear.

173. Every person who by operation of law, transfer or other means whatsoever shall become entitled to any share shall be bound by every notice in respect of such share which previously to his name and address being entered on the register shall be duly given to the person from whom he derives his title to such shares.

174. Any notice or document delivered or sent by post to or left at the registered address of any member in pursuance of these articles shall, notwithstanding that such member may be then deceased and whether or not the company shall have received notice of his decease, be deemed to have been duly served in respect of any registered shares, whether held solely or jointly with other persons by such member, until some other person be registered in his stead as the holder or joint-holder thereof, and such service shall for all purposes of these articles

be deemed a sufficient service of such notice or document on his heirs, executors, or administrators, and all persons, if any, jointly interested with them in any such share.

175. The signature to any notice to be given by the company may be written or printed.

176. In the event of a winding up of the company, every member of the company who is not for the time being normally resident in the town in which the office is situate shall be bound, within eight weeks after the passing of an effective resolution to wind up the company voluntarily or the making of an order for the winding up of the company, to serve notice in writing on the company appointing some householder residing in that town upon whom all summonses, notices, process, orders and judgments in relation to or under the winding up of the company may be served, and in default of such nomination the liquidator of the company shall be at liberty on behalf of such member to appoint some such person, and service upon any such appointee, whether appointed by the member or the liquidator, shall be deemed to be good personal service on such member for all purposes, and where the liquidator makes any such appointment he shall with all convenient speed give notice thereof to such member by advertisement in some newspaper circulating in the province in which the office is situated and in at least one issue each of a daily newspaper in the English language and a daily newspaper in the Urdu language circulating in the province in which the stock exchange on which the company is listed is situated or by a registered letter sent through the post and addressed to such member at his address as mentioned in the register, and such notice shall be deemed to be served on the day on which the advertisement shall first appear or on the day following that on which the letter is posted, as the case may be. The provisions of this article shall not prejudice the right of the liquidator to serve any notice or other document in any other manner prescribed by the regulations of the company.

PUBLICATION OF NOTICES IN NEWSPAPERS

177 Subject to such provisions of the listing requirements as may apply specifically to the manner in which certain notices are to be published in the newspaper(s):

1. Every prospectus issued by or on behalf of the company or by or on behalf of any person who has been engaged or interested in the formation of the company shall, in its full text or in such abridged form as may be prescribed, be published by the company in at least one (1) Urdu and one (1) English daily newspaper, in accordance with the provisions of sections 53, 57 and 64 not less than seven (7) days or more than thirty (30) days before the subscription list, as specified in the prospectus, is due to open. Provided that the company may, for special reasons and with permission of the commission, publish the advertisements of a prospectus more than thirty (30) days before the subscription list is due to open.
2. The company may, on giving not less than seven (7) days notices by advertisement in a newspaper having circulation in the Province, or part of Pakistan not forming part of a province, in which the office of company is situated and, in addition, in a newspaper having circulation in the Province, or other part as aforesaid, in which the stock exchange(s) on which the company is listed is / are situated, close the register of members or debenture holders, as the case may be, for any time or times not exceeding in the whole forty-five (45) days in a year and not exceeding thirty (30) days at a time, in accordance with section 151.
3. The notice of a general meeting of the company, whether annual or extraordinary general meeting, shall be published in at least one (1) issue each of daily newspaper in English

language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 158(3) and 159(7).

4. All notices received by the company in pursuance of section 178 (3) for election as a director, shall be transmitted to the members not later than seven (7) days before the date of the general meeting at which the directors are to be elected, by publication in at least one (1) issue each of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the Province in which the stock exchange(s) on which the Company's securities are listed is / are situated, in accordance with section 178 (4).

5. If a resolution is to be passed at the company's annual general meeting appointing as auditors a person other than a retiring auditors, the company shall, not less seven (7) days before the date fixed for the annual general meeting, publish in at least one (1) issue each of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 253 (2).

6. Notice of any resolution for winding up a company voluntarily under section 358, shall be given by the company within ten (10) days of the passing of the same by advertisement in the official Gazette of Pakistan, and also in a newspaper circulating in the province where the office of the company is situated and, in addition, shall also published in at least one (1) issue of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 361 (1).

IX. AMALGAMATION, DIVISION AND RECONSTRUCTION

178. Subject to and in accordance with the provisions of section 287, the company may reconstruct, amalgamate into another company or divide into two (2) or more companies in the process of which the whole or any part of the undertaking, property or liabilities of the company or any other company, may be transferred to any other company or the company, respectively, as the case may be. Provided that any sale of the undertaking of the company, the directors, or the liquidator on a winding up, may, if authorised by a special resolution, accept fully paid shares, debentures or securities of any other company, whether incorporated in Pakistan or not, either then existing or to be formed, for the purchase in whole or in part of the property of the company, and the directors (if the profits of the company permit) or the liquidator (in a winding up) may distribute such shares, or securities, or any other property of the company amongst the members without realization, or vest the same in trustees for them, and any special resolution may provide for the distribution or appropriation of the cash, shares or other securities, benefits or property, otherwise than in accordance with the strict legal rights of the members or contributories of the company, and for valuation of any such securities or property at such price in such manner as the meeting may approve, and all holders of shares shall be bound to accept and shall be bound by any valuation or distribution so authorised, and waive all rights in relation thereto, save only in case the company is proposed to be or is in the course of being wound up, such statutory rights (if any) under section 167 of the ordinance as are incapable of being varied or excluded by these articles.

X. SECRECY

179. Every director, manager, adviser, auditor, trustee, member of a committee, officer, servant, agent, accountant or other person employed in the business of the company shall, if so required by the directors before entering upon his duties, sign a declaration pledging himself to observe a strict secrecy respecting all transactions of the company with its customers and the state of accounts with individuals and in matters relating thereto and shall by such declaration pledge himself not to reveal any of the matters which may come to his knowledge in the discharge of his duties except when required to do so by the directors or by any meeting or by any court of law and except so far as may be necessary in order to comply with any of the provisions in these articles contained.

180. No member or other person (not being a director) shall be entitled to enter upon the property of the company or to inspect or examine the company's premises or properties of the company without the permission of the directors for the time being or, subject to the provisions of article 119, to require discovery of or any information respecting any detail of the company's trading or any matter which is or may be in the nature of a trade secret, mystery of trade, or secret process or of any matter whatsoever which may relate to the conduct of the business of the company and which in the opinion of the directors it will be inexpedient in the interest of the members of the company to communicate.

XI. ARBITRATION

181 Whenever a difference arises between the company on the one hand and any of the members, their executors, administrators, or assignees on the other hand touching the true intent or construction or the incident or consequences of these presents, or of the status of enactment's of the legislature, or touching anything then or thereafter done, executed, omitted or suffered in pursuance of these presents or of the status of enactment's touching any breach or alleged breach or otherwise relating to the premises or to these presents, or to the status or to any of the affairs or officers of the company, the company by written agreement refer to arbitration in accordance with the Arbitration Act 1940 (X of 1940) and every such difference shall be referred to the decision of an arbitrator to be appointed by the parties in difference or if they cannot agree upon a single arbitrator, to the decision of two arbitrators, one appointed by such party, or in the event of disagreement of the arbitrators, to that of an umpire appointed by arbitrators themselves. The provisions of Arbitration Act 1940 (X of 1940) shall apply to all arbitrations between the company and persons having such difference.

182. The costs of, or incidental to any such reference and award shall be in the discretion of the arbitrator/arbitrators or umpire as the case may be who may determine the amount thereof and may award by whom, and to whom, and in what manner the same shall be borne and paid.

XII. WINDING UP

183. If the company shall be wound up and the assets available for distribution among the members, subject to the rights attached to any preference share capital, as such shall be insufficient to repay the whole of the paid-up capital, such assets shall be distributed so that

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as nearly as may be the losses shall be borne by the members in proportion to the capital paid up on the shares held by them respectively. And if in a winding up the assets available for distribution among the members shall be more than sufficient to repay the whole of the capital paid up at the commencement of the winding up, the excess shall be distributed amongst the members in proportion to the capital at the commencement of the winding up, paid up on the shares held by them respectively. But this article is to be without prejudice to the rights of the holders of shares issued upon special terms and conditions.

184. If the company shall be wound, whether voluntarily or otherwise, the liquidator may with the sanction of a special resolution divide among the members in specie or kind any part of the assets of the company, and may with the like sanction vest any part of the assets of the company in trustees upon such trusts for the benefit of the members or any of them as the liquidator with the like sanction shall think fit.

XIII. INDEMNITY

185. Every director or officer of the company and every person employed by the company as auditor shall be indemnified out of the funds of the company against all liability incurred by him as such director, officer or auditor in defending any proceedings, whether civil or criminal, in which judgment is given in his favour, or in which he is acquitted, or in connection with any application under section 488 of the ordinance in which relief is granted to him by the court.

We, the several persons whose name and addresses are subscribed below, are desirous of being formed into a Company in pursuance of this Article of Association, and we respectively agree to take the number of shares in the Capital of the Company indicated herein below against our respective names:

S No	Name & Surname (Present & Former) / Father / Husband Names In Full Block Letters	NIC No (In Case Of Foreigner, Passport No)	Nationality With Any Former Nationality And Occupation	Residential Address In Full	Number Of Shares Taken By Each Subscriber	Signature of the Subscriber
1	Mr. Abdur Rahim S/O Muhammad Tariq Rafi	42201-0409988-5	PAKISTAN Business	House No 34-H-1, Block-6, PE.C.H.S , Karachi	10,000 (Ten Thousand Shares)	
2	Ibrahim Shamsi S/O Aftab Ahmed Shamsi	42301-4652147-5	PAKISTAN Business	House No 59, Street 19, Khayaban-e-Badban, Phase-V, DHA, Karachi	10,000 (Ten Thousand Shares)	
3	Mr. Muhammad Tariq Rafi S/O Muhammad Rafi	42000-8453226-9	PAKISTAN Business	House No 34-H-1, Block-6, PE.C.H.S , Karachi	10,000 (Ten Thousand Shares)	
4	Mrs. Nighat Tariq W/O Muhammad Tariq Rafi	42201-9906534-6	PAKISTAN Business	House No 34-H-1, Block-6, PE.C.H.S., Karachi	10,000 (Ten Thousand Shares)	
5	Mrs. Anum Abdur Rahim W/O Abdur Rahim	42201-8648714-6	PAKISTAN Business	House No 34-H-1, Block-6, PE.C.H.S , Karachi	10,000 (Ten Thousand Shares)	
6	Mrs. Alia Sajjad W/O Sajjad Ahsan	42000-72412SB-4	PAKISTAN Business	House No 19, Khayaban-e-Hilal, Phase-VI, DHA, Karachi	10,000 (Ten Thousand Shares)	
7	Mrs. Rahma Ibrahim W/O Ibrahim Shamsi	42301-0468767-6	PAKISTAN Business	House # 59, Street 19, Khayaban-e-Badban, Phase-V, DHA, Karachi	10,000 (Ten Thousand Shares)	
				Total Number of Shares	70,000 (Seventy Thousand Shares)	

Dated the 23rd day of May 2015
Witness to above signatures.
Name: National Institutional Facilitation Technologies (Pvt.) Ltd.
Nationality: Pakistani
Address: 5th Floor, AWT Plaza, I. I. Chundrigar Road, Karachi

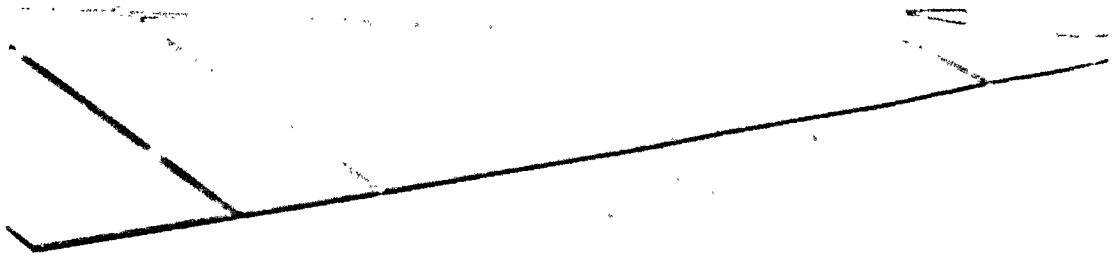
11/6/15

Shamsons Solar Limited Karachi

ANNEX-14
FEASIBILITY STUDY REPORT

Siddiqsons Solar Limited Karachi

8.2



Feasibility Study

Type of Report:	Feasibility Study
Project:	Siddiqsons, 50 MWp PV Power Plant, Haasil, Chakwal, Pakistan
Client:	Siddiqsons Solar Limited
Purpose:	Assessment of the technical and economic viability of a 50 MWp Solar PV Project at Haasil, Chakwal, Pakistan
Site location, Country:	Haasil (33.202 N; 72.547 E), Pakistan
Operator:	Siddiqsons Solar Limited
Report number:	14K5498-PV-MBS-Siddiqsons-F00-JBU_FD-2015
Date of Inspection:	2015-05-26

8.2 Ingenieurpartnerschaft Obst & Ziehmann
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Revision

Version	Modifications
F00	Final Feasibility Study

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List of Technical Abbreviations

a	Year
A	**A**mpere
AC	**A**lternating **C**urrent
AJB	**A**rray **J**unction **B**ox (string combiner at structure table)
CE	**C**onformité **E**uropéenne
DC	**D**irect **C**urrent
GJB	**G**enerator **J**unction **B**ox (main combiner before inverter)
EBB	**E**quipotential **B**us **B**ar
EN	**E**uropean Standard
EL	**El**ectro**l**uminescence
F(A)	Surface factor (Flächenfaktor), indicates the value by which the annual global irradiation at module level changes (depending on inclination and alignment of the generator)
GaSC	**G**round **a**nd **s**hort-**c**ircuit
Gh [kWh / m² a]	**G**lobal irradiation [kilowatt hour per square metre and year]
GJB	**G**enerator **J**unction **B**ox
h	**H**our
HV	**H**igh **V**oltage (44kV and higher)
I	Electric Current
IAM	**I**ncidence **A**ngle **M**odifier (adjustment value inclined irradiation)
IEC	**I**nternational **E**lectrotechnical **C**ommission
INV	**Inv**erter; converts the direct current from the solar generator into grid-compatible alternating current.
INVS1	**Inv**erter **s**tatiion **1**
ISFH	**I**nstitut für **S**olarenergie**f**orschung **H**ameln (Institute for Solar Energy Research Hameln)
ISO	**I**nternational **O**rganization for **S**tandardization
kV	**K**ilo**v**olt
kVA / MVA	**K**ilo**v**olt-**a**mpere / **M**ega**v**olt-**a**mpere
kW	**K**ilo**w**att
kWh	**K**ilo**w**att **h**our
kWp	**K**ilo**w**att **p**eak
LCOE	**L**evelized **c**ost **o**f **E**nergy
LV	**L**ow **V**oltage

MPP	**M**aximum **P**ower **P**oint (point of maximum power = operating point of module, string or even entire solar generator)
MPP-Tracker	Electrotechnical tracking system assuring the optimal operating point
MV	**M**edium **V**oltage
MWp	**M**ega**w**att **p**eak
NOCT	**N**ominal **O**peration **C**ell **T**emperature (practical operating conditions); irradiance on cell surface 800 W/m²; air temperature 20°Celsius; wind velocity 1 m/s
O&M	**O**perations and **M**aintenance
PE	**P**otential **E**qualization
POA	**P**lane **o**f **A**rray
PPA	**P**ower **P**urchase **A**greement
PR	**P**erformance **R**atio
PV	**P**hoto**v**oltaic
PV-Module / Module	Single solar module; smallest, essentially planar assembly of solar cells and ancillary parts, such as interconnections and terminals intended to generate direct current power
Solar generator	Total of all PV strings of a PV power supply system which are electrically interconnected
STC	**S**tandard **T**est **C**onditions Irradiance at module level 1,000 W/m² Cell junction temperature 25°C Solar spectral irradiance distribution AM 1.5 (AM = Air Mass)
String / Module string	Consists of 24 PV modules connected in series and is the smallest site assembled power unit
TA	**T**echnical **A**dvisor
TC	**T**echnical **C**onsultant
TF station	**T**rans**f**er station; interface to the power utility with electricity meter for billing purposes
TS	**T**ransformer **s**tation; transforms the alternating current from LV to MV
V	**V**oltage
UPS	**U**ninterrupted **P**ower **S**upply
Wp	**W**att **p**eak, rated power output or peak power at STC is the output data for solar modules or solar plants

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List of Financial Abbreviations

P10	10% Probability that the actual value of energy yield would not be around expected value of the energy yield
P50	50% Probability that the actual value of energy yield would not be around expected value of the energy yield
P75	75% Probability that the actual value of energy yield would not be around expected value of the energy yield
P90	90% Probability that the actual value of energy yield would not be around expected value of the energy yield
LCOE	**L**evelized **C**ost of **E**nergy
LLCR	**L**oan **L**ife **C**overage **R**atio
DSCR	**D**ebt **S**ervicing **C**overage **R**atio
CAPEX	**Cap**ital **Ex**penditures
OPEX	**Op**erational **Ex**penses
IRR	**I**nternal **R**ate of **R**eturn
ROI	Return on Investment
kWh/kWp	kilowatt hour/ kilowatt peak (Energy output received as compared to the maximum energy yield of the plant)
Z-Score	The statistical measure that determines relationship between the expected value of a variable and the other values of the variable in a normal distribution.
Normal Distribution	The continuous probability distribution of a random variable, symmetric around its mean, forming a bell shaped curve.
Confidence Interval (CI)	Probability that a range of values will fall between an upper and lower bound of a probability distribution e.g. 95% CI or 68% CI.

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A. General Data

A.1. Assignment

Task:	Preparation of a Feasibility Study
Scope of Work:	8.2 Ingenieurpartnerschaft Obst & Ziehmann (8.2) was commissioned to perform a feasibility study to evaluate the viability and potential of the site as part of phase 1 of the contract.
Client:	Siddiqsons Solar 27th Floor, Ocean Tower, Plot G-3, Block 9, Clifton Road Karachi Pakistan
Order Date:	2014-11-28
Consultant:	8.2 Ingenieurpartnerschaft Obst & Ziehmann Brandstwiete 4 D- 20457 Hamburg Germany
Author / Inspector:	Jens Buchholz, M.Eng.
Second Inspector:	Faisal Dar, BS Eng.
Report number:	14K5498-PV-MBS-Siddiqsons-F00-JBU_FD-2015

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A.2. Project Identification

Solar plant	Siddiqsons Solar
Coordinates (Lat; Lon)	33.202 N; 72.547 E
Location, Country	Chakwal, Pakistan
Altitude above sea level	380 m
Plant type	ground mounted
Size of the site	approx. 2.43 km² (600 acres)
Expected plant size	50,000.00 kWp (according to modules' type plate)
Grid connection	High Voltage Level, 132 kV substation
Electric utility company	NTDC
General Contractor	To Be Selected
Project Developer	Siddiqsons Limited
Site Owner	Siddiqsons Solar
Road Access	Paved Road available 5km from the site
Water Access	Currently there is no water access to the site
Feed-in framework	Upfront Tariff

B. Executive Summary

This study assesses the feasibility for 50 MWp PV Power Plant in Haasil, Chakwal, Pakistan, (Siddiqsons Solar) a site near the salt range. The assumptions, results and conclusions of this study have been refined during multiple site visits conducted.

Even though site is located in a hilly area with structured terrain, analysis of data obtained from various sources lets us conclude that the site allocated for Siddiqsons Solar is feasible. Components, currently available in the market, are suitable for the environmental conditions of the region. However, a risk management strategy for development, construction and operation is highly recommended.

On a technical front, it is recommended that a fix type mounting structure be considered for this project, as it has the least capital and operational risks. For the economic viability of a fixed type installation versus a tracking device, accurate ground irradiation data will be required, which is not available yet. Additionally, tracking devices require more maintenance due to their moving parts.

- Generally, the project development takes place in following three phases: First Phase: Feasibility study
- Second Phase: Achievement of financial close
- Third Phase: Erection and Grid Connection of Solar power plant

The client has opted for NEPRA upfront tariff for the project size of 50 MW with all the terms and conditions stated therein and the amendments in the revised NEPRA Upfront tariff determination document no. NEPRA/UTS-01/7915-7917, Dated 25th May 2015. Therefore a detailed financial model for the feasibility is not a requirement.

A project time line of 10 months after financial close until the commercial operation date is a reasonable assumption for a 50 MWp PV Plant.

Hamburg, August, 2015

Jens Buchholz, M.Eng.

Lahore, August, 2015

Faisal Dar, B.Sc.

This report consists of 66 pages and is retained by 8 2 Ingenieurpartnerschaft Obst & Ziehmann until the end of 2025 (document retention period)

C. Summary

This feasibility study assesses and summarizes the given information and includes additional results from extensive site visits.

C.1. Technical Project Description

50MW Siddiqsons Solar Park is located near Haasil, Chakwal. The plant is proposed to be connected to the 132 kV Ahmadal Grid Station which is located about 10 km from the site. As there is an absence of basic infrastructure on the proposed site, development of the site area including the construction of transmission lines to the grid station will have to be carried out. It is suggested that the plant follow a modular installation with blocks of 1MW per 5 Acres each. The client has opted to use thin film module technology along with central inverters for the installation. However, make and model of the equipment will only be finalized once the EPC is selected.

C.2. Project Status

The project is currently in the feasibility stage. Topographical survey, Geotechnical Investigation, Initial Environmental Examination and Grid Interconnection Study of the site have already been conducted. Master Plan of the project area showing access to basic facilities is being developed.

C.3. Technical Risk Factors for the PV Power Plant

The following table shows the possible risks and their assumed occurrence probabilities associated with the project.

Deal Breaker: high risk not possible to solve	
High Risk, possible to solve	
Medium Risk, possible to solve	
Low Risk, possible to solve	
OK	

Sr.-No	Subject	Risk	Risk Value	Risk Mitigation
1	Geographic parameters	Plant location of Siddiqsons Solar has been finalized however there is some natural vegetation.	Low Risk	Removal of vegetation is under process.

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Sr.-No	Subject	Risk	Risk Value	Risk Mitigation
2	Climatic conditions	Hot and humid climate requires robust components. Amongst other criteria, effective cooling, dust/sand filters, abrasive and humidity resistant materials shall have to be utilized.	Low Risk	To be considered in detailed design.
3	Environmental Aspects	Precautions against rodents shall be made to protect cabling effectively.	Low Risk	To be considered in detailed design.
4	Topography and grounding	Foundations for Buildings have to be well prepared. Screw- / Concrete Block Foundation are the best options for PV-generator. Overall design, components, constructions, foundations, and cabling have to be suitable for these conditions.		Soil analysis and terrain have to be considered for foundation design.
5	Irradiation Data	There is a potential bias of satellite irradiance data for this area by 7.0% towards the downside of the expected value		Ground measurements for at least 6 to 12 months should be carried out before financial close to reduce the uncertainty.
6	Transport Access	Accessibility to the PV development area will have to be established via a solid access road. Construction and service roads within the Plant's area have to be erected.		To be done during detailed design.
7	Water Access	A water management plan for construction and operation of the plant shall be carried out.	Low Risk	To be done during detailed design.
8	Grid Access	A medium voltage (11 kV) Line for providing auxiliary power 132 kV HV grid access is absent at the site. MV to HV step-up stations must be erected.	Low Risk	MV Power Line to be constructed for construction phase. 132 kV Transmission Line will have to be constructed. Erection of MV/HV step-up stations to

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Sr.-No	Subject	Risk	Risk Value	Risk Mitigation
				be considered during planning phase.
9	Facility Access	Access to public facilities (fire / police station, hospital) is absent. Fire hydrants have to be established along the roadside in a distance of max. 120 m.		Plant facilities to be equipped with emergency handling services like fire hydrant, clinic and fire station.
10	Grid Connection	The specific requirements and approval for grid connection need to be confirmed by NEPRA / NTDC	Low Risk	Grid interconnection study completed and applied for NOC from NTDC

Siddiqsons Solar Limited Karachi

D. Overview of Solar Photovoltaic Plants and Related Technologies

D.1. Basic Principles of Solar Photovoltaic Plants

Solar photovoltaic plants use the global irradiation (GI), which is converted into electric energy. Adequate project locations should offer at least 1,200 kWh/m² per year. The basic concept of a PV power plant is shown in Figure 1 below.

The solar energy collected by the modules is aggregated in several steps until it reaches the inverter. The inverter converts the DC power provided by the modules into AC power to feed into the grid.

8.2

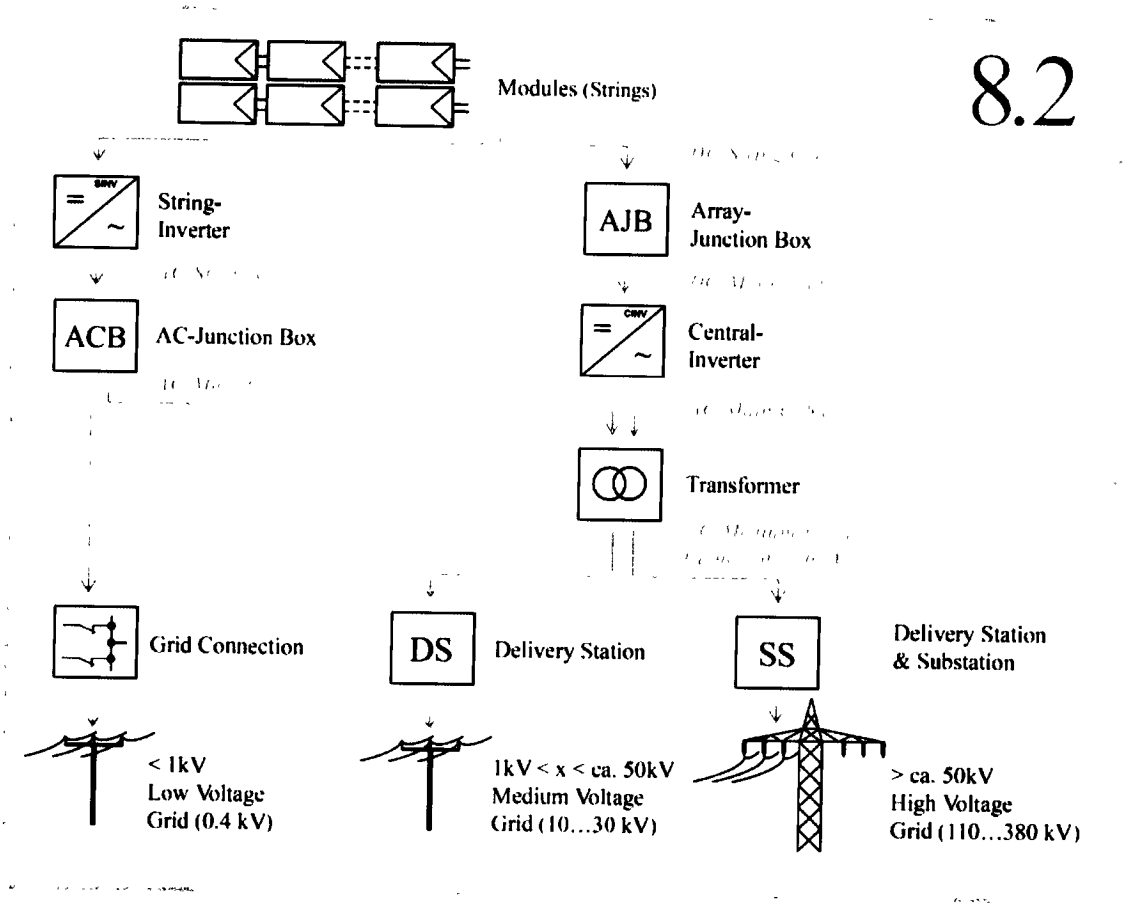

Figure 1: Schematic Overview / Principle of Photovoltaic Systems, Single Line Diagram

D.2. Basic Principles of Photovoltaic Modules

Photovoltaic technologies differ primarily by the type of manufacturing process, which leads to different price ranges, manufacturing cost and performance for the different technologies. Photovoltaic technology is based on the photoelectric effect, in which the photons emitted by the sun get converted to electric power by the semiconductor. The semiconductor is typically made of silicon (80% of the global market).

These absorbed photons hit the atoms, releasing electrons, which causes a chain reaction that multiplies the effect of electrons released. The electrons get lifted from a lower potential to higher. This increase in potential results in the generation of current through potential difference (voltage). The reactions and release of electrons is continuous.

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

The efficiency of a solar cell (η) is the percentage of power from solar energy, incident on the panel, converted to electrical energy. This term is calculated using the ratio of the maximum power point of the cell, Pm, divided by the light power that reaches the cell, the global irradiance (E, in W / m²) and the surface area of the solar cell (Ac in m²).

$$\eta = \frac{Pm}{E\ x\ Ac}$$

As this efficiency varies in different irradiance conditions, the PV industry defined certain conditions for efficiency rating of PV panels. These are called standard test conditions (STC).

Another important standardized variable is the Normal Operating Cell Temperature (NOCT) for modules. This is a characteristic cell value defined as the temperature of the cells, which they reach at an irradiance of 800 W / m², an ambient temperature of 20°C and a wind speed of 1 m / s – typically given at open circuit.

Three main solar cell technologies are commercially available:

- Monocrystalline
- Polycrystalline
- Thin Film

D.2.1. Monocrystalline Technology (Not assumed in this Feasibility Study)

The manufacturing process of monocrystalline cells requires more effort in comparison to other technologies. However, these cells offer higher efficiency – typically within 15 – 20 %.

Advantages:

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

Disadvantages:

- The initial investment costs are higher.
- Higher risk of damages (micro-cracks) during transport or during operation at sites with high wind speeds.

D.2.2. Polycrystalline Technology (Not assumed in this Feasibility Study)

This technology exists since 1981. The manufacturing process is simpler when compared with monocrystalline technology.

Advantages:

- Lower production costs.

Disadvantages:

- Lower efficiency, due to lower purity of the cell material: 13 – 16 % (module size)
- Because of the lower efficiency, slightly more ground surface area is required to reach the same capacity (as for monocrystalline).
- Higher risk of damages (micro cracks) during transport or during operation at sites with high wind speeds.
- Faster degradation rate of up to 0.7 % per year.

D.2.3. Thin Film Technology (Assumed in this Feasibility Study)

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

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

Thin Film technologies have a low market share but CIS / CIGS technologies are having an increasing market, because of their higher efficiency. Depending on the technology, standard thin film module efficiencies have generally reached 11 - 15%. Also CdTe has achieved 15.5% currently. Prototypes of these technologies reach an efficiency of 16% and more which is expected to be transformed to standard products in the future.

Advantages:

- Easier to manufacture, thus lower costs.
- Less affected by high temperatures and shadowing.

- Low degradation of maximum 0.5 % per year (manufacturer guarantee is 0.7 % degradation per year; however reality proves to be less).

Disadvantages:

- Lower power rating leads to more structure requirements, for the same capacity.

Table 1: Comparison of the Module Technologies

		Crystalline		Thin Film	
	Parameter	**Monocrystalline**	**Polycrystalline**	**CdTe**	**CIS / CIGS**
1	Voltage rating – V_{mp} and V_{oc}	80 % – 85 %	80 % – 85 %	72 % - 78 %	72 % - 78 %
2	Temperature Coefficient	Higher losses (ca -0,4 %/K)	Higher losses (ca -0,45 %/K)	Lower losses (ca. -0,2 %/K)	Higher losses (ca -0.35 %/K)
2a	Performance Losses for 40°C ambient temperature (~ 60°C cell temperature) versus STC conditions (25°C cell temperature)	~ 14 %	~ 15.75%	~ 7%	~ 12 25%
3	I-V curve Fill Factor	Higher 70 % - 85 %	Higher 70 % - 85 %	Lower 60 % - 72 %	Higher 70 % - 85 %
4	Module Construction	Framed with structural or anodized aluminum	Framed with structural or anodized aluminum	Normally Frameless	Normally Frameless
5	Module Efficiency	14 % - 20 %	12 % - 17 %	10 % - 16 %	13 % - 15 %
6	Inverter Compatibility and Sizing	High efficiency ← less modules ← less inverters	High efficiency ← less modules ← less inverters	Low efficiency ← more modules ← more inverters	High efficiency ← less modules ← less inverters
7	Mounting System	Industry Standard practices	Industry Standard practices	Special clips and structures for frameless modules may be needed to hold the module Mounting system has to be accepted by module manufacturer.	Special clips and structures for frameless modules may be needed to hold the module Mounting system has to be accepted by module manufacturer
8	Layout Area	Much smaller size for the same output	Smaller size for the same output	Generally require more space for the given project size The extra space can't be standardized and depends	Smaller size for the same output.

		Crystalline		Thin Film	
	Parameter	**Monocrystalline**	**Polycrystalline**	**CdTe**	**CIS / CIGS**
				on the design (rows over each other) and the site conditions	
9	Applications	On grid and off grid usage More usual as a reference cell and used for scientific tests.	On grid and off grid usage	On grid and off grid usage	On grid and off grid usage
10	PV Plant cell cost	More expensive than polycrystalline and CdTe modules due to high cell efficiency	Cost Higher than CdTe due to higher cell efficiency, Production process easier which lowers the basic cost	Cost Lower due to cheaper raw material and double pane glass sheeting	Very expensive up to now
11	PV Plant module unit cost	Cost per kWp slightly higher as for polycrystalline modules, but comparable to the cost per kWh due to fewer losses	Cost per kWh comparable	Cost per kWp slightly higher as for polycrystalline modules, but comparable to the cost per kWh due to fewer losses	Cost per kWp slightly higher as for polycrystalline modules, but comparable to the cost per kWh due to fewer losses
12	PV Plant total cost	Lower Cost due to higher efficiency of the modules (less modules and less mounting Structures) Entire cost depends on the market situation (module price) and the concerned country (m² cost)	Usually lowest cost (low m² cost and less m² needed because of the higher efficiency compared to thin film modules) Entire cost depends on the market situation (module price) and the concerned country (m² cost)	Highest cost due to additional space and mounting structures needed (Entire cost depends on the market situation (module price) and the concerned country (m² cost)	High cost due to additional space and mounting structures needed. Entire cost depends on the market situation (module price) and the concerned country (m² cost)
13	Module power output	Immediate and stable, but zero shadow tolerance, high losses when temperature high and irradiation suboptimal	Immediate and stable, but zero shadow tolerance, high losses when temperature is high and irradiation suboptimal	Requires time to stabilize power output, even slightly shadowed output is feasible	Very good weak light performance (best results of the technologies in winter)
14	Degradation	Around 0,3 % per year	Around 0,3 % per year	Around 0,4 % per year	Around 0,2 % per year

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		Crystalline		Thin Film	
	Parameter	Monocrystalline	Polycrystalline	CdTe	CIS / CIGS
15	Market perspective	Some of the providers of the polycrystalline modules also offer monocrystalline modules	Standard technology, many providers	One big provider (First solar)	Little number of providers, new technology (2009)

D.3. Mounting structures and tracking systems

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

D.3.1. Fix mounted structure

Fixed structures are usually tilted to face south (north in southern hemisphere) with a fixed angle depending on several parameters e.g. the location. Nowadays, more and more PV power plants are installed with modules tilted to east and west usually with tilt angles between 10° to 15°. This installation type would offer lower peak capacity. However, the generation curve would be less spiked and allow an energy generation distribution to be more spread out over the day. The row shading of these installations is less, such that the rows can be installed closer to each other and more modules can be installed on the same area as it is possible with modules facing south. Depending on the construction, the installation costs of east-west installations are often lower than south oriented systems.

Figure 2: Fix Mounted Structure facing south or north

Figure 3: Fix Mounted Structure facing east and west

For the location Haasil (33.202 N; 72.547 E), the optimal tilt for the module directed to an azimuth of 180° (N=0°) is in between 28° up to 30° (based on SolarGIS and Meteonorm irradiation data). With this angle, the highest irradiation into the module plane can be achieved for an unshaded single module. The transposition factor (FT), the ratio between solar irradiation on tilted versus horizontal surface, is 1.03. Once further technical details of the plant are known (e.g. module type, layout of mounting structure), the final optimal tilt angle can be calculated.

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D.3.2. Tracker systems

The aim of trackers is an optimized adjustment of the module surface to the sun during the day to increase the total irradiation onto the module surface. This can also lead to greater efficiency in converting solar energy. Commonly used tracking systems are single and dual-axis trackers.

Dual-axis trackers follow the sun in azimuth and tilt. With it, the sun can be exactly tracked over the course of the day to achieve an optimized irradiation angle. Dual-axis trackers have one pole which is carrying and tracking a frame with modules mounted on. Usually, between 20 and 30 modules are installed on one tracker. The installed module capacity on the plant has to be lower than with fixed mounted structures to avoid overwhelming shading losses (15-25 Wp/m^2 instead of 50-75 Wp/m^2). Dual-axis trackers are almost independent of the landscape.

The transposition factor for a two-axis tracker for the location is 1.35 and therefore 132% of that of the fixed plane's optimum.

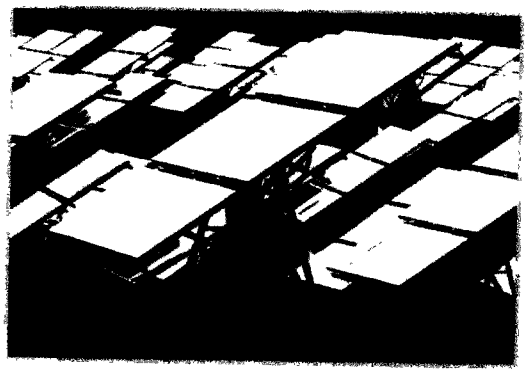

Figure 4: Dual-Axis Tracker

Single-axis trackers usually follow the azimuth of the sun. Several construction types exist. One is similar to dual-axis trackers with one pole carrying a module frame (vertical axis system). In that case, the module tilt is fixed and the pole is used as rotation axis. The tilt depends on the location. For the location Haasil (33.202 N; 72.547 E), Chakwal the optimal installation has a tilt in between 45° up to 50° (based on SolarGIS and Meteonorm irradiation data).

Because the single-axis tracker, as described above, needs similar space as dual-axis trackers, nowadays another type of single-axis tracker is in use. This one has a horizontal rotation axis oriented from south to north or from east to west. The modules are installed parallel to the rotation axis. Depending on the way of installation and length of horizontal axis the requirements to the flatness of the area can be higher, because the horizontal axis itself is not able to compensate irregularities. The single-axis tracker with the east-west axis has a transposition factor of around 1.09, whereas the tracker with north-south axis has a transposition factor of 1.29 or 129% of that of the fixed plane's optimum.

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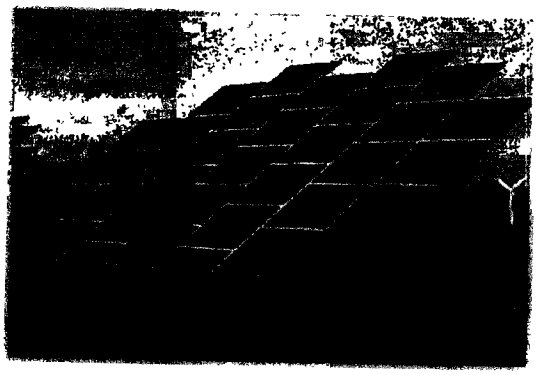

Figure 5: Single Axis Tracker, vertical Axis

Figure 6: Single Axis Tracker, horizontal Axis

The decision to choose any of the three types of mounting structures is based on technical and economical evaluation. When choosing a tracking system, the extra energy generation in combination with the energy price must be compared with the additional investment and maintenance costs required for tracking systems.

In general, tracker solutions gather more irradiation per installed module capacity than fixed mounted modules. The peak of the production curve is wider during the day compared to fixed mounted modules. But the installation effort is higher for tracker solutions based on their design. More attention has to be laid into the resistance against heavy storms.

Table 2: Comparison of the Mounting Systems

	Parameter	Fixed-tilted		Horizontal single-axis tracker		Vertical single-axis tracker	Dual-axis tracker
		South faced	East-west	East-west	North-south		
1	System costs	Lower than for tracker solutions, as no mechanical parts		Higher costs than fixed-tilted High differences between the manufacturers Higher costs than fixed-tilted High differences between the manufacturers		Higher costs than horizontal tracker	The highest costs of all systems
2	Installation costs	Lower than for tracker solutions, as less complex system But the difference regarding the total installation cost is minimal compared to the horizontal tracker.		Higher costs than the fixed tilted system, but lower than the vertical tracker. Higher costs than the fixed tilted system, but lower than the vertical tracker		Higher installation costs, especially for the commissioning phase	Higher installation costs, especially for the commissioning phase
3	Maintenance costs	Lower than for tracker solutions, as no mechanical parts		Depends on the selected manufacturer (options without mechanical parts available), but cost higher than fixed-tilted		Higher costs based on the mechanical parts	Higher costs based on the mechanical parts
4	Transposition factor	1.03	0 994	1 09	1 29	1 31	1 35
5	Max pivoting angle range	10° to 35°	5° to 20°	-120° to 120°	-120° to 120°	Fixed tilt for site 45° - 50°, vertical axis -180 to 180°	Motorized tilt 00-80° and vertical axis -180° to 180°

	Parameter	Fixed-tilted		Horizontal single-axis tracker		Vertical single-axis tracker	Dual-axis tracker
		South faced	East-west	East-west	North-south		
6	Site requirements	System is adaptable to uneven ground and high slopes Standard system up to 35°(North/South) and 10°(East/West)		Ground might be uneven with slopes up to 28°	Ground might be uneven with slopes up to 28° The system makes just sense if the site is not facing South	Ground might be uneven but sites with higher slopes are not suitable without huge extra effort	Ground might be uneven but sites with higher slopes are not suitable without huge extra effort
7	Space requirement	Several rows can be installed over each other Space requirement low	No row shading, so the rows can be installed near to each other. Best space requirement	Installation of rows over each other is limited, but space requirement not much higher than fixed- tilted	Installation of rows over each other is limited, but space requirement not much higher than fixed- tilted	The distance between the trackers must be high. Space requirement is high	The distance between the trackers must be high Space requirement is high
8	Space factor (Wp/m2)	~50 – 75	~60 – 90	~40 - 65~	~45 - 55	~15 - 25	~15 - 25

D.4. Inverter Technology

Because photovoltaic panels generate DC electricity, it must be converted to alternating current before it can be fed into the grid. This is achieved by an electronic device called inverter.

State of the art inverters offer a broad range of operational stages, which generally fulfill all the requirements of the international grid codes in terms of fault-ride-through and reactive power provision. Inverter stations provide a protective shell in which PV-strings can be connected to inverters. Centralized inverters typically have a capacity from 500 kWp to 1.5 MWp of DC PV-Power, depending on the size of inverter.

From the inverter stations the AC power is stepped-up by a MV or HV-Transformer, and then connected to a medium or high voltage grid (for instance 132 kV and 220 kV as in Pakistan).

Regarding the inverter system, two design types can be selected: a central or a decentralized design.

D.4.1. Central Inverter

Use of central inverters is the standard practice in large PV plants. The strings are combined in string combiner boxes and several combiner boxes are connected to an inverter. Typically the output power of central inverters is between 500 kW and 1.5 MWp. The inverter can be installed in a compact station, in a container or as an outdoor system depending on the space for installation and the transport opportunities.

Typically, central inverters have a better price per MW and have less start-up and operation problems. But they require a specific training of the electricians for the commissioning procedure and in case of failures.

The efficiency is around 1 - 2% higher than of string inverters.

D.4.2. String (decentralized) Inverter

String inverters are commonly used in small sized PV plants but there is also a trend to use them in large scale PV plants. The strings are connected directly to inverters, which are typically up to 50 kW.

String inverters can be installed and exchanged by basic educated electricians and spare parts can be stored near the side. The inverters are easy to transport and handle. In complex terrain, with a lot of shading, the benefit is lesser module strings and therefore fewer modules are combined per inverter. Therefore, in case of partial shading of the PV generator, the mismatch losses are less because fewer modules are affected.

D.5. Control System

A PV plant is typically controlled by a SCADA System (Supervisory Control and Data Acquisition) and can remotely be managed and supervised. However, for preventive, planned and corrective maintenance, adequate staff and qualified contractors must be identified for the Operations & Maintenance (O&M) of the plant.

E. Site Description and Assessment

E.1. Geographic Parameters

The site for Siddiqsons Solar is in the northern region of the Punjab province about 40 km North West of Haasil (33.202 N; 72.547 E), Chakwal, see Figure 7 and Figure 8. The actual site conditions vary from hilly to flat land being presently used for agriculture.

Figure 7: Overview of Location / Region in Pakistan

Figure 8: Site Boundary Map

There are some objects in the environment of the planned solar plant which may cause shading of the solar generator: such as agriculture and some trees, see Figure 9, and uneven hills, see Figure 10, in the site of the solar park. These aspects cause temporary impact only on some parts of the generator field. Most parts of the park remain unaffected. Agriculture and any other vegetation will have to be relocated and removed before any construction begins. These shadings can be considered and simulated within a shading analysis.

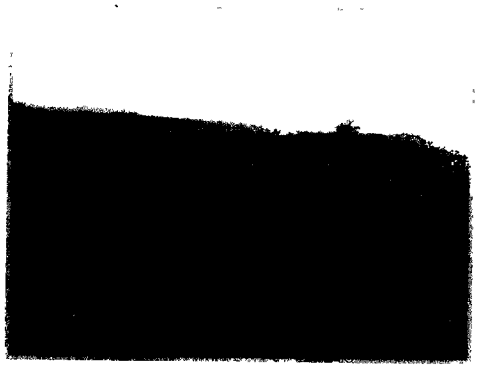

Figure 9: Agriculture

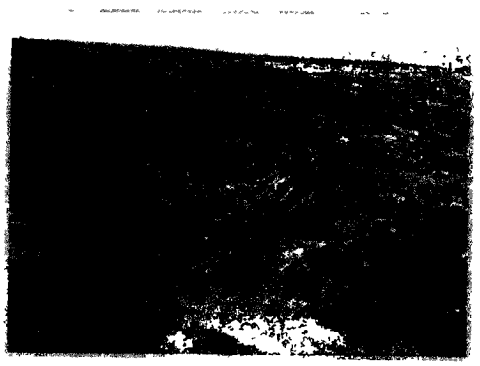

Figure 10: Hilly Terrain

Geographic parameters	Plant location of Siddiqsons Solar has been finalized however there is a presence of vegetation. Hilly Terrain has to be considered during detailed design.	**Relocation/Removal of vegetation has to be considered. Hilly Terrain has to be considered during detailed design**

E.2. Climatic conditions

Climatic conditions have an influence on construction and foundation layout as well as energy production. The region is part of the Potohar Plateau. There are seasonal variations in weather, ranging from cold winters to hot summers, with temperatures up to 40°C.

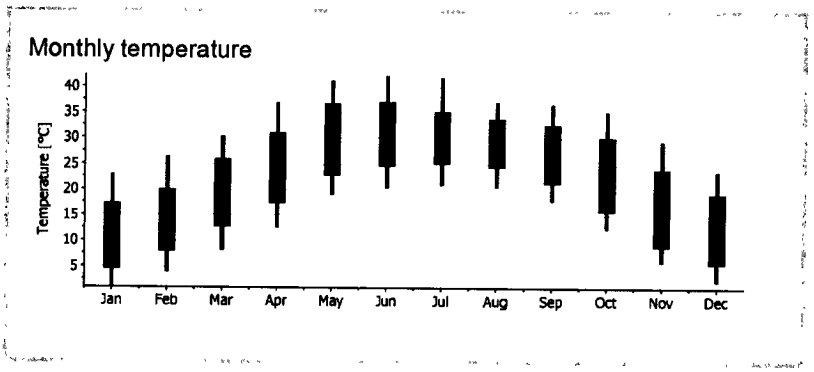

Figure 11: Site Temperature Range

The monsoon season lasts from May through September with a peak in July and August. 60 – 70 % of the yearly rainfall comes in these months. The average rain fall per year is about 170 – 200 mm.

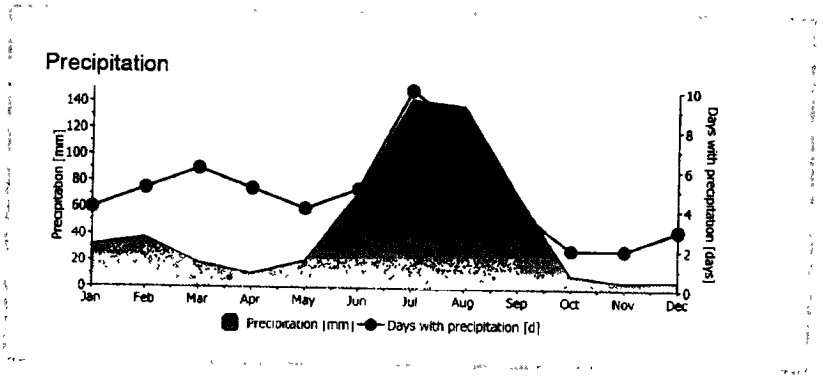

Figure 12: Monthly Precipitation (Mean)

Drainage from the site is not an issue. The hills provide a natural slope for water to flow which then enters into the channels created by rain water. There exists a small dam which accumulates rain water that can be used during project construction.

Figure 13: Rain Water Dam

There is an average of 8.1 hours of clear sky per day throughout the year and 2900 - 3200 sun hours annually.

The region is a generally low wind area with winds of less than 4.6 m/s. During the monsoon season, frequent storms are likely to occur with high wind speeds. Micro climate effects can cause dusty and windy conditions which should be evaluated more thoroughly in the detailed design phase.

Impact on the project:

The inverters for this site should be designed for high ambient temperatures and all of the equipment including inverters, transformers etc. should be installed on an elevated terrain. Dusty conditions should be considered for the design of filters for all electrical equipment and buildings. The position of the modules and other structures should be chosen so that an intelligent drainage and seepage network can be incorporated into the park.

Climatic conditions	Hot and humid climate requires robust components. Amongst other criteria, effective cooling, dust filters and abrasive resistant materials shall be utilized.	**Low Risk – to be considered in detailed design**

E.3. Other Environmental Aspects

The area, at present, is pollution-free. No industrial activities are present. There are few agricultural activities around the site. Pakistan Environment Protection Agency (Pak-EPA) has no regulations or requirements for solar power generation (PEPA Regulations 2000). Rainfall and some wind cause slight erosion of soil. No protected wild plants or animals are reported at the site. The ecosystem is described as fragile. The acoustic environment is good with low noise from little local traffic. Impact on project is highlighted in light of the IEE carried out by ECSP for Siddiqsons Solar 50 MWp Solar PV Plant.

Potential risk of earthquakes is to be considered for detail design of foundations as the site is found in the 2B seismic zone with magnitude ranging 5.1 to 6.0 on Richter scale in that region. Geological activity is frequent. Overall, the region is of stable structure. More information will be collected for proper design of substructures and foundations. The ground conditions can be described as somewhat complicated because of the tough hilly terrain.

More information is available in the detailed soil study which will be used during detailed designing.

Seasonal flooding is not a point to be considered as the site is having a higher elevation than the River Soan which is close to the site. Recent events of flooding have had no impact in this specific region.

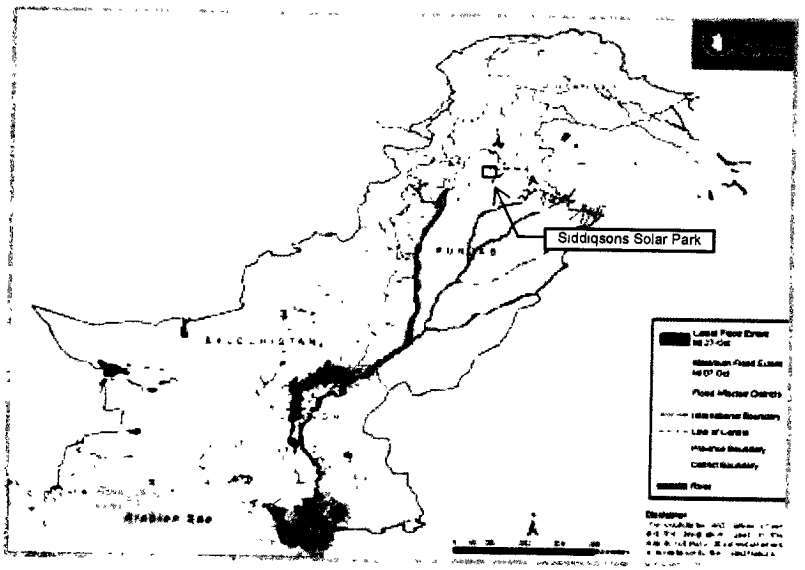

Figure 14: Flooding Events
(Source: World Food Program (http://de.wfp.org/))

There are few signs of presence of rodents at site which are known to eat plastic and cables.

Impact on Project:

This pose no serious impact on the project as precautionary measures will be taken i.e. proper sealing of the inlets in inverters, combiner boxes etc.

Environmental Aspects	Precautions against rodents shall be made to protect cabling effectively.	Low Risk – to be considered in detailed design

E.4. Topography and Grounding

The soil in this hilly region is compact, mostly dusty and salty as the region is a part of the salt range. Several rocks can also be found in the ground. Halophytic shrubs along with some other wild plants grow in this region.

Figure 15: 4-Wheel-Drive Tracks

The rain water causes the ground to deform and is not suitable for heavy transport traffic, as frequent traffic is likely to loosen the soil surface, see Figure 15. Further investigations with focus on necessary preparations are required. Detailed soil study has to be carried out.

In general, for greater part of the solar park the terrain is mostly uneven. The uneven steep slopes will make the Solar PV installations more difficult and some areas facing north, not feasible at all. Therefore, the ground needs to be leveled. For the planning of the solar park, a closer look and a thorough study of the topographic data is necessary before finalizing the layout of the plant.

The ground looks ideal for block concrete foundations or screw piles and will offer mechanical resistance. More details are available in the geo-tech study.

Ground water will not affect the electric grounding as the installation will mostly be done on top of the hills and the water table is low.

Impact on the project:

Overall conditions are more or less standard and various solutions can be settled to implement the project.

Topography and grounding	Foundations for Buildings have to be well prepared. Screw Pile or concrete block foundations present the best options for installation of PV-generator. The overall design, selection of components, and all constructions and foundations, as well as cabling have to be suitable for these conditions.	**Soil analysis has to be considered for foundation design.**

E.5. Meteorology including Solar Resource

Pakistan is exposed to strong solar irradiation, long hours of sunshine, and abundant solar energy resources. The annual sunshine hours range between 2900 - 3300 hours, with a daily average of 12 hours of astronomic sunshine.

The Township of Haasil is located in Chakwal district which is situated in the north of Punjab Province. For this location, the average sunshine duration sums up to 8.1 hours per day resulting in approx. 3000 hours of sunshine per year. The Meteorological Station in Chakwal District is located at 32°55' north latitude and 72°51 east longitude (in terms of the geographical coordinates), and the Observation Field is 519 m above sea level. The basic available meteorological data and the sunshine hours from 1982 to 2012 (30 years) of this Meteorological Station can be collected from a weather station which has already been installed at the site.

Overall, the region of Chakwal is warm as shown in the following table:

Table 3: Climate Data of the Region (Extract)

	Sun hours *	T Amb	Wind Vel
	h	°C	m/s
January	6.4	9.1	2.0
February	6 6	11.9	2.7
March	6.4	17.2	3.1
April	8 2	23.9	3.8
May	10	30.7	4.3
June	10	34.8	4.6
July	8.2	34.8	4.0
August	8	32.9	3.2
September	8.4	29.4	2.6
October	8.5	22.7	1.8
November	8.2	16.0	1.5
December	6.4	10.9	1.5
Annual average	3000	22.9	2.9

Source. SolarGIS and Meteonorm 7

Sun hours	Hours (* Meteonorm 7)
T Amb.	Average ambient temperature
Wind Vel	Average wind velocity

For the first part of this feasibility study, solar irradiance resource from the Meteonorm database is used. However, to further determine the best data for solar irradiation predictions, data sources from NASA and Solar GIS have also been analyzed as explained below. Generally, different sources refer to the same satellite and ground measured data. In the following paragraphs, we will describe the differences and define the preferred meteorological dataset for the yield assessment.

The high level of global horizontal irradiation with the typical shape of seasonal variation through the monthly values shows differences of only 2 - 3% on annual basis between different sources.

SolarGIS provides irradiation data based on calculations from satellite images. The database represents long-term global data (1994 to 2013). The spatial resolution is 250 m. SolarGIS typically has an uncertainty of 3.5 % based on experiences in other countries of the MENA region and Middle East. For Pakistan and the region of Cholistan, we calculate an uncertainty of 5% due to missing close reliable reference meteorological stations with measurement for irradiance values.

Meteonorm uses several sources e.g. different satellites and ground stations for mean values. The main time period is 1991 – 2010 (totally 1942 stations). The most important source of radiation data is the Global Energy Balance Archive (GEBA, https://protos.ethz.ch/geba/). This database is also used to extract uncertainty, variability and trend information (770 stations are used for this). Additionally the global radiation values of the stations of NREL's TMY3 database (http://rredc.nrel.gov/solar/ old_data/nsrdb/1991-2005/tmy3/) with the highest quality level (NSRDB class I) have been included in the Meteonorm database. Interpolation of global radiation data is based on a mixture of ground measurements and satellite data. The calculation of the uncertainty values of global radiation is based on (1) uncertainty of ground measurement based on long term variability of local climate, (2) uncertainty of interpolation of ground measurement and uncertainty of satellite based data and (3) on uncertainty of splitting into diffuse and direct radiation and inclined planes. Four parameters have been classified: (1) duration of measurement period, (2) standard deviation, (3) decadal trend and (4) end of measurement period. Interpolation of ground stations is modelled with help to the nearest station. For the designated site the nearest meteorological station is at Rawalpindi (70 km from site) which is quite a distance but acceptable

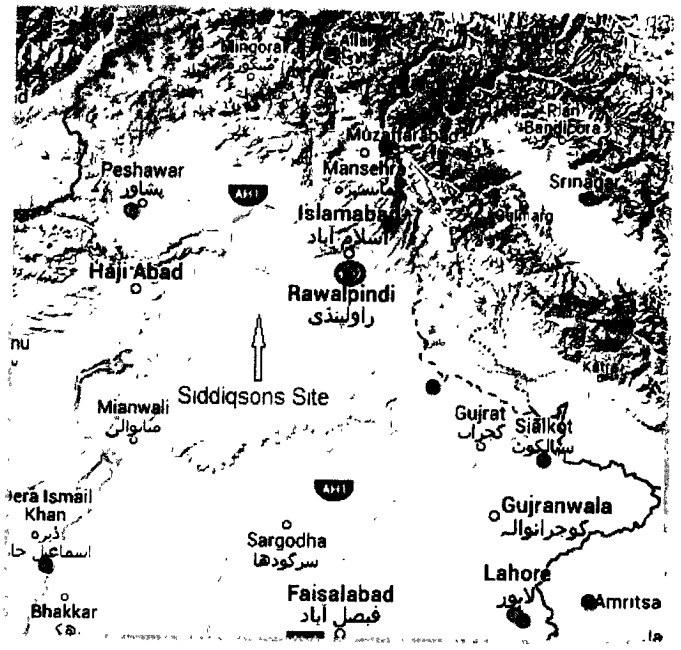

Figure 16: Meteonorm, nearest Ground Stations (http://meteonorm.com)

High latitudes and high albedo would increase the uncertainty even more which is not the case for the site. The uncertainty of satellite data is given by Meteonorm with 4 - 8 %. The overall year to year uncertainty calculated internally by the Meteonorm software comes out with 9.0% based on the available 20 years long term data set for this region for global horizontal irradiation (Ghi).

NASA source also uses satellite images but with their own calculations for irradiance data. For Pakistan, we can recommend an uncertainty of not better than 15 % due to experiences with ground measured data in India.

For the first energy yield calculations in the region of Haasil based on best estimation of basic system design, the irradiance and weather data were generated from the Meteonorm database (see also chapter H.1).

For a more exhaustive overview, the different sources can be viewed in detail in Table 4 and Figure 17.

Table 4: Results from different Sources for Irradiance Data

Irradiation Sources Siddiqsons Solar Average monthly sum	Meteonorm 7* 1991-2010 GlobHor	Solar GIS 1999-2012 GlobHor	NASA 1983-2005 GlobHor
	kWh/m²	kWh/m²	kWh/m²
January	84.8	91.2	101.1
February	88.1	99.8	116.7
March	142.7	154.3	157.5
April	165 3	176.6	187.2
May	201.3	208.8	220.7
June	193.4	195.5	214.2
July	182.0	173.9	186.3
August	170 5	163.1	172.4
September	162.1	156.2	155.7
October	141.6	139.7	143.5
November	108.3	98.8	112.8
December	82.2	87.8	95.5
Annual sum kWh/m²*a	1722.4	1745.7	1863.5

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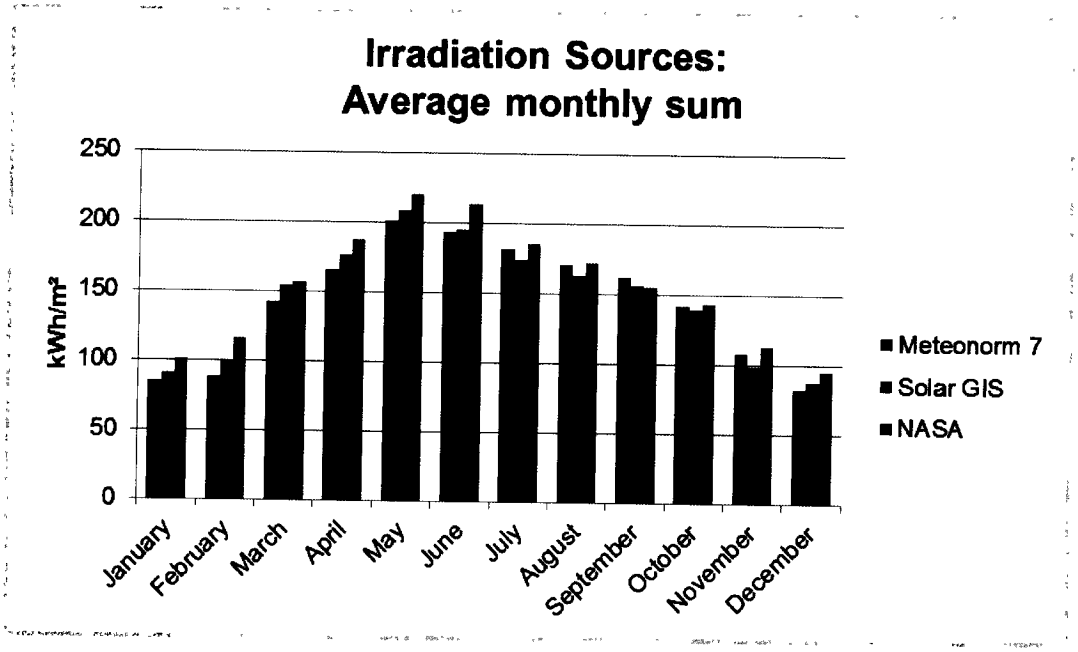

Figure 17: Comparison of Results from different Sources for Irradiance Data

All data sets (SolarGIS, Meteonorm and NASA) are within a range of 5 % of average annual irradiation at site. Based on the Consultant's experience, these values are in close proximity and deviate only slightly. The Meteonorm data gives a more conservative approach regarding the energy yield, compared to the other resources. Therefore for energy yield analysis in this Feasibility Report, Meteonorm data will be used. Meteonorm irradiance data will also be used to receive comparable values, since the power tariff paid by the grid operator is based on those irradiance values.

Impact on the project:

Irradiation Data	There is a potential bias of satellite irradiance data for this area by 7.0 % towards the downside of the expected value	[redacted]

E.6. Transport Access

The site is 34 km from Chakri Interchange at Motorway M-2 and is 102 km from Chakwal. Sea freight may be shipped to Karachi harbor and then be transported to the site via road.

The Dehri Village road from Chakri interchange is under construction till Ganda Kass village which is 10km from site and the rest has to be developed for heavy traffic. After road construction the solar park will be easily accessible by any car or lorry coming from the motorway.

Figure 18: Access Road under Construction

The Master Plan for infrastructure development is being developed.

E.6.1. Road Traffic Planning

Besides accommodating the roads, the corridors will also be used for overhead power lines, buried water pipelines, telecommunication lines and other utilities.

E.6.2. Design of Road Works

The roads should turn orthogonally at 90° as much as possible. Precautionary lights along the roads are recommended. Considering the small population and light traffic, the road turnings should be planned to be rounded off only at the roadway edge. No public transportation should be permitted to enter the solar park. Solar Plant sponsors will arrange vehicles according to their needs for travelling in and out of the Plant along with parking lots within their boundaries.

E.6.3. Road Vertical Design

As terrain within the solar park is uneven, special care will have to be taken while designing the roads. In specific cases like escarpments, the gradient limitation may be relaxed according to site conditions. In order to ensure smooth longitudinal curve of the road, cut and fill balance method should be used. Factors such as comfort, smooth ride, engineering parameters and proper visibility are to be considered in vertical design, especially at road turnings whereas the longitudinal slopes of roads on both sides of the turning should remain the same.

E.6.4. Road bed / Subgrade

The road bed is required to be strong, stable and economical and should be prepared according to the local conditions including geology, hydrology and available material as well as other construction requirements. Accordingly, the subgrade is proposed to have a minimum thickness of 300 mm having CBR values of 8%. Compaction of filling material in the subgrade should be 95% of AASHTO T-180 (MDD). Borrow pits and spoil heaps should be properly dressed to avoid any hazards.

E.6.5. Pavement

It is expected that during construction of the solar plants, there will be considerable vehicle movement on the roads. However, during the operation stage the traffic will be quite light. The road pavement has been accordingly designed on the basis of one million ESAL traffic load and subgrade CBR requirement of 8%. The road surface needs to be stable and strong enough to meet the requirements of being smooth, anti-sliding and having a good drain system. Accordingly, the Consultant has proposed a sub-base thickness of 150 mm, overlain with

175 mm thick water bound macadam meeting the standard AASHTO specification. The asphalt wearing course is designed to have a thickness of 50 mm. The shoulders have a double surface treatment over the 150 mm thick water bound macadam. Thickness of sub-base and subgrade is the same as that for the main carriageway.

E.6.6. Road Traffic Safety Facilities

Necessary traffic safety facilities (see Figure 19) are proposed according to safety regulations, to ensure the safety of vehicles and pedestrians.

Figure 19: Traffic Safety Facilities next to the Road

Impact on the project:

Transport Access	The accessibility to the complete PV development area has to be established via a solid access road. Construction and service roads within the Plant's area have to be erected.	**Low Risk - to be done during detailed design**

E.7. Water Access

Water will be required for dust prevention during the construction phase and for cleaning of modules in the operation phase.

E.7.1. Water Demand

The majority of the water will be needed for regular cleaning of the modules. Furthermore, small amounts of water will be needed for domestic consumption (e.g. living), landscaping and dust prevention on roads / tracks. Wet cleaning of the modules is supposed to take place on a monthly basis (once every 4 weeks). The total demand of fresh water is estimated to be approx. 4563 m^3 / year including the amount for domestic, landscaping and dust prevention consumption for the 50 MW Solar Park. The daily water demand equals to approx. 12.5 m^3 / day.

However, after extensive analysis of the site conditions, it is suggested that the modules be cleaned via dry brushing at least once per week to ensure maximum output. In case of weekly wet cleaning, the water demand would rise to approx. 50 m^3 / day.

E.7.2. Water Supply

The region has moderate water resources from rain (less than 600 mm/a) and groundwater, the accessibility of which will have to be confirmed. There exists a rain water dam that can be used as a water supply during the construction period but additional tube wells with storage tanks will be required to fulfill the needs. Proper planning will be required to provide water access to the site.

E.7.3. Water Reuse / Treatment / Disposal

The water utilized for cleaning the modules will not be reused or treated after the module cleaning procedure. The water will be let to seep away into the ground, as catching the water before dropping off the modules is a very complex process. As environmental pollutants, e.g. dust, sand, and bird droppings, are mixed within the used cleaning water, those naturally occurring elements are not regarded to give any negative influence to the PV plant's soil. However, in long term of solar plant operations, it can be efficient to apply some type of water recycling system to reduce fresh water consumption for module cleaning process. However, the module manufacturer's specifications regarding water quality have to be respected.

Water used for domestic supply will be collected in underground waste water storage tanks. A procedure to recycle grey water, e.g. from lavatory, is recommended to be applied for efficient reduction of fresh water consumption.

A waste water treatment plant is currently not intended, however waste water from the plant shall not be dissipated into the ground without treatment.

E.7.4. Water related Environmental Impact Analysis

The water related environmental impact analysis is covered in the sections 3.4 and 3.5.

E.7.5. Water Management Plan

We recommend carrying out a water management plan for construction and operation of the solar park, office and residence block. In particular:

- Water demand of the plant (e.g. for construction and cleaning of the modules).
- Water supply to the plant (based on the hydrological situation in the area).
- Water reuse / recycling schemes (e.g. waste treatment, storage ponds...).
- Waste water discharge (e.g. quality and amount of waste water, run-off systems, etc.).
- Water-related (hydrological) environmental impact analysis.

Impact on the project:

Water Access	A water management plan for construction and operation of the plant, as specified above has to be carried out.	**Low Risk - to be done during detailed design**

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E.8. Grid Access

Currently, there is no direct high voltage grid access on site. A 132 kV step-up station and transmission lines will be needed for connection and power evacuation to the Ahmadal Grid Station which is 10 km from the site.

There exists no medium voltage grid for auxiliary supply on the site. The closest 11 kV gridis 5 km from the site that has to be enhanced and extended for use or a dedicated HV line has to be brought from Ahmadal Grid Station.

Proper planning is required to provide HV/MV grid access to the site.

Impact on the project:

Grid Access	The medium voltage (11 kV) grid accessibility for the construction phase is not available. However, load shedding might occur so a backup facility will be needed. 132 kV HV is unavailable at the site. MV to HV step-up stations must be erected.	**MV Power Line to be upgraded for construction phase. Erection of MV/HV step-up stations to be considered during planning phase.**

E.9. Facility Access

The PV development site is about 40 km away from Chakwal, where facilities such as a fire department, a police station and a hospital are available.

The fire station can meet the fire protection requirements of the solar park but because of being far a dedicated fire station will be required. The arrangement of water for fire-fighting requires proper planning.

According to the features of the solar park, and on the basis of the relevant specifications of Code of Design on Building Fire Protection and Prevention (GB50016-2006), fire hydrants will have to be provided in the general services area and the 132 kV step-up station. The outdoor fire hydrant shall be erected along the roadside, and the arranged distance between the hydrants shall be no more than 120 m. The fire devices shall be designed according to the secondary load power supply standard, using double circuit power supply and automatic switching at the end. The fire devices shall use fire protection or fire-resistant cables. The fire protection and firefighting system in the solar park is part of safety requirement and shall be designed and provided by the EPC contractor.

Due to the hospital being far from site an emergency kit has to be provided to each station on site, along with an emergency guideline, the emergency call number and a description of the travel route to enable a rapid aid.

Due to the police station being far from site it is recommended that the site has its own full time security staff located near or on the site.

Impact on the project:

Facility Access	Access to public facilities (fire / police station, hospital) is approximately 40km from the site in Chakwal. Lack of full size access road does not allow quick rescue services in case of an emergency.	**To be initiated**

F. Plant Layout and Description of Technical Equipment

F.1. Power Supply Infrastructure

There exists no HV and MV line close to the site. Both 132 kV and 11 kV transmission lines have to be constructed for evacuation and auxiliary supply respectively.

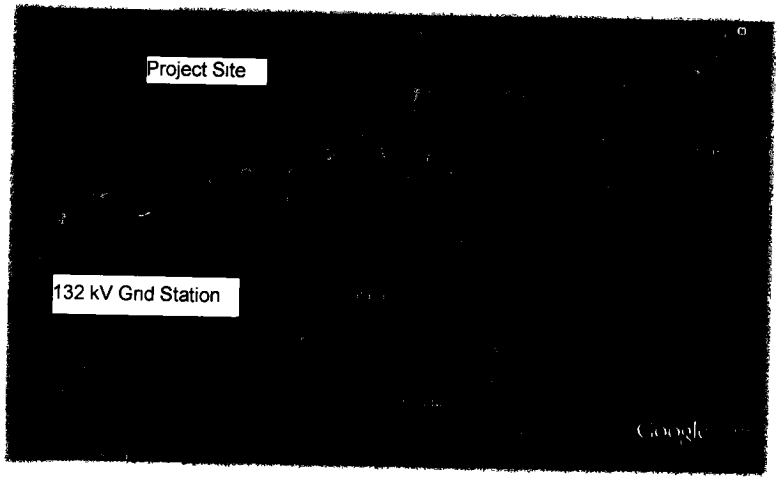

Figure 20: Overview Infrastructure

The grid connection of this 50 MWp solar plant will be done at Ahmadal grid station 10 km from the project site.

F.2. Power plant Technology Configurations

In general, several technology configurations can be implemented.

Easiest and cheapest technology configuration is a fixed mounted module installation with a tilt to the south with central inverters. The density of installed PV power to ground space is highest and the specific energy output by installed PV power is lowest.

Alternatively, a dual-axis tracking system represents the complete opposite:

- it is more expensive,
- it has the lowest density of installed PV power to ground space, and
- it has the highest specific energy output of installed PV Power.

A compromise of these two technologies is the single-axis tracking system. This option offers a good cost to power ratio. Due to this insight, several versions of single axis tracking systems (with horizontal North-South axis) may be compared.

Fixed tilt installation is considered for the purpose of this feasibility study, because it is the easiest and cheapest solution. Additionally, due to large amount of diffuse irradiation, the benefit of tracking systems against fixed mounted systems is not as strong.

Pile rammed substructure is the most recommended type of foundation for PV racks, but the best foundation for this specific site should only be decided after geotechnical investigation.

Impact on the Project:

Detailed yield analyses have to be carried out for multiple options. RFP should not be fixed to one option, but to the highest yield / cost ratio.

F.3. Basic System Design

In the following paragraphs, the main assumptions and the components preselected for the Energy Yield Assessment can be found. The basic system design considers thin film modules at a tilt of 28° and central type inverters.

F.3.1. Preliminary Layout

The preliminary layout shows a typical layout for a solar plant of this size. The final layout will be defined only once the final choice of modules, structures and inverters is made.

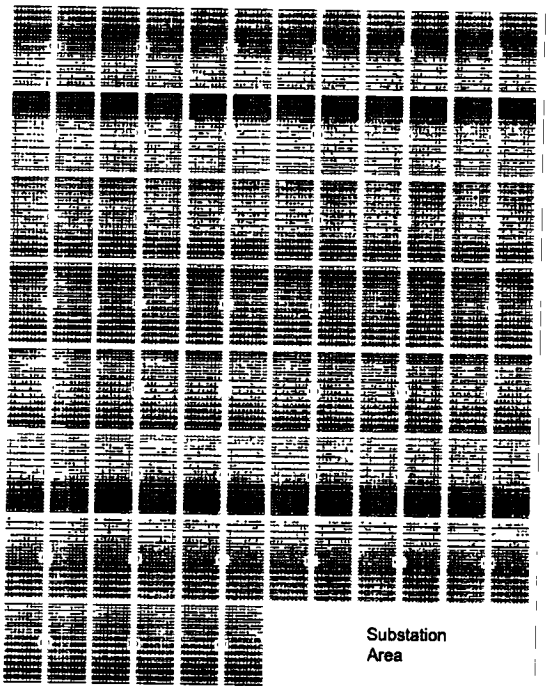

Figure 21: Schematic Overview PV Plant

F.3.2. Modules

Standard CdTe thin-flim PV modules were selected for the system design. This type of module is currently state of the art. Such modules are available in cost-efficient and sufficient amounts to implement a 50 MWp solar plant.

Quality of the modules is recommended to be assured by a pre-construction factory-audit of the manufacturer, laboratory testing of recently produced modules and on-site testing of modules delivered to construction site.

F.3.3. Structure

For mounting the PV modules on site a standard fixed tilted metal mounting structure was selected. Using ramming piles or earth-screws as the structure's foundation is a common and

cost efficient method. The method has proven its reliability in PV projects throughout the world. In the case of rough site conditions, as present in this project, fixed systems are more robust than tracked systems, because they don't have any moving parts. Therefore, the maintenance costs are lower.

The modules are mounted to the structure with a tilt- angle of 28° to the ground to enable sun exposure and high energy yield. In a first exemplary approach this angle was chosen, as it is in the above mentioned range of the optimum tilt angle of modules.

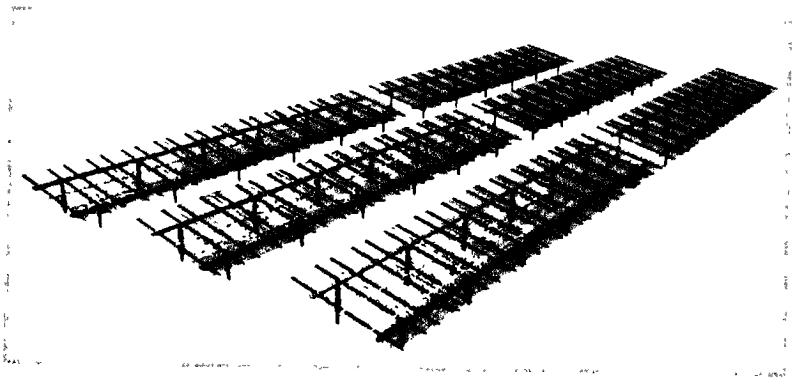

Figure 22: Schematic of PV Mounting Structure

F.3.4. Cables

The electrical interconnection between PV modules and inverters is recommended to be made of minimum 4 mm² copper cable. This is a standard approach according to international best practice and suitable for the project.

F.3.5. Inverters

For this feasibility study centralized type inverters were selected. This type of inverter is a typical and high quality state of the art product suitable for the project. Inverter quality shall be secured by a factory-audit of the manufacturer before production and delivery.

Centralized type inverters were selected due to their capacity of dynamic grid support, which is a relevant point in the project site. Additionally, the specific purchase price per MW is lower, and efficiency is higher than for decentralized inverters.

F.3.6. HV Station

The substation is considered as a critical part of the project concerning the time line for its construction. Availability and delivery time of the chosen components and design criteria, acceptable to NTDC, have to be considered.

A standard substation consisting of a Medium Voltage part including HV transformer, HV portion of the plant, double bus bar single breaker scheme designed for HV portion is recommended to be used in this project.

F.3.7. Monitoring

A SCADA system of high temporal resolution (minimum should be 15 Minute average values) is recommended to be adopted. It is also recommended to measure fine resolution of plant components, e.g. in one channel combination of two module strings only.

To achieve an optimum energy yield, it is recommended to keep staff operating on site for continuous monitoring of the performance of the solar plant.

F.3.8. Security

To secure the site against theft and vandalism as well as for staff's and resident's protection, a 2m high fence at least with barbed wire on top should be erected. As an alternative, a solid concrete wall should be erected. Additionally, a video surveillance system connected to a maintenance office is recommended to be installed to remotely supervise activities on site.

F.4. Required infrastructure developments

The main access road, along with the roads inside the solar PV plant, have to be constructed.

Water distribution system will have to be developed into the specific PV plant site area for construction or maintenance reasons, e.g. washing of modules.

The 11 kV medium voltage power line providing auxiliary power supply during construction phase has to be constructed to the PV plant site. Points of interconnection have to be established.

G. Grid interconnection

G.1. Assessment of possible electrical Faults and their Impact on the Power Network

In developed countries, many years of experience with grid connected renewable energy power plants have shown that it is possible to integrate these power plants into the grid under consideration of clearly defined technical aspects. For Pakistan, NTDC grid code will be followed for integration of the plant with the grid.

G.2. Possible electrical Faults and their Impact on the Grid

In general, measures have to be taken in order to assure that all types of electrical faults of the PV plant are managed in accordance with the relevant national grid code (NEPRA Grid Code June-2005) and potentially existing so-called "Technical Conditions for Grid Connection" of the corresponding grid operator. The needs can be fulfilled by selecting the right safety equipment and a safety concept which includes all components from inverter up to the grid connection point.

G.3. Impact on the Evacuation Network

With respect to the transmission grid at high voltage level, the conditions for safe grid integration of 50 MW nominal DC power needs to be formally assessed externally and signed off. The corresponding key indicators for this assessment are the short circuit power and the impedance angle of the grid at the grid connection point.

G.4. Balancing Power

Due to their very nature, PV plants as such are not suitable for providing balancing power. According to the installed inverters, the PV plant has to be operated far below nominal power at certain times of the day to ensure the requested reactive power. Usually, inverters react slowly to the request to change the share of reactive power. Due to the slow reaction of the inverters and the need for fast power balancing, a compensation system has to be implemented. The PV plant needs to be formally assessed, so that adequate measures to provide the required balancing power can be implemented and an overall monitoring and control system installed.

G.5. Grid control Strategies

Basically grid control strategies can only be set up with a somewhat clear understanding of the potential energy mix of a specific region in the future. Once this mix is known at least on "target basis", it is feasible to exploit the potential of modern inverters to the full extent, for instance their capabilities of providing reactive power on demand in more or less real time or in case of low voltage.

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G.6. Technical Specifications

Prior to setting up technical specifications for the grid connection, a comprehensive analysis of the existing grid codes, relevant guidelines and national regulations, has to take place with the target to establish the exact conditions for a safe, technically and economically viable grid connection of the solar plant. Following this analysis, detailed technical requirement specifications, concerning the behavior of the grid connected solar park, can be set up in order to make sure that faults and deviations from the established set of conditions result in predefined actions. Key issues in this respect are:

- Decoupling of the solar plant in case of short circuit and voltage or frequency deviation above or below defined thresholds
- Dynamic grid support in case of short term voltage drops
- Provision of reactive power and control of effective power as required

G.7. Approvals

There has to be a grid integration and connection study completed by PPI is to be got approved to confirm the conditions of integration of this 50 MWp solar plant. In particular:

- Potentials and limitations for the integration of the power product of the different scales of SPV plants into the daily and yearly load curves.
- Quantitative and qualitative needs and already available grid-inherent potentials to provide balancing power.
- Quantitative and qualitative needs for additional balancing power.
- Further risks and necessary risk mitigation measures for ensuring grid stability.
- Required power quality output parameters of the plant.
- Technical requirements of inverters, transformer, switching devices, circuit breakers etc.
- Control parameters and control interfaces to the grid operators control schemes.
- Further risks and necessary risk mitigation measures avoiding and handling electric failures of the plant.

Impact on the project:

Grid connection	The specific requirements and approval for grid connection need to be confirmed by NEPRA / NTDC	Low Risk - to be initiated asap

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H. Energy Yield Assessment

H.1. Solar Irradiation Data

The weather data from Chakwal weather station that is about 40 km for the site can be acquired however, for this feasibility we have considered satellite data from Meteonorm. The given sunshine hours can only indicate the volatility through the years which is around 20%. Besides the sun hour data, there are other sources for irradiation data as well. To calculate energy values, the dimension to be taken into consideration should be expressed in kWh/m² instead of sun hours. For a first energy yield analysis, the annual horizontal global irradiation was evaluated 1722.4 kWh/m² (Meteonorm data base, see also chapter E.5).

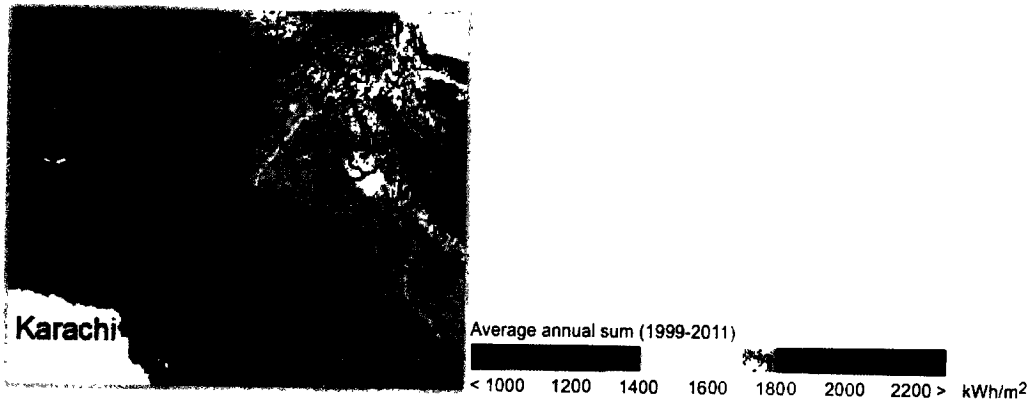

Figure 23: Global horizontal Irradiation (GHI) for Pakistan (Source: SolarGIS 2012)

Table 5: Global horizontal Irradiance (Ghi) and Ambient Temperature (Ta) Monthly means (by Meteonorm)

Month	GlobHor (Ghi)	T Amb (Ta)
	kWh/m²	°C
January	84.8	10.3
February	88.1	13.6
March	142.7	19.0
April	165.3	24.4
May	201.3	29.7
June	193.4	31.4
July	182	30.2
August	170.5	29.1
September	162.1	27.2
October	141.6	22.6
November	108.3	16.1
December	82.2	11.8
Year	1722.4	22.1

The deviation of single years from the long-term average can amount up to 15% and can show the same trend over several years. To minimize deviations for yield calculations, it is necessary to take into account a long term average of irradiation. Figure 24 below exemplary demonstrates the maximum deviation of measuring periods of different duration from the long-

term average in the years 1937-1999 at the Potsdam site. In fact, there will always be deviations in irradiance between each year of operation. Regarding the long term of operation these deviations will lead to an average irradiance very close to the number given in the yield analysis.

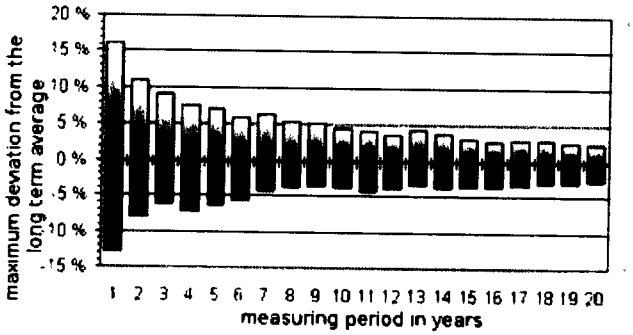

Figure 24: Deviation of solar irradiation from the long-term average (source: Quaschning, Volker. "Unstete Planungsgröße." In *Sonnenenergie*, June 2001: pp 24-27.)

For the PV plant's geographical location, the uncertainty of irradiance measurement data year to year is 7.0% (source: Meteonorm software, Version V7.1.2.15160), as the nearest ground measurement station for comparative values is only available at a distance of around 70 km.

H.2. Shading Analysis

From several site visits in 2014 and 2015, we can summarize that the hilly terrain may cause significant shading. The present vegetation will have to be removed before any construction begins. This aspect has been assessed in detail in the environmental study carried out by ECSP.

H.3. Performance Ratio

A solar cell is the smallest semiconductor element within a PV module to perform the immediate conversion of sunlight into electrical energy by the photovoltaic effect. Depending on the employed technology, the degree of efficiency amounts up to 18 %. This value seems to be quite low but the free supply of primary energy (solar radiation) and the corresponding absence of power dissipation in the conventional sense should be taken into consideration. By using appropriate technology, the direct current generated by the solar modules is converted into alternating current that can be fed into the public power supply.

The conversion into alternating current implicates losses depends on the PV system configuration, the choice of components and to a minor degree on the local site conditions.

If these losses are identified and evaluated, the system operation quality – the performance ratio (PR) – can be ascertained.

The PR is stated as percentage and describes the relationship between the actual and theoretical energy outputs of the PV plant considering module efficiency.

PR = energy yield / (unshaded annual irradiation on array surface * module efficiency according to STC)

$$PR = 100\% \times \left[\frac{E_{AC}}{E_{Irradiation} \times A_{Array} \times \eta_{STC}}\right]$$

E_{AC}	= energy coming from the inverter or measured at the energy meter in kWh
$E_{Irradiation}$	= unshaded irradiation at module level in kWh/m²
A_{Array}	= total surface of all solar modules in m²
η_{STC}	= module efficiency at STC

The module efficiency (contrary to the cell efficiency) considers the gross module surface and can be calculated as follows:

$$\eta_{STC} = \left[\frac{P_{Module}}{A_{Module} \times 1{,}000\text{W/m}^2}\right]$$

H.4. Expected Losses

A fundamental step in understanding this important quality criterion is the explanation of the typical loss factors affecting the energy yield with different weights. In every simulation step, all described aspects have an hourly impact on the overall result.

All technical losses described below are calculated in the energy yield analysis depending on system design and chosen components and operation conditions.

H.4.1. Irradiation Gain by Inclination of Modules

In non-equatorial zones, the degree of irradiation at module level can be improved by the inclination of modules southwards (northern hemisphere) or northwards (southern hemisphere) against the horizontal. When reaching a normal module inclination angle of 25 - 30 degrees, the irradiation gain can amount up to 10 – 15% in temperate zones. It is expressed by the surface-factor F (A) ~ 1.10 – 1.15. The inclination angle causes an additional irradiation because the ground reflects the light to the modules. This reflection on different soil types is expressed by the Albedo Factor. There are empirical values for different soil surfaces. For example, the solar reflectance of grassland and cropland is about 20%. The effect on the energy yield is scarcely weighty but it is even so considered in the yield simulations. The product of irradiated amount of energy at module level and module efficiency (not cell efficiency, which is higher) is the basis for the initial value for the PR calculation and is defined to be 100%.

H.4.2. Technical Losses because of Shading

If there are objects in the immediate environment of the planned solar plant causing shading of the solar generator, these shadings can be considered and simulated previously within a shading analysis. A distinction is made between "horizon shading" and "nearby shading".

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Horizon shading causes a shading effect which has a permanent impact on the entire generator field. The simulation considers this effect by adjusting the horizon line. Objects that are in a large distance to the modules, e.g. mountain ranges, are typical horizon shadings. Such shadings always affect a larger module field, i.e. an array.

Nearby shading has a temporary impact only on some parts of the generator field. Most parts of the park remain unaffected. Objects at close distance to the modules act as cast shadows, e.g. power poles, trees but also row shading in large rack-mounted solar fields.

Greater distances between the mounting rows will lead to less nearby shading, as the effect of shading at low sun-angle will reduce.

Depending on the site conditions, these aspects are considered in the yield simulation.

Best in class shading losses would be represented by values in the range of up to 1%. Acceptable values would range between 1% up to 5% always depending on the required use of ground and intended energy yield of the PV plant. Shading above 5% would be unacceptable.

H.4.3. Technical Losses because of Soiling

Dirt on the modules also causes shading effects which can change over time and seasonally. This shading impact on the energy yield depends for example on the surrounding landscape, cultivation and precipitation. The impact can only be appraised and is based on experience values as well as contracted cleaning. Consequently, the uncertainty is high. It is recommended to clean the modules at least once per month. The energy loss effect can be expected around 1%.

Best in class soiling losses would be represented by values in the range of up to 1%. Acceptable values would range between 1% up to 4%. Soiling above 4% would be unacceptable.

H.4.4. Technical Losses because of Temperature Fluctuation

Ambient temperature and degree of irradiation have an influence on the cell temperature and so affect the energy conversion process. According to the defined STC value of 25°C the electrical power output decreases with higher module cell temperature and increases with lower cell temperature. The module model shows this characteristic by means of temperature coefficients for current and voltage.

Best in class losses due to temperature fluctuation would be represented by values in the range of up to 5%. Acceptable values would range between 5% up to 13%. Temperature fluctuation losses above 13% would be unacceptable.

H.4.5. Technical Losses because of Reflection

In particular inclined irradiation causes reflection of sunlight at the glass and cell surface. For "solar glass" it is considered by an empirically determined factor: IAM (Incidence Angle Modifier) = 0.05.

Best in class losses due to reflection would be represented by values in the range of up to 1%. Acceptable values would range between 1% up to 4%. Reflection losses above 4% would be unacceptable.

H.4.6. Technical Losses because of low Irradiance Level

Due to production processes the relative power of the Modules might differ under different light levels.

Best in class losses due to this effect would be 0.2%. Acceptable values would range between 0.2% up to 0.8%.

H.4.7. Technical Losses because of Module Quality

The module quality loss is defined as a parameter describing the module's performance with respect to the manufacturer's specifications and tolerances. Due to production reasons, the module performances are subject to slight fluctuations (see data sheet "module performance").

Best in class losses due to module quality would be represented by values in range of up to 0.0%. Acceptable values would range between 0.0% up to 1.5%. Module quality losses above 1.5% would be unacceptable.

H.4.8. Technical Losses because of Array Mismatch

Array mismatch losses are mainly caused by the fact that in a string of modules the lowest current drives the current of the whole string. With its statistically distributed parameters of current, voltage and power in each module, most of the modules will not be driven at their optimum operating conditions.

Best in class losses due to mismatch would be represented by values in the range of up to 0.8%. Acceptable values would range between 0.8% up to 1.5%. Mismatching losses above 1.5% would be unacceptable.

H.4.9. Technical Cable Losses

The whole wiring of the solar park is subjected to cable losses due to the natural resistance of conductors - the ohmic resistance. Due to small-scaled plant design and cable dimensioning for maximum performance, losses normally amount to 1 - 2%.

Best in class ohmic losses would be represented by values in the range of up to 1%. Acceptable values would range between 1% up to 2.5%. Ohmic losses above 2.5% would be unacceptable.

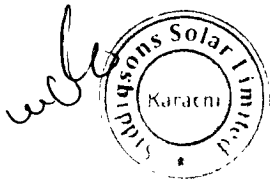
H.4.10. Technical Losses because of DC to AC Inversion

The conversion of direct current into grid compatible alternating current entails inevitable losses. The manufacturer's data of the inverters relating to the European standard efficiency regard typical European operating conditions. The temporal distribution of the performance quantity is evaluated here.

Best in class losses due to DC/AC inversion would be represented by values in range of up to 1.8%. Acceptable values would range between 1.8% up to 3%. DC/AC inversion losses above 3% would be unacceptable.

H.4.11. Technical Losses because of Transformation (Transformer Losses)

Transformer losses depend simultaneously on several parameters. Basic technical parameters like ohmic and magnetic resistance can be taken into calculation. Depending on technology the losses are around 1 - 2%. For LV/MV step-up transformers this value is typically 1.3%, whereas for MV/HV step-up transformers this value is typically < 1%. This sums up to transformer losses of 1.9% for a plant feeding into HV level.



Best in class losses due to voltage transformation would be represented by values in range of up to 1.4%. Acceptable values would range between 1.4% up to 2.5%. Transformation losses above 2.5% would be unacceptable.

H.4.12. Technical Losses because of Self-Consumption

Inverters (operation, fans, heating ...), monitoring and security systems as well as communication systems consume power. During energy production the necessary power is reducing the current output of the PV plant.

H.4.13. Technical Losses because of Plant-Availability

The technical availability of a PV plant crucially determines the energy yield. Outages due to failure of fuses, disconnected strings or broken inverters are likely to occur and therefore must be considered in the expected energy yield.

Best in class technical availability losses would be represented by values in range of up to 0.3%. Acceptable values would range between 0.3% up to 1.2%. Availability losses above 1.2% would be unacceptable.

H.4.14. Technical Losses because of Weathering and Degradation

Changes in the energy yield because of weathering need to be considered in the expected long term energy yield. As degradation of modules is a continuous process, depending on time, performance will decrease with time of operation. Performance guarantees of manufacturer and different practical results diverge a lot. Former long-term study findings cannot be applied easily to modules produced with today's manufacturing processes and product features. But it is assumed that today's processes and technologies lead to a higher module quality. The consideration of an annual correction value for weathering / degradation is recommended for the overall result.

Best in class degradation losses would be represented by values in range of up to 0.3%. Acceptable values would range between 0.3% up to 0.8%. Degradation losses above 0.8% would be unacceptable.

H.4.15. Overview to Technical Losses

As the technical design is not decided yet, our calculations are based on typical assumptions and state of the art components. The above mentioned described losses come out of the yield calculations of a so called waterfall diagram. Table 6 summarizes values of loss-factors.

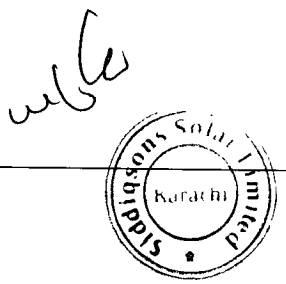


Table 6: Overview to Loss Factors and Quality Classification

Loss factor	Quality classification		
	Best in class	Fixed case assumption	Not acceptable
	%	%	%
Shading	< 1.0	2.9	> 5.0
Soiling	< 1.0	3.0	> 4.0
Temperature fluctuation	< 9.0	5.9	> 13.0
Reflection	< 1.0	2.7	> 4.0
Module low light performance	< 0.2	0.5	> 0.8
Module quality performance	> 0.2	1.0	> 1.5
Module mismatch losses	< 0.5	1.0	> 1.5
Cable losses DC	< 1.0	1.0	> 2.5
Cable losses AC		0.5	
DC/AC conversion	< 1.8	2.9	> 3.0
Voltage transformation	< 1 4	0.8	> 2.5
Self-consumption	< 0.3	0.7	> 1.2
Availability	< 0.3	1.2	> 1 2

See below the results for fixed mounted structure with 28° tilt angle of the modules.

General explanation of the waterfall diagram: (1) Starting with the Horizontal Global Irradiance: the tilted installation increases the irradiance on tilted module plane. Near shadings, soiling losses and glass reflections reduce that gain. (2) Once the irradiance reaches the active cell, it is converted to electric power ("PV conversion"). (3) Further, electrical losses occur in the electrical system depending on the characteristic behavior of the components used, cabling design, and operation of the equipment. Performance ratio of the whole system is calculated between "Energy injected to grid" and "Array nominal energy (at STC efficiency)".

For a fixed design, a simulation has been run. A fixed tilted array with 28° tilt angle shows the following results, see Figure 25. The losses are in the expected range for the design and environmental conditions. The relating loss diagram is as follows.

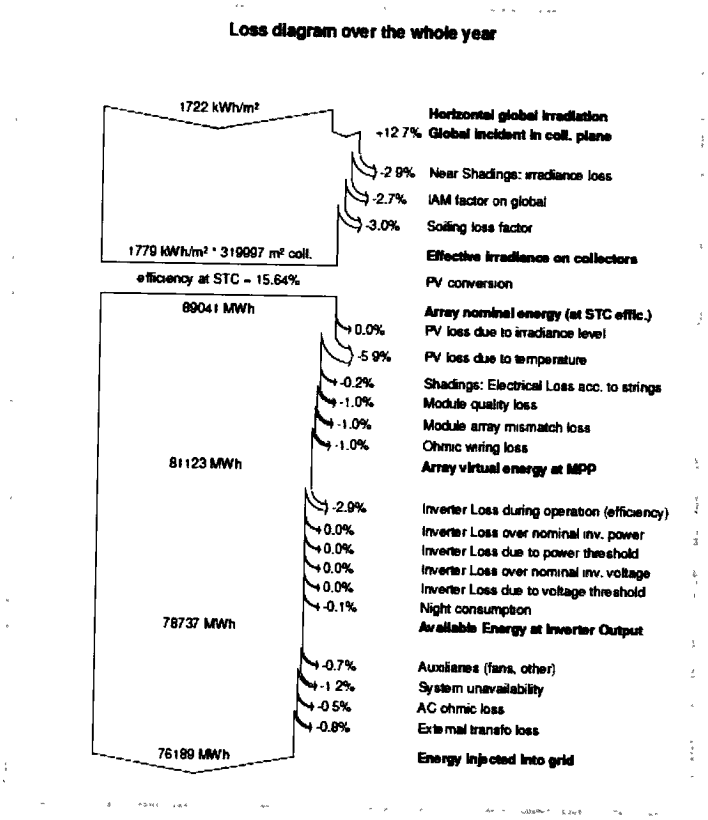


Figure 25: Waterfall Diagram of Losses
(Example for fix Tilt 28° to south with a Pitch of 5.5 m)

H.5. Energy Yield Simulation for most suitable Technical Design

Different pre-assessments have been calculated with the simulation software PVsyst which takes as input the meteorological data as well as an individual system design and a component selection. Then it simulates a whole operational year in two-minutes-steps through a whole year.

The options for technical design are described in chapter F. The first high level yield assessment presents following initial annual output to grid at P50 level. The results (see Table 7) are calculated for the interconnection point with the HV grid.

The results include transformer losses and cable losses to the point of interconnection to the HV Power line.

Table 7: Summarized Main Results of Yield Simulation

Item	Unit	Fixed mounted 28° to south
Irradiation in module plane	kWh/m²/year	1941.1
Performance Ratio (PR)	%	78.5
Initial specific output	kWh/kWp	1,524
Total output for 50 MWp	kWh/year	76,189,000

H.5.1. Uncertainty of Simulation

The single values of the input data and intermediate results are subject to uncertainties. In order to evaluate the total uncertainty of the simulation result, the standard deviation[1] is applied here. These values have been generated under the assumption that these parameters are normally distributed variables and are independent. The total standard deviation in uncertainty after accounting for all these losses comes out to be 8.23%. The values are summarized in Table 8, shown below.

The total year to year uncertainty of the irradiation data is 10%. This value needs to be assessed in its impact on the energy yearly generated. However, due to the positive correlation between irradiation and temperature changes and the negative correlation between ambient temperature and power plant output, the irradiation uncertainty will not be entirely transformed and needs to be adjusted.

[1] The mathematical method of the standard deviation originates from statistics For the individual results, it calls for a sufficient number of events with Gaussian distribution These circumstances are assumed as idealized here. The standard deviation is the square root of the sum of the squares.

Table 8: Uncertainties of Simulation

Description	Uncertainty
Irradiation	7.00%
Conversion to inclined plane	3.00%
Shading	1.00%
Soiling	2.00%
Temperature fluctuation	0.50%
Reflection	0.50%
Module low light performance	0.50%
Module quality performance	0.50%
Module mismatch losses	1.00%
Cable losses DC	0.30%
Cable losses AC	0 30%
DC/AC conversion	1.00%
Voltage transformation	0.50%
Self-consumption	0.50%
Plant Availability	1.00%
Total Standard Deviation of Uncertainty	***8.23%***

H.6. Risk Mitigation

All the risks on the energy output can be controlled, except for the meteorological uncertainties. We strongly recommend specifying contractually each qualitative relevant detail in the EPC and O&M contract. This includes the quality criteria, how they are to be measured for the single PV plants and the consequences if they are not met. This point is valid for the PV modules and inverters. To enforce the deliverables, a financial security should be in place for a minimum of two years, preferably five years.

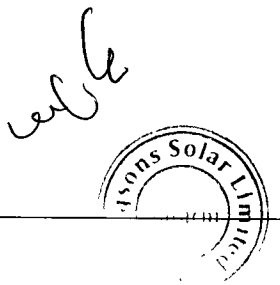
The meteorological uncertainties will also have to be considered in the financial model to analyze the impact on financial viability of the project. For the Project Siddiqsons Solar, this is the case under the provision that the annual Tariff determination is as per the upfront Tariff proposal.

I. Financial Analysis

The financial model provides a medium to translate technical aspects of the project into a financial investment case which helps facilitate the decision of execution of the project and initiate the financing negotiations. The financial model is built on the basis of project assumptions and its validity depends on how realistic these assumptions are.

These assumptions, the input parameters, are uncertain till the time of financial close or even until the end of lifetime as far as irradiation and plant performance is concerned. Hence the decision to build and finance the project has to be taken under some uncertainty.

The client has opted for upfront tariff for project size of 50 MW in the northern region as stated in NEPRA upfront tariff determination document with all the terms and conditions mentioned therein. Therefore a detailed financial model is not required.



J. Appendices

J.1. Appendix A

Main Results of PVSYST Simulation

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Grid-Connected System: Simulation parameters

Project :	**Grid-Connected Project at Chakwal**		
Geographical Site	**Chakwal**	Country	**Pakistan**
Situation	Latitude 33.2°N	Longitude	72.5°E
Time defined as	Legal Time: Time zone UT+5	Altitude	380 m
	Albedo: 0.20		
Meteo data:	**Chakwal**: Synthetic - Meteonorm file		

Simulation variant : **fixed28: P50; CdTe**

Simulation date 22/07/15 12h46

Simulation parameters

Collector Plane Orientation	Tilt	28°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Erbs, Meteonorm
Horizon	Free Horizon			
Near Shadings	According to strings		Electrical effect	50 %

PV Array Characteristics

PV module	CdTe Model	**FS-4112-2 Sept2014**		
	Manufacturer	First Solar		
Number of PV modules	In series	10 modules	In parallel	44444 strings
Total number of PV modules	Nb. modules	444440	Unit Nom. Power	112.5 Wp
Array global power	Nominal (STC)	**50000 kWp**	At operating cond.	45771 kWp (50°C)
Array operating characteristics (50°C)	U mpp	634 V	I mpp	72192 A
Total area	Module area	**319997 m²**	Cell area	300477 m²
Inverter	Model	**Sunny Central 500CP XT**		
	Manufacturer	SMA		
Characteristics	Operating Voltage	430-850 V	Unit Nom. Power	500 kWac
			Max. power (=>25°C)	550 kWac
Inverter pack	Nb. of inverters	90 units	Total Power	45000 kWac

PV Array loss factors

Array Soiling Losses			Loss Fraction	3.0 %
Thermal Loss factor	Uc (const)	30.7 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	0.14 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	1.0 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP

Incidence effect, user defined profile

0	30	50	60	70	75	80	85	90
1.00	0.99	0.97	0.95	0.90	0.86	0.75	0.48	0.00

System loss factors

AC loss, transfo to injection	Grid Voltage	20 kV		
	Wires: 3x1000.0 mm²	4355 m	Loss Fraction	1.0 % at STC
External transformer	Iron loss (Night disconnect)	48852 W	Loss Fraction	0.1 % at STC
	Resistive/Inductive losses	0.0 mOhm	Loss Fraction	1.0 % at STC
Unavailability of the system	3.6 days, 5 periods		Time fraction	1.0 %

User's needs :	Unlimited load (grid)			
Auxiliaries loss	Proportionnal to Power	7.0 W/kW	... from Power thresh.	0.0 kW

Siddiqsons Solar Limited Karachi

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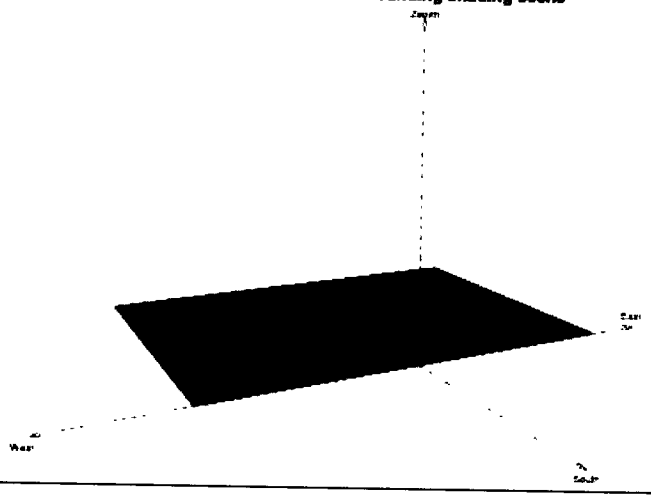
Grid-Connected System: Near shading definition

Project : **Grid-Connected Project at Chakwal**

Simulation variant : **fixed28: P50; CdTe**

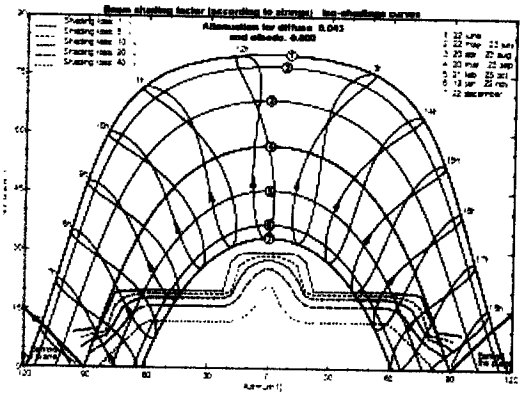
Main system parameters	System type	**Grid-Connected**		
Near Shadings	According to strings		Electrical effect	50 %
PV Field Orientation	tilt	28°	azimuth	0°
PV modules	Model	FS-4112-2 Sept2014	Pnom	113 Wp
PV Array	Nb. of modules	444440	Pnom total	**50000 kWp**
Inverter	Model	Sunny Central 500CP XT	Pnom	500 kW ac
Inverter pack	Nb. of units	90.0	Pnom total	**45000 kW ac**
User's needs	Unlimited load (grid)			

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Grid-Connected Project at Chakwal



PVsyst Licensed to [illegible]

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Grid-Connected System: Main results

Project : **Grid-Connected Project at Chakwal**

Simulation variant : **fixed28: P50; CdTe**

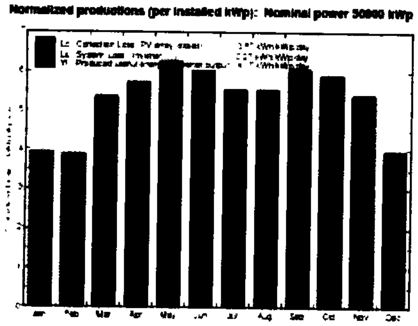
Main system parameters	System type	**Grid-Connected**		
Near Shadings	According to strings		Electrical effect	50 %
PV Field Orientation	tilt	28°	azimuth	0°
PV modules	Model	FS-4112-2 Sept2014	Pnom	113 Wp
PV Array	Nb. of modules	444440	Pnom total	**50000 kWp**
Inverter	Model	Sunny Central 500CP XT	Pnom	500 kW ac
Inverter pack	Nb. of units	90.0	Pnom total	**45000 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results

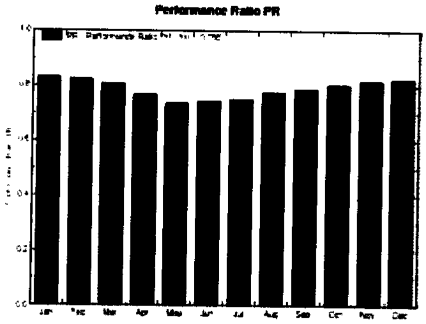
System Production — **Produced Energy** **76189 MWh/year** Specific prod 1524 kWh/kWp/year

Performance Ratio PR 78.5 %

Normalized productions (per installed kWp): Nominal power 50000 kWp



Performance Ratio PR



fixed28: P50; CdTe

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	84.8	10.38	122.3	112.4	5347	5083	13.66	12.98
February	88.1	13.52	109.1	99.8	4736	4494	13.50	12.87
March	142.7	19.13	168.3	153.0	7070	6726	13.28	12.64
April	185.3	24.12	172.3	157.4	7159	6821	12.98	12.01
May	201.3	29.81	184.7	178.0	7884	7164	12.65	11.50
June	193.4	30.99	180.9	164.8	7318	6718	12.64	11.60
July	182.0	30.30	172.1	156.2	6987	6447	12.09	11.71
August	170.5	29.08	171.9	156.7	7030	6661	12.78	12.14
September	162.1	26.84	182.4	167.6	7546	7179	12.93	12.30
October	141.0	22.84	183.7	170.5	7749	7380	13.18	12.55
November	108.3	15.96	162.4	150.1	6962	6632	13.40	12.78
December	82.2	11.82	122.9	112.8	5333	5064	13.50	12.88
Year	1722.4	22.09	1941.1	1779.5	81123	76189	13.06	12.27

Legends:
- GlobHor — Horizontal global irradiation
- T Amb — Ambient Temperature
- GlobInc — Global incident in coll. plane
- GlobEff — Effective Global, corr. for IAM and shadings
- EArray — Effective energy at the output of the array
- E_Grid — Energy injected into grid
- EffArrR — Effic. Eout array / rough area
- EffSysR — Effic. Eout system / rough area

Report No. PPI-152.1-Draft/15

INTERCONNECTION STUDY

For

45.59 MW Solar Power Project by Siddiq Sons Solar Pvt. Ltd near Ahmadal, District Attock, Punjab

Final Report
(August 2015)

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Siddiq Sons Solar Limited Karachi

Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client Siddiq Sons Solar Pvt. Ltd has been validated.
- The month of June 2016 have been selected to carry out the study as it will help determine the maximum impact of the project after the expected COD.
- The IESCO system data as available with PPI for other studies have been used.
- The nearest substations for the interconnection of Siddiq Sons Solar PP in IESCO are Ahmadal and Pindigheb 132 kV substations. The most feasible scheme of interconnection to evacuate maximum AC power of 45.59 MW is of Siddiq Sons Solar Power Plant is to loop in-out the Ahmadal to Pindigheb 132 kV circuit at Siddiq Sons Solar PP. The looping distance will be 9.2 km and the conductor used would be Lynx.
- Detailed load flow studies have been carried out for the peak load conditions of June 2016 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 45.59 MW of the plant under normal and contingency conditions. It is clear from the steady state analysis that Siddiq Sons Solar Plant helps to improve the voltage profile in the area.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Siddiq Sons Solar Power Plant at 132 kV, and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Siddiq Sons Solar Power Plant.

  The maximum short circuit level of 132 kV bus bar of Siddiq Sons Solar Power Plant 132 kV is 4.16 kA and 2.49 kA for 3-phase and 1-phase faults respectively for June 2016. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

- ❖ The dynamic stability analysis of proposed scheme of interconnection has been carried out for June 2016. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Siddiq Sons solar power plant substation followed by the final trip of 132 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 132 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Siddiq Sons 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- ❖ The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Siddiq Sons Solar Limited Karachi

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7.2.4 Fault at Pindigheb 132 kV (Far-End Fault)

7.4 Conclusion of Dynamic Stability Analysis

8. Conclusions

Appendices

Appendix –A: Maps & Sketches for Chapter 4

Appendix –B: Plotted Results of Load Flow for Chapter 5

Appendix –C: Results of Short Circuit Calculations for Chapter 6

Appendix –D: Plotted Results of Stability Analysis for Chapter 7

1. Introduction

1.1 Background

Siddiq Sons Solar (Private) Limited is setting up a 45.59 MW solar power plant near Ahmadal, District Attock, Punjab. The site of the proposed project is located in the concession area of Islamabad Electric Power Company Limited (IESCO). The peak AC net output planned to be generated from the project is about 45.59 MW. The electricity generated from this project will be supplied locally to the Ahmadal, Pindigheb Grid Stations and to the IESCO network through the 132 kV grid located in the vicinity of this project.

1.2 Objectives

The overall objective of the Study is to develop an interconnection scheme between Siddiq Sons Solar Power Project and IESCO network, for stable and reliable evacuation of 45.59 MW of electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives are:

1. To develop a scheme of interconnections at 132 kV for which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
3. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 132 kV and that voltage levels are within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at the Siddiq Sons Solar Power Plant.
4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping after 3-phase faults on the system.

1.3 Planning Criteria

The planning criteria as per Grid Code required to be fulfilled by the proposed interconnection is as follows:

Steady State:

Voltage	± 5 %, Normal Operating Condition
	± 10%, Contingency Conditions
Frequency	50 Hz, Continuous, ± 1% variation steady state
	49.2 - 50.5 Hz, Short Time
Power Factor	0.95 Lagging; 0.95 Leading (for conventional synchronous generators but would not be applicable to solar PP)

Dynamic/Transient:

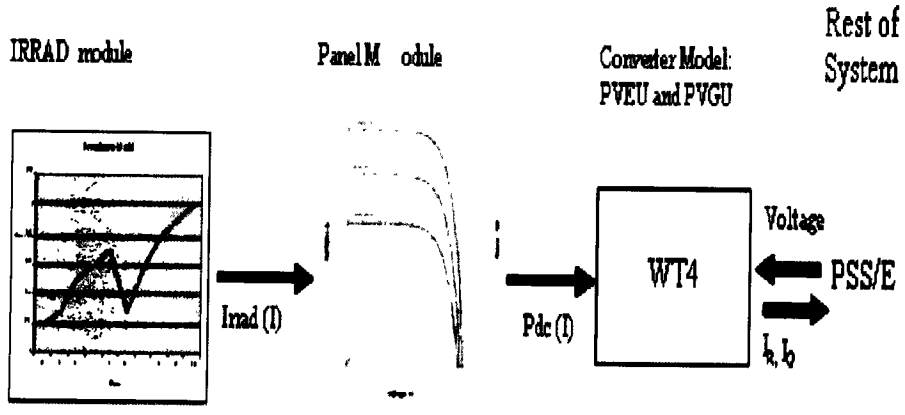
- The system should revert back to normal condition after the transients have died down without losing synchronism with good damping. For 11 kV the total maximum fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 180 ms (9 cycles).
- For the systems of 132 kV and above the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).
- For the systems of 132 kV and above, in case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles).

2. Assumptions of Data

The detailed electrical parameters would be designed at the EPC stage. However for the purposes of this study, following assumptions have been made:

2.1 Solar Power Plant data

The Solar Power plant has been modeled according to the following block diagram



The way this works is that the irradiance profile from the sun is used as an input to the panel module which then calculates the DC power at that value of the irradiance. This value is then input to the electrical model of the solar power plant (inverter module) which then goes on to calculate the AC power supplied by the solar power plant.

Due to the presence of the inverter module, from the point of view of the network, the solar power plant is considered a voltage source convertor.

Dynamic Data:

Converter time constant for IQcmd seconds = 0.02 s

Converter time constant for IQcmd seconds = 0.02 s

Voltage sensor for LVACR time constants = 0.02 s

Voltage sensor time constant = 1.1 s

2.2 Network data

The 132 kV networks available for interconnection to Siddiq Sons Solar Power Plant are as shown in Sketches 1 and 2 in Appendix-A.

The PEPCO/IESCO system data of National Grid have been assumed in the study as already available to PPI.

3. Study Approach and Methodology

3.1 Understanding of the Problem

The 45.59 MW Solar Power Plant by Siddiq Sons Solar (Pvt.) Limited is going to be a Photovoltaic (PV) based solar project embedded in the 132 kV network of Siddiq Sons. It would run almost all the months of the year though with some variation in its output due to variation in the intensity of light during winter and rainy season.

The existing nearest grid stations available for interconnection are Ahmadal 132 kV and Pindigheb 132 kV Substation. The addition of this source of power generation embedded in local distribution network of this area shall provide relief to the generating substations feeding the local network. The 132 kV network surrounding Siddiq Sons has significant load demand, therefore most of the power from the Siddiq Sons Solar Power Plant will be utilized locally in meeting this load demand.
The adequacy of IESCO network of 132 kV in and around the proposed site of Siddiq Sons Solar Plant has been analysed in this study for absorbing and transmitting this power, fulfilling the reliability criteria.

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for June 2016 considering maximum AC out of 45.59 MW for the solar plant by Siddiq Sons Solar (Pvt.) Limited, comprising all 500 kV, 220 kV and 132 kV system and envisaging the load forecast, the generation additions and transmission expansions for that year particularly in IESCO.
- The month of June 2016 have been selected to carry out the study as it will allow the maximum impact of the project to be judged after the expected COD.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, has been developed.
- Performed technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme has been subjected to standard analysis like load flow and short circuit, transient stability study and

power quality analysis to check the strength of the plant and the proposed interconnection scheme under disturbed conditions.

- Determine the appropriate equipment for the proposed technically feasible scheme.
- Recommend the technically most feasible scheme of interconnection.

4. Development of Scheme of Interconnection

4.1 The Existing Network

The nearest existing IESCO interconnection facilities at the time of commissioning of Siddiq Sons Solar Power Project would be as follows:

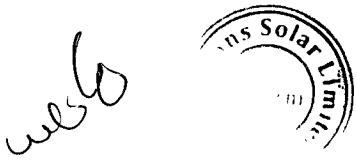
- Ahmadal 132 kV Substation
- Pindigheb 132 kV Substation

The existing 132 kV network available around these 132 kV grid station is shown in Sketch-1 in Appendix-A.

Given the physical proximity of Siddiq Sons Solar PP to Ahmadal and Pindigheb 132 kV gridstations and the fact that the other facilities are at a considerable distance from the plant, the most feasible interconnection of the Siddiq Sons Solar Power Plant will be with these two 132 kV substation.

4.2 The Scheme of Interconnection of Solar Power Plant

Keeping in view the above mentioned 132 kV network available in the vicinity of the site of the Siddiq Sons Solar Power Plant, the interconnection scheme has been developed as shown in Sketch-2 in Appendix A by looping in-out the Ahmadal to Pindigheb 132 kV circuit at Siddiq Sons Solar PP. The looping distance will be 9.2 km and the conductor used would be Lynx.



5. Detailed Load Flow Studies

5.1 Load Flow without Siddiq Sons Solar Power Plant, June 2016

A base case has been developed for the peak load case of June 2016, using the network data of Siddiq Sons Solar-PP and IESCO network.

The results of load flow for this case are shown in Exhibit 0.0 of Appendix-B. The system plotted in this Exhibit shows 132 kV network around Siddiq Sons Solar PP and its surrounding substations.

The load flow results show that the power flows on all circuits are within their specified normal current carrying rating. Under voltages at Fatehjang, Ahmadal, Pindigheb and Talagang can be observed but this is an inherent problem of the IESCO network.

For N-1 contingency conditions we have performed the following cases

Exhibit-0.1	Ahmadal to P.Gheb 132kV Single Circuit Out
Exhibit-0.2	P.Gheb to Talagang 132kV Single Circuit Out
Exhibit-0.3	Chakwal to Talagang 132kV Single Circuit Out
Exhibit-0.4	Chakri to Chakwal 132kV Single Circuit Out
Exhibit-0.5	Rawat-2 to Chakwal 132kV Single Circuit Out
Exhibit-0.6	Rawat-2 to Adyala 132kV Single Circuit Out

The power flows on all circuits remain within their ratings. Thus we find that there are no capacity constraints in terms of the MW or MVAR flows in the 132 kV network available in the vicinity of Siddiq Sons Solar Power Plant for its connectivity under normal and contingency conditions prior to its connection.

Some under voltages can be observed during Chakwal to Talagang 132 kV circuit outage. This is an inherent problem in the IESCO network.

5.2 Load Flow with Siddiq Sons Solar Power Plant, June 2016

The scheme of interconnection modeled in the load flow for Siddiq Sons Solar Power Plant is by looping in-out the Ahmadal to Pindigheb 132 kV circuit at Siddiq Sons Solar PP. The looping distance will be 9.2 km and the conductor used would be Lynx.

The results of load flow with Siddiq Sons Solar Power Plant interconnected as per the proposed scheme are shown in Exhibit 1.0 in Appendix-B. The power flows on the circuits are well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of ± 5 % off the nominal.

It can be seen that the introduction of Siddiq Sons Solar PP helps in improving the voltage profile in this area, eliminating the under voltages that were observed when the plant was not connected.

We find no capacity constraints on 132 kV circuits under normal conditions i.e. without any outages of circuits.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – B as follows;

Exhibit-1.1	Siddiq Sons to Ahmadal 132kV Single Circuit Out
Exhibit-1.2	Siddiq Sons to P.Gheb 132kV Single Circuit Out
Exhibit-1.3	P.Gheb to Talagang 132kV Single Circuit Out
Exhibit-1.4	Chakwal to Talagang 132kV Single Circuit Out
Exhibit-1.5	Chakri to Chakwal 132kV Single Circuit Out
Exhibit-1.6	Rawat-2 to Chakwal 132kV Single Circuit Out
Exhibit-1.7	Rawat-2 to Adyala 132kV Single Circuit Out

5.4 Conclusion of Load Flow Analysis

From the analysis carried out above, we conclude that the proposed interconnection scheme of looping in-out the Ahmadal to Pindigheb 132 kV circuit at Siddiq Sons Solar PP ensures its reliability and availability under all events of contingencies i.e. planned or forced outages. It also helps to improve the voltage profile in the area.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been adopted in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies. The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

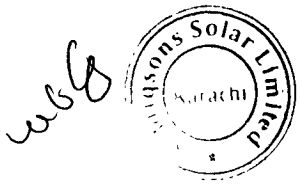
For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2016 i.e. all the generating units have been assumed on-bar in fault calculation simulations.

6.2 Fault Current Calculations without Siddiq Sons Solar Power Plant, June 2016

In order to assess the short circuit strength of the network of 132 kV without the Solar Power Plant for the grid of IESCO in the vicinity of the site of the Plant, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions. These levels will not only give us an idea of the fault levels without Siddiq Sons Solar Power Plant and later on how much the contribution of fault current from the Solar Power Plant may add to the existing levels, but we are also able to assess the strength of the proposed node to connect this Power Plant depending on its relative short circuit strength.

The results are attached in Appendix – C.

The short circuit levels have been represented graphically on the bus bars of 132 kV along with fault current contributions from the incoming circuits, which are shown in the Exhibit 3.0 attached in Appendix-C.



Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-C for the 132 kV bus bars of our interest i.e. 132 kV circuits lying close to Siddiq Sons Solar PP. The tabular output is the detailed output showing the contribution to the fault current from the adjoining sources i.e. the lines and transformers connected to that bus. The phase currents, the sequence currents and the sequence impedances are shown in detail for each faulted bus bar.

The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 132 kV substations which are normally 31.5 kA, 40 kA.

Table - 6.1
Maximum Short Circuit Levels without Siddiq Sons Solar PP, June 2016

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Ahmadal 132kV	4.42	2.61
Pindi Gheb 132kV	3.36	2.08
Talagang 132kV	4.08	2.61
Chakwal 132kV	8.09	5.56
Chakri 132kV	5.44	3.51
Adyala 132kV	6.11	4.01
Rewat-2 132kV	14.58	11.92

6.3 Fault Current Calculations with Siddiq Sons Solar Power Plant, June 2016

Fault currents have been calculated for the electrical interconnection of the proposed scheme. Fault types applied are three phase and single-phase at 132 kV bus bars of Siddiq Sons Solar Power Plant itself and other bus bars of the 132 kV substations in

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the electrical vicinity of Siddiq Sons. The graphic results are shown in Exhibit 3.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV bus bars of the network in the electrical vicinity of Siddiq Sons Solar Power Plant are placed in Appendix-C. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2.

Comparison of Tables 6.1 and 6.2 shows an increase in short circuit levels for three-phase and single-phase faults. This increase is limited considering the fact that the Solar Power Plant is a voltage source convertor. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed on these substations. The maximum short circuit level of 132 kV bus bar of Siddiq Sons Solar Power Plant is 4.16 kA and 2.49 kA for 3-phase and 1-phase faults respectively. Therefore an industry standard switchgear of the short circuit rating of 40 kA should be installed at 132 kV switchyard of the Solar Power Plant leaving enough margin to accommodate fault current contributions from any future reinforcements taking place in that area.

Table-6.2
Maximum Short Circuit Levels with Siddiq Sons Solar PP, June 2016

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Siddiq Sons 132 kV	4.16	2.49
Ahmadal 132 kV	4.56	2.70
Pindi Gheb 132 kV	3.45	2.14
Talagang 132 kV	4.14	2.65
Chakwal 132 kV	8.14	5.60
Chakri 132 kV	5.46	3.53
Adyala 132 kV	6.13	4.03
Rewat-2 132 kV	14.62	11.95

6.5 Conclusion of Short Circuit Analysis

The short circuit analyses results show that for the proposed scheme of interconnection of Siddiq Sons Solar Power Plant, we don't see any violations of short circuit ratings of the already installed equipment on the 132 kV equipment of substations in the vicinity of the Solar Power Plant due to fault current contributions from this plant due to three-phase faults or single phase faults.

The maximum short circuit level of 132 kV bus bar of Siddiq Sons Solar Power Plant is 4.16 kA and 2.49 kA for 3-phase and 1-phase faults respectively for June 2016. Therefore an industry standard switchgear of the short circuit rating of 40 kA should be installed at 132 kV switchyard of Siddiq Sons Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements taking place in that area.

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7. Transient Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Stability Models

The assumptions about the generator and its parameters are the same as mentioned in Ch.2 of this report.

We have employed the generic stability models available in the PSS/E model library for dynamic modelling of the PV-Solar power generator, its electrical model and the panel as follows;

Generator	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1

We have done studies with the inverter which has reactive support capability of ± 0.95 PF.

7.1.2 System Conditions

We have used the system conditions of June 2016 because in this season the irradiance from the sun is at its peak and hence the maximum impact of the Solar Power Plant can be evaluated.

The proposed scheme is of looping in-out the Ahmadal to Pindigheb 132 kV circuit at Siddiq Sons Solar PP. The looping distance will be 9.2 km and the conductor used would be Lynx.

All the power plants of WAPDA /NTDC from Tarbela to HUBCO have been dynamically represented in the simulation model.

7.1.3 Presentation of Results

The plotted results of the simulations are placed in Appendix - D. Each simulation has been run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish that the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for ten seconds. Usually all the transients due to non-linearity die down within 2-3 seconds after disturbance is cleared in the system.

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7.1.4 Worst Fault Cases

Three phase faults are considered to be the worst disturbance in the system. We have considered 3-phase fault in the immediate vicinity of the Solar Power Plant i.e. right at the 132 kV bus bar of the solar power plant substation, cleared in 9 cycles, as maximum clearing time for 132 kV i.e. 180 ms, followed by permanent trip of 132 kV single circuit connected to this substation.

7.2 Transient Stability Simulation Results, June 2016

7.2.1 Fault at 132 kV Siddiq Sons

We applied three-phase fault on far-end 132 kV bus bar of Siddiq Sons to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 132 kV systems, followed by a trip of the 132 kV circuit between the Siddiq Sons Solar Power Plant and Pindi gheb. We monitored different variables for one second pre-fault and ten seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 132 kV bus bars of Siddiq Sons-PP, Ahmadal, Pindigheb, Talagang, Chakwal and Rewat have been plotted. The results show quick recovery of the voltages after clearing of the fault.

Fig. 1.2 Frequency

We see the system frequency recovers normalcy quickly after clearance of the fault.

Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 45.59 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Voltage Sensor for LVACR

The value for LVACR reverts to its pre-fault value after the fault clears.

Fig. 1.5 MW /MVAR Flow on Siddiq Sons to Ahmadal 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Siddiq Sons to Pindigheb circuit caused the entire output of Siddiq Sons to flow through the intact 132 kV circuit between Siddiq Sons and Ahmadal. We plotted the flows of MW and

MVAR on this intact circuit and see that the power flows on this circuit attain steady state with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generator of Mangla 132 kV have been plotted relative to machines at Mangla 220 kV. The results show that the rotor angles get back to their normal state after the first swing and damp down quickly. The system is stable and strong enough to dampen the post fault oscillations.

7.2.2 Fault at 132 kV Siddiq Sons (Stuck Breaker Case)

We applied three-phase fault on far-end 132 kV bus bar of Siddiq Sons to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 9 cycles (180 ms) as standard clearing time for 132 kV systems, followed by a trip of the 132 kV circuit between the Siddiq Sons Solar Power Plant and Pindi gheb. We monitored different variables for one second pre-fault and ten seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 132 kV bus bars of Siddiq Sons-PP, Ahmadal, Pindigheb, Talagang, Chakwal and Rewat have been plotted. The results show quick recovery of the voltages after clearing of the fault.

Fig. 2.2 Frequency

We see the system frequency recovers normalcy quickly after clearance of the fault.

Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 45.59 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Voltage Sensor for LVACR

The value for LVACR reverts to its pre-fault value after the fault clears.

Fig. 2.5 MW /MVAR Flow on Siddiq Sons to Ahmadal 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Siddiq Sons to Pindigheb circuit caused the entire output of Siddiq Sons to flow through the intact 132 kV circuit between Siddiq Sons and Ahmadal. We plotted the flows of MW and

MVAR on this intact circuit and see that the power flows on this circuit attain steady state with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generator of Mangla 132 kV have been plotted relative to machines at Mangla 220 kV. The results show that the rotor angles get back to their normal state after the first swing and damp down quickly. The system is stable and strong enough to dampen the post fault oscillations.

7.2.3 Fault at Ahmadal 132 kV (Far End Fault)

We applied three-phase fault on far-end 132 kV bus bar of Ahmadal to study the impact of a disturbance in the far- end grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 132 kV systems, followed by a trip of the 132 kV circuit between the Siddiq Sons Solar Power Plant and Ahmadal. We monitored different variables for one second pre-fault and ten seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 132 kV bus bars of Siddiq Sons-PP, Ahmadal, Pindigheb, Talagang, Chakwal and Rewat have been plotted. The results show quick recovery of the voltages after clearing of the fault.

Fig. 3.2 Frequency

We see the system frequency recovers normalcy quickly after clearance of the fault.

Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 45.59 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Voltage Sensor for LVACR

The value for LVACR reverts to its pre-fault value after the fault clears.

Fig. 3.5 MW /MVAR Flow on Ahmadal to Fatehjang 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Siddiq Sons to Ahmadal circuit caused the load at Ahmadal to be fed through the Fatehjang to Ahmadal 132 kV single circuit. We plotted the flows of MW and MVAR on this

intact circuit and see that the power flows on this circuit attain steady state with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generator of Mangla 132 kV have been plotted relative to machines at Mangla 220 kV. The results show that the rotor angles get back to their normal state after the first swing and damp down quickly. The system is stable and strong enough to dampen the post fault oscillations.

7.2.4 Fault at Pindigheb 132 kV (Far End Fault)

We applied three-phase fault on far-end 132 kV bus bar of Pindigheb to study the impact of a disturbance in the far- end grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 132 kV systems, followed by a trip of the 132 kV circuit between the Siddiq Sons Solar Power Plant and Pindigheb. We monitored different variables for one second pre-fault and ten seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

Fig. 4.1 Bus Voltages

The bus voltages of 132 kV bus bars of Siddiq Sons-PP, Ahmadal, Pindigheb, Talagang, Chakwal and Rewat have been plotted. The results show quick recovery of the voltages after clearing of the fault.

Fig. 4.2 Frequency

We see the system frequency recovers normalcy quickly after clearance of the fault.

Fig. 4.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Solar Power Plant was 45.59 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 4.4 Voltage Sensor for LVACR

The value for LVACR reverts to its pre-fault value after the fault clears.

Fig. 4.5 MW /MVAR Flow on Pindigheb to Talagang 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Siddiq Sons to Pindigheb circuit caused the load at Pindigheb to be fed through the Pindigheb to Talagang 132 kV single circuit. We plotted the flows of MW and MVAR on this

intact circuit and see that the power flows on this circuit attain steady state with power swings damping down fast.

Fig. 4.6 Rotor Angles

The rotor angles of the generator of Mangla 132 kV have been plotted relative to machines at Mangla 220 kV. The results show that the rotor angles get back to their normal state after the first swing and damp down quickly. The system is stable and strong enough to dampen the post fault oscillations.

7.4 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed scheme for the severest possible faults of 132 kV systems near and far away from the Solar Power Plant of Siddiq Sons. Therefore there are no issues of dynamic stability for interconnection of this Solar Power Plant; it fulfils all the criteria of transient stability. The reactive support from the inverter also helps the system stability.

8. Conclusions

- The study objective, approach and methodology have been described and the plant's data received from the client Siddiq Sons Solar Pvt. Ltd has been validated.
- The month of June 2016 have been selected to carry out the study as it will help determine the maximum impact of the project after the expected COD.
- The IESCO system data as available with PPI for other studies have been used.
- The nearest substations for the interconnection of Siddiq Sons Solar PP in IESCO are Ahmadal and Pindigheb 132 kV substations. The most feasible scheme of interconnection to evacuate maximum AC power of 45.59 MW is of Siddiq Sons Solar Power Plant is to loop in-out the Ahmadal to Pindigheb 132 kV circuit at Siddiq Sons Solar PP. The looping distance will be 9.2 km and the conductor used would be Lynx.
- Detailed load flow studies have been carried out for the peak load conditions of June 2016 for the proposed scheme under normal and N-1 contingency conditions to meet the reliability criteria.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 45.59 MW of the plant under normal and contingency conditions. It is clear from the steady state analysis that Siddiq Sons Solar Plant helps to improve the voltage profile in the area.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Siddiq Sons Solar Power Plant at 132 kV, and the substations of 132 kV in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from the Siddiq Sons Solar Power Plant.

  The maximum short circuit level of 132 kV bus bar of Siddiq Sons Solar Power Plant 132 kV is 4.16 kA and 2.49 kA for 3-phase and 1-phase faults respectively for June 2016. Therefore industry standard switchgear of the short circuit rating of 40 kA is considered adequate with enough margins for future increase in fault levels due to future reinforcements in this area.

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- The dynamic stability analysis of proposed scheme of interconnection has been carried out for June 2016. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Siddiq Sons solar power plant substation followed by the final trip of 132 kV circuit connected to this substation has been performed for fault clearing of 9 cycles (180 ms) as understood to be the maximum fault clearing time of 132 kV protection system. The system is found to retain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Siddiq Sons 132 kV bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

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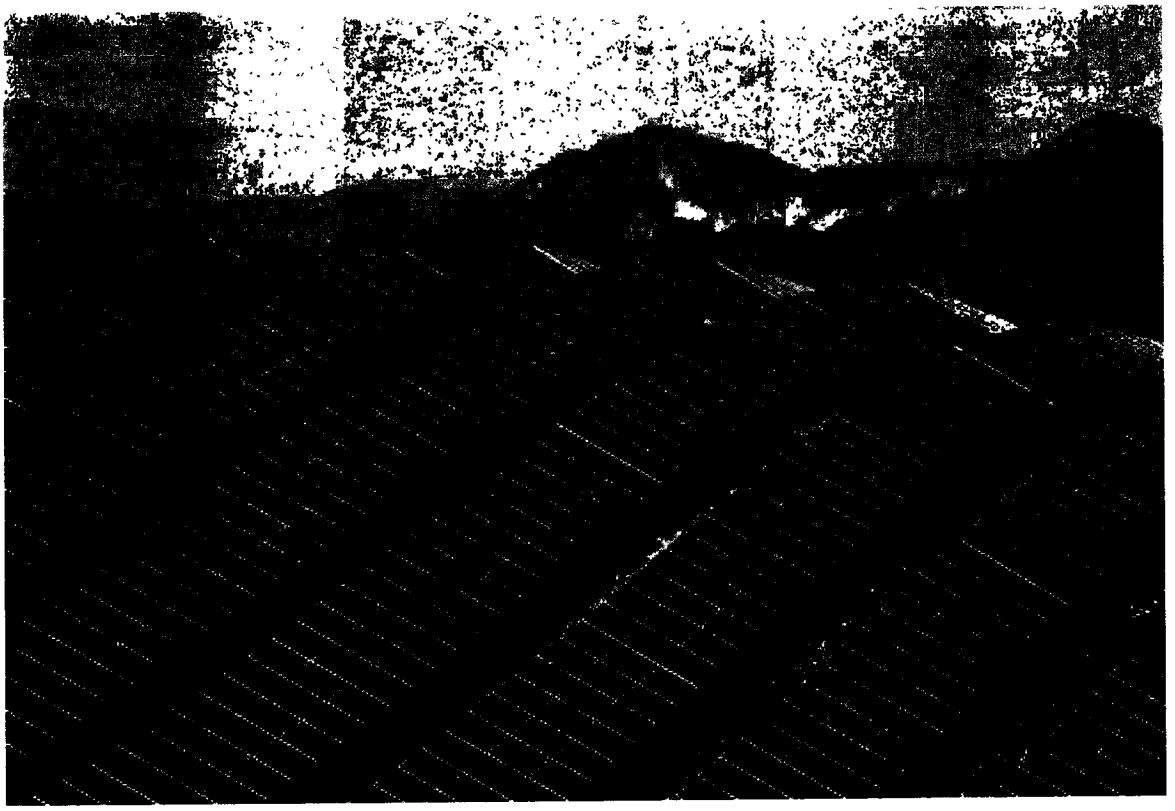

INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT

July 2015

ECSP

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INTIAL ENVIRONMENTAL EXAMINATION

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List of Abbreviations

CDM	Clean Development Mechanism
CSP	Concentrating Solar Plants
CNG	Compressed Natural Gas
CAA	Clean Air Act
DC	Direct Current
DEO	Divisional Executive Officer
EIA	Environmental Impact Assessment
EA	Environment Assessment
ECSP	Engineering Consultancy Services Punjab
EPA	Environment Protection Agency
EPD	Environmental Protection Department
EMC	Environment Management Committee
EMP	Environment Management Plan
EMMP	Environmental Management and Monitoring Plan
EMF	Electromagnetic Field
EMS	Environmental Management Standards
GEL	Global Environmental Lab
GHG	Green House Gas
GoP	Government of Punjab
IEE	Initial Environment Examination
IPPs	Independent Power Producers
LAA	Land Acquisition Act
LAC	Land Acquisition Collector
M & E	Monitoring ad Evaluation
MW	Mega Watt
MWp	Mega Watt Peak
NOC	No Objection Certificate
NEQS	National Environmental Quality Standards
NAAQS	National Ambient Air Quality Standards
NGO	Non-Governmental Organization
PC	Public Consultation
PEPA	Pakistan Environmental Protection Act Pakistan
PEPC	Pakistan Environmental Protection Council
PPDB	Punjab Power Development Board
PV	Photovoltaic
PPEs	Personal Protective Environment
REC	Renewable Energy Corporations
ROW	Right of Way
RNR	Renewable Natural Resources
RCC	Reinforced Cement Concrete Rental Power stations
SSL	Siddiqsons Solar Limited
SWMP	Site Waste Management Plan
UNFCCC	United Nations Framework Convention on Climate
TOR	Terms of Reference
VO	Veterinary Officer

EXECUTIVE SUMMARY

Name of the Project:	**Consulting Services for 50 MW Solar Power (PV) Plant at Chakwal, Pakistan**
Proponent:	**Siddiqsons Solar Limited (SSL)**
Consultants:	**Engineering Consultancy Services, Punjab (Pvt.) Limited (ECSP)**

1. INTRODUCTION

Pakistan has been experiencing an acute shortage of energy right across all sectors in particular, industry and domestic users. Due to this crisis the economy of Pakistan is declining day by day. The current resources of energy production are oil and fossil fuel and hydro which are expensive and less eco-friendly. In this regard Siddiqsons Solar Limited (SSL) has taken initiative to install the Solar Power (PV) Plant of 50MWp capacity at Chakwal, almost 37km away from Chakri Interchange.

According to the ADB guidelines, this Project falls under category C, which shows that it has very minor adverse impacts which can easily be mitigated. The objective of this study is to identify the adverse impacts earned due to the construction of proposed project and devise mitigation measures.

In essence to its commitment to environment sustainability, Siddiqsons Solar Limited (SSL) is also going green with alternative solar renewable energy. It is developing a 50 MWp Solar Power (PV) Plant in Chakwal district. The project is being developed on a fast track basis and is expected to be commissioned in 2016.

Engineering Consultancy Services Punjab (Pvt.) Limited (ECSP) has been engaged to carry out the Initial Environmental Examination (IEE) process as a part of above mentioned services to fulfill the environmental regulatory requirements.

The further legislation and the laws/policy are also triggering due to this project viz on environment include National Environment Policy (2005), Pakistan Labor Policy (2010), Punjab Environmental Protection Act (1997), Environmental Quality

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Standards (NEQS), Cutting of Trees (Prohibition) Act (1975), Punjab Wildlife (Protection, Preservation, Conservation and Management) Act (1974), etc.

After the ratification of 18th amendment, Environment Protection Agency (EPA, 1997) has been given the powers to issue NOC to carry out various Projects/ construction activities. The IEE report has been prepared with due concern of all legal requirements.

3. APPROACH AND METHODOLOGY

The approach and methodology which is applied for the implementation of the impact assessment study is stated as below:

- Conclusion of reconnaissance survey
- Preparation of Environmental checklist and questionnaire survey in order to conduct the detailed field study and for collection of social baseline information of the environment's Project area.
- Collection of secondary information from various sources and its review
- Steps for CDM Process Cycle and its types
- Detailed discussions with the local and community representatives and identifying of key issues
- Regulatory review was undertaken to understand the applicable, local and national legislation and regulatory frameworks.
- Field surveys and compilation of data
- Collection of Laboratory Samples and analysis of environmental parameters.
- Impact assessment, mitigation and rectification measures
- Preparation of Environment Management and Monitoring Plan
- Conduction of reconnaissance survey

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4. PROJECT DESCRIPTION

Following are the key feature of the Project:

SiddiqSons Solar Limited (SSL) 50 MWp Solar PV Plant Chakwal, Punjab Pakistan	
Parameter	**Features**
Location	Chakwal
Country	Pakistan
Angle and Height of Panels	Angle 45^0, 3 ft.
Project Capacity	50 MWp
Category	C
Status	Under Construction (Feasibility Stage)
Overall terrestrial site for project area	380 acres
Type of Technology	Photovoltaic (PV)
Project Commission Date	Around 10 months
Operator (s)	Siddiqsons Solar Limited (SSL)
Owner (s)	Siddiqsons Solar Limited (SSL)
Adjacent TL interconnection	13 Km from the Grid

5. SOCIO-ENVIRONMENTAL BASELINE CONDITIONS

The main project area consists of 380 acres and located in the Chakwal District. The closest location is Chakri which is approximately 37 kilometers away from the main Project Site. The main Project area is under Barani and has moderate climatic conditions with practically no population. Geographically project area is placed in the Potohar plateau and the physical features of Chakri are typical of the region. The general terrain is mountainous and rocky, covered with below man heighted bushes, interspaced with flat lying plains.

The soil of the area is fertile, consist of Granular loam and silt loam with pH range 7-9 and that's why the project area is enriched with Flora and Fauna. The information on air quality, water quality and noise level was collected through EPA approved laboratory. According to the lab analysis the air and surface water is largely clean. According to results of the approved lab the area falls under silence zone because of no population. No threatened and endangered species were present in the main project area. As Project area comprises favorable climatic conditions but mountainous and rocky area, there is no permanent settlement present in the area.

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6. ENVIRONMENTAL IMPACTS AND MITIGATION STRATEGIES

This IEE identified the all possible impacts and propose control measures. Implementation of this Solar Power Plant Project will have some useful impacts to the environment. It will be an environmental friendly project because:

- It is reliable energy source as compared to other conventional sources and is a long term solution to overcome the power shortage in the country about 20 to 25 year.
- It will not add any further air pollution as well as no greenhouse gases emission with respect to other fossil fuel based energy sources.
- Adverse impacts will be observed during construction and operational phases which are supposedly mitigated easily.
- Deforestation can be a severe adverse impact onto the Project as well as the wildlife.
- During Project installation, local population will not be affected significantly due to noisy environment.
- Discarded solid material during various operational and construction phase will be dumped at safe place far from the project area.

Some other adverse impacts in the form of light pollution and possibility of electric shock may be observed during Project construction.

7. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)

An environmental management and monitoring plan provides a detailed mechanism to address the potential environmental impacts of the Project during its construction and operational phases, to enhance project benefits, protect environment and to introduce health and safety standards of good practice to be adopted for proposed Project. The EMMP provides the organization structure for the environmental and social management system during the project, operation and consultation and defines the roles and responsibilities of various players. The EMMP includes a mitigation plan, a monitoring plan, tree plantation plan, solid waste management plan and training needs, in the context of the environmental and social management of the project. The proponent will ensure the proper implementation of mitigation measures for the concerned operation and maintenance phase through adequate monitoring.

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8. STAKEHOLDER CONSULTATION

Stakeholder consultations were carried out as part of the IEE study. The main objectives of the consultations were to:

- Disclose information about the proposed project, as well as, to apprise the stakeholders about the proposed Project activities;
- Obtain their views, concerns and recommendations; and
- Address/incorporate them in the Project design thus enhancing the environmental and social performance of the Project.

The consultations identified some potential environmental and social impacts and perceptions of the affected communities. The public consultation was conducted from during July, 2015. The community generally supports the 50 MWp Solar (PV) Power Plant Project. The local poor people predominantly requested for unskilled and semi-skilled jobs on priority basis with the contractors during implementation of the Project. No land acquisition and resettlement is involved for this project because no permanent or legal inhabitants are living in project area. On the basis of the consultations so far, it appears that the Project will have no insurmountable environmental and social impacts.

9. CONCLUSIONS AND RECOMMENDATIONS

This is a renewable energy Project which uses solar energy for power generation thus it is a cleaner and environment friendly project as compared to fossil fuel based energy Projects. This Project also falls under the category of Clean Development Mechanism.

There are certain recommendations to cater for the aforesaid issues and mitigate the adverse impacts of the proposed Project which are negligible. It is recommended that the proponent should obtain an environmental approval (No Objection Certificate) from the Punjab-EPA before proceeding further into the construction activities as per regulatory requirements.

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The Group believes in innovation and catering to unique market segments in Pakistan. After being the pioneers of denim manufacturing and tinplate in Pakistan, Siddiqsons Solar Limited (SSL) is diversifying into the power business using untapped fuels in Pakistan, including coal and solar renewable energy.

Siddiqsons Solar Limited (SSL) is in the development phase of 50 MWp Solar Power (PV) Plant. Siddiqsons Solar Limited (SSL) understands that low-cost electricity is extremely crucial for the economic growth and stability of the country and a solar power (PV) plant is the key to addressing this issue. Siddiqsons Solar Limited (SSL) has selected state-of-the-art, advanced supercritical technology in order for the plant to be more efficient and result in a lower carbon footprint.

In essence to its commitment to environment sustainability, Siddiqsons Solar Limited (SSL) is also going green with alternative solar renewable energy. It is developing a 50 MW PV Solar Power Plant at Chakwal districts in Punjab. The project is being developed on a fast-track basis and is expected to be commissioned in 2016. Siddiqsons Solar Limited (SSL) is the brighter future of Pakistan and believes in innovating, energizing and powering up, by turning its conceptions into reality.

1.3 Project Location, Nature and Size

The proposed site for 50 MWp Solar Power (PV) Plant is located in Chakwal. This site was selected by the Siddiqsons Solar Limited (SSL), in view of availability of abundant land with adequate sunshine.

The proposed project area is situated in Tehsil & District Chakwal. It is 37 km away from the Chakri interchange. The nearest prominent village Ganda Kus is away 12 km from the project area while Hasil and Ahmadabad are around 3 km. The road from Chakri to project area is metaled but a small portion of road 3 km is unmetaled (Kacha road). There is no agricultural activity on the project area. There are 15 big trees in the project area. The sources of water on the project site are both ground water and surface water. There is a local reservoir in which rainy water is stored. The local reservoir covers an area of approximately 6-7 acres.

Total land allocated for 50 MWp solar power plants is 380 acres, however for present development project. The coordinates of the proposed project are given in Table 1.1.

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1. INTRODUCTION

1.1 Project Background

Pakistan has been experiencing an acute shortage of energy right across all sectors in particular, industry and domestic users. These shortages have highlighted the need for reliable, budget realistic and effective sources of energy and an improvement in the distribution of energy. Pakistan currently relies disproportionately on thermal power generation from local gas fields and expensive imported oil to fuel both government and privately owned and rented power plants. Due to its huge applications and requirements the demand and supplies are all poles apart. With the passage of time as the requirement increases the production capacity must also be increased, staying within the limited resources for the economic progress.

Pakistan is ideally located in the Sunbelt to take advantage of solar energy. This energy source is widely distributed and abundantly available in the country. The development and adaptation of solar energy technology, that is, to use both light and heat energy of sun to produce electricity can help reduce the short fall and meet the demands. Thus, the country has begun diversifying its energy producing capacity by investing in solar energy plants to help offset the energy shortage.

Siddiqsons Solar Limited (SSL) is part of the Siddiqsons Group's initiative to enter the Green/ Sustainable Energy industry, and to contribute to Alternate Energy Development Board's (AEDB) target of adding 10% renewable energy to Pakistan's overall power generation base. The Company is envisioned to be a full scaled IPP, with a mandate to enter into the business of power generation through solar power. The company is engaged in developing a 50 MW Solar PV project (the Project) on a fast track basis, with the intention of ranking amongst one of the first private solar IPPs in the country.

Siddiqsons Solar Limited (SSL) limited has planned to construct a 50 Megawatt (MW) Photovoltaic Power (PV) Plant in Chakwal, Punjab Pakistan. This IEE came up with a set of impact mitigation measures as well as monitoring programs for the Project in order to ensure minimal adverse impacts on the environment and communities nearby.

1.2 Project Overview

Siddiqsons Solar Limited (SSL) was incorporated in 2014 and is the latest venture of the Group aiming to address the acute issue of the energy crisis in Pakistan.

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Table 1.1: Project Location

Location	Area Size	Coordinates	
Area 1	147614.262m^2	33^{0}12'21.45" N	72^{0}32'28.71" E
Area 2	228913.839m^2	33^{0}12'13.10" N	72^{0}33'47.10" E
Area 3	143124.881m^2	33^{0}12'8.02" N	72^{0}32'23.97" E
Area 4	76015.559m^2	33^{0}12'9.50" N	72^{0}33'19.27" E
	84512.921m^2	--	
	223779.325m^2	--	
	103180.66m^2	--	
	20814.915m^2	--	
Area 5	184149.602 m^2	33^{0}11'24.77" N	72^{0}33'8.29" E

The solar radiation map of Pakistan showing Project area is given below as Figure 1.1 and Figure 1.2.

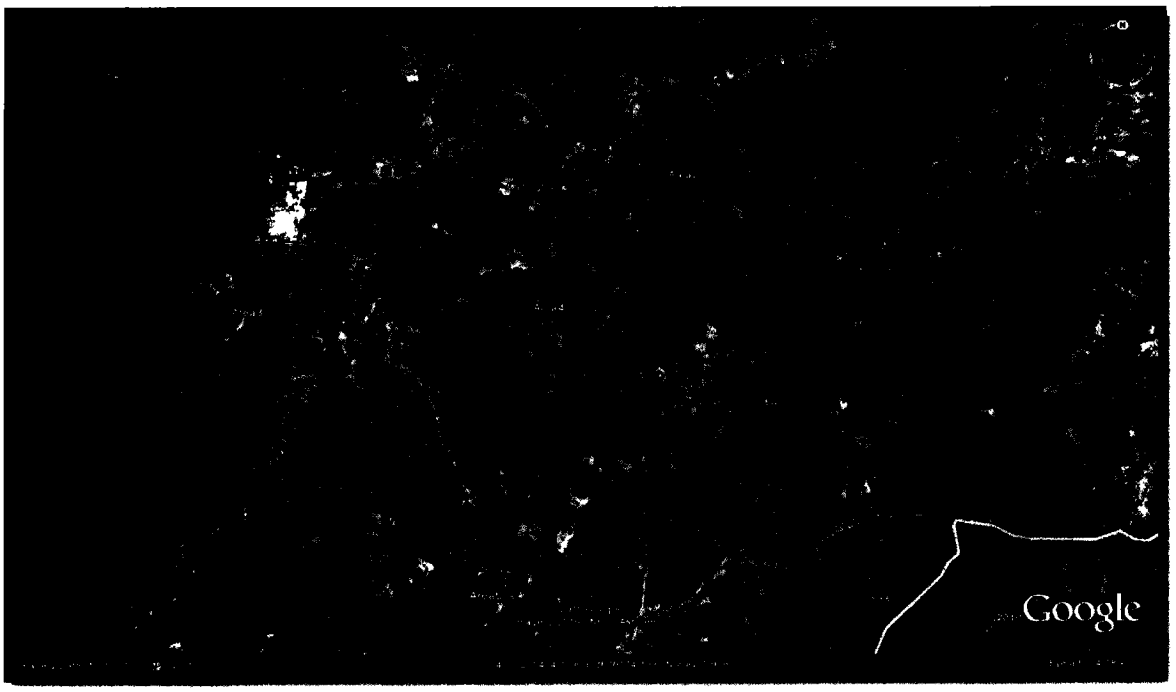

Figure: 1.1: Proposed Project Area

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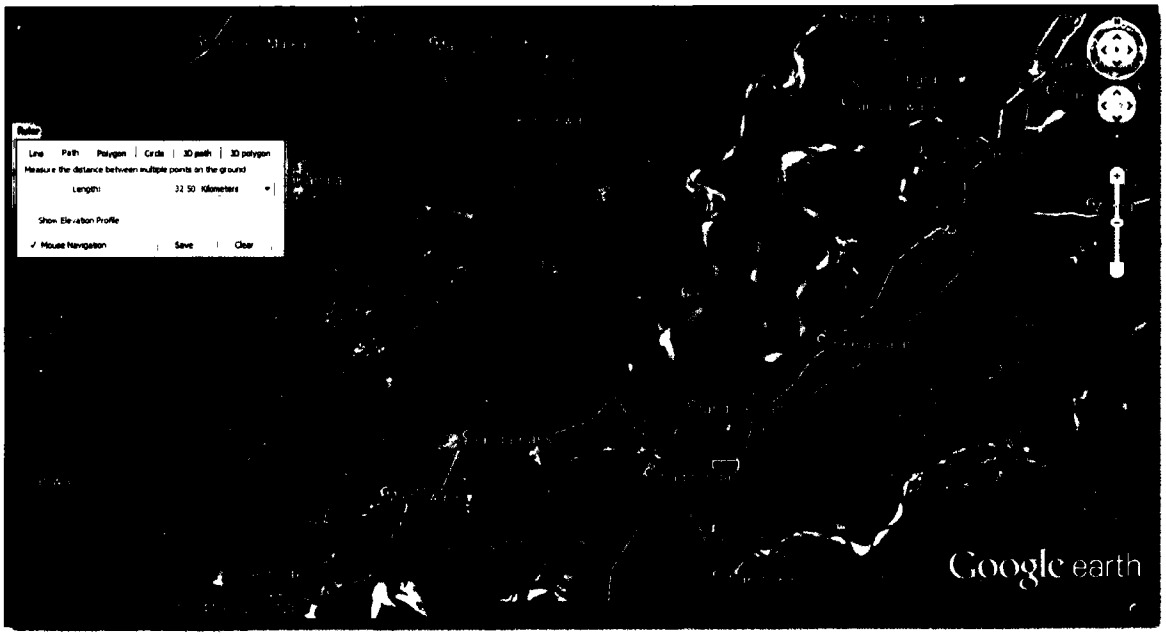

Figure 1.2: Road Plan of Project Area

1.4 Scope of Project

The Scope of this Study is based upon the requirements of Government of Pakistan. This study establishes the various environmental and social impacts of the proposed Project and devises mitigation measures accordingly based on its size and location. For this purpose; the published and unpublished data was collected for assessing the environmental conditions besides primary data collection from the field.

The environment team visited the proposed Project site and adjoining areas to collect (primary) baseline data and to investigate physical, biological, and socioeconomic conditions. In addition, meetings were held with the stakeholders and community members in the Project area to collect primary information about the Project and recorded their views and concerns regarding the proposed Project.

The ultimate objective of this study is to assess realistically whether or not the Project is environmentally manageable. This would make the Project environmentally sound and socially acceptable. Specific objectives of this study can be identified as follows:

- To collect the baseline data regarding physical, biological and social environment within the Project area of influence (as discussed in Chapter 5).
- To carry out environmental assessment (physical, biological and socio-economic) of the proposed Project

- To identify mitigation measures for any potential adverse environmental impacts
- To carry out Public Consultation
- To propose institutional responsibilities and methods of monitoring the mitigation measures and monitoring procedures
- To prepare Environment Management Plan for those environmental impacts which may be considered as adverse

1.5 Objective of Report

The Initial Environmental Examination (IEE) study will be used to:

- The purpose of conducting an IEE is to provide information about the general environmental setting of the project area.
- Evaluate the likely environmental, social and health impacts that may potentially be generated from the project
- Minimize / eliminate negative impacts and maximize positive impacts
- Ensure that environmental, social and health factors are considered in the decision making process
- Inform the public about the project

1.6 Environmental Sensitivity of the Project

Solar energy technologies provide obvious environmental advantages as compared to other conventional energy resources but if used in appropriately can also interfere with existing land uses, animals, burro management, military uses and mineral production.

Photovoltaic panels may contain hazardous materials, therefore as a safety measure they are sealed under normal operating conditions; but if they are aged or improperly disposed they can contaminate the environment.

In operational phase, Concentrating Solar Power (CSP) involves high temperatures and little generic issues that may pose an environmental or safety risk.

This Project falls into category C of ADB requirements, which reflects that this Project has no significant adverse or negative impacts. The little temporary adverse impacts can be minimized with good engineering practices as recommended in this IEE.

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1.7 Limitations of Study

In Pakistan, no regulations relevant to solar power are available with Environment Protection Agency (EPA). EPA regulations for thermal power are suitable for solar power which may be used in this report.

The Pakistan Environment Protection Act (PEPA 2000) states that installation of above 50 MWp project requires IEE study before applying for environmental approval to Punjab-EPA. The environmentally benign nature of Solar Energy have ever compelled the Client to request the Consultants for carrying out an IEE study of 50MW Power (PV) Plant and the Proponent is not required to go for EIA study.

Professional judgment and subjective interpretation of facts has been applied for analysis of various aspects. All information and inferences presented herein are based on the details currently available as per the scope of work, information provided by the Client or its representative, existing secondary data, budget and schedule.

1.8 Purpose of the Report

The purpose of this IEE report is to examine and assess the environmental impacts of the proposed Projects and to devise mitigation measures for the expected impacts that are likely to occur during in construction and operational phases. The proposed Project must comply with both the EPA and PEPA regulations prior to issuing a permit for the proposed Project.

The main purpose of this IEE is to work closely with the Project engineers to ensure that the Project design reflects environmental sensitivities and meets the social needs of the beneficiaries and the people living in the surroundings.

1.9 Project Proponent

Siddiqsons Solar Limited (SSL) is the proponent of the 50 MWp Solar Power (PV) Plant at Chakwal project while Engineering Consultancy Services Punjab (ECSP) is hired to carry out Initial Environmental Examination (IEE) for the installation of aforesaid project.

The authorized representative is the following:

Mr. Khawaja Bilal Hussain (CEO Solar)

7th Floor, Siddiqsons Tower, Plot # 3,

Block 7/8, J.C.H.S Shahrah-e-Faisal, Karachi-Pakistan

Siddiqsons Solar Limited Karachi

Phone: (92-21) 32361201-9

UAN: 111-111-001

Email: info@siddiqsons.com

1.10 Details of Consultant

Engineering Consultancy Services Punjab (Pvt.) Limited (ECSP) has prepared this Final IEE for an Environment and Social Impact Assessment on behalf of the project proponent in accordance with the Punjab-EPA guidelines.

The primary contact for ECSP is:

Dr. Sultan Mahmood (Chief of Environment Section)

Engineering Consultancy Services Punjab (Pvt.) Limited

83-A, E/1, Main Boulevard, Gulberg-III, Lahore

Phone: 042-35717681-4

Fax: 042-35717685

Email: drsultan@gmail.com

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2. KEY APPLICABLE NATIONAL ENVIRONMENTAL LAWS AND REGULATIONS

In this section, the environmental and social regulations are described which are applicable to the proposed 50 MWp Solar Photovoltaic Power Plant.

All activities under the 50 MWp Solar Photovoltaic Power Plant must be consistent with the applicable laws, regulations and notifications of the GoP that are relevant in the context of the proposed interventions/activities. The concerned line departments/agencies will ensure that the investments proposed and executed under Siddiqsons Solar Limited (SSL) are consistent with the regulatory and/or legal framework, whether national, districts or municipal/VDCs. Additionally, it is also to be ensured that activities are consistent with the World Bank's operational policies and guidelines. This section is not a legal opinion on the applicability of the law, but serves as guidance in the application of the various laws and regulations to the current project context.

Under Clause 12 of the Pakistan Environmental Protection Act 1997 (PEPA, 1997), in general it is mandatory for the Proponent of any project to arrange Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) before the start of the project. At present, Pakistan Environment Protection Agency (Pak-EPA) has no regulation for solar power generation in their Schedule I or Schedule II (PEPA Regulations 2000). Thermal power generation is the closest energy generation reference which may be quoted for solar energy generation, according to which this project needs an EIA. It is, however, decided with the consultation of Punjab-EPA authorities that 50 MWp solar power generation unit will undergo an IEE. In consequences of the 18th Amendment passed in the National Assembly in 2010, Pak-EPA was devolved in provincial subjects, hence, Punjab-EPA is undergoing a process of amendments in the PEPA Act, 2000 where solar and wind power generation subjects will soon be added by the time the regulations are amended.

This section highlights the salient features of selected laws that may have a bearing on the Siddiqsons Solar Limited (SSL) design and implementation. A summary of such applicable policy, plan, guidelines, standards and rules and regulations are furnished in the Table 2.1.

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Table 2.1 Key Requirements and Features

Policy/Plans/ Guidelines/standards Act/Regulation	Key Requirement/s or Salient Features	Applicability
National Policy and Administration Framework	The Pakistan National Conservation Strategy (NCS), approved by the Federal Cabinet in March 1992, is the principal policy document on environmental issues. The NCS outlined the country's primary approach towards encouraging sustainable development, conserving natural resources, and improving efficiency in the use and management of resources. The NCS has specific programs in core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment. The core areas that are relevant in the context of the proposed project are pollution prevention and abatement, conserving biodiversity, supporting forestry and plantations.	✓
Pakistan Environmental Protection Act, 1997	The Government of Pakistan promulgated "Pakistan Environmental Protection Act (PEPA) in 1997. Two organizations, the Pakistan Environmental Protection Council (PEPC) and the Pak-EPA (now developed), are primarily responsible for administering the provisions of the Act at the federal level. The PEPC oversees the functioning of the Pak-EPA. Its members include representative of the government industry, non-governmental organization, and the private sector. The Pak-EPA is required to ensure compliance of the National Environmental Quality Standards (NEQS) and establish monitoring and evaluation systems. The Pak-EPA was authorized to delegate powers to its provincial counterparts, the provincial EPAs or EPD (Environmental Protection Department in Punjab), but the provinces are now conferred full authority after development. One of the functions delegated by the Pak-EPA to provincial EPAs/EPD is the review and approval of environmental assessment reports of projects undertaken in their respective jurisdictions. The Pakistan's Environmental Protection Act, 1997, empowers the Pak-EPA to: Delegate powers including those of environmental examination/ assessment to the provincial EPAs/ EPD. Identify categories of the projects to which the environmental examination/ impact assessment provisions will apply. Develop guidelines for conducting IEE and procedures for the review and approval of the same. Develop environmental emission standards for parameters such as air, water and noise pollutants. Enforce the provisions of the Act through environmental protection orders and environmental tribunals headed by magistrates with wide-ranging powers, including the right to fine violators of the Act. Under the provisions of the 1997 Act, the Pak-EPA has empowered four provincial EPAs/ EPD to manage the environmental concerns of their respective provinces. The provincial EPAs/ EPD can frame environmental regulations tailored to the requirements of their province, provided these regulations meet or exceed the minimum standards set by the Pakistan EPA. They are also required to review and approve IEEs/ EIAs of all the development projects.	✓
National Environmental Quality Standards,	The NEQS 2000 specify the following standards: Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents	

2000	discharged to land waters, sewerage treatment facilities, and the sea (three separate sets of numbers). Allowable noise levels from vehicles.	✓
	Other Provincial Agencies	
Punjab Environmental Protection Department	The Proponent will responsible for providing the complete documentation required by the Punjab Environmental Protection Department and remain committed to the approved project design. No deviation is permitted during the project implementation without the prior and explicit permission of the Punjab EPA/ EPD.	✓
Provincial Departments of Forest and Wildlife	In case the implementation of the proposed project involves the clearing of vegetation and trees in project area, the project contractor will be responsible for acquiring "No Objection Certificate" (NOC) from concerned provincial Department. The application for NOC will need to be endorsed by the Proponent. Where the construction is to be carried out in close proximity of protected forests and wildlife areas, the Proponent is required to coordinate with the departments to ensure that impact on flora and fauna species are minimized.	✓
Provincial Revenue Departments	Under the National laws, the matters relating to land use and ownership are provincial subjects and the Revenue department of the concerned province is empowered to carry out the acquisition of private land and built-up property for public purposes, including on behalf of another Provincial or Federal Agencies.	✓
Agriculture Department	It also requires a liaison with the Provincial departments of agriculture, horticulture and forestry in case of issues associated with these departments. The concerns could be related to the affected vegetation resources, such as trees and crops.	✓
Coordination with District Government	The Project Proponent will coordinate with all concerned Government department and ensure that the project meets the criteria of District Government / Authorities as related to the establishment of construction camps and plants and the safe disposal of waste, solid waste and toxic material. Proponent will also ensure periodic monitoring of the EMP during both construction and operation period through deployment of an Environment Specialist.	✓
	Other Relevant Acts	
Punjab Wildlife Protection Act, 1974	The Punjab Wildlife Protection Act, 1974 was passed by the Provincial Assembly of Punjab in 1974. This Act is applicable to the whole of the Punjab province for protection, conservation, preservation and management of Wildlife. This Act also addresses designated areas of sanctuaries and protection of rare and endangered species.	✓
Local Government Act 2001 and Amended in 2003	These ordinances, issued following the devolution process, establish regulations for land use, the conservation of natural vegetation, air, water, and land pollution, the disposal of solid waste and wastewater effluents, as well as matters related to public health and safety.	✓
Land Acquisition Act, 1894	The Land Acquisition Act 1894 is a law for the acquisition of land, which is implemented to fulfill the needs of Government and companies for land required by them for their projects and secondly, to determine and pay compensation to those private persons or bodies whose land is to be acquired. The experience of the power of acquisition has been limited to a	

	cash compensation policy purposes such as the acquisition of land and built-up property and age to other assets such as crops, trees and infrastructure. The LAA does not take into account the rehabilitation and settlement of displaced population and restoration of their livelihoods. Presently, the requisite land for the proposed project is already owned by the project Proponent, as such no additional private or government land will need to be acquired for the project.	✓
Protection of Trees and Brushwood Act, 1979	This Act prohibits cutting or lopping of trees and brushwood without permission of the concerned Forest Department and demands a NOC from Forest Department before cutting of trees.	✓
Clean Air Act, (1990)	The Clean Air Act (CAA) is the comprehensive Federal law that regulates air emissions from stationary and mobile sources. Among other things, this law authorizes EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and public welfare and to regulate emissions of hazardous air pollutants.	
	The IPCC was established to provide the decision-makers and others with an objective source of information about climate change.	

2.1 Applicable World Bank Policies

The World Bank's environmental and social safeguard policies (ten of them) are a cornerstone of its support to sustainable poverty reduction. The objective of these policies is to prevent and mitigate undue harm to people and the environment in the development process. These policies provide guidelines for the identification, preparation and implementation of programs and projects.

2.1.1 Environmental Assessment

Environment is triggered because the activities/interventions proposed under Siddiqsons Solar Limited (SSL) may have low impacts on the natural environment and human health. The project during construction requires clearing up of sites, excavations which have impacts (though minimal) to physical and biological environment.

Environmental Assessment is used by the World Bank to identify, avoid and mitigate the potential negative environmental impacts associated with the Bank's operations early on in the project cycle. The policy states that Environment Assessment (EA) and mitigation plans are required for all projects having significant adverse environmental impacts or involuntary resettlement. Assessment should include analysis of alternative designs and sites, including the "No Project Option" and require public participation and information disclosure before the Bank approves the project.

Pakistan National Environmental Draft policy 2005, which provides a framework for addressing environmental issues of Pakistan, particularly pollution of fresh water sources, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification, natural disaster and climate change.

National Forest Policy covers natural renewable resources of Pakistan including forests, rangelands, Watersheds, Wildlife, biodiversity and their habitats. The main objective of the policy is to foster the Renewable Natural Resources (RNR) of Pakistan.

2.1.2 Procedures for Environmental Approval

This section describes the procedures required for obtaining NOCs for IEE from concerned authorities. The following general stages have to be followed in the application and approval process for obtaining an "Environmental Approval" for the 50MWp Solar Power Project, Siddiqsons Solar Limited (SSL), Chakwal.

a) Classification of the Project
b) Submission of IEE; and
c) Issuance of NOC

Detailed process for obtaining NOC according to PEPA-1997 is as follows;

a. Classification of the Project

The proposed project requires an IEE in accordance with Schedule-I of PEPA-1997. According to the TOR /Scope of Work of the 50MW Solar Power Project, Siddiqsons Solar Limited (SSL) Chakwal Pakistan Consultants are required to prepare the IEE and to assist in obtaining NOC from EPD, Punjab.

b. Submission of IEE

Under Section 12 of the PEPA 1997, a project falling under any category specified in Schedule-I, requires the proponent to file an IEE with the Federal EPA or Provincial Agency for obtaining the NOC. After preparation of IEE report, eight hard copies and two electronic copies need to be submitted to the concerned agencies along with completed Schedule IV form and a non-refundable review fee. In case of the proposed Project, EPD Punjab based in Lahore will be the main Government agency responsible for the issuance of an NOC.

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c. Issuance of NOC

Within ten working days of the filling of the IEE; the concerned agencies will confirm that the document submitted is complete for the purpose of review. During this time, should the concerned agency require the proponent to submit any additional information, it will return the IEE to the proponent for revision, clearly listing those aspects that need further discussion. Subsequently, the concerned agency should make every effort to complete an IEE review within 45 days of filing and final decision on IEE shall be communicated to the proponent in the form prescribed in Schedule V. In case of approval, conditional NOC having validity of three years will be issued. The NOC process for IEE is given below in Table 2.2:

Table 2.2: IEE Approval Process

Category	Description
Project Phase	Detailed Design
Approving Authority	Environment Protection Department Punjab
Applicable Legislation	Pakistan Environmental Protection Act, 1997
Application File Prepared by	Siddiqsons Solar Limited (SSL) assisted by ECSP (Consultants)
Project Title	Construction of 50 MW Solar Power Project, Siddiqsons Solar Limited, Chakwal
Pertinent Regulatory Steps	
Submission of IEE	• Review fee as per rates in Schedule III • Filled Application form (Schedule IV) • IEE Report (08 hard copies and 02 electronic copies)
Decision on IEE	• Decision communicated to proponent in form prescribed in Schedule V • In case of approval, Issuance of NOC

3. APPROACH AND METHODOLOGY

This section refers to the approach and methodology adopted for collection of baseline data. The underlying principles and practices adopted in this regard are also discussed.

The environment team visited the Project site and adjoining areas during July, 2015 to collect (primary) baseline data and to investigate physical, biological, and socioeconomic conditions. In addition, meetings were held with the stakeholders and community members in the Project area to collect primary information about the Project and record their views and concerns regarding the proposed Project.

3.1 Adopted Procedure

The approach and methodology adopted for this IEE study was according to the provisions of EPA, 1997. During July 2015, detailed requisite data and information was collected by the Environment team of ECSP as under:

- Desk Analysis
- Initial interaction with the community and district level stakeholders
- Collection and review of secondary sources of information
- Preparation of Project Specific Checklist
- Field Survey
- Public Consultation
- Compiling and collection of Existing Information and Impact Identification
- Monitoring Plan and Mitigation Measures
- Collection of Laboratory Samples
- Conclusion and Recommendations

3.2 Survey of the Proposed Project Area

A multi-disciplinary team visited the project area for updating/verification of the baseline information on physical, biological, socio-economic and cultural environment of the proposed Project, to evaluate the anticipated environmental impacts and propose the practical mitigation measures.

Following team of professionals were responsible for data collection, field study, analysis and report writing:

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1. Dr. Sultan Mahmood, Chief of Environment Section, supervised the field team in Chakwal district and guided them to use correct methodology of data collection process, as well as interviewed the district authorities of Chakwal including DCO.

2. Engr. Athar Aslam, HSE Expert and Resettlement Specialist, emphasized over the status of the affected families for their resettlement options, as well as planned for the future construction activities.

3. Mr. Mohammed Amir, Senior Sociologist, provided the details of the land acquisition record as prepared by the design team of the Consultant.

4. Mr. Saad A. Sheikh, Integrated Communication Specialist, participated in field work, received and discussed the existing drawings to build a census among the team members, also helped out other team members in record keeping, and photo-banking.

5. Mr. Zeeshan Ajmal, Environment Specialist, conducted detailed field surveys; He received the environmental monitoring results of the laboratory and discussed accordingly to be made a part of this report also write some part of this report.

6. Ms. Alishba Inayat, Sociologist, designed socio-economic questionnaires and conducted focus group discussions and social survey which included identification of proposed sites and study area.

7. Mr. Muhammad Usman Maqsood, Junior Sociologist, recorded field truths through Social Impact Assessment checklists, focus on group discussion, as well as helped other team members in recording the socio-economic data.

8. Engr. Rebab Maria Mehmood, Environmental Engineer, recorded ground truths through structured questionnaire and also helped out other team members in record keeping.

9. Mr. Mohsin Majeed, Environmental Specialist, conducted detailed field surveys; He received the environmental monitoring results of the laboratory and discussed accordingly to be made a part of this report.

10. Mr. Samiullah Shah, Junior Environmental Scientist, recorded field truths through environmental checklist, as well as helped other team members in recording the socio-economic data.

11. Ms. Samiya Latif, IT Specialist/ Enumerator, recording all the data of survey, formulated, compiled it in tabulated form.

12. Mr. Mohammed Yasir Qureshi, Enumerator, supported report formatting and also helped out other team members in record keeping, recording of coordinates of different physical inventory and keeping records for photo-banking.

3.3 Public Consultation and Information Disclosure

In order to ensure the public involvement, the following procedures were followed during IEE report preparation:

- IEE team also carried out interaction with local communities and related stakeholders during field survey to collect the public concerns and suggestions.
- Information about the proposed project and IEE study was disseminated through person to person contacts and interviews and group discussions during field study of IEE. The approved IEE report will be accessible to interested parties and general public from the following:

1. Siddiqsons Solar Limited, Karachi, Sindh
2. ECSP Office, Lahore, Punjab
3. Environment Protection Department, Lahore, Punjab

3.4 The Final Report

The IEE report was prepared by untiring efforts of above mentioned study team. After reviewing the final IEE report according to TOR, it was submitted to Environment Protection Department through client for approval.

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4. PROJECT DESCRIPTION

This Chapter provides an overview of the proposed Project, its associated components, design considerations, construction procedures, and operation and maintenance activities. The Project alternatives are also discussed within this chapter.

4.1 Project Clarification

Pakistan's existing resources are not enough to fulfill the needs of rapidly growing population and therefore have the negative impact on economic condition of the country. The requirement of sufficient and reliable energy source to carry out the domestic and socio-economic activities is inevitable. For this purpose, Punjab Government facilitate the private companies to come up and invest in energy sector, so Siddiqsons Solar Limited initiated his solar energy project in Chakri, this Project will somehow fulfill those electricity requirements; yet it is the best energy solution for this electricity deficient country.

4.2 Important Nominal Characteristics of the Project

The proposed Project "50 MWp Solar Power (PV) Plant at Chakwal" will cover the area of about 380 acres. This planned Project would be completely equipped with all the obligatory things including solar energy producing apparatus, a switching place, a specialist care and repairs facility, a Project substation and all arrangements including barrier and access road expansion, after that the powerhouse divisions will be established at ground level. This Solar Power (PV) Plant would be the combination of several PV components which will be fixed at steel type supportive constructions often known as tables. In which the topography will play the important role because it will change the distance from ground level to PV unit's tables. The PV modules would be electrically associated by electric wiring harnesses running alongside the lowermost side of each table to combiner boxes that receive power from various rows of segments. By means of underground cables DC command would be given to the combiner boxes from the units to the local grid.

A number of the important characteristics of suggested Project to be installed at Chakri are given in Table 4.1.

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Table 4.1: Important Nominal Characteristics of the Project

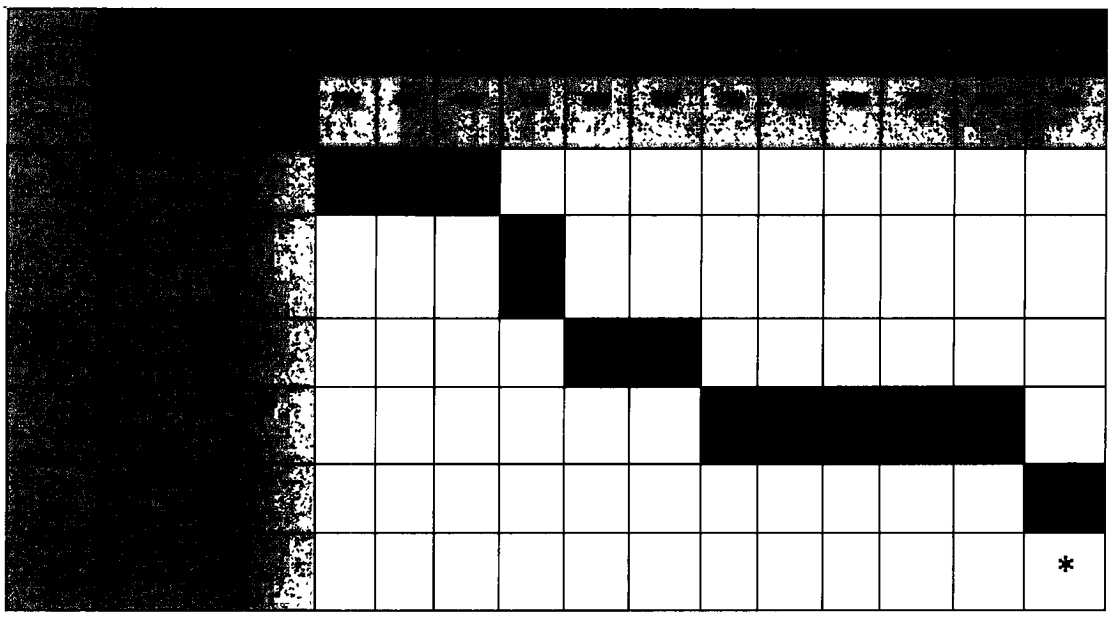
Parameter	Feature
Nature of region	Hilly Area
Project range	50 MWp
Solar energy producing zone New services establishment Overall terrestrial site for suggested project area	294 acres 86 acres 380 acres
Form of technology	Photovoltaic (PV)
Project finishing point	Around 10 months
Transportation arrangement	Parallel to existing 132 KV TL
Kind of apparatus to be used	Fixed installation type X-Si solar cells

4.3 Cost and Magnitude of Operation

Cost of the proposed project is $78 million and it will take 10 months duration for its initial stages to end production stage.

4.4 Schedule of Implementation

Table 4.2 Timeline for Construction of Project



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4.5 Appropriate Information of PV Solar Energy Technology

During the daylight various PV units receive 80% of sunlight from the sun round and PV technology converts this solar radiation into DC electricity. The absorbed sunlight energy is transferred to electrons in the atoms of the PV cell. With their fresh originated energy; these electrons outflow from their ordinary sites in the atoms of the semiconductor PV material becomes the part of the electrical flow, or current, in an electrical route. Figure 4.1 shows the flowchart of Photovoltaic electric power generation. This gives a true image of the current Project that how it would produce electrical energy and distribute it to the national grid.

4.6 Inquiry of Substitutes

This segment represents the idea of substitute's inquiry for the proposed solar power Project. The following scenarios have been considered:

- Substitute Approaches of power production
- No project Development
- Alternative Site for the proposed project

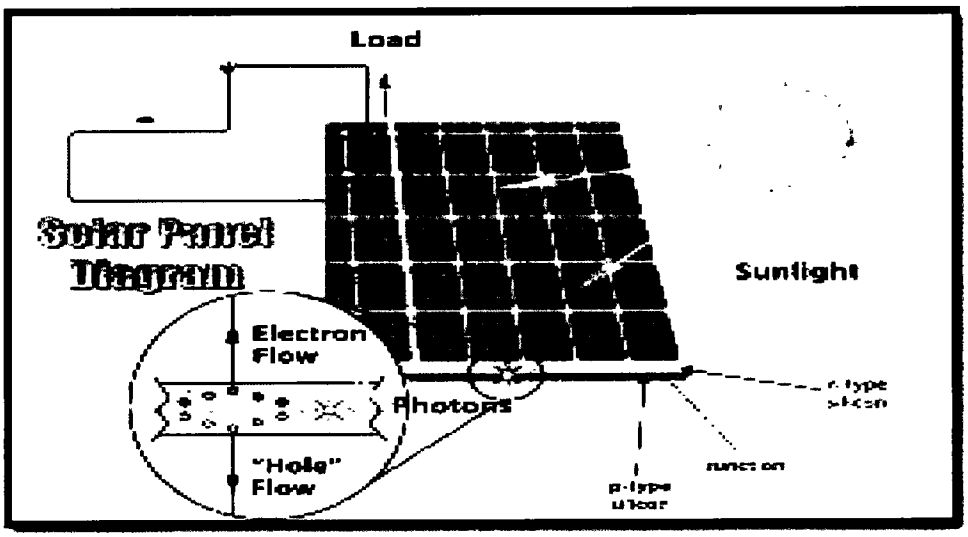

Figure 4.1: PV Technology Schematic Diagram

4.6.1 Substitute Approaches of Power Generation

In Pakistan, there are many power stations with total power production of about 20,215 MWp. Sources like thermal station shares 6590 MWp, hydro having 6,463 MWp, nuclear site gives 462 MWp, and 6,414 are generated from independent power stations. Rental power station produces about 286 MWp. Production of power from nuclear source is not considered to be an efficient way. Energy production from hydro power station has become a political issue in Pakistan. So, in order to solve this problem, wind and solar energy has become the last option to combat these complications. However, all the planners are focusing on these two methods, because they are the most suitable ways to overcome the obstacles. Some kind of energy source Comparison is shown in Table 4.3.

Coal fired power plants are considered to be the air polluters and therefore have great environmental significance due to producing huge quantity of GHG. While biomass, nuclear, hydroelectric, wind, and solar photovoltaic natural gas, and to some degree oil, all these are supposed to be environmental friendly. Their detail is shown in Figure 4.2.

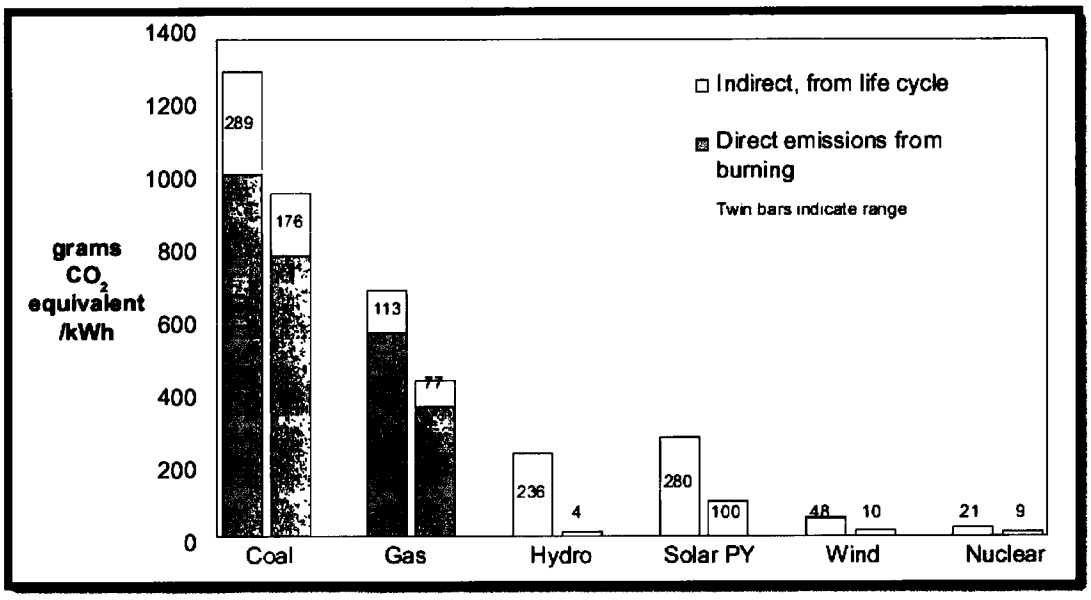

Figure 4.2: Lifecycle GHG Emissions Intensity of Electricity Generation

In current situation, the sorting out of most feasible solution to conflict these problems was the solar power generation. The reason is that Pakistan has wasted land mostly, like Thar, Thal and some hilly areas which provide solar light to fight all these issues. Most interesting thing is that in our country there was no specific study on solar power except 100 MWp PV project at Cholistan before 2013 which was also prepared by ECSP in 2013. But in recent months there have been a major breakthrough in Solar Energy. Several new projects are already in pipeline in different stages for production of Solar Energy.

4.6.2 No Project Option

Pakistan is situated in the equatorial sun belt of the earth, thus getting plentiful solar energy. In Pakistan, solar radiation and daily sun light duration is observed through Meteorological Department of Pakistan. Being a part of good climatic zone, our country is facing about 250 to 300 days a year. Pakistan receives 16-21 MJ/m^2 per day of solar radiation as an annual mean value, with 19 MJ/m^2 per day over most areas of the country.

The annual average values of sunlight interval fall between 8 to 10 hours per day around the country, excluding northern areas. The present power source scenario clearly reflects the obvious shortfall in supply. So, there is need for new method to solve this demand and supply issue. For this purpose we need to increase renewable/ non- conventional sources of power over conventional sources. That's why the current Project is related to the non-conventional sources to overcome the shortfall in the country.

Government of Punjab is trying hard to tackle the power shortages and is consuming all existing energy producing means. Therefore, many other projects including nuclear, thermal, coal and renewable energy producing projects are in running phase to fulfill the country demand. Keeping in view this condition, the No Project Option will further deplore the power crisis of the country. Therefore, No Project Option is not considered.

4.6.3 Alternative Site of the Proposed Project

Solar power projects are supposed to be environmental friendly, energy generation projects that are totally dependent upon the accessibility of adequate solar energy. In Pakistan, the most areas especially the Southern Punjab receive maximum solar radiation due to extremely hot and dry weather conditions. The Project promoter has passed out evaluation studies in order to recognize the power generation capacity of different locations. The following supplementary criteria have been measured for site selection:

- The sites should be situated away from main settlements
- The sites do not fall under any reserved or protected forests
- The land acquired for the locations contains of income property which was not used by the communal for any determination

4.6.4 Alternate Technology for Project

There are various kinds of solar sections for generating solar energy, but the proposed Project intends to use tandem arrangement/ thin film solar PV technology. The power generation by photovoltaic is an energy demanding method, particularly the poly crystalline and the mono crystalline units. They also oblige huge amounts of bulk materials. Thin film components require little key energy necessity per watt than poly crystalline or mono-crystalline modules.

4.7 Construction Features

4.7.1 Contractor's Conveniences

It will be contractor responsibility to provide all the facilities for machinery, labor and vehicle etc. It is predicted that here is huge area found for the contractor nearby the planned site without alarming any native, ecosystem or the substructure.

4.7.2 Work Force

It is estimated that the skillful control will be involved in the manufacturing and fixing things during the construction phases of the project. The analysis of the staff power

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during the normal and highest construction points is estimated as 300 and 1000 workers, respectively.

4.7.3 Edifice Material and Conveyance

All the solar panels will be established on steel bars that are stable in the ground. Likewise, other building material will also be used to form associated arrangements like office, supply room, entertainment site, switchyard, etc. using mounted building technology. The mounted configuration will consist of Reinforced Cement Concrete (RCC) by means of mostly steel, cement, sand, cumulative for construction purposes.

The movement of construction machinery/vehicles in the Project area is difficult due to unpaved earthen tracks. The pathways cannot bear the load of heavy machinery/vehicles; therefore movement will be restricted in rainy days.

4.8 Restoration and Rehabilitation Plan

After completion of the construction work all the disturbed sites will be changed into conditions as they were prior to the commencement of the project or better than that. The area will be planted with indigenous vegetation and all the access roads will be broken in the strategic places so that it can no longer be used. All the concrete will be broken and disposed of according to the waste disposal plan. The fences will be removed, the borrow areas leveled and top soil restored separately after the construction.

4.9 Site Waste Management Plan

All construction projects must have Site Waste Management Plan (SWMP), which explains how construction waste is handled by following the law on managing waste. The project contractor should not start construction work until they have an approved SWMP in place. It must contain a response to the following questions:

- What kind of waste will be produced by the site
- How to ensure the waste disposal, e.g. reuse, recycle, landfill, etc.
- How many waste carriers are required and the supply
- The address and environmental permission of the site. Where waste is going

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Table 4.3: Energy Source Comparison

Energy Source	Merits	Demerits
Solar Energy	Nonpolluting Most plentiful energy source existing Methods last 15-30 years	Firstly Extraordinary investment Reliant on sunlit weather condition. Need of extra energy in low sunlight areas Requires large physical space for PV cell
Wind Energy	No emissions Affordable Little disruption of ecosystems Relatively high output	Output is proportional to wind speed Not feasible for all geographic locations High initial investment/ongoing maintenance costs Extensive land use
Hydropower	No emissions Reliable Capable of generating large amounts of power Output can be regulated to meet demand	Environmental impacts by changing the environment in the local reservoir area Hydroelectric s are expensive to build s may be affected by drought Potential for floods
Natural Gas	Widely available Cleanest-burning fossil fuel Often used in combination with other fuels to decrease pollution in electricity generation Made safe by adding artificial odor so that people can easily smell the gas in case of a leak	Transportation costs are high Lack of infrastructure makes gas resources unavailable from some areas Burns cleanly, but still has emissions Pipelines impact ecosystems
Petroleum	Efficient transportation fuel for the world Basis of many products, from prescription drugs to plastics Economical to produce Easy to transport	High CO_2 emissions Found in limited areas Supply may be exhausted before natural gas/coal resources Possible environmental impact from drilling/transporting
Biomass	Abundant supply Fewer emissions than fossil fuel sources Can be used in diesel engines Auto engines easily convert to run on biomass fuel	Source must be near usage to cut transportation costs Emits some pollution as gas/liquid waste Increases emissions of nitrogen oxides, an air pollutant Uses some fossil fuels in conversion
Coal	Abundant supply Currently inexpensive to extract Reliable and capable of generating large amounts of Power	Emits major greenhouse gases/acid rain High environmental impact from mining and burning, although cleaner coal-burning technology is being developed Mining can be dangerous for miners
Uranium	No greenhouse gases or CO_2 emissions Efficient at transforming energy into electricity Uranium reserves are abundant Refueled yearly (unlike coal plants that need trainloads of coal every day)	Higher capital costs due to safety, emergency, containment, radioactive waste, and storage systems Problem of long-term storage of radioactive waste Heated waste water from nuclear plants harms aquatic life Potential nuclear proliferation issue

4.10 Government Approvals

Approvals from all the concerned departments like PPDB, Revenue, CAA, Forest, Agriculture, Livestock and Irrigation will be provided by the client.

4.11 Road Access Plan

Kindly refer to Annex F for road access plan.

5 SOCIO-ENVIRONMENTAL BASELINE CONDITIONS

5.1 Introduction

This chapter comprises the detailed baseline environmental conditions of the 380 acres of proposed project area with reference to physical, biological, ecological and social aspects. This information has been derived from primary data collected through monitoring field observation, public consultation and secondary data review from concerned department and available online resources.

5.2 Study Area

An area within 3-4 kilometers around the project can be considered as influence zone and hence it has been taken as study area to collect the primary data related to physical, biological and socio-economic environment.

5.3 General Characteristics of Project Area

Main project site is situated 37 kilometers away from the Chakri Interchange which is closest one to the Chakwal city. It is located 90 km south-east of the federal capital, Islamabad and is named after Chaudhry Chaku Khan, chief of the Mair Minhas tribe from Jammu, who founded it in 1525 CE during the era of the Mughal Emperor, Zaheerudun Babur. It remained a small but central town of the Dhan Chaurasi Taluka for many centuries. In 1881, during the British era, it was declared the Tehsil Headquarters. It was finally upgraded to district status in 1985. The area of Chakwal city is about 10 square kilometers.

Chakwal is located in the Dhanni region of the Potohar in northern Punjab, Pakistan. During the Independence War of 1857 Chaudharials of Chakwal strengthened the hand of the British Raj by escorting the treasury from Chakwal to Rawalpindi and got the khilats and Jagirs. Chakwal's non-Muslim minorities departed during the independence of Pakistan in 1947 but the city is still in their heart and mind and had never forgotten it.

5.4 Geological Features of Study Area

Geographically project area placed in the Potohar plateau, the physical features of Chakri are typical of the region. The south and southeast is mountainous and rocky,

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covered with scrub forest, interspaced with flat lying plains; the north and northeast consist of softly undulating plains, with patches of rocky areas.

Figure 5.1: Geological Features of Project Area

Chakri is mainly a Barani area. Most of the soils in District Chakwal range from Granular loam and silt loam with pH ranging from 7-9. There are no irrigation canals or rivers. The only major rivulets and seasonal channels that run through Chakwal are the Soan, and the Soj Nullah. A number of small s has been constructed in the district through which some irrigation takes place. There are some storm water channels, which are mostly active during rainy season. The plains of the district are being cultivated, even those which lie in the hilly regions, and a considerable area is covered by forests. The proposed project area is wide spread area covering hilly features and green land.

5.5 Weather and Climate

As Chakri falls in District Chakwal, so, it lies in the subtropical region and its climate is typical of the area, with the exception that it varies a little on the cooler side, owing to its elevation, from central Punjab. Winter temperatures normally range between –4°C and 25°C, and summer temperatures average between 15° C and 40°C and may go up to a maximum 15 °C.

Chakri lies within the monsoon range, and apart from occasional rainfall, there are two rainy seasons: the first, caused by the monsoon winds originating from the Bay of

Bengal, begins from 15th of July and continues up to around the 15th of September; the second, caused by Mediterranean winds lies in the last two weeks of December and the first two weeks of January. The average rainfall is 22 to 25 inches. Chua Saidan Shah, Sub-division has the maximum rainfall in the district.

5.6 Hydrology

Chakwal is an un-irrigated, or what is called "Barani" in local language, area, and there is no canal system in the district like those, which exist in the other parts of the Punjab. However, a number of small s has been constructed in the district, which irrigates a small acreage of cultivated land through water channels. The detail of these is as follows:

- **Khichari zer** - this lies in the south of Chakwal subdivision, its capacity is 2602 A.Ft and irrigates 1200 acres. Water supplied to Chakwal city also comes from this.
- **Surrlah** - this lies adjacent to Khokharzer ; the capacity is 1555 A.Ft and the area irrigated by it is 1800 acres
- **Dhurnal** – Dhurnal is situated near the village of Dhurnal, subdivision Talagang; its capacity is 712 A.Ft and it irrigates 1004 acres.
- **Ghurab** - located near the Pira Fathial village, this holds 243 A.Ft in its reservoir and irrigates 730 acres
- **Wallana** - situated at 44 KM west of Chakwal city, its reservoir has a capacity of 1277.7 A.Ft. and it irrigates 1200 acres
- **Nikka** - this is located in Kallar Kahar sub-tehsil. It has reservoir capacity of 1248 A.ft and it irrigates 692 acres
- **Bughtal** – newly constructed near the village of Bhughtal, Talagang subdivision, the has reservoir capacity of 675 A.Ft and irrigates 495 acres
- **Dhoke Qutb Din** - constructed near Dewalian, this can store 827 A.Ft. and irrigates 714 acres
- **Kot Raja** - Kot Raja is situated near the village of Kot Raja in Chakwal subdivision and it can hold 1344 A.Ft and irrigates 1116 acres
- **Pira Fathial** - this can hold 2900 A.Ft., irrigates 1366 acres and is situated

near Jhatla in subdivision Talagang

Major source of drinking water for the project area is ground water. People of the nearby area, use to extract water by hand pumps or electricity motor pumps. To access the ground water, deep boring is required. Approximately the water table of the projected area is below 110 feet. For the chemical analysis of the ground water, two samples were taken from the hand pump present in the study area. Chemical analysis of the ground water shows that pH value of the both samples is in the normal range while TDS of both samples are quite high from the guidelines of WHO. These are 1610.0 and 1438.0 respectively whereas WHO guideline is 1000. The other parameters like Chloride, Sodium and Total Colony count are showing value ranges more than the WHO guidelines. Other parameters like Fluoride, Sulphate, Nitrate, and Iron are under the limits. For details, refer to Annex-D.

Figure 5.2: Source of Drinking Water

The main project area is irrigated or facilitated with two Nullah sources. These two Nullahs are named locally as Soan and Barsati. These both Nullahs filled up during rainy season. Nullah Soan originate from Pindhi and move towards River Jhelum. It is located approximately at a distance of 5 to 5.5 kilometers from project area. Barsati Nullah is passing through the in between area of village Ahmadabad and Hasil. Its approximate distance from the project area is 1.5 kilometers.

Figure 5.3: Source of Irrigation Water

Other than these both sources of water for irrigation, there is a local reservoir located within the projected area. Its water is spread within the large mountains and covers approximately an area of 6-7 acres. This water is not use by the nearby population and livestock and nor agriculture purposes, but this will be used during the construction of proposed project. Two samples were taken from different points of the Project area for the chemical analysis in the laboratory. According to the results, surface water of the projected area contains different parameters that fall under the detected values of the NEQS. These parameters include pH value, BOD5, COD, TSS, TDS, Chloride, Fluoride, Sulphate, Silver and Zinc etc. For more details, see Annex-D.

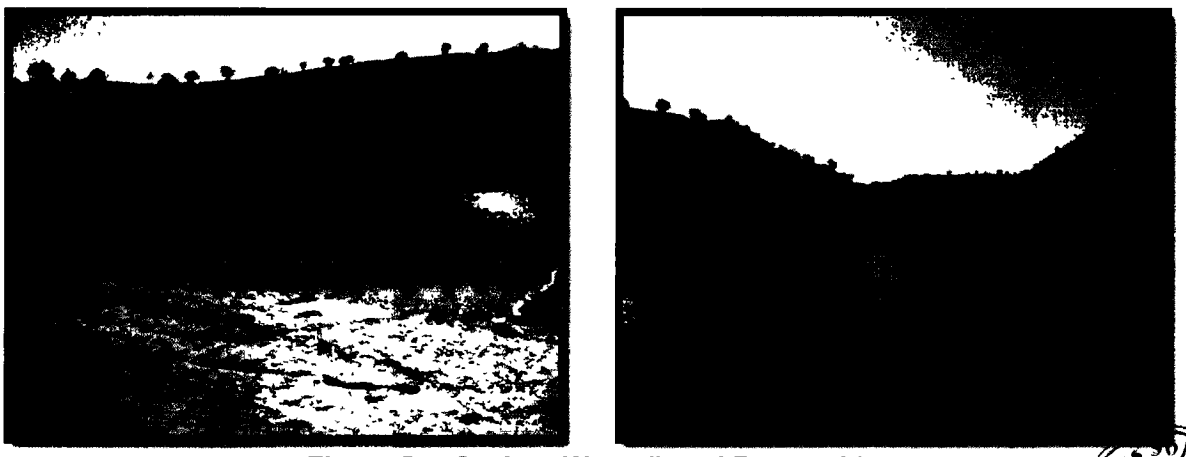

Figure 5.4: Surface Water (Local Reservoir)

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5.7 Air and Noise Quality

Propose project area is considered as a silent area because of no population and other activities. Two settlements named "Hasil" and "Ahmadabad" is present away from the project area at a distance of 2.8 and 3.0 kilometers respectively. Unpaved and aged jeep tracts/roads lead towards the project area. People of the nearby settlements come to the project site by walk on foot and by the means of their own vehicles i.e. Tractor, Bike and Jeep etc. No smoke or exhaust gasses emitted from the heavy transportation in the area. Two samples of air were taken from different points at different time intervals for analysis in the EPA approved laboratory. According to the results, ambient air quality of the project area is free from pollutants like Carbon monoxide, Nitrogen dioxide and Sulphur dioxide. Value of these pollutants is analyzed below the detectable limit declared by the NEQS. Wind velocity of the project area is moderate according to the result. The results of the other parameters like Particulate matter and temperature are same at the both points but the humidity value is found different because of time factor. For more details, see Annex-D. The project area falls under the silent zone category as the noise level value is monitored below the NEQS value. Average value of the noise level of the project area is 47.4 dB (A). For further details, refer to Annex-D.

5.8. Ecological Resources of the Area

Project area contains some of the most rare and interesting wildlife in Pakistan. Natural flora and fauna is present within the project area that provides stability to the existing ecosystem of the area.

An ecosystem present in the water body gives rise to its own floral and faunal ecology to support other species and makes a food-web to harbor main candidates of aquatic ecology, which is mainly fish. This local reservoir denotes fresh water ecosystem and there may be good number of fish species in local reservoir. The water quality of the local reservoir is highly productive and slightly alkaline in nature, so local reservoir is much safer from the pollutants produced by human, animal, agriculture etc.

a. Flora

There is a very wide range of plant species in the area.

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ANNEX – 20
PROSPECTUS

(i) A Brief Introduction of the Applicant

Siddiqsons Group (the Group) is one of the leading business groups in Pakistan. Established in 1959 to manage textile and denim business, the Group now handles Construction and Real Estate, Banking, Kids' Entertainment, Dairy and Industrial Metal companies under its umbrella. The Group is also one of the major shareholders in MCB Bank Limited (Pakistan's largest commercial bank by asset base). As of date, the net worth of core Sponsors' of the Group is in excess of USD 500 Million with businesses having extremely low leverage that allow for tremendous growth in future. The core Sponsors of the Group are progressively looking for avenues to diversify business and expand upon new opportunities.

Siddiqsons Solar Limited shall be the Project Company for the Project, whereas Siddiqsons Limited shall be the Main Sponsor, *vide* the LOI issued by AEDB, committing at least 20% equity in Siddiqsons Solar Limited till at least for 6 years after the Commercial Operation Date (COD). As submitted above, the Company is developing its Project under the NEPRA Upfront Tariff regime. It is anticipated that the construction of 1x50MW power plant on PV solar technology will take approximately 9-10 months from the issuance of notice to proceed to the project EPC contractors. The plant is targeting its commissioning in the fourth quarter, 2016.

(ii) Salient Features of the Facility of the System

	Technical Details of Equipment	
(a)	**Solar Panels - PV Modules**	
	Type of Module	Thin Film
	Type of Cell	CdTe semiconductor
	Dimension of each Module	1200mmX600mmX6.8mm
	Module Surface Area	0.72 m2
	No. of Panel/Modules	427,200

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	Total Module Area	180 Acres
	Total Land Area Used	225 Acres
	Panel's Frame	Aluminium alloy
	Weight of one Module	12 kg
	Module Output Warranty	From year 1 to 25th year
		Not exceeding 0.7% per annum of initial power output)except first year)
	Number of Solar Cells in each module	216
	Efficiency of module	16.00%
	Environment Protection System	
	Maximum Power (Pmax)	115W
	Voltage @ (Pmax)	70.5 V
	Current @ Pmax	1.63 A
	Open circuit voltage (Voc)	87.8 V
	Short circuit current (Isc)	1.78A
	Maximum system open Circuit Voltage	1500 V
(b)	**PV Array**	
	Nos. of Sub-array	100
	Modules in a string	24
	Total Nos. of Strings	17800
	Modules in Sub-Array	4272
	Total No. of Modules	427200
(c)	**PV Capacity**	
	Total	50 MWp
(d)	**Inverters**	
	Capacity of each unit	1000 MW
	Inverter Model	GEPSC-1000
	Manufacturer	
	Rated Input Voltage	DC900V
	Number of Inverters	45
	Total Power	45 MW
	Efficiency	98.2% Europe efficiency

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	Max. Allowable Input voltage	DC1500V
	Max. Current	DC input 1200A
	Max. Power Point Tracking Range	DC900V~DC1300V
	Output electrical system	AC Output range
	Rated Output Voltage	AC 550 V
	Rated Frequency	50HZ/60HZ
	Power Factor	>0.99 (Rated Power)

(iii) Proposed Investment

	In USD Million
Debt through Local financial Institutions	57.68
Equity injection by Sponsors	19.22
Total	**76.90**

(iv) The Social and Economic Impact of the Facility

The Project will help in the improvement of power supply position in the country, which is vital for economic growth as well as improving the quality of life. The improved power supply will reduce the dependence of general public and commercial establishments on Solar technology thereby reducing the air pollution at local levels.

The Project shall provide employment potential under unskilled, semi-skilled and skilled categories. The employment potential shall increase with the start of construction activities, reach a peak during construction phase and then reduce with completion of construction activities. During operation phase also there will be employment opportunities, mainly in the service sector. The employment opportunities with the project shall exist mainly with the contractors and sub-contractors. These agencies will be persuaded to provide the jobs to local persons on a preferential basis wherever feasible.

The sponsors will ensure that the activities during construction stage do not create adverse environmental effects. Contractor and sub-contractor will work

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in an environmental friendly manner under the supervision of HSE department of the sponsors. All the regulatory agencies including Punjab EPA will be contacted as and when required to get advice for environmental management and they will be kept informed of the environmental conditions of the area periodically by sponsors management and their contractors/sub-contractors.

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