#### CATALYST ENERGY PRIVATE LIMITED

24-DD Defence Housing Authroity
Phase V, Lahore
Pakistan

November 9, 2016

THE REGISTRAR

NEPRA Tower Attaturk Avenue (East),

SS Sector G-5/1,
Islamabad.

SUBJECT: <u>APPLICATION FOR A GENERATION LICENSE OF CATALYST ENERGY PRIVATE LIMITED FOR ITS</u>

100 MW SOLAR POWER PROJECT TO BE LOCATED IN THE QUAID-E-AZAM SOLAR PARK, CHISTIAN

I, Mr. MUHAMMED SOHAIL KHAN, CHIEF EXECUTIVE OFFICER being the duly authorized representative of CATALYST ENERGY PRIVATE LIMITED by virtue of Board Resolution dated SEPTEMBER 15, 2015, hereby apply to the National Electric Power Regulatory Authority (NEPRA) for the grant of a generation license to CATALYST ENERGY PRIVATE 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 abovesaid regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

A BANK DRAFT in sum of Rupees 343,940 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, has already been submitted along with our earlier application dated September 21,2015 and a copy of the same is enclosed while a PAY ORDER in sum of Rupees 23,280 being differential amount in applicable fee of Rupees 367,220 is enclosed herewith.

Sincerely,

MUHAMMED SOHAIL KHAN CHIEF EXECUTIVE OFFICER

CATALAYST ENERGY PRIVATE LIMITED

#### CATALYST ENERGY PRIVATE LIMITED

24-DD Defence Housing Authroity Phase V, Lahore Pakistan

EXTRACT OF THE MINUTES OF THE 1ST MEETING OF THE BOARD OF DIRECTORS OF CATALYST ENERGY PRIVATE LIMITED HELD AT 3PM ON SEPTEMBER 15, 2015

#### **BOARD RESOLUTIONS:**

The following resolutions were discussed in detail by the Board and approved unanimously:

"RESOLVED THAT CATALYST ENERGY PRIVATE LIMITED (a company incorporated under the laws of Pakistan with its registered office located at 24-DD Defence Housing Authority, Phase V, Lahore (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 100 MW solar power generation project to be located at QA Solar Park (QASP) near Chistian Punjab (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. Muhammed Sohail Khan as Chief executive officer and Mrs. QUDSIA HAMAYUN ALVI as DIRECTOR 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 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".

#### CATALYST ENERGY PRIVATE LIMITED

24-DD Defence Housing Authroity Phase V, Lahore Pakistan

"AND FURTHER RESOLVED THAT MR. MUHAMMED SOHAIL KHAN AS CHIEF EXECUTIVE OFFICER 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."

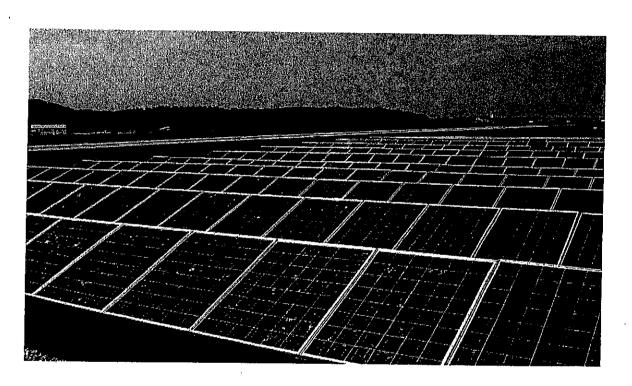
SIGNATURE OF

MR. MUHAMMED SOHAIL KHAN CHIEF EXECUTIVE OFFICER

CATALYST ENERGY PRIVATE LIMITED

# Prospectus

Catalayst Energy 100 MW Solar PV Power Plant Quaid-e-Azam Solar Park, Lal Sohanra, Chistian, Punjab, Pakistan



September 10th, 2015



The Project & Sponsors

StormHarbour Partners has formed Catalyst Energy Private Limited for the purpose of establishing a 100mw Solar Power Park in Pakistan. A Project Commitment Agreement was signed on March 10, 2015 and a guarantee for \$300,000 was submitted to Punjab Power Development Board on March 16, 2015. Land is being allocated at the Chistian site for the project.

The Project Site

The Project will be located in Quaid-e-Azam Solar Park, Chistian, Punjab, Pakistan. The Sponsors is in process of being allocated 500 acres of land in the Park for this purpose by the Revenue Department, Government of Punjab. Indicative coordinates of the land parcel, for insolation assumptions, are attached below:

Latitude:

29.52.77 N

Longitude:

72.84,10 E

Interconnection Study

An interconnection study for the project has been submitted to NTDC to ensure the Project operates in sync with the power purchaser's grid. The Project is expected to be connected at a voltage of 132kV to the existing network of the power purchaser. The interconnection study will provide information on load flows, short circuits, transients' stability and power quality.

Capacity / Generation

It is expected that in the first full year of operation, the 100 MW $_{\rm p}$  design shall deliver net 153 GWh of electricity to the grid after taking into account first year degradation and losses. Over the twenty-five years of planned operation the power plant is expected to generate 3500+GWh of electrical energy. These are estimates and the numbers shall be confirmed through a renowned international independent consultant.

Project Cost

The Project cost has been budgeted at USD 156 million (including interest during construction) for a gross capacity of  $100~\text{MW}_p$  as per initial estimates. The project will be financed on a non-recourse project finance basis under a 75:25 debt to equity ratio (equity may be 20-30% of the capital structure). The sponsors have the financial strength and expertise to arrange the required equity for the project. The Sponsors' and their advisor's long standing relationships with local and international financial institutions is testament to their capability to raise the required capital structure.

Technology & Conceptual Design

The plant will consist of a number of poly-crystalline photovoltaic modules installed in arrays in a number of strings. The number of modules will add up to a capacity of  $10 MW_p$ . The output from modules will be fed into inverters through combiner boxes.

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The number of inverters and their capacities will be in accordance with the expected AC output after losses, which will be simulated, based on satellite irradiation data. The AC output from inverters at 350-400 volts will be stepped up through MV step up transformers to 22kV. Thereafter, this output will be further stepped up from 22kV to 132kV. For this purpose, a complete 132kV substation will be established at the plant site as per the power purchaser's specification for interconnection of the grid system.

The plant will have an internal monitoring system to monitor the operation of the plant. In addition to this, equipment will be installed for connection of irradiation and temperature data at regular intervals. The SCADA system will be available for the control of the plant as a part of 132kV network. The protections at plant and other equipment will match the utility standards.

#### Construction Period

The estimated construction period for the Project by the EPC Contractor including detailed design and procurement/delivery of all materials is 9 - 12 months from Financial Close.

#### Other Studies

As part of the development of the project and its feasibility, the Sponsors have completed the detailed Feasibility Study, Initial Environmental Examination (IEE), Geotechnical Study and Topographic Survey.

#### **O&M Management**

The O&M will consist of routine operational checks via SCADA and local monitoring; check calibration and maintenance of electrical equipment, module cleaning and general groundwork and repairs. Most of the maintenance is expected to be planned, however a rapid response mechanism will be formulated to deal with unforeseen outages.

#### Health & Safety

The Plant and all systems forming part of it, shall be constructed and operated with safety as a prime consideration. The health and safety of all personnel, whether constructors, operators, maintenance workers or others, shall be of foremost consideration at all stages of the development, construction and operations and the Contractor and operators shall ensure that the safety of all is guaranteed during development, construction and operations.

#### Social Benefits

The Project is expected to result in job creation in an area of the country where opportunities away from agriculture are scarce. Bringing cutting edge technology through the Park will help create an ecosystem, that over time, will significantly enhance the quality of life of those in its vicinity. In addition, Catalyst Energy plans to partner with CARE Foundation to adopt 10-25 schools in the area to help bring about positive long term



change to the communities in which we operate. CARE is the largest educational NGO in Pakistan with 175,000 children enrolled in highly successful schools through private-public partnerships.

#### **Key Milestones**

The Sponsors' primary focus is to complete all activities to start construction well within the guidance provided by PPDB. Towards that end, we endeavour to proceed as follows:

Milestone	Completion
Feasibility Study Approved	July 2015
Generation License - Resubmission	November 2016
Upfront Tariff Approval - Resubmission	November 2016
Signing of EPA/IA	December 2016
Financial Close	December 2016
Project COD	October 2017

### Annexure – I

# PROJECT INFORMATION

# Schedule III of the Licensing Regulations

# 1. Location (location maps, site map) and Land Details

The Main Sponsors are being allocated 500 acres of land in the Quaid-e-Azam Solar Park off of Chistian - Dharanwala highway, approximately 6km south of Dahranwala town.

#### Indicative Coordinates:

29°31'45.81"N 72°48'44.50"E

29°31'21,92"N 72°48'44,43"E

29°31'22.01"N 72°49'58.91"E

29°31'31.81"N 72°50'11.33"E

29°31'32.30"N 72°50'48.16"E

29°31'51.33"N 72°50'48.12"E

29°31'56.30"N 72°50'37.13"E

29°31'51.09"N 72°49'59,04"E

29°31'47.00"N 72°49'39,73"E

### 2. Technology & Plant Details

#### General Information

(i).	Name of Licensee	Catalyst Energy Private Limited
(ii).	Registered/ Business Office	24-DD Defence Housing Authority, Lahore Pakistan
(ifi).	Plant Location	Quaid-e-Azam Solar Park, Chistian, Punjab, Pakistan.
(iv).	Type of Generation Facility	Solar Photovoltaic (PV)



#### Solar Power Generation Technology & Capacity Technical Details of Equipment (At Each Site)

(a). Solar Panels - PV Modules			
1	Type of Module	CS6P-250P	
2	Type of Cell	crystalline silicon	
3	Dimension of each Module	approx. 1,638 mm x 982 mm	
4	Module Surface Area	approx. 1.6085 m²	
5	No. of Panel /Modules	approx. 400,000	
6	Total Module Area	approx. 643,406 m <sup>2</sup>	
7	Total Land Area Used	approx. 2 km²	
8	Panel's Frame	aluminium frame	
9	Weight of one Module	approx. 19 kg	
10	Module Output Warranty	For year 1 to 2,5 <sup>th</sup> year	
		Not exceeding 0.7% per annum of initial power output	
11	Number of Solar Cells in each module	60	
12	Efficiency of module	approx. 15.54%	
13	Environment Protection System	ISO14001:2004, QC08000HSPM, REACH-conformity	
14	Maximum Power (P <sub>max</sub> )	approx. 250 Wp	
15	Voltage @ (P <sub>max</sub> )	approx. 30.1 V	
16	Current @ P <sub>max</sub>	approx. 8.3 A	
17	Open circuit voltage (V <sub>oc</sub> )	approx. 37.2 V	
18	Short circuit current (I <sub>sc</sub> )	approx. 8.87 A	
19	Maximum system open Circuit Voltage	1000 V (IEC) / 600 V (UL)	

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}	PV Array	······································	
1	Nos. of Sub-array	арргох. 180	
2	Modules in a string	22	
3	Total Nos. of Strings	18,180	
4	Modules in Sub-Array	approx. 2,222	
5	Total No. of Modules	approx. 400,000	
(b).	PV Capacity		
1	Total	100 MW <sub>p</sub>	
	Inverters		
1	Capacity of each unit	500 kW AC	
2	Inverter Model	Protect PV.500	
3	Manufacturer	AEG	
4	Rated Input Voltage	not applicable	
5	Input Operating Voltage Range	approx. 345 V up to 1,000 V	
6	Number of Inverters	180	
7	Total Power	approx. 510 kVA @ 50°C	
8	Efficiency	Max. 98.3%, Euro 98.1%, CEC 98%	
9	Max. Allowable Input voltage	approx. 1000 V DC	
10	Max, Current	approx. 1000 A DC, approx. 1144 A AC	
	Max. Power Point Tracking Range	approx. 500 V up to 820 V	
11	Output electrical system	three phases	
12	Rated Output Voltage	approx. 283 V AC	
13	Rated Frequency	50 / 60 Hz	
4	Power Factor	-0.9 up to +0.9	
5	Power Control	depending on requirements	
6	Environmental Enclosures	Operating -20°C up to +50°C	

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		Range		
		Relative Humidity	15% up	to 95% non condensing
		Audible Noise	60 db(A	)
		Operating Elevation	1,500 m	n, 3,000 m max. 40°C
		Warranty Period	5 years	
		(a).	anti isla	nding protection
		(b).	voltage	regulation
		(c).	frequenc	cy regulation
,,,	Grid Operation	(d).	voltage a	and frequency fault ride through
17	Protection	(e).	steady st	on of voltage fluctuation and of tage voltage changes up to 2% of inal value
		(f).	limitatio	on of short circuit current
		(g).	limitation of current harmonics and higher frequency components up to 9 kl-	
	Junction Boxes Install	led and fixed on mair	n steel stru	ucture in Array yard.
1	Number of J/Box units	i	to be sel	lected
2	Input circuits in each b	DOX	to be sel	lected
3	Max. input current for	each circuit	to be selected to be selected	
4	Max. input voltage			
5	Power at each box	······································	to be sel	lected
6	Protection Level		to be sel	lected
	Overcurrent protection		to be sel	lected
	Output switch		to be selected	
	Surge protection		to be selected	
	Data Collecting System	m	<u> </u>	-
1	Weather Data		(i).	Pyranometer— 4 Sets (Incline to record irradiation level)

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		(ii). The	rmometer - 4 Sets (to ord ambient temp)
1			nput voltage(V) & current of each Inverter (Phase, )
			l DC power (kW) rated by PV array.
		(iii). curre	utput voltage(V) and ent (A) of each Inverter se, Total)
2	System Data	(iv). AC of energy	utput power (kW) and gy (kWh) of each Inverter
		(v). Frequ	uency (Hz)
		(vi). Powe	r Factor (PF)
		(vii). Temp	erature inside inverter n
	Isolating Transformer		
1	Rating	to be selected (from 0.5 up to	2 MVA)
2	Type of Transformer	to be selected (oil cooled)	
3	Input voltage	283 V	,
4	Output Voltage	to be selected (depending on applicable grid voltage)	
5	Purpose of Transformer	step up of AC vo	ltage
6	Efficiency	to be selected (approx. 98%)	
	Outdoor Cubicle Control Room		
<del></del>	Data record	Continuous loggii software	ng with data logging
2	Control Room System	Computerized da	ta acquisition system
3 .	Control room System Detail	Interfacing Hardy Industrial Type P	ware & Software, C, which will be robust



		& rugged suitable to operate in the Control Room environment
	Mounting Structure	
1.	Structure	fix tilted
2	Tilt of Array Frame	24° up to 28°
3	Array Specification	Certified for wind and seismic requirements
·-	Foundation Pillars/Piling	
1	No, of Foundations	to be selected according to structure design
2	Foundation Structure	to be selected (screw piles or ramming piles)

#### 3. Interconnection Study

An interconnection study for the Project, conducted by Power Planners International, has been submitted to NTDC. The report investigates the grid connection scheme for the Project and it is expected that the Project will connect to the NTDC grid at the nearest possible point and includes information on load flows, short circuits, transient stability etc.

#### 4. Infrastructure

The Project is located in the Quadi-e-Azam Solar Park, off of Chistian - Dharanwala highway, approximately 6km south of Dahranwala town. GOPb will be building out the infrastructure, inclduing dual carriage access road, internal roads, security etc.

#### 5. Project Cost

The total Project cost, is estimated to be \$156 million, with an EPC component of approx. \$140 million. The Project cost is budgetary in nature and subject to change as final EPC proposals are received. We will be using a US or European EPC for the project. The breakup of the Project Cost is summarized as follows:

		USD million
1	Total EPC Cost (US/European EPC)	140
2	Other Costs (Development, Non-EPC, Insurance, Financing)	13
3	Interest during Construction	3
4	Total Project Cost	156

The total Project cost of approximately \$156 million is to be financed with a combination of debt and equity. Based on initial discussions with financial institutions, the Company is likely to finance the Project on the basis of a Debt: Equity ratio of 75:25. However, the final equity component may range from 20-30%. The debt amount is expected to be in foreign currency with interest payable quarterly on the basis of 3-Month-prevailing LIBOR plus 450 basis points. The term of the loan is expected to be 10 years plus construction period. Principal repayment and interest payment is expected to be on the basis of 40 quarterly installments starting from scheduled commercial operations.

All equity injection required for the Project will be arranged by the Main Sponsor.

#### 6. Project commencement and completion schedule with milestones

Milestone	Timing
Approval of Feasibility Study	July 2015
Generation License November 2016	
Upfront Tariff Approval November 2016	
Signing of EPA/IA December 2016	
Financial Close December 2016	
Project COD	October 2017

#### 7. ESSA (Environmental and Social Soundness Assessment)

The energy sector of Pakistan relies heavily on imported fuels for generation of electricity, much of which has a significant carbon footprint. Solar power allows for a reduced carbon footprint, low gestation power generation whilst moving the country towards fuel independence. In addition, it reduces the volatility within the fuel mix attributable to input costs of conventional power. The operational environmental impacts of solar power generation are almost zero and largely consist of the minor impact that the O&M practices introduce. Whilst there is an impact to the environment through setting up of a solar project, this is much more manageable than the comparative impact of a conventional thermal plant. The emissions to land, water or air are almost insignificant and use of solar power, in comparison to a plant that emits pollutants.

An initial Environmental Examination (IEE) has been conducted by ECSP for the Project. The IEE demonstrates that such a project will have multiple positive impacts and negligible negative impacts to the existing environment

The detailed IEE has been submitted to the Environmental Protection Department for their approval.

#### SOCIAL IMPACT

The Project is expected to result in job creation in an area of the country where opportunities away from agriculture are scarce. Bringing cutting edge technology through the Park will help create an ecosystem, that over time, will significantly enhance the quality of life of those in its vicinity.

In addition, Catalyst Energy plans to partner with CARE Foundation to adopt 10-25 schools in the area to help bring about positive long term change to the communities in which we operate. CARE Foundation is the one of largest and most well respected educational sector NGO in Pakistan with 175,000 children enrolled through private-public partnerships.

#### 8. Safety plans, emergency plans

#### SAFETY

#### Health, Safety & Environment (HSE) Protection & Policies

The health and safety of those who work for us are of paramount importance. The company is committed to maintaining the highest safety standards commensurate with a plant of this size. To ensure across the board compliance, the Company will also require its contractors to follow the Company's HSE policy or develop comprehensive standards on their own.

#### Environment

The Project Company will actively encourage its employees and contractors/subcontractors to contribute to waste reduction. In the permanent workspaces, a predefined set of measures to reduce consumption of electricity, water and paper will be put in place.

At the construction sites, the Company will maintain a high level of housekeeping. All employees, contractors & subcontractors will be required to ensure that no waste (hazardous or otherwise) is left behind without proper handling. All employees and contractors/contractors will be expected to demonstrate a high level of care when handling solar modules, inverters and cables to minimise waste from breakage. Hazardous materials will be identified before they enter the site and the proper disposal of any hazardous waste will be monitored.

#### 9. System studies: load flow, short circuit, stability, reliability

An interconnection study has been submitted by our consultants, Power Planners International (PPI), to NTDC. The study contains the results for the relevant system studies such as Load Flow, stability and reliability.

10. Plant characteristics: generation voltage, frequency, power factor, automatic generation control, ramping rate, time(s) required to synchronize to grid

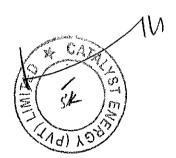
Please refer to Plant Technical details in Section above

#### 11. Control, metering, instrumentation and protection

Please refer to Plant Technical details in Section above

#### 12. Training and development

Catalyst Energy will constantly being investing in its people. Through ongoing training and development we seek to ensure enhanced productivity, job enrichment, career mobility and development. We will also be entering into a collaboration agreement with a leading global EPC to ensure appropriate transfer of technology.



## ANNEX - I (A) & (B) of the Licensing Regulations

### 1. Technology & Plant Details

#### **General Information**

(i).	Name of Licensee	Catalyst Energy Private Limited
(ii).	Registered/ Business Office	24-DD Defence Housing Authority, Lahore Pakistan
(iii).	Plant Location	Quaid-e-Azam Solar Park, Chistian, Punjab, Pakistan.
(iv).	Type of Generation Facility	Solar Photovoltaic (PV)

#### Solar Power Generation Technology & Capacity Technical Details of Equipment (At Each Site)

(a).	Solar Panels - PV Modules		
1	Type of Module .	CS6P-250P	
2	Type of Cell	crystalline silicon	
3	Dimension of each Module	approx. 1,638 mm x 982 mm	
4	Module Surface Area	approx. 1,6085 m²	
5	No. of Panel /Modules	approx. 400,000	
6	Total Module Area	approx. 643,406 m <sup>2</sup>	
7	Total Land Area Used	approx. 2 km²	
8	Panel's Frame	aluminium frame	
9	Weight of one Module	approx. 19 kg	
10	Module Output Warranty	For year 1 to 25 <sup>th</sup> year	
		Not exceeding 0.7% per annum of initial power output	
11	Number of Solar Cells in each module	60	
12	Efficiency of module	approx. 15.54%	
13	Environment Protection System	ISO14001:2004, QC08000HSPM, REACH-conformity	

14	Maximum Power (P <sub>max</sub> )	approx. 250 Wp
15	Voltage @ (P <sub>max</sub> )	approx. 30.1 V
16	Current @ P <sub>max</sub>	approx. 8.3 A
17	Open circuit voltage (V <sub>oc</sub> )	approx. 37.2 V
18	Short circuit current (I <sub>sc</sub> )	approx. 8.87 A
19	Maximum system open Circuit Voltage	1000 V (IEC) / 600 V (UL)

	PV Array				
1	Nos. of Sub-array	approx. 180			
2	Modules in a string	22			
3	Total Nos. of Strings	18,180			
4	Modules in Sub-Array	approx. 2,222	_		
5	Total No. of Modules	approx. 400,000	_		
(b).	PV Capacity				
1	Total	100 MW <sub>p</sub>			
	Inverters				
1	Capacity of each unit	500 kW AC	_		
2	Inverter Model	Protect PV.500			
3	Manufacturer	AEG			
4	Rated Input Voltage	not applicable			
5	Input Operating Voltage Range	approx. 345 V up to 1,000 V			
6	Number of Inverters 180		-		
7	Total Power	approx. 510 kVA @ 50°C			
8	Efficiency Max. 98.3%, Euro 98.1%, CEC 98%				
9	Max. Allowable Input voltage	approx. 1000 V DC	-		
10	Max. Current	approx. 1000 A DC, approx. 1144 A AC			

<del></del>	Max. Power Point Tracking Range	approx. 500 V u	p to 820 V		
11	Output electrical system	three phases			
		three phases			
12	Rated Output Voltage	approx. 283 V AC			
13	Rated Frequency	50 / 60 Hz			
14	Power Factor	-0.9 up to +0.9			
15`	Power Control	depending on requirements			
		Operating Temperature Range	-20°C up to +50°C		
47	Environmental Enclosures	Relative Humidity	15% up to 95% non condensing		
16		Audible Noise	60 db(A)		
		Operating Elevation	1,500 m, 3,000 m max. 40°C		
		Warranty Period	5 years		
	Grid Operation Protection	(a).	anti islanding protection		
		(b).	voltage regulation		
•		(c).	frequency regulation		
		(d).	voltage and frequency fault ride through		
17		(e).	limitation of voltage fluctuation and of steady stage voltage changes up to 2% of the nominal value		
		(f).	limitation of short circuit current		
		(g).	limitation of current harmonics and higher frequency components up to 9 kHz		
	Junction Boxes Installed a	and fixed on mai	n steel structure in Array yard.		
1	Number of J/Box units		to be selected		
2	Input circuits in each box		to be selected		
3	Max. input current for each circuit		to be selected		
4	Max. input voltage		to be selected		
5	Power at each box		to be selected		
6	Protection Level		to be selected		
	Overcurrent protection		to be selected		

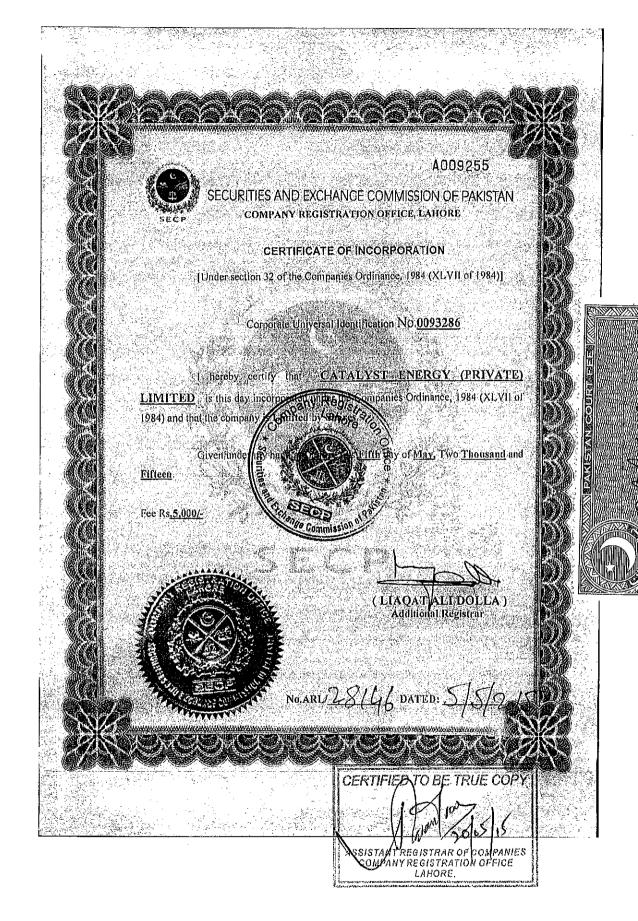
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	Output switch	to be selected  to be selected				
	Surge protection					
	Data Collecting System					
		(i).	Pyranometer— 4 Sets (Incline to record irradiation level)			
1	Weather Data	(ii).	Thermometer - 4 Sets (to record ambient temp)			
		(i).	DC input voltage(V) & current (A) of each Inverter (Phase, Line)			
		(ii).	Total DC power (kW) generated by PV array.			
		(iii).	AC output voltage(V) and current (A) of each Inverter (Phase, Total)			
2	System Data	(iv).	AC output power (kW) and energy (kWh) of each Inverter			
		(v).	Frequency (Hz)			
		(vi).	Power Factor (PF)			
		(vii).	Temperature inside inverter station			
**	Isolating Transformer					
1	Rating to be selected (from 0.5 up to 2 MVA)					
2	Type of Transformer		to be selected (oil cooled)			
3	Input voltage	283 V	283 V			
4	Output Voltage	<b>I</b>	to be selected (depending on applicable grid voltage)			
5	Purpose of Transformer	step up	step up of AC voltage			
6	Efficiency	1	to be selected (approx. 98%)			

	Outdoor Cubicle Control Room	
1	Data record	Continuous logging with data logging software
2	Control Room System	Computerized data acquisition system
3	Control room System Detail	Interfacing Hardware & Software, Industrial Type PC, which will be robust & rugged suitable to operate in the Control Room environment
	Mounting Structure	
1	Structure	fix tilted
2	Tilt of Array Frame	24° up to 28°
3	Array Specification	Certified for wind and seismic requirements
	Foundation Pillars/Piling	
1	No. of Foundations	to be selected according to structure design
2	Foundation Structure	to be selected (screw piles or ramming piles)

### Annexure – II

# CERTIFICATE OF INCORPORATION



### Annexure – III

# MEMORANDUM AND ARTICLES OF ASSOCIATION

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THE COMPANIES ORDINANCE, 1984

(Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

OF

#### CATALYST ENERGY (PRIVATE) LIMITED

#### I. NAME

The name of the Company is CATALYST ENERGY (PRIVATE) LIMITED (the "Company").

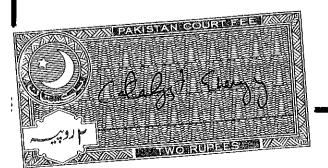
#### II. REGISTERED OFFICE

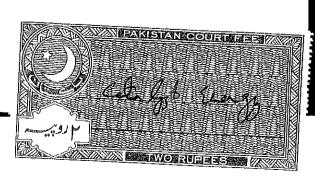
The registered office of the Company will be situated in the Province of Punjah, Pakistan.

#### III. OBJECTS

The objects for which the Company is established are to undertake all following:

1. To carry on the business of establishing, operating and managing electric power generating projects and transmission systems for the generation and supply of electric power, in any manner that may be deemed necessary and expedient by the Company, including but not restricted to setting up of thermal power plants, wind power plants, hydro electric power plants, solar power plants, biomass power plants, biogas power plants, other renewable energy plants and to manufacture, assemble, acquire and supply all necessary power stations, transmission systems, control systems, cables, wires, lines, accumulators, lamps and works to generate, accumulate, distribute and supply electricity to customers, both public and private, including but not limited to villages, cities, towns, streets, docks, markets, theatres, buildings, industries, plants, utilities and places, both public and private, and for all other purposes for which energy can be utilized or is required, subject to permission from the relevant authority/NEPRA...





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- To acquire, manufacture, produce, use, sell and supply electricity for lighting, heating
  or power purposes and to deal with, manufacture and render saleable all residual
  products obtained in the production of electric power subject to permission from the
  relevant authority/NEPRA.
- 3. To enter into any arrangements with the Government of Pakistan, Provincial Governments, the Alternative Energy Development Board or its successors-in-interest, Private Power & Infrastructure Board or any other Federal or Provincial department, operating under Ministry of Water & Power or any autonomous/semi -autonomous body and or with private sector power consumers/buyers for the purpose of providing, generating and distributing power and energy, if any or any other provincial or local government or with any supreme, national, municipal or local authority, autonomous region if any or with any person, and at any place where the Company may have interest that may seem conducive to the Company's objects, or any of them in any mode and to obtain from such government or authority, or other persons any right, privilege and concession which the Company may think is desirable to obtain and to carry out, exercise and comply with any such arrangement, right, privilege and concession.
- 4. To purchase or otherwise acquire, generate, sell, supply, market, distribute and transmit electric energy and perform services and operations related thereto or do all such other things as may be deemed incidental or conducive to the attainment of the said objects or egistration convenient or advantageous in connection therewith, subject to permission from the ahore relevant authority/NEPRA.
- 5. To locate, establish, construct, equip, operate, use, manage and maintain spar power plant, power grid station, transforming, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops, dispensing machines for pre-payment cards and other devices, showrooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities, subject to permission from the relevant authority/NEPRA.
- 6. To carry on all or any of the businesses of wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturers, installer, filters, testers, repairers, maintainers, contractors, constructors, operators, users, inspectors, reconditioners, improvers, alterers, protectors, removers, hirers, replacers, importers and exporters of and dealers in, electrical appliances, systems, products and services used for energy conservation, equipments, machinery, materials and installations, including but not limited to cables, wires, meters, pylons, tracks, rails, pipelines and any other plant, apparatus equipment, systems and things incidental to the efficient generation, procurement, transformation, supply and distribution of electricity.
- 7. To undertake the business of consultants of power generation, and to grant rights or privileges in respect of, or otherwise deal with all or any part of the property and rights including engineering, designs, intellectual and tangible property, and to establish laboratories, research and development centers to perform such research and development as the Company may deem advisable or feasible, and to expend money or experimenting upon and testing

and improving or securing any processes, patent or protecting any invention or inventions which the Company may acquire or propose to acquire or deal with.

- 8. To ascertain the tariff for bulk supply that will secure recovery of operating costs, interest charges and depreciation of assets, redemption at due time of loans, expansion projects, payment of taxes, and return on investment, to quote the tariff to bulk purchasers of electrical power, and to prefer petition to the appropriate authority for approval of the schedule of tariff and of adjustments or increases in its bulk supply tariff, where desirable or necessary.
- 9. To construct, own, purchase, acquire, take on lease, build, erect, install, establish, operate, manage and maintain plants, laboratories, equipment, apparatus and other facilities for the generation, transmission, sale and distribution of electrical energy and its allied parts, equipments and resources.

10. To import, buy, own, install or otherwise procure plants, machineries and other equipments and to forge machine parts in the Company's workshop or to take on rental plants, machineries and other equipments for the purposes for which the Company is established and/or dispose off such plants, machineries and spare parts which have reation of becomes obsolete or worn out.

11. To pay all costs, charges and expenses, if any, incidental to the promotion, formation registration and establishment of the company.

- 12. To acquire or undertake the whole or any part of the business, goodwill, and assets of any person, firm or company carrying on or proposing to carry on any of the business Exchant which the Company is authorized to carry on and as part of the consideration for such acquisition to undertake all or any of the liabilities of such person, firm or company, or to acquire an interest in, amalgamate with, or enter into partnership or into any arrangement for sharing profits, or for cooperation, or for mutual assistance with any such person, firm or company, or for subsidising or otherwise assisting any such person. firm or company, and to give or accept, by way of consideration for any of the acts or things aforesaid or property acquired, any shares, debentures, debenture stock or securities that may be agreed upon, and to hold and retain, or sell, mortgage, and deal with any shares, debentures, or debenture stock so received.
- 13. To acquire, purchase, take on lease, hire, exchange, sell transfer, convey or dispose of any moveable and immovable property rights and privileges on such terms and conditions as the Company may think necessary or convenient for the purposes of its Business, and to manage, construct, repair, develop, mortgage, charge, sell, turn to account, grant licences, options and rights and privileges in respect of or otherwise deal with all or any part of the property and rights of the Company necessary or convenient for the purposes of the business of the Company.
- 14. To enter into agreement(s) with any individual, firm, co-operative or other society, company, corporate body, Government or local authority or other legal entity necessary or expedient for the purpose of carrying on the business of the Company.

- 15. To purchase or otherwise acquire become interested in, deal in and with, invest in, hold, sell, mortgage, pledge or otherwise dispose of, turn to account or realize upon, all forms of securities, including stocks, bonds, debentures, notes, evidences of indebtedness, securities of any nature or form convertible into all exchangeable for other securities of any nature or forms, certificates of interest, participation certificates, voting trust certificates and certificates evidencing shares of or interest in trusts and trusts estates or associations, certificates of trust of beneficial interests in trust, mortgages and other instruments, securities and rights but not to act as an investment company.
- 16. To institute, participate or promote commercial, mercantileand industrial enterprises and operations directly or indirectly related to power sector or otherwise.
- 17. To supply to any transmission and distribution companies, governmental or autonomous bodies, cities, towns, villages, communities and the inhabitants thereof, corporations, partnerships, individuals, places of amusement or exhibitions, or any two or more of either or same with water, light, heat, gas and/or electric power and to do any and all things incidental, necessary, and/or proper in furtherance of and/or in connection with the foregoing objects and purposes.

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18. To subscribe for, take, purchase, or otherwise acquire, hold, sell and dispose of, shares, debentures, debenture stocks, bonds, obligations or securities issued or guaranteed by any other company constituted or carrying on business in any part of the world, and depentures, debenture stocks, bonds obligations or securities issued or guaranteed by any government or authority, municipal, local or otherwise, in any part of the world, but notice act as an investment company.

remunerate any person, firm or company rendering services to the Company either by cash payment or by the allotment to him or them of shares or other securities of the Company credited as paid up in full as may be thought expedient.

- 20. To buy, take on lease, sell, exchange or otherwise acquire and to construct, lay, maintain and operate facilities and other conveyers for the transportation/supply of electric power and other substances.
- 21. To buy, sell, manufacture, store, repair, alter, improve, exchange, hire, import, export and deal in all factories, works, plant machinery, tools, utensils, aircrafts, vehicles, appliances, apparatus, products, materials, substances, articles and things capable of being used in any business which this Company is competent to carry on or required by any customers of or persons dealing with the Company or commonly dealt with by persons engaged in any such business or which may seem capable of being profitably dealt with in connection therewith and to manufacture, experiment with, render marketable and deal in all products of residue and by-products incidental to or obtained in any of the businesses carried on by the Company.
- 22. 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, dispose of and turn to account concession, grants, decrees, licenses, privileges, claims, options, property (movable or immovable), or rights or powers of any kind which may appear to be necessary or convenient for any business of the

Company or for purposes of investment or re-investment and to purchase, charter, hire, build or otherwise acquire vehicles of any or every sort or description and to use the same for carriage of merchandise or passengers of all kinds and to carry on the business of owners of trucks, lorries, motor-cars and aircraft in all or any of their respective branches.

- 23. To construct and provide or otherwise acquire, whether by purchase, take on lease or otherwise, residential accommodation for persons engaged in the business of the Company.
- 24. To appropriate any part or parts of the property of the Company for the purposes of, and to build offices find other places of business.
- 25. To promote and form other companies for undertaking any business in accordance with the law and to take or otherwise acquire, hold shares, debentures or other securities of any such company and to subsidize or otherwise assist any such company.
- 26. To obtain all powers and authorities necessary to carry out or extend any of the objects herein including any other business which is permissible under the laws of land.

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27. To take or otherwise acquire and hold shares, stock, debentures, debenture stock and/or acquire and undertake the whole or any part of the business, property or liabilities of 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 tenefathis Company.

Solution of interest, co-operation, joint-ventures, reciprocal concessions, or otherwise with any individual, first co-operative or other company, association, corporate body, research and education institutions, affiliates, Government or local authority or other legal entity whether national or not, as may be necessary or expedient for the purpose of carrying on any business of the Company.

- 29. To open, close and operate bank accounts of the Company with any bank or banks and to draw, make, accept, endorse, discount, execute and issue promissory notes, bills of exchange, bills of lading, warrants, debentures and other negotiable or transferable instruments and do any banking transactions which may be deemed appropriate in the best interest of the company.
- 30. To borrow money and to receive the proceeds of loans and to secure payment of money in such manner as the Company may decide is necessary for realization of the purposes mentioned above and in particular by:
- (i) the issue of perpetual or redeemable and convertible or nonconvertible PTCs, TFC s and like instruments and finances under the interest free system such as finances by purchase of movable and immovable properties, securities and instruments with buy back agreements including sukuks and other Islamic modes of financing instruments, debentures or debenture stock (perpetual or otherwise), bonds, promissory notes, bills of exchange and such other securities;

- (ii) furnishing undertakings and guaranteeing the performance by the Company or on behalf of its any associate/ sister concern company of any obligation undertaken by the Company or its associate/sister concern company as the case may be, depositing securities, shares and documents of title;
- (iii) hypothecating, charging and mortgaging all or any of the properties and assets (both present and future, movable and immovable) of the Company and creating pledge, liens or any other security, on any part of the property or assets of the Company (both present and future) such properties on the condition that such transactions shall not effect the performance of the Company; and
- (iv) appointing attorneys, counsels and giving them powers and authority for executing documents, registering documents, selling and managing the properties, undertaking any business of the Company and furnishing and creating such other securities as may be considered expedient; and for the purposes aforesaid, or otherwise, execute, complete and deliver agreements and such other documents as may be required;
- 31. To guarantee the payment of money and the performance of contracts of engagement of the Company and to secure the payment of money and the performance of any contracts or engagements entered into by the Company and to discharge any debt or any obligations of or binding upon the Company by a mortgage or charge upon all or any office \*part of the undertaking, property and rights of the Company (either present or future or both) or by the creation or issue of bonds debentures stocks, pledges, liens or any other securities or by any other means.

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- of graphtee the payment of money unsecured or secured by or payable under or in respect of promissory notes, bonds, debentures, debenture stock (perpetual or otherwise), contracts, mortgages, charges, obligations, instruments and securities of the Company and generally to guarantee or become sureties for the performance of any securities contracts or obligations concerning the business of this Company.
  - 33. To draw, make, accept, endorse, seal, execute, negotiate, purchase, hold and dispose of cheques, promissory notes, bills of exchange, drafts, charter parties, bills of lading, warrants and other negotiable documents and contracts, deeds and other instruments and to cancel and vary such instruments, relating to the business of the Company.
  - 34. To apply for purchase or otherwise acquire and protect and renew in any part of the world any patent, patent rights, brevets d'invention trademarks, designs, licences, concessions, and the like, conferring any exclusive or non-exclusive or limited right to their use, or any secret or other information as to any invention 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 or grant licences in respect of, or otherwise turn to account the property, rights or information so acquired, and to expend money in experimenting upon, testing or improving such patents, inventions or rights, and to sell any patent rights or privileges belonging to the Company, or which may be acquired by it, or any interest in the same, and to grant licences for the use and practice of the same or any of them and to let or allow to be used or to otherwise deal with any inventions, patents or privileges in which the Company may be interested, and to do all such acts and things

as may be deemed expedient for turning to account any inventions, patents and privileges in which the Company may be interested.

- 35. To establish and operate provident funds, gratuity or any other retiring benefits for the employees and to establish and support or aid any schools and any educational, scientific, literary, religious or charitable institutions or trade societies whether such societies be solely connected with the trade carried on by the Company or not, and any club or other establishment calculated to advance the interests of the Company or its employees.
- 36. To subscribe money for any national, charitable, benevolent, public, general or useful object or for any exhibition.
- 37. To provide services to any business or concern that the Company may find convenient or advantageous and to do any kind of commercial and agency business.
- 38. To transact or carry on all kinds of agency, commission and contract business in particular in relation to industry and to act as agents of any person, firm, company, Government or local authorities, but to not act as managing agent.
- 39. To accept stock or shares in, debentures, mortgage-debentures or other securities of any other company in payment or part payment for any services rendered or for any sale made to or debt owing from any such company.

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To improve, develop, sell, exchange, take on lease, mortgage, pledge, hypothecate, assign, transfer, dispose of turn to account or otherwise deal with, all or any part of the present and future property, assets, equipment, immovable and movable, corporeal or improporeal, tangible or intangible and any right, title and interest therein of the company, including rights, licence, privileges, concessions, easements and franchises as may seem expedient.

- 41. To payout of the funds of the Company all expenses of and incidental to the formation, registration, advertisement of the Company and the issue and subscription of the share or loan capital including brokerage and/or commission for obtaining applications for or placing of shares or any debentures, debenture stock and other securities of the Company and also all expenses relating to the issue of any circular or notice and the printing, stamping and circulating of proxies and forms to be filled up by the members of the Company.
- 42. To pay for rights or property acquired by the Company and to remunerate any person or company whether by cash payment or by the allotment of shares, debentures or other securities of the Company as fully paid up.
- 43. To adopt such means of making known the business, services and products of the Company as may seem expedient and in particular by undertaking seminars, training and demonstration programs and by advertising in the press, media and internet by circulars and by purchase and exhibition of works of art or interests, by publication of books and periodicals and by granting prizes, rewards and donations.

- 44. To establish and maintain or procure the establishment and maintenance of any contributory or non-contributory pension or superannuation funds for the benefit of and give or procure the giving of donations, gratuities, pensions, allowances or emoluments to any persons who are or were at any time in the employment or service of the Company, and also to establish and subsidize and subscribe to any institutions, associations, clubs or funds calculated to be for the benefit of or to advance the interests and well being of the Company or of any such other company as aforesaid and do any of the matters aforesaid, either alone or in conjunction with any such other company as aforesaid.
- 45. To open branches, liaison offices, register the Company and to undertake all or any of the business of the Company in any part of the world and to become a member of various associations and trade bodies whether, in Pakistan or abroad.
- 46. To apply for and obtain necessary consents, permissions and licences from any Government, State, Local and other national or international authorities for enabling the Company to carry any of its objects into effect or for extending any of the powers of the Company or for effecting any modification of the constitution of the Company or for any other purpose which may seem expedient, and to oppose any proceedings or applications which may seem cancelled, directly or indirectly to prejudice the interests of the Company

To enter into arrangements with any Government or authorities, central, provincial, municipal, local or otherwise, public or quasi-public bodies or with any natural persons and legal entities, in any place where the Company may have interests that may seem conducive to the objects of the Company or any of them or to obtain from such Georgen authorities or persons, any rights, privileges and concessions which the Company may think fit to obtain and to carry out exercise and comply therewith for the purposes of the Company.

- 48. To adopt such means of making known the products of the Company as may seem expedient, including, in particular, by advertisement in the press, circulars, purchase and exhibitions of work of art or interests, publication of books and periodicals.
- 49. To insure the property, assets and employees of the Company in any manner deemed fit by the Company, and to create any reserve fund, sinking fund, insurance fund, or any other special fund whether for depreciation or for repairing, insuring, improving, extending or maintaining any of the property of the Company or for any other purpose conducive to the interests of the Company.
- 50. To invest the surplus monies of the Company, not immediately required, in any manner as may from time to time be determined and to hold or otherwise deal with such investment made.
- 51. To advance money or give credit to such persons or companies, with or without security, and on such terms as the Company may approve, in particular to customers and others having dealings with the Company.

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- 52. To import, export, buy, sell, own, install and/or rent machinery and other equipment, goods, materials, raw materials and spare parts required for or in connection with the business of the Company.
- 53. To enter into partnership or other joint venture or co-operation with any person or company or other legal entity, local or foreign, carrying on or engaged in any business or transaction which this company is authorized to carry on or engage in, or otherwise assist any such person or company or legal entity and/or to buy, purchase wholly or partially the shareholding or enter into a collaboration arrangement with any other power generating company or business concern, on such terms which are best for the company.
- 54. To receive, declare and distribute profits and to capitalize such portion of the profits of the Company as are not distributed among shareholders of the Company, in the form of dividends, and as the Company may think fit, and to issue bonus shares, as fully paid up in favor of the shareholders of the Company.
- 55. To file any documents required to be filed under law, and to pay any fees, charges, expenses, rents, taxes, duties and other dues payable in connection with the business or operation of the Company.

56. To amalgamate, consolidate, or merge, with a view to affecting a union of interests, 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 the Company is authorized to carry on.

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To improve, manage, develop, grant, rights or privileges in respect of or otherwise deal with all or any part of the property.

accept, buy, sell, market, supply, transfer (including transfer of actionable claims) or deliver any and every kind of moveable property for such price and subject to such terms, conditions and warranties as the Company may think fit.

- 59. To sell, improve, manage, develop, exchange, mortgage, enfranchise, dispose of, turn to account, or otherwise deal with, all or any part of the property, assets or undertaking of the Company for such consideration as the Company may think fit, and in particular for shares, debentures, or other securities of any other company whether or not having objects altogether or in part similar to those of this Company.
- 60. To guarantee the performance of contracts, agreements, obligations or discharge of any debt of the company or on behalf of its any associate/ sister concern company or person in relation to the payment of any financial facility including but not limited to loans, advances, letters of credit or other obligations through creation of any or all types of mortgages, charges, pledges, hypothecations, on execution of the usual banking documents or instruments or otherwise encumbrance on any or all of the movable and immovable properties of the company, either present or future or both and issuance of any other securities or sureties by any other means in favour of banks, Non-Banking Finance Companies (NBFCs) or any financial institutions and to borrow money for purpose of the company on such terms and conditions as may be considered proper.

- 61. To settle disputes by negotiation, conciliation, mediation, arbitration, litigation or other means and to enter into compromise with creditors, members and any other persons in respect of any difference or dispute with them.
- 62. To develop and/or transfer technology and to acquire or pass on technical know-how.
- 63. To train personnel and workers, both in Pakistan and abroad, to obtain technical proficiency in various specialties connected with the business of the Company.
- 64. To carry on any other trade or business which can be advantageously carried on in connection with or ancillary to any of the businesses.
- 65. To distribute among the members of the Company, in specie, any property of the Company of whatever nature, or any proceeds of sale or disposal of any property of the Company, so that no distribution amounting to a reduction of capital be made except with the sanction (if any) for the time being required by law, in the case of winding up of the Company.

66. To generate and sell carbon credits and enter into agreements and/or required arrangements with the interested parties for the sale of the same.

7. It is hereby undertaken that the Company shall not engage in banking business or business of an investment company or any unlawful business and that nothing in object clauses shall be construed to entitle it to engage in such business or undertake business business directly and indirectly. The Company shall not launch multi-level marketing ((MLM)), Pyramid and Ponzi schemes; and

68. Notwithstanding anything stated in any object clause, the Company shall obtain such other approval or license from the competent authority, as may be required under any law for the time being in force, to undertake a particular business.

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#### IV, LIABILITY

The Liability of the members is limited.

#### V. SHARE CAPITAL

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The Authorized Share Capital of the Company shall be Rs.1,00,000/- (Rupees One Hundred Thousand) divided into 10,000 Ordinary Shares of Rs. 10/- (Rupees Ten only) each with powers to the Company from time to time shall have power to increase or reduce or consolidate or sub-divide the shares into higher or lower denominations as may be for the time being provided by the Articles of Association of the Company.

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

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Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality	Occupation  Occupa	Residential Address in	Number of shares taken by each subscriber	Signatures
MUHAMMED SOHAIL KHAN	352026- 616167-5	MUHAMMED ASLAM KHAN	PAKISTANI	BUSINESS- MAN	24-DD DHA PHASE V, LAHORE	9000	
HUM AYUM	35202- 2459109- 2	w/o HAMAYUN TARIQ ALVI	PAKISTANI	BUSINESS- WOMAN	24-DD DHA PHASE V, LAHORE	1000	Hamay
- <b></b>			Total nu	mber of share:	s taken	10,000	

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	Dated the 16+44 day of March 2015

Witness to above signatures.

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Full Name: Shah Imray
NIC No: 31203-6889639-9
Father's Name: Muhammad James L
Full Address: 28-AL-Rahmay Society, Mughalpura, Lahare Coutt.
Occupation: Consultancy.

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### THE COMPANIES ORDINANCE, 1984

(PRIVATE COMPANY LIMITED BY SHARES)

### **Articles of Association**

of

# CATALYST ENERGY (PRIVATE) LIMITED

### **PRELIMINARY**

1. Subject as hereinafter provided, the Regulations contained in Table 'A' of the First Schedule to the Companies Ordinance, 1984, (hereinafter referred to as Table 'A') shall apply to the Company so far as those are applicable to Private Companies, with the exception of the Regulations which are modified, altered or added hereunder.

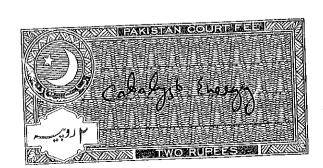
### PRIVATE LIMITED COMPANY

- 2. The Company is a Private Company within the meaning of Clause (28) of Section 2(1) of the Companies Ordinance, 1984 and accordingly:-
  - (a) No invitation shall be issued to the public to subscribe for any shares, debentures or debentures-stocks of the Company.
  - (b) The number of members of the Company (exclusive of persons in the employment of the Company) shall be limited to fifty provided that for the purpose of this provision when two or more persons hold one or more shares in the Company jointly they shall for the purposes of this clause be treated as a single member; and
  - (c) The right to transfer shares in the Company is restricted in the manner and to the extent hereinafter appearing.

### **BUSINESS**

- 3. The Company is entitled to commence business from the date of its incorporation.
- 4. The business of the Company shall include all or any of the objects enumerated in the Memorandum of Association.





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5. The business of the Company shall be carried out at such place or places in the whole of Pakistan or elsewhere as the Directors may deem proper or advisable from time to time.

### **CAPITAL**

- 6. The Authorized Capital of the Company is Rs.1,00,000/- (Rupees One Hundred Thousand only) divided into 10,000 ordinary shares of Rs. 10/- (Rupees Ten only) each with powers to increase, reduce, consolidate, sub-divide or otherwise re-organize the share capital of the Company.
- 7. The shares shall be under the control of the Board of Directors who may allot or otherwise dispose of the same to such persons, firms, corporation or corporations on such terms and conditions and at any such time as may be thought fit.
- 8. The shares in the capital of the Company may be allotted or issued in payment of any property, land, machinery or goods supplied or any services rendered to the Company or promotion or formation of the Company or conduct of its business and any shares so allotted may be issued as fully paid shares.

### SHARES, TRANSFER AND TRANSMISSION

9. Every person whose name is entered as a member in the Register of Members shall without payment, be entitled to a certificate under the Common Seal of the Company specifying the shares held by several persons. The Registral Sompany shall not be bound to issue more than one certificate and delivery of a Lahore Share certificate to any one of several joint holders shall be sufficient delivery to

10. The Directors may decline to register any transfer of share to transferee of whom they do not approve and shall be bound to show any reasons for exercising their discretion subject to the provisions of Sections 77 and 78 of the Companies Ordinance, 1984.

11. No share can be mortgaged, pledged, sold, hypothecated, transferred or disposed off by any member to a non-member without the previous sanction of the Board of Directors.

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12. The legal heirs, executors or administrators of a deceased holder shall be the only persons to be recognised by the Directors as having title to the shares. In case of shares registered in the name of two or more holders the survivors and the executors of the deceased shall be the only persons to be recognized by the Company as having any title to the shares.

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### **GENERAL MEETING**

13. The First Annual General Meeting shall be held within 18 months from the date of incorporation of the Company in accordance with the provisions of Section 158 and thereafter once at least in every year and within a period of four months following the close of its financial year and not more than fifteen months after the holding of its last preceding Annual General Meeting as may be determined by Directors. The Directors may, whenever they think fit, call an Extraordinary General Meeting of the shareholders in terms of Section 159 of the Companies Ordinance, 1984.

### PROCEEDINGS AT GENERAL MEETING

- 14. Twenty one days' notice at least specifying the place, day and hour of the General Meeting and in case of special business the general nature of such business, shall be given to the members in the manner provided in Table "A" but accidental omission to give such notice to or non-receipt of such notice by the member shall not invalidate the proceedings of the General Meeting.
- 15. The Chairman, with the consent of a meeting at which quorum is present and shall if so directed by the meeting 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 adjourned took place.

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### **QUORUM**

16. 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. Two members, present in person, representing not less than total voting power either on their own account or as proxies, shall form a Quorum for a General Meeting.

### VOTES OF MEMBERS

- 17. At any General Meeting a resolution put to the vote of the General Meeting shall be decided on a show of hands, unless a poll is deninded citia accordance with the provisions of Section 167 of the companies Ordinance, 1984.
- 18. On a show of hands every member present shall have one vote and on a poll, every member present in person or by proxy shall have one vote in respect of each share held by him.
- 19. The instrument appointing a proxy and the power of attorney or other authority under which it is signed or notarially certified copy of that power of attorney or authority shall be deposited at the Registered Office of the Company 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 will not be treated as valid.

#### **CHAIRMAN**

20. The Directors may from time to time appoint one of the members to be the Chairman of the company for a period not exceeding three years on such terms and conditions as they deem fit. The Chairman shall preside over the meetings of the Board of Directors and members of the Company. In his absence, the Directors may elect one of them to preside over Board's/ General Meetings. The question arising at the meeting of the Directors shall be decided by a majority of votes. In the case of equality of votes, the Chairman or the director presiding over the meeting, as the case may be, shall have a casting vote.

### CHIEF EXECUTIVE

21. The first Chief Executive of the Company will be appointed by the Board of Directors within fifteen days from the date of incorporation of the Company who shall hold office till the first Annual General Meeting.

### DIRECTORS

22. Unless otherwise determined, the number of Directors shall not be trained less than two. The following are the first Directors of the Company.

MUHAMMED SOHAIL KHAN

2. QUDSIA H MAYUN

23. The election of the Directors shall be held in accordance with the provision of Section 178 of the Companies Ordinance, 1984.

- 24. The first Directors, including the Chief Executive, shall hold office up to the First Annual General Meeting in accordance with the provisions of the Companies Ordinance, 1984, unless any one of them resigns earlier or becomes disqualified for being Director or otherwise ceases to hold office.
- 25. A resolution for removing a Director shall not be deemed to have been passed if the number of votes against him is equal to, or less than the number of votes that would have been necessary for the election of Directors at the immediately preceding annual election of Directors in the manner aforesaid but as provided under Section 181 of the Companies Ordinance, 1984.
- 26. The remuneration of Directors except regularly paid Chief Executive and full time working Directors shall, from time to time, be determined by the Board of Directors but it shall not exceed Rs. 500/- per meeting at which the Directors are present.

- 27. The Directors may sanction the payment of such additional sums as they may think fit to any Director for any special service he may render to the Company or be thought capable of rendering either by fixed sum or an any other form as may be determined by the directors subject to the provisions of the companies Ordinance, 1984.
- 28. The Director who resides out of station shall also be entitled to be paid such traveling and other expenses for attending the meeting for the Company as may be fixed by the Directors from time to time according to the provisions of the Companies Ordinance, 1984.
- 29. Any casual vacancy occurring on the Board of directors shall be filled in by a resolution of the Board of Directors and the person so appointed shall hold office for the remainder of the term of the Directors in whose place he is appointed.
- 30. No Director shall be disqualified from his office by contracting with the Company either as vendor, purchaser or otherwise nor shall any Director be liable to account for any profit released from any such contract or arrangement or the fiduciary relation thereby established, but the nature of his other interest must be disclosed by him at the first meeting of the Directors after ahore acquisition of his interest.

### NOMINEE DIRECTOR

31. In addition to the elected Directors, the Financial Institutions shall be entitled, during the currency of their respective loan(s) to the Company to appoint one person on the Board of Directors of the Company to be called hange from Nominee Director and to recall and /or replace such a person from time to time. Such Nominee Director on the Board of Directors of the Company may not be holders of share(s) in the Capital of the Company and regulations and /or rules pertaining to the election, retirement, qualification and/or disqualification of Directors shall not apply to him.

### NOTICES

32. Notices for every meeting of the Board of Directors will be given in writing and there must be given a reasonable time in advance. The nature o the business to be transacted at an intended Board meeting will be specified in the notice.

### MANAGEMENT

33. The whole business and affairs of the Company shall, subject to the control and supervision of the Board of directors, be managed and controlled by the Chief Executive.

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- 34. Subject to the limit fixed by the Directors, the Chief Executive may from time to time raise or borrow any sums of money for and on behalf of the Company from other companies, banks or financial intuitions on such terms as may approved by the Board of Directors from time to time.
- 35. Without prejudice to the powers conferred by these Articles, the Board of Directors shall have the following powers:-
  - (a) To take on lease, purchase, erect or otherwise acquire for the Company any assets, stocks, lands, buildings, 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.
  - (b) To let, mortgage, sell exchange or otherwise dispose of absolutely or conditionally all or any part of the assets, stocks, raw materials, properties, privileges and undertaking of the Company upon such terms and conditions and for such consideration as they think fit.
  - (c) To appoint any person or persons to be 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, from time to time, think fit.

To enter into, carry out, rescind or vary all financial arrangements with any bank, person, company, firm or corporation or in connection with such arrangements to deposit, pledge or hypothecate property of the Company or the documents representing or relating to the same.

- (e) To make and give receipts, release and discharge all moneys payable to the Company and for the claims and demands of the Company.
- (f) To compound or allow time to the payment or satisfaction of any debt due to or by he Company and any claim and demands by or against the Company and to refer claims or demands by or against the Company to arbitration and observe and perform the awards.
- (g) To institute, prosecute, compromise, withdraw or abandon any legal proceedings, by or against the Company or its affairs or otherwise concerning the affairs of the Company.
- (h) To raise and borrow money from time to time for the purposes of the Company, on the mortgage of its property or any part there and/or on any bond or debenture payable to

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bearer otherwise repayable in such a manner and generally upon such terms as they think fit.

(i) To open, operate and maintain bank/banks account(s) individually or jointly as the Board may authorize or to any other person on its behalf.

### **BORROWING POWERS**

- 36. The Directors may from time to time raise, borrow or secure the payment of any sums for the purposes of the Company in such manner and upon such terms and conditions as they think fir and in particular by the issue of debentures, debenture-stock or other securities charged upon all or any part of the property of the Company present or future.
- 37. Debentures, debenture-stock, or other securities may be issued with any special privileges as to redemption, surrender, allotment of shares, attending and appointment of Directors or other privileges subject to any permission required by law.

### THE SEAL

SU

38. The Company shall have Common Seal and the Director shall provide for the safe custody of the same. The Seal shall not be applied on any instrument except by the authority of the Board of Directors and in the presence of at least two Directors who shall sign every instrument to which the Seal shallon Of the affixed in their presence. Such signatures shall be conclusive evidence that the Seal has been properly affixed.

### ACCOUNTS

- 39. The Director shall cause to be kept proper books of account required under Section 230 of the Companies Ordinance, 1984.
- 40. The Books of account shall be kept at the registered office of the Company or at such other place as the Directors shall think fit subject to the provisions of Section 230 of the Companies Ordinance, 1984.

### **AUDIT**

41. Once at least in every year the accounts of the Company shall be audited and correctness of the Balance Sheet shall be ascertained by one or more Auditors. The Auditors shall be appointed and their duties regulated in accordance with the provisions of Section 252 to 255 of the Companies Ordinance, 1984.

### SECRECY

04/05/15

Every director, 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 the transaction 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 by the directors or by any meeting or by a court of law and except so far as may be necessary in order to comply with any of the provisions in these Articles contained.

04/05/15

No member or other person (not being, a Director of the Company) shall be entitled to enter 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 to require discovery of or any information with respect to any detail of the Company's trading or any matter which is or may be in the nature of 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 will be inappropriate in the interest of the company to communicate.

### INDEMNITY



Every officer or agent for the time being of the company may be indemnified out of the assets of the company against any liability incurred by him in defending affectantly proceedings, whether givil or criminal arising out of his dealings in relation to the affairs of the company, except those brought by the company against him, in which judgment is given in his favour or in which he is acquitted, or in connection with any application under Section 488 in which relief is granted to him by the Court.

We the several persons, whose names and addresses are subscribed below are desirous of being formed into a Company in pursuance of the Articles of Association and we respectively agree to take the number of shares in the capital of the Company set opposite our respective names:-

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigne r, Passport No)	Father's/ Husband's Name in full	National ity with any former National ity	Occupation	Residentia I Address in full	Number of shares taken by each subscribe r	Signat ures
MUHAM MED SOHAIL KHAN	352026- 616167-5	MUHAMME D ASLAM KHAN	PAKISTA NI.	BUSINESS- MAN	24-DD DHA PHASE V, LAHORE	9000	

### INDEMNITY

42. In connection with carrying on the business of the Company, the Chief Executive, every Director, or other officers of the Company shall be indemnified by the Company for all losses and expenses occasioned by error of judgment or oversight on his part, unless the same happens through his own dishonesty or willful act and defaults.

### **SECRECY**

43. No member shall be entitled to visit and inspect the Books of the Company without the permission of the Chief Executive or one of the Directors or to require discovery of any information regarding any detail of the Company's business or any matter which is or may be in the nature of trade secret, or secret process which may relate to the conduct of the Company's business and which in the opinion of the Directors, will not be in the interest of the members of the Company to communicate to the public.

### ARBITRATION

44. Whenever any difference arises between the company on the one hand and the members, their executors, administrators or assignee on the other hand, touching the true intent or construction or the incident or consequence of these present or of the statutes or touching any thing thereafter done, executed, constituted or suffered in pursuance of these present or otherwise relating to these present or to any statutes affecting the Company, every such difference shall be referred for the decision of the arbitrator who will be qualified in Islamic law.

45. The cost incidental to any such reference and award shall be at the discretion of the arbitrator or umpire respectively who may determine the amount thereof and direct the same to be shared between the attorney and client or otherwise and may award by whom and in what manner the same shall be borne and paid.

### WINDING UP

Crchange Co

46. If the Company is wound up whether voluntarily or otherwise the liquidator may, with the sanction of a special resolution, divide among the contributories in specie any part of the assets and liabilities of the Company, subject to Section 421 and other provisions of the Companies Ordinance, 1984 as may be applicable.

Sk



QUDSI/ HUMA	35202- Yull 2459109- 2	w/o HAMAYUN TARIQ ALVI	PAKISTA NI	BUSINESS- WOMAN	24-DD DHA PHASE V, LAHORE	1000	Hams	egeen.
			Total	number of sha	res taken	10.000		U

04 5 N Dated the 16th day of March

Witness to above signatures.

Full Name: Shah Immay

NIC No: 31203-6889639-9
Father's Name: Muhammad Jameel
Full Address: 28-AL-Rehman Society, Mughalpina Lahore Contt.
Occupation: Consultancy

CERTIFIED TO BE TRUE COPY

Su

# Annexure-IV

# LAST FILED ANNUAL RETURN

# CATALYST ENERGY PRIVATE LIMITED

24-DD Defence Housing Authroity Phase V, Lahore Pakistan

# (A return comprising information as required pursuant to the Third Schedule to the Companies Ordinance, 1984) — Updated for Share Transfer to StormHarbour Caymans

1	Registration No.	0093286						
2	Name of the Company	Catalayst Ener	gy Private Lim	ited				
3		P	ART-A					
5	Registered office address:	24-DD DHA P	hase V, Lahore	<del></del>				
V	respirate differentials.		naso , namer	<u> </u>				
6	Email Address:		S	Sohail.khan@stor	mharbour.com			
7	Office Tel. No.:			+1 917 292 3627				
8	Office Fax No.:							
9	Nature of Business:		(	Generation and Sa	ale of Electricity			
10	Authorized Share Capital							
	Type of Shares	No. of Shares	Amount (Rupees)	Face Value (R	Face Value (Rupees)			
	Ordinary Shares	10,000	100,000	10				
11	Paid up Share Capital							
	Type of Shares	No. of Shares	Amount	Issue Price				
	Ordinary Shares	10,000	100,000	10				
12	Amount of Indebtedness on the		orm A is made	in respect of all				
	Mortgages/Charges	None			<del></del>			
13	Particulars of the holding com	pany	· -					
	Name	1,81181 74 171		0/ (1) T3				
14	Registration No.	<del></del>		% Shares H	.eia			
14	Chief Executive	Muhammed Sol	oil Whom	NIC	352026-			
.	Name	iviumanimed 201	iaii ixiiaii	NIC	616167-5			
	Address	24-DD DHA Ph	ase V Lahore		01010/-3			
				· ···				

# CATALYST ENERGY PRIVATE LIMITED

24-DD Defence Housing Authroity Phase V, Lahore Pakistan

15	Chief Accountant																
	Name																
	Address		l				•										
16	Secretary																
	Name Mu			uhammed Sohail Khan					NIC			- 1	352026- 616167-5				
	Address	24-	DD DHA Phas	e V	Lal	nore	:										
17	17 Legal Adviser																
	Name HaidermotaBNR& Co.																
	Address 65-FCC, Gulberg IV, Lahore, Pakistan																
18	Auditors																
	Name																
	Address														t.		
19	List of Directors or	ı the date o	f For	rm-A													
	Name of Director	Addres	SS	Nationality			N	[C (	Pass	spor	t N	o. if	for	eigi	ier)		
	• •			Cayman													
	aymans			Entity	_			_	_	_		-	_		_		
2. Qu	dsia Humayun	As above		Pakistani	3	5	2	0	2	2	4	5	9	_T	0	9	2
		<u> </u>	-	<u> </u>	<u> </u>				L								

# PART-B

Folio		Address	Nation- ality	No. of shares		which this Form A is made  NIC (Passport No. if foreigner)											
	<u>Members</u>																
	Catalyst Energy		Canadian	90%													
	Qudsia Humayun	As above	Pakistani	10%	3	5	2	0	2	2	4	5	9	1	0	9	2
	Debenture holders																

\*\*\*Use separate sheet, if necessary\*\*\*

21.	Transfer of shares (	debentures) since last	Form A was made	· · ·
	Name of Transferor	Name of Transferee	Number of shares transferred	Date of registration of transfer
	Members			
	Debenture holders			

## CATALYST ENERGY PRIVATE LIMITED

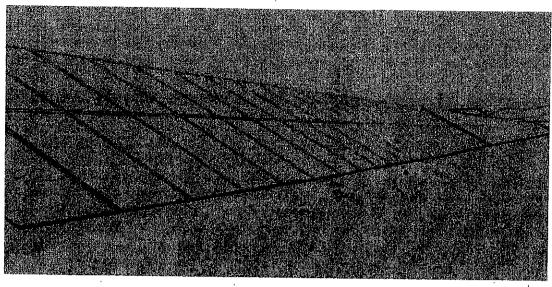
24-DD Defence Housing Authroity Phase V, Lahore Pakistan

\*\*\*Use separate sheet, if necessary\*\*\*

	22. which this	,		d the acco	ompanying stateme	nts state the facts o	correctly and completely as on the date upto
Date		10	November	2016		Signature	
					Designation (	(Please tick)	Chief Executive/Secretary

### INSTRUCTIONS FOR FILLING FORM-A

- 1. The Form shall be made upto the date of last AGM of the Company or the last date of the year where no AGM is held during the year.
- 2. Under nature of business, please give precisely the specific nature of business in which the company is engaged.
- 3. Under S. No.20 above, the aggregate number of shares held by each member should be stated, and the aggregates must be added up so as to agree with the number of shares stated against NO. 11.
- 4. When the shares are of different classes the columns should be subdivided so that the number of each class held, or transferred, is shown separately against S. Nos. 10.11,20 and 21.
- 5. If the space provided in the Form is insufficient, the required particulars should be listed in a separate statement attached to this return which should be similarly certified and signed.
- 6. The return and any statement attached hereto shall be signed by the chief executive or the secretary.
- 7. In case a body corporate is a member, NIC number may be omitted to be given.
- 8. In case of foreign nationals, indicate "passport number" in the space provided for "NIC No." Pakistani nationals will only indicate "NIC NO."
- 9. This form is to be filed within 30 days (45 days in case of listed company) of the date indicated in S.No.3 above.



# Feasibility Study

Type of Report:

Feasibility Study

Project:

Chishtian

Client:

StormHarbour

Purpose:

Assessment of the technical and economic viability of a

100 MWp Solar PV Project at Chishtian-Dahranwala PV,

Pakistan

Site location, Country:

Chishtian-Dahranwala PV (29,5277 N; 72.8410 E),

Pakistan

Report number:

15K6537-PV-MBS-Chishtian-D00-ASC\_TM-2015

Date of Inspection:

2015-10-16

8.2 Ingenieurpartnerschaft Obst & Ziehmann

Ing. Alexander Schleiffer

Brandstwiete 4

20457 Hamburg

Germany

Tel:

+49 (0)40 / 18 12 604-29

Fax:

+49 (0)40 / 18 12 604-99

E-Mail:

alexander.schleiffer@8p2.de

### **General Data**

The company Catalyst Energy Private Limited intends to build a photovoltaic power plant at a site 7 km south of Dahranwala in the Chishtian region.

### Assignment

Task:

8.2 Ingenieurpartnerschaft Obst & Ziehmann (8.2) was commissioned to perform a Technical Site Assessment to

evaluate the suitability and potential of the site.

Client:

StormHarbour Partners LP 140 East 45th Street, 33rd Floor

NY 10017 New York United States of America

Order Date:

18.06.2014

Date of Inspection:

Hamburg, 2015-10-16

Authors:

Ing. Alexander Schleiffer

Talha Munir, B.S.

Project Number:

15K6537

# Basic Data: Plant Location and PV System

Client: Site:

StormHarbour

Chishtian

Latitude

29.527° N

Longitude

72.841° E

Altitude above sea level

151 m

### Revisions

Version	Modifications
R00	First Issue of Feasibility Study
R01	Update according new studies and reports 2016-01-05

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7.3.7	MONITORING

### 1 Executive Summary

This study assesses the feasibility for the 100 MWp solar power plant at a site in Chishtian. The assumptions, results and conclusions of this study have been refined during multiple site visits.

Analysis of data obtained from various sources lets us conclude that the site allocated for Catalyst Energy plant 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.

Solar parks of this size are not standard, but through the vast knowledge collected over many years of experience with this technology, it is possible to develop highly efficient parks irrespective of their size. The experiences of these large scale solar parks around the world together with the lessons learnt can be disseminated and implemented in Pakistan by knowledge transfer.

Concerning the technology and mounting options we recommend fixed type installation as it has least capital and operational risks. For the economic viability of a tracking device versus a fixed installed system, accurate irradiation data would be required on ground level which is not yet available. In addition tracking devices require more maintenance due to their moving parts.

The client is opting for upfront tariff as has been stated in the NEPRA Upfront Tariff Determination Document no. NEPRA/UTS-2015/17871-17874, Dated 16<sup>th</sup> December 2015 along with corresponding parameters quoted therein. The total cost of project is expected to be 151 million USD. A project timeline of 12 months from financial close is a reasonable assumption for a project of this size.

The Catalyst Energy power plant in Chishtian will be very beneficial to the people of Pakistan receiving more and more power through one of the cleanest sources of energy.

Hamburg, January 2016

Lahore, January 2016

Ing. Alexander Schleiffer

Talha Munir, B.S.

# 2 Project information and outstanding items

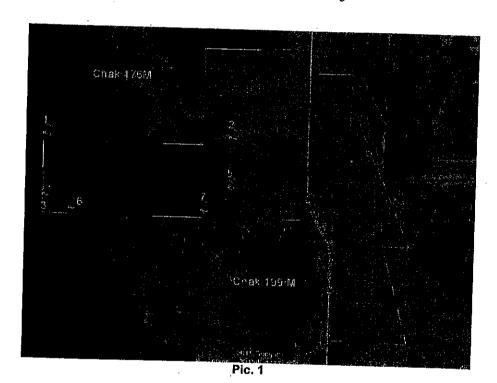
This feasibility study summarizes and assesses the given information and includes additional results from extensive site visits.

# 2.1 Technical Project Description

The Catalyst Energy Solar Park will be developed in the eastern region of the Solar Park as shown in the figure below marked red. This part shall be connected to the 132 kV overhead power line. The plants will use polycrystalline module technology and central inverters. However, design and make and model of equipment will only be finalized after the final EPC is selected.

## 2.2 Project Status

The Project is currently in the feasibility stage. It is recommended that a master plan should be developed and published by Energy Department, Government of the Punjab. Within the master plan, an overview of available information, the first steps of investigation into resources, and the rights and general information should be given.



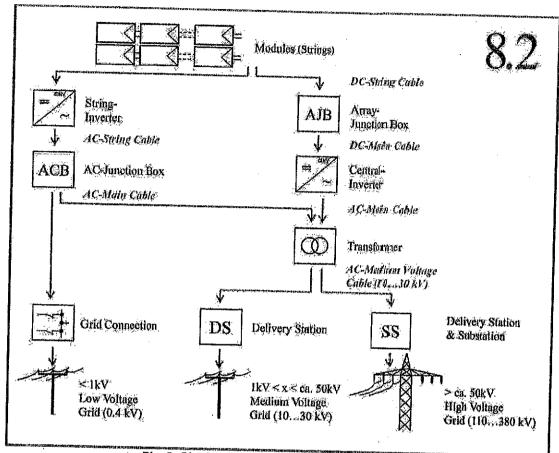
# 3 List of Abbreviations:

Figt of Apple viations;	
a A AC BOS CE DC DIN EN EPC h HTA HTB HV   IEC ISO kV kVA / MVA kW kWh kWp MV MV/HV MWp	Year Ampere Alternating Current Balance of System Conformité Européenne Direct Current Deutsches Institut für Normung (German Institute for Standardisation) European Standard Engineering, Procurement and Construction Hour High Tension between 1 kV and 50 kV AC High Tension exceeding 50 kV AC High Voltage Electric Current International Electro-technical Commission International Organization for Standardization Kilovolt (1,000V) Kilovolt-ampere / Megavolt-ampere Kilowatt (1,000W) Kilowatt hour Kilowatt peak (PV module rated DC power) Medium Voltage Medium Voltage (transformer) Megawatt peak
NEPRA	Energy Regulator in Pakislan
NEPRA-PTD	NEPRA Procedure for Tariff Determination
O&M PR PV RFP TA TC U	Operations and Maintenance Performance Ratio Photovoltaic Request for Proposal Technical Advisor Technical Consultant Electric Voltage Volt

# 4 Overview of Photovoltaic Technology

# 4.1 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 1200 kWh/m² per year.



Pic. 2: Single Line Diagram Photovoltaic System

# 4.2 Basic Principles of Photovoltaic Modules

Photovoltaic technologies differ primarily by the type of the 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 impact a semiconductor surface and are absorbed. The semiconductor is typically made of silicon.

These absorbed photons hit the atoms and thus are releasing electrons, which causes a chain reaction that multiplies the effect of electrons released. The electrons move from lower potential to higher. This increase of potential results in the generation of current through potential difference (voltage). The reactions and the release of electrons are continuous. The purity level of the conductor material is important and that there are no gaps at the molecular and atomic level of the semiconductor material. Higher the purity of the used material, the greater is the likelihood that it achieves the maximum potential of a photoelectric cell.

The efficiency of a solar cell  $(\eta)$  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) under standard conditions (STC, 1000 W/m², 25°C, AM 1,5), and the surface area of the solar cell ( $A_c$  in  $m^2$ ).

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

A solar cell can operate in a wide range of voltages and currents. This can be achieved by varying the load resistance in the electric circuit on the one hand, and on the other, by varying the impedance of the cell from the value zero (short circuit) to very high (open circuit). The theoretical maximum power point can be determined this way, i.e. the point in which the product of voltage V and current I are maximized in time. In other words, the load for which the cell can deliver the maximum electric power for agiven level of radiation. Another important variable is the Normal Operating Cell Temperature (NOCT) of the module. 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.

Three main cell categories can be defined:

- Monocrystalline
- Polycrystalline
- Thin Film

### Monocrystalline Technology

The manufacturing process of monocrystalline cells requires more effort in comparison to other technologies; however, these cells offer higher 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 during transport or during operation at sites with high wind speeds.

### Polycrystalline Technology

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

### <u>Advantages</u>:

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).

### Thin Film Technology

This technology is called Thin Film because only a couple nanometers of the semiconductor material are 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, except of the CdTe material. Depending on the technology, standard thin film module efficiencies have reached 7-14 %. Prototypes of these technologies reach 16 % and more which is expected to be transformed to standard products in the future.

### Advantages:

- Easier to manufacture, thus lower costs.
- · Homogenous appearance.
- Flexible, hence for use at different applications and surfaces.
- · Less affected by high temperatures and shadowing.

### Disadvantages:

- Faster degradation rate of up to 0.7 % per year.
- Lower efficiency leads to greater surface area requirements, for the same capacity.

### 4.3 Mounting structures and tracking systems

The photovoltaic panels may be installed on fixed structures or on structures that are tracking the sun. Trackers can be equipped with either a single axis or dual axis tracking system. Fixed structures are usually just tilted to face south (north in southern hemisphere), or may have south as their main angle and a slight inclination to the east and west as secondary angle (for example 10°). This roof-shape inclination would offer lower peak capacity, however the generation curve would be less spiked and will allow an energy generation distribution to be more equal over the day.

Alternatively, for tracker solutions, the aim is to follow the sun and maintain the panels perpendicular to the axis of incidence of the sun. Thus a greater efficiency in converting solar energy can be achieved. The dual axis tracking can follow the sun both in azimuth and angle - this means that the sun can be tracked over the course of the day - from east to west and the tilt angle can also be adjusted to compensate for the changing angle the sun has over the year. The decision to choose any of the three types of mounting structure is based on a technical and economic evaluation. When choosing a tracking system, the extra energy generation in combination with the energy price must be compared to the additional investment and maintenance costs required for tracking systems.

### 4.4 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 that performs this function.

State of the art inverters offer a broad range of operational stages, which generally fulfil 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 1500 kWp 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 as in Pakistan).

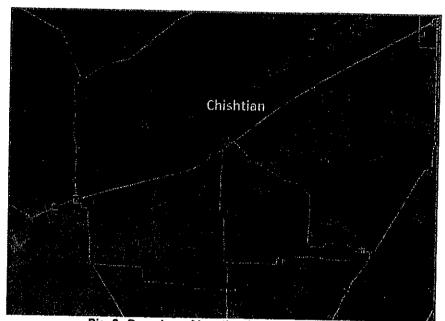
## 4.5 Control System

A PV plant typically is 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 PV plant.

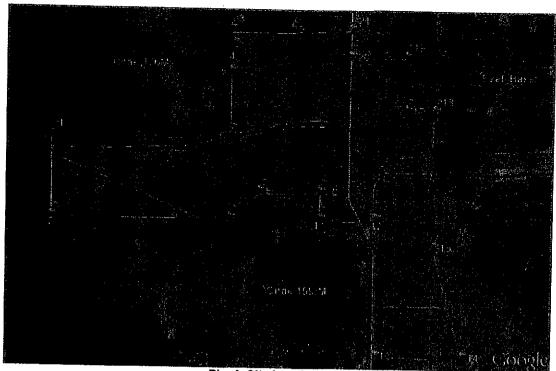
# 5 Site Description and Assessment

# 5.1 Geographic Parameters

The site of Catalyst Energy Solar Plant is located in the southern region of the Punjab province about 7 KM south of Dahranwala (geographic coordinates: 29.527° N / 71.841° E in the PV development region) in the Chishtian region. The overall site includes slightly different conditions according to land use (agriculture) and soil conditions (unused arid regions and desert).



Pic. 3: Overview of location / region in Pakistan



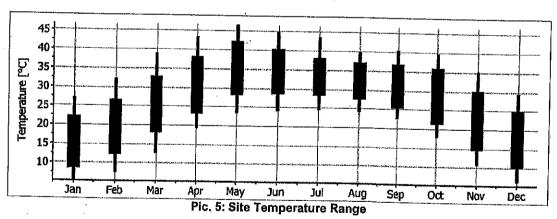
Pic. 4: Site location map

Geographic parameters The exact position of the PV plant within the Catalyst Energy solar development region has been specified. However, there is some vegetation and agriculture.

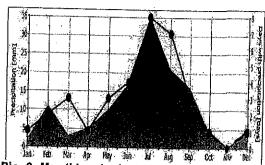
The exact position of the PV plant within the Catalyst Energy solar development region has been specified. However, there is some vegetation and agriculture.

### 5.2 Climate conditions

Climate conditions have influence on the construction and foundation layout as well as energy production. There are seasonal variations from cold winters to hot summers with up to 40 or even 50°C.

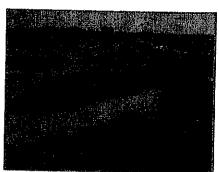


The monsoon season lasts from May through September with a peak in July and August. 60-70 % of the yearly rainfall occurs in these months. The average rain fall per year is about 120-170 mm.



Pic. 6: Monthly rain day's precipitation (mean)

Drainage from the site seems not to be an issue. Few puddles could be found but seepage into the ground seems to be effective.

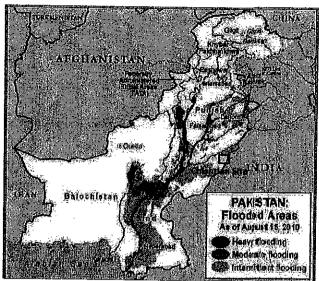


Pic. 7: Puddle at the site surface

There is an average of 8 to 9 hours of clear sky per day throughout the year and 2900 h - 3300 h sun hours annually.

The region is a moderate low wind area. With the monsoon season the wind speeds up especially at daylight. Storm statistics from the nearest meteorological station will have be considered during detail design.

Micro climate effects can cause dusty and windy conditions which should be evaluated more deeply. Seasonal flooding is possible, however, recent events of flooding have had no impact in this specific region.



Pic. 8: Flooding events (Source: US State Department)

### Impact on the Project:

The inverters for this Site should be designed for high ambient temperatures and all of the Inverters, transformers etc. should be installed on elevated terrain. Dusty conditions shall be considered for the design of filters for all electric 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 Solar Park.

Climate conditions

Hot and dry desert-like climate requires robust components. Amongst other criteria effective cooling, dust/sand filters and abrasive resistant materials shall be utilized.



### 5.3 Environmental Aspects

The area at present is free of pollution. No industrial activities are present. There are few agriculture activities around the Site. Pakistan Environment Protection Agency (PEPA) has no regulations or requirements for solar power generation (PEPA Regulations 2000). Low rainfall and some wind cause slight erosion of soil. No protected wild plants or animals are reported for that Site. The ecosystem is described as fragile. The acoustic environment is good with low noise from some local traffic on dirt roads.

### Impact on the Project:

No critical aspects can be detected as long as all obligatory safety rules are respected e.g. for oil pollution from facilities and transformers. Details can be found in the Initial Environmental Examination Report that has been carried out for the site. Protection against rodents and other animals would have to be considered. They are known to eat plastics and cables.

Environmental Aspects

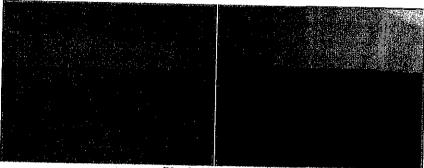
Precautions against browsing of rodents shall be adopted to protect cabling effectively.

Environmental impact study has been carried out to find the exact environmental impact on the project,



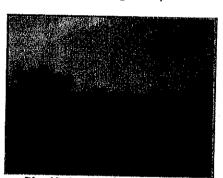
### 5.4 Topography and grounding

The soil in this desert like region is mostly sandy to dusty. However, during one of the site visits it was observed that the ground was damp and there was grass growing at the site.



Pic. 9: Vegetation

The soil has to be prepared for heavy transport traffic. The natural state layer is not suitable as a foundation bearing layer. A topographical survey and geolechnical investigation has been conducted. The reports have been annexed as part of this feasibility. The terrain for the solar park area is mostly even. For the planning of the Solar Park a closer look at the data and a small scale on site viewing is required.



Pic. 10: Impressions of terrain

The ground looks ideal for screw piles. More details will have to be considered according the geotechnical investigations at the site.

Even though the site is located in a low seismic activity region, potential risk of earthquakes should be considered during detailed design. Overall the region is of stable structure. More information is required for specific design of substructures and foundations. The ground conditions can be summarized as intermediately complicated.

Water table depth will have to be considered for any issues that might arise during electrical grounding.

Topography and grounding

Screw pile mounted sub construction seems to be the best foundation for PV-generator.



### 5.5 Meteorology including Solar Resource

Pakistan is exposed to strong solar radiation, long hours of sunshine, and abundant solar energy resources. The annual sunshine hours range between 2900h - 3300h, with a daily average of 8-9 sunshine hours.

Chishtian District is located in the south of Punjab Province. Metrological Data from the nearest weather station should be obtained for better understanding of the metrological conditions of the site.

The region of Cholistan desert is hot and dry, as shown in the following table:

	Sun hours / day	T Amb	Wind
	h	°C	m/s
January, we will be a	* d= 725 = **	1,514.8 3	7/3/1
February	7.8	19.1	3.5
Valor	875	39 926 A 38	180
April	9.0	30.9	4.2
Way - Farth Francisco	88 ( 19	H 8 35 2	**************************************
June	7.3	34.9	5.0
Total State of the	** # 17/2 *** The F	882	44 17 1
August	8.3	32.2	3.7
September 1 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	111936		7087455
October	9.2	28.3	2.9
Vovember, 1994	18.8	2222	178 28 22
December	7.2	16.8	2.9
Annuellaverage	are potalismos	1270	3/

Sun hours: T Amb:

Sunshine duration per day (Meteonorm 7)
Average ambient temperature (Meteonorm 7)

Wind:

NASA at 50m

Table 1: Climate data of the region (extract)

For this Technical Site Assessment we calculated the solar irradiance resource from the Meteonorm database because this source was used by NEPRA for determining the actual Tariff. For determining the best data for the solar irradiation predictions we also analyzed data sources from NASA and SolarGIS. Generally, the 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 a difference of only 5 % on yearly basis between different sources.

**SolarGIS** provides irradiation data based on calculations from satellite images. The database represents the 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 the missing reliable reference of meteorological stations with measurement for irradiance values. Further details can be provided in a separate copious report.

**Meteonorm** uses several sources like different satellites and ground stations for mean values. The main time period is 1986 – 2005 (total 1942 stations). The most important source of radiation data is the Global Energy Balance Archive (GEBA, <a href="https://protos.ethz.ch/geba/">https://protos.ethz.ch/geba/</a>). 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 the 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 stations are Bikaner (176 KM) and Hissar (283 KM).

High latitudes and high "albedo" would increase the uncertainty additionally which is not the case for the site. The uncertainty of satellite data is given by Meteonorm with 4-8 %. The annual uncertainty calculated internally by the Meteonorm software comes out at 10 % based on the available 20 years long term data set for this region for global horizontal irradiation (Ghi).

The **NASA** source also uses satellite images with its own calculations for irradiance data. For Pakistan we can recommend an uncertainty of not better than 15 % due to our experience with ground measured data in India.

For the first energy yield calculations in the region of Chishtian, based on best estimation of basic system design, the irradiance and weather data were generated from the Meteonorm database (see also 8.1).

For a more exhaustive overview the different sources of irradiance data are shown below.

Irradiation Sources	Meteonorm 7	Solar GIS	NASA
Bahawalpur	1986-2005	1999-2012	1981-2011
Average monthly sum	GlobHor	GlobHor	GlobHor
	kWh/m².mth	kWh/m².mth	kWh/m².mth
January 1 Constant of the Cons		1 2 3 10 15	1088 4
February	120.9	122.7	119,3
Marchy all a flat, the same of	LEAD NOVO AND A	<b>建设设施方型规则</b>	and the second
April	184.1	196.8	171.9
May	44年202年	10 10 10 10 10 10 10 10 10 10 10 10 10 1	e politice in the
June	192.5	182.4	190.8
	i jeyre	Harry Harry Harry	
August	181.1	181.2	169.6
September	<b>美国的</b> 1076年	721	15216
October	146.6	155.4	142.9
November 1. The Management			A CONTRACTOR
December	100.3	102.6	101.1
Annualisum (Wivingra 🐉 👢 🗸	- # - 38767	7807.9	7.707

Table 2: Results from different sources for irradiance data

For further energy yield analyses the Meteonorm data will be used. A comparison between actual ground data of the last 6 months and meteonorm data should be performed to reduce the uncertainty in irradiation before financial close.

Irradiation Data

The uncertainty of the satellite irradiance data for this area is given by Meteonorm with 10 %



### 5.6 Transport Access

The site is right next to the Dahranwala fort Road. In Bahawalnagar the nearest airport is located at a distance of 78 km and the nearest railway station is at a distance 32 km in Chishtian.

A solid road able to carry heavy traffic will have to be developed. The current road that accesses the site might not be able to bear the heavy traffic load.



Pic. 11: Access Road

### **Road Traffic Planning**

The main roads of the overall Solar Park should be planned. Any roads near HV transmission lines should be at a minimum distance of 30 m for safety reasons.

Besides accommodating the roads, the corridors will also be used for the overhead power lines, buried water pipelines, telecommunication lines and other utilities. The main roads passing through the corridors should have a total width of 12.7 meters with a carriageway of 7.3 meters, and have a 50 mm thick asphalt wearing course over water bound macadam base, treated shoulders 1.2 m wide and earthen berms 1.5 m wide. Cross slope of the road will be 1.5 % for easy surface drainage. Right of way for the roads is recommended as 40 m.

### **Design of Road Works**

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

### **Road Vertical Design**

As the land within the solar park is undulating, the range of longitudinal gradient of roads is recommended to be 0.3 %. In specific cases like escarpments, the gradient limitation may be relaxed according to the site conditions. In order to ensure smooth longitudinal curve of the

### 5.7 Water Access

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

### Water demand

The majority of the water will be needed for regularly cleaning the modules. Further small amounts of water will be needed for domestic consumption (e.g. living), landscaping and dust prevention on roads/tracks. Cleaning of the modules is supposed to take place once per month. The total demand of fresh water is estimated to approx. 9125 m³ / year including the amount for domestic, landscaping and dust prevention consumption. The daily water demand equals to approx. 25 m³ / day per 100 MW PV plant. In case of realizing shorter wet-cleaning intervals (e.g. twice per month) for prevention of greater soiling losses, the water demand could rise up to approx. 50 m³ / day per 100 MW PV plant.

### Water supply

The desert like region has only little water resources from rain (less than 200 mm/a) and some groundwater (likely fresh water) from seepage next to some channels but outside of the Site. A canal runs along the eastern boundary of the plant however a detailed study for water sources will have to be carried out.

### Water re-use / 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 only 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 the long term of operating the solar plant it can be efficient to apply some type of water recycling to reduce fresh water consumption for module cleaning process. Water used for domestic supply is supposed to be collected in underground waste water storage tanks. A procedure to recycle grey water, e.g. for lavatory, is currently not scheduled but recommended to be applied for efficient reduction of fresh water consumption. A waste water treatment plant is currently not intended, but recommended to be adopted in due course. Waste water from domestic use shall not be dissipated into the ground without treatment.

### Water related environmental impact analysis

The water related environmental impact analysis will have to be considered.

### Water management plan

We recommend to carry out a water management plan for construction and operation of the solar power plant, specifying clearly in context of the O&M stralegy. 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.

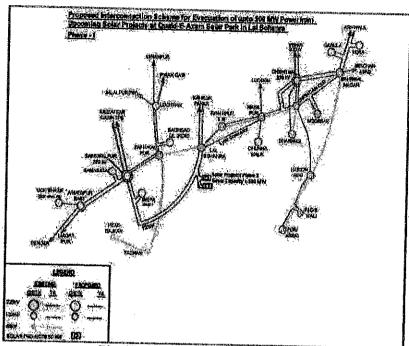
Water Access

A water management plan for construction and operation of the plant, as specified above shall to be carried out.



# 5.8 Grid Access

Currently there is no high voltage grid access directly on Site, but the site is proposed to be connected to the Chishtian grid station. A grid interconnection study has been carried out to find out the evacuation capabilities this grid station, however it is yet to be approved by NEPRA. A 132 kV step-up station will be needed for connection to the 132 kV line.



Pic. 13: E-Grid overview / power-lines

An 11 kV medium voltage grid is available, from which arrangements of auxiliary supply for the project area during construction phase will have to be made.

**Grid Access** 

The medium voltage (11 kV) grid accessibility for the construction phase is available. However, load shedding might occur so a backup facility will be needed.



# 5.9 Facility Access

The PV development site is about 30 km away from Chishtian, where facilities such as a fire department, police station and hospital are available.

It will have to be checked if the fire station can meet the fire protection requirements of the Solar Park. The water for fire-fighting is pro-posed to be supplied through the main water supply pipe running between the eastern and western corridors.

According to the features of the Solar Power Park, and on the basis of the relevant specifications of Code of Design on Building Fire Protection and Prevention (GB50016-2006), fire hydrants will be provided in the general services area and the step-up stations. 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 switching automatically at the end. The fire devices shall use fire protection or fire-resistant cables. The fire protection and firefighting system of each plot in the Park is part of safety requirement and shall be designed and provided by each solar farm entrepreneur. The distance to the hospital is acceptable. An emergency kit has to be provided in each station on Site, along with an emergency guideline, the emergency number and a description of the travel route to enable a rapid aid.

The distance to the police station is also acceptable, but it is recommended that the Site has its own full time security staff located near or on the Site.

**Facility Access** 

Access to public facilities (fire / police station, hospital) is well available nearby. The access road enables quick rescue services in case of an emergency. Fire hydrants have to be established along the roadside at a distance of max. 120 m.



## 6 Grid interconnection

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. PV plants, especially, are also able to offer reactive power 24/7 and can thereby help to stabilize the grid.

# 6.1 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 as well as, all other states of the PV plant are managed in accordance with the relevant national grid code ( Grid Code June-2005) and the existing "Technical Conditions for Grid Connection" of the corresponding grid operator. The requirements 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.

# 6.2 Impact on the evacuation network

With respect to the transmission grid at high voltage level the conditions for a safe grid integration of 100 MVA nominal AC power needs to be formally assessed 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.

# 6.3 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.

# 6.4 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. Accordingly, to the aims of the Master plan the requirements of the grid code have to be broken down into requirements for the PV plants. Therewith the PV plant can be designed to support a proper control of the grid.

# 6.5 Technical Specifications

Technical specifications for grid interconnection and the equipment have to be in compliance with international and national standards (voltage and frequency range, power factor, voltage drop, current rating, switching capability, safety features, control and monitoring etc.) 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 be carried out with the target to establish the exact conditions for a safe, technically and economically viable grid connection of the PV plant. Following this analysis, detailed technical requirement specifications concerning the behaviour of the grid connected PV plant 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 PV 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

## 6.6 Approvals

A grid connection study considering evacuation of the complete park was carried out. Only 100 MW DC are being constructed right now and there shall be no limit for this project in evacuation capacity. There has been a grid integration and connection study to confirm the conditions of integration of this 100MWp PV solar plant, however it is yet to be approved. Within the connection conditions of the Energy Purchasing Agreement and its Annexes the details of the quality of power and measurements have to be fixed. 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.

	The specific requirements and approval for	
Grid connection	grid connection need to be confirmed by	I POLOTICAL:
	NEPRA / NTDC	to be initiated.

# 7 Plant Layout and Description of Technical Equipment

## 7.1 Power supply infrastructure

An 11 kV overhead power cable line will have to be made available for auxiliary loads.

This power line will be large enough for supplying the auxiliary power, but not large enough to evacuate the produced electricity of the park.

The grid connection for this 100 MWp PV power plant can be realized by connecting the Park to the nearest 132 kV power line access to which will have to be established.

# 7.2 Power plant technology configurations

In general several technology configurations can be realized.

Easiest and cheapest technology configuration is fixed mounted module installation with a 25-30° 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 the highest specific energy output of installed PV Power.

A compromise of these two technologies lays in a 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.

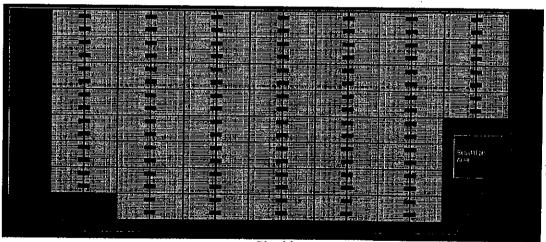
A fixed tilt installation is being considered for the plant due its lowest risk profile.

Pile rammed sub-structures are the best recommended foundations for PV racks, according to geotechnical investigations, but the best foundation for this specific site will be decided by the executing company.

# 7.3 System Design

# 7.3.1 Preliminary Layout

The final layout will be defined once the final choice of modules, structures and inverters has been made.



Pic. 14

# 7.3.2 Modules

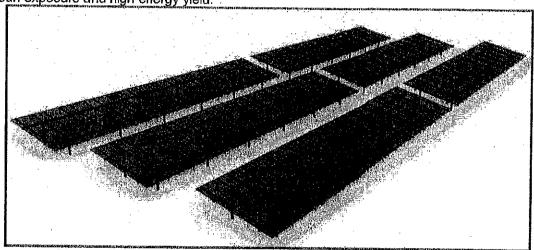
Standard crystalline PV modules, sorted according to a positive tolerance, were selected for the system design. This type of module is currently state of the art. Such modules are readily available in cost-efficient and sufficient amounts to realize a 100 MWp Solar Park Project. Quality of the modules will 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.

## 7.3.3 Structure

For mounting the PV modules on Site a standard fixed tilt metal mounting structure will be proposed. 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 several PV projects throughout the world.

The modules are mounted to the structure in a tilt- angle of 25°-28° to the ground to enable

sun exposure and high energy yield.



Pic. 15: Schematic diagram of PV mounting structure, Source S-Flex GmbH

#### 7.3.4 Cables

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

## 7.3.5 Inverters

For this Technical Site Assessment centralized type AEG 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 delivering stage.

## 7.3.6 HV Station

The substation is considered as a critical part for 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 PV plant, double bus bar single breaker scheme designed for HV portion is recommended for utilization in this Project.

# 7.3.7 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 the fine resolution of PV plant components, e.g. in one channel combination of two module strings only.

To achieve an optimum energy yield it is recommended to keep the staff operating on Site for monitoring the performance of the PV plant continuously.

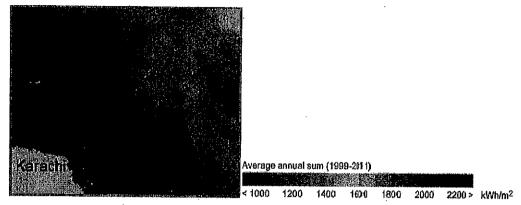
# 7.3.8 Security

For securing the Site against theft and vandalism as well as for protection of personnel, a fence of minimum 2 m height plus barbed wire should be erected. As an alternative, a solid concrete wall should be erected. In addition, a video surveillance system connected to a maintenance office is recommended to be installed to remotely supervise activities on Site.

# 8 Energy Yield Assessment

### 8.1 Solar irradiation data

The given sunshine hours can only indicate the volatility through the years which is around 20 %. Besides these sun hour data there are also other sources for irradiation data available e.g. satellite. Dimension shall be kWh/m² instead of sun hours to calculate energy values. For initial energy yield analysis the annual horizontal global irradiation was evaluated as 1875.7 kWh/m² (Meteonorm data base, see also 5.5).



Pic. 16: Global horizontal irradiation (GHI) for Pakistan, source: SolarGIS 2012

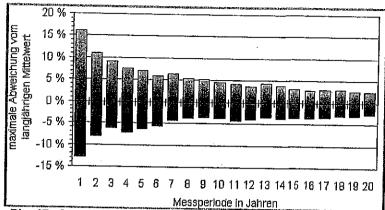
Month	Circulation (Circulation)	
MOTITI	GlobHor (Ghi)	( Amb ( Ia)
	kWh/m² * a	°C
TO ME Guanuary,	1067	1276
February	120.9	19.1
(a) survey (March 2012). Find	(6440 · 5)	7972 E
April	184.1	30.9
ing the May on Cond	1,202,1	10 to 6 to 7 to 7
June	192.5	34.9
	3078	1 2021 S
August	181.1	32.2
September :	w	tyjny effoliajsky
October	146.6	28.3
Neveriber	904 F	222
December	100.3	16.8
year	(# 7 % 18757	2004

Table 3: Global horizontal irradiance (Ghi) and ambient temperature (Ta) by Meteonorm / monthly means

# 8.2 Uncertainty Analysis of Irradiation Data

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. The figure below demonstrates the decrease of deviation from the long term average according to the number

of measurement years. 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 that number given in the yield analysis.



Pic. 17: Deviation of solar irradiation from the long-term average

Source: Volker Quaschning "Unstete Planungsgröße"; Maximum devlation of measuring periods of different duration from the long-term average in the years 1937-1999 at the Potsdam/Germany site.

The uncertainty of annual irradiance data is 10 % (source: Meleonorm software, Version 7.1.1.122). This value is high because the nearest ground measurement station for comparative values is at quite a large distance.

# 8.3 Performance Ratio

A solar cell is the smallest semi-conductor 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 depending 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 percent and describes the relationship between the actual and theoretical energy outputs of the PV plant considering module efficiency. PR = energy yield / (un-shaded 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<sub>AC</sub>

= energy coming from the inverter or measured at the energy meter in kWh

E Irradiation

= un-shaded irradiation at module level in kWh

A Array

= total surface of all solar modules in m2

n stc

= module efficiency at STC

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

$$\eta_{STC} = \left[ \frac{P_{Module}}{A_{Module} \times 1.000} \right]$$

# 8.4 Shading analysis

From multiple site visits we can safely assume that vegetation and terrain causes no relevant shading. No relevant objects can be seen so far. Few trees and small bushes existing at site have been proposed to be cut. This eliminates all chances of external shading.

## 8.5 Expected losses

## System Operation Quality / Performance Ratio

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.

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  $F(A) \sim 1.10-1.15$ . 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 even so, it is 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 %.

## Description of types of technical losses

Technical losses are calculated in the energy yield analysis depending on system design, chosen components and operation conditions.

Technical losses because of shading

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

"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", on the contrary, has a temporary and impact only on some parts of the generator field. Other parts of the plant remain absolutely 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.

Technical losses because of soiling

Dirt on the modules also causes shading effects which can change over time and season. This shading impact on the energy yield depends, for example, on the surrounding landscape, cultivation and precipitation. The impact can only be estimated and is based on experience. Consequently, the uncertainty is high. It is recommended to clean the modules at least once per month.

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.

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 co-efficient for current and voltage.

Best in class losses due to temperature fluctuation would be represented by values in the range of up to 10 % under the site conditions. Acceptable values would range between 9 % up to 13 %. Temperature fluctuation losses above 13 % would be un-acceptable.

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 un-acceptable.

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 %.

Technical losses because of fluctuations in module quality

Due to measurement errors or contractually allowed tolerances, the module output power under standard test conditions might deviate.

Best in class losses due to module quality are negative if only positive tolerances would be allowed. Acceptable values would range between 0 % up to 1.5 %.

Technical losses because of fluctuations in module arrays
 Due to production reasons, the module performances are subject to fluctuations:

Because of the different manufacturing technologies the module wiring to module strings causes the so-called mismatch effect.

Best in class losses due to mismatch would be represented by values in the range of up to  $0.5\,\%$ . Acceptable values would range between  $0.5\,\%$  up to  $1.5\,\%$  Mismatching losses above  $1.5\,\%$  would be un-acceptable.

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-scale 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 non-acceptable.

Technical losses because of DC/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 the range of up to 1.8 %. Acceptable values would range between 1.8 % up to 3 %. DC/AC inversion losses above 3 % would be un-acceptable.

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 step-up transformers (MV/HV) this value is typically <1%.</li>

Best in class losses due to voltage transformation would be represented by values in the range of up to 0.6 %. Acceptable values would range between 0.6 % up to 1.2 %. Transformation losses above 1.2 % would be un-acceptable.

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 the range of up to 0.3 %. Acceptable values would range between 0.3 % up to 0.8 %. Availability losses above 0.8 % would be un-acceptable.

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 the modules is a continuous process, depending on time, performance will decrease with the time of operation. Performance guarantees of the 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 the range of up to 0.3 %. Acceptable values would range between 0.3 % up to 0.8 %. Degradation losses above 0.8 % would be un-acceptable.

Up to now, the technical design has not yet been decided. We have made conservative assumptions by also using state of the art components.

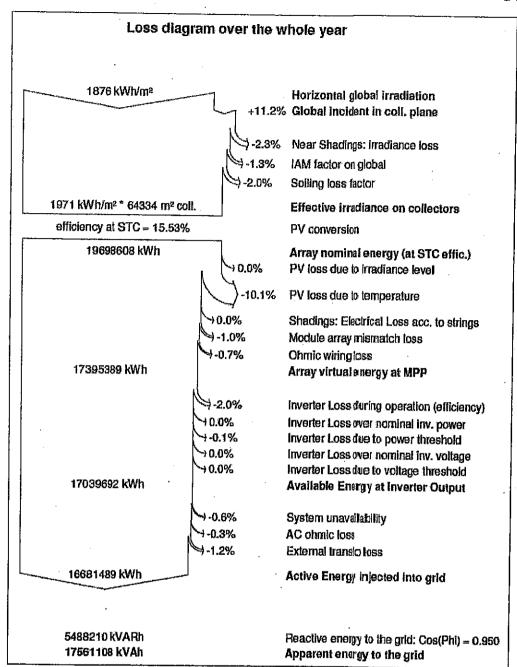
		quality classification	
Loss factor	best in class	our assumption	non acceptable
	%	%	%
Sindling to the state of the st		123	250 4 3
Solling	< 1.0	2.0	> 4.0
Temperatire duction and the second	<b>*</b>		1 5 100 5
Reflection .	< 1.0	1.3	> 4.0
Moduledow light performance	e esponente		THE RESIDENCE OF
Module quality performance	<-0.2	0.0	> 1.5
Wodule nismatch losses	er grenor by	100	7 (15 - 17 )
Cable losses	< 1.0	0.7	> 2.5
DC/AC conversion		21	200.0
Voltage transformation	< 0.6	1.2	> 1.2
Avallablika, essa separa sersi e	98, 158 DB 3, 115	2062	151-11-11-11-11-11-11-11-11-11-11-11-11-
Degradation on average	< 0.3	0.5	> 0.8

Table 4: Overview to loss factors and quality classification

Shown below are the results for fixed mounted structure with a fixed tilted array with 25° tilt angle of the modules.

General explanation to the waterfall diagram: (1) Starting with the Horizontal Global Irradiance the tilted installation increases the irradiance on tilted module plane – in the shown example – by 11.1 %. Near shadings and glass reflections reduce that gain. (2) Once the irradiance reaches the active cell it is converted to electric power by the efficiency of the cell ("PV conversion"). (3) The electrical system then causes more losses which depend on the characteristic behavior of the components cabling design and operation.

The PR is calculated between "Energy injected to grid" and "Array nominal energy (at STC efficiency)".



Pic. 18: Waterfall diagram of losses (simulation for 10MW cluster with fixed tilt 25° to south)

# 8.6 Energy yield simulation for most suitable technical design

Different pre-assessments have been calculated with the simulation software PVSyst. PVSyst takes as an input the meteorological data as well as a given 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 fixed mounted at different tilt-angles. The yield assessments show following annual outputs to the grid. The results are calculated for the point of interconnection with the HV grid and include transformer losses and cable losses to the point of interconnection to the HV Power line.

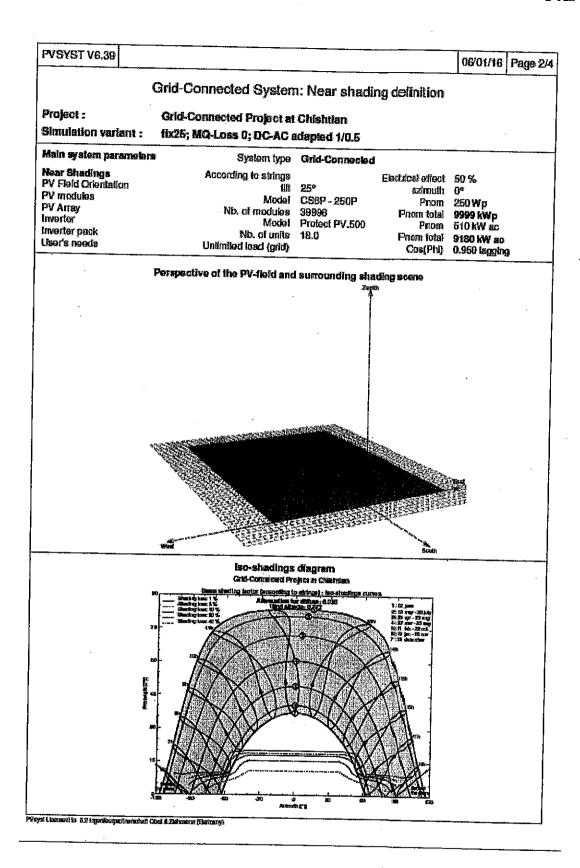
	Fixed mounted
	25° to south
Irradiation	
in module plane	2086.5
kWh/(m²*a)	
- Periotinance/Rajib (PR)	
是是在100000000000000000000000000000000000	50.0
Specific output	4000
kWh/kWp	1668
Total output for 100 MWp	166 P10 000
kWh/a	166,810,000

Table 5: (Summary of Simulation results)

9 Appendices

**Appendix 1**: Main results of Yield Simulation for 10MW can be extrapolated to 100MW, Fix Mounted, **tilt angle 25°** 

		······································			06/01/16 Page
	Grid-Co	nnected Syste	m: Simulati	ion parameters	
Project :	Grid-Cor	nected Project a	t Chishtlan		
Geographical Sile		Chishlian	ì	Country	Pakistan
Situation Time defined as			29.5°N	Longitude	
i una cieta aci		Legal Time Albedo	Time zone U 0.20	T+5 Allitude	151 m
Meteo date:	•		Synthetic - N	eli monoetel	
Simulation variant :	fix25; MC	D-Loss 0; DC-AC	edapted 1/0.5	<u> </u>	
		Simulation date	-		
Simulation parameters				-	
Collector Plana Orient		T#	25°	Azimuth	02
Models used		Transposition	Pornz	Diffuse	Erbs, Melegnorm
Horizon	•	Free Horizon		Dintag	not maintheally
Near Shadings	i	According to strings		Electrical effect	<b>50</b> %
PV Array Charactertalli PV module Osigna Pveystomasse			CS6P - 250P Canadian Sol		
Number of PV modules Fotal number of PV mod Array global power Array operating characle Fotal area		in series Nb. modules Nominal (STG) U mpp Module area	9999 kWp 587 V	in paralie) Unit Nom. Power At operaling cond. I mpp Cell area	8914 kWp (50°C) 15174 A
inverter Characieristics		Model Manufacturer Operaling Voltage	Protect PV.56 AEG Power S 500-820 V	00 Coluitions Camb H Unit Norn, Power	510 kVA
Inverter pack		Nb. of inverters		Total Power	
PV Array loas factors Array Solling Losses				Loss Fraction	2001
Thermal Loss factor		Uc (const)	29.0 W/m³K		0.0 W/m²K / m/s
Wiring Ohmic Loss		Global array res.	0.44 mOhm	Loss Fraction	1.0 % at STC
Aodule Quality Loss Aodule Mismalch Losse:	3			Loss Fraction Loss Fraction	
ncidence effect, user de	lined profile	107 20° 1.00 1.50	80° 40°	50° 60°	1.U 76 86 (MP) 70° 80° 90° 192 573 8.00
iyatam loss factors IC wire loss inverter to b	Wire	inverter voltage sa: 3x15000.0 mm²	33 m	Loss Fraction	
External transformer	fron loss	(Night disconnect) e/Inductive losses	9795 W	Loss Fraction Loss Fraction	0.f % at STC
Inavaliability of the syste		1.8 days, 5 period		Time fraction	
lser's needs :	U	nlimited toad (grid)			
		- 17			



#### PVSYST V6.39 06/01/16 Page 3/4 Grid-Connected System: Main results Project: Grid-Connected Project at Chishtian fix25; MQ-Loss 0; DC-AC adapted 1/0.5 Simulation variant: Main system parameters System type Grid Connected **Near Shadings** According to strings Electrical effect 50 % PV Field Orientation 25° tiit ezimulh: O2 PV modules CS6P - 250P Model Pnom 250 Wp PV Array Nb. of modules 39996 9999 kWp Priori total Invertor Model Protect PV.500 Pnom 510 kW ac Inverter pack Nb. of units 18.0 Pnom total 9180 kW ac User's needs. Unlimited load (grid) Cos(Phi) 0.950 lagging Main simulation results System Production Produced Energy 16681 MWN/year Specific prod. 1668 kWh/kWp/year Apparent energy 17561 MVAh Perf. Ralio PR 80.0 % Morenatized productions (per installed MWp): Naminal power 2000 MWp Performance Radio PR 878 : Faltmanck Pale (177 h); GARS fix25; MQ-Loss o; DC-AC adapted 1/0.5 Balances and main results Globling TANK Giobine GlobEH Elding E Grea **EADGER** EHSysR idVivini kWhim! 70 KWI-J-P MAYIN 機力 MVAh MINE Y 106.1 14.00 145.6 188.5 1301 1212 129/ 13.06 February 120.9 19.02 1532 146.6 1337 1200 1356 1207 March 164.0 25.20 187.1 177.2 1570 杨ઠ 1584 1268 Àρα 184.1 30.51 491.1 100.2 1555 150 1 1580 (2.2) May 202.1 35.24 196.0 1832 1582 1675 11.04 June 1926 34 AC 179.9 168.6 1446 (39C 1450 12 OG Ally 487 B 23.23 177.4 166*2* 1438 (3)4 1457 12.13 AUGUS 191.1 37.2% 481.E 170.G 1402 1431 † EDG 12.25 September 170.7 30.90 197.6 177A 1537 dia 1541 12.13 October 146.6 28.34 178.7 169.7 14B3 1364 1457 1204 Howe orbes 119.4 21.89 169.1 158,4 1430 150100 1452 12.90 December 100.3 16.85 143.3 135.8 1265 1220 1295 1324 Year 1875.7 26.94 200E.5 1671.4 17306 C 68 1 17551 Legende: Cable Horizontal giobal inadiation EAWAY Effective energy at the computed the acray T Amb Ambient Temperature E\_GAR Energy injected this grid

EApGrid

EHSpall

Apparationary to the grid

Ellia Ecutaysians/ rough area

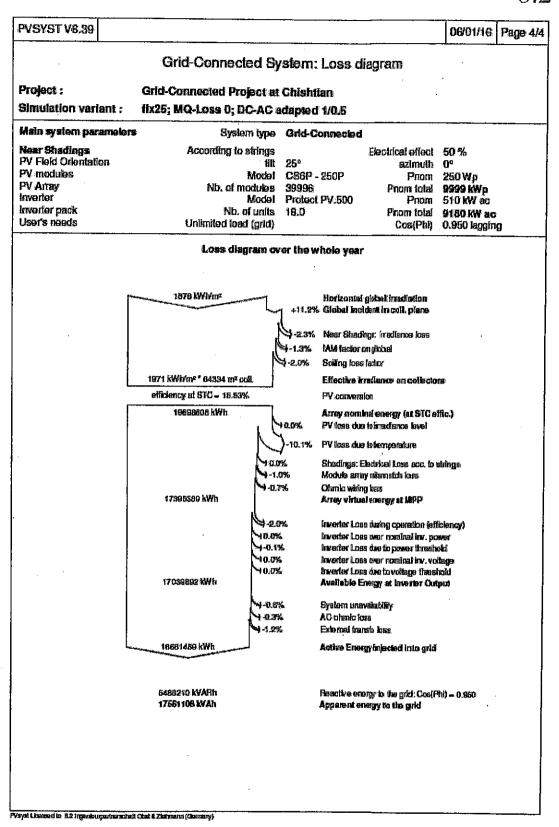
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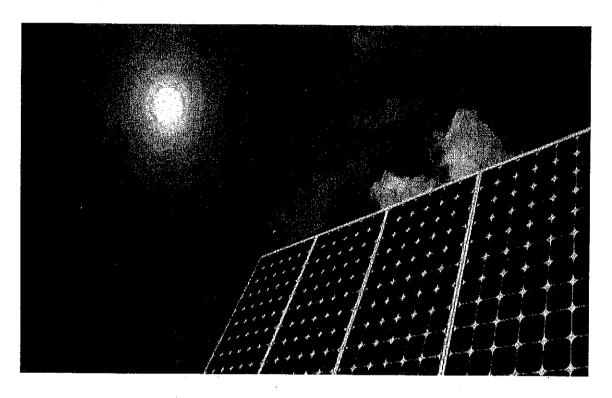
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# Annexure – X

# INITIAL ENVIRONMENT EXMINATION REPORT FOR CATALYST ENERGY (PVT.) LIMITED & SE PLANS, CONTROL METERING AND T&D

Quaid-e-Azam Solar Park (QASP) 100 MWp Solar Photovoltaic Project, Bahawalpur Block (H + K)



# INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT

**MAY, 2015** 



Engineering Consultancy Services Punjab (Pvt.) Limited 83-A, E/1, Main Boulevard, Gulberg-III, Lahore. Phone: 042-35717681-4 Fax: 042-35717685; Email: info@ecsp.com.pk

# List of Acronyms

AC Alternate Current

ADB Asian Development Bank
AJK Azad Jammu Kashmir

CDM Clean Development Mechanism
CSP Concentrating Solar thermal Plants
CSR Corporate Social Responsibility
CER Certified Emission Reduction

DC Direct Current

DCO District Coordination Officer
DEO Divisional Executive Officer

R&D Research and Development

EHS Environment Health and Safety
EIA Environmental Impact 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 ESMP Environmental and Social Management Plan ESMS Environment and Social Management System

GEL Global Environmental Lab

GHG Green House Gas

GW Giga Watt

GRI Global Reporting Initiative
HSE Health Safety Environment

HA Hectare

IEE Initial Environment Examination IPPs Independent Power Producers

IET International Emissions Trading (IET)

ICUN International Union for the Conservation of Nature ISO International Organization for Standardization

IJ Joint Implementation

LAA Land Acquisition Act

LAC **Land Acquisition Collector** 

LV Low Voltage

**MBTA** Migratory Bird Treaty Act

MW Mega Watt

MWp Mega Watt Peak

MV Mid Voltage

No Objection Certificate NOC

NCS National Conservation Strategy

National Environmental Quality Standards **NEQS** 

Non-Governmental Organization NGO

NPO Non Profit Organization

PAP **Project Affected Persons** PCS **Power Conversion Station** 

Pakistan Council of Research in Water Resources PCRWR PEPA Pakistan Environmental Protection Act Pakistan PEPC Pakistan Environmental Protection Council

**PUC** Pollution Under Control

PV Photovoltaic **PWh** Petawatt Hour

Project Affected Person PAP

QASPP Quaid-e-Azam Solar Park Project

**REC** Renewable Energy Corporations

ROW Right of Way

Reinforced Cement Concrete Rental Power stations RCC

SC Supervisor Consultants

TW **Terawatt** 

Terms of Reference ToR

VO Veterinary Officer



1-

# 100MWp SOLAR PHOTOVOLATIC PROJECT BAHAWALPUR, PAKISTAN BLOCK H + K INTIAL ENVIRONMENTAL EXAMINATION

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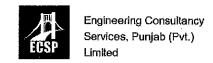
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# **Executive Summary**

# Introduction & Background

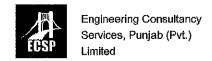
The power situation in Pakistan is critical with an estimated shortfall of 6,000 to 7,000 megawatts; long periods of 'load-shedding' are having adverse economic and social impacts across the country. To meet this shortfall, power generation from burning of fossil fuels is being expanded, which causes harm to the environment. Fossil fuels are non-renewable and will run out one day. Burning fossil fuels generates greenhouse gases and relying on them for energy generation is unsustainable. Hence, there is a need to find more renewable and sustainable ways of generating energy.

In this regard; StormHarbour has taken a step forward to install the renewable energy project 100MWp Solar Photovoltaic (PV) in the Cholistan desert (falling under Clean Development Mechanism (CDM) category), some 11km south of Bahawalpur city sprawling over an area of about 487 acres (4 kanals). According to Pakistan Environment Protection Act, this proposed project falls under the category 'C' that means this project has no adverse impacts. Planning objectives of the environmental assessment are to carry out the identification of impacts (positive or adverse); and to measure mitigation accordingly during construction, operational and maintenance activities of the proposed project.

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.

# **Key Applicable National Environmental Laws and Regulations**

The Pakistan Environmental Protection Act (PEPA), 1997 is the key regulation which authorizes the government to frame further rules for environmental protection. This section comprises of the current detailed environmental policy as well as administrative and legal framework; particularly related to the EIA of Solar Plants. Documents related to environment have been studied including National Environment Policy (2005), Pakistan Labor Policy (2010), Punjab Environmental Protection Act (1997), Environmental Quality Standards (NEQS), Cutting of Trees



(Prohibition) Act (1975), Punjab Wildlife (Protection, Preservation, Conservation and Management) Act (1974), etc.

After the endorsement of 18th amendment, powers for the grant of NOC have been passed on to the provincial Environmental Protection Agencies (EPAs).

Under this act, no project involving construction activities or any modification in the physical environment can be accepted, unless an EIA detailed study is conducted, followed by an approval of the provincial EPA.

This EIA report has been prepared with due concern of PEPA, 1997, Punjab Environmental Protection (Amendments) Act, 2012 and all other legal requirements of Pakistan.

# Approach and Methodology

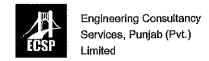
The approach and methodology applied for the execution of the impact assessment study is approved:

- Review of secondary Information
- Collection of base line information on physical, biological and socioeconomic conditions prevailing in the project area.
- Impact assessment, mitigation and enhancement measures;
- Field surveys and data acquisition
- Group/Community consultation, Group meeting and consultations with local and community representatives.
- Regulatory review was undertaken to understand the applicable, local and national legislation and regulatory frameworks.

# **Project Description**

Following are the prominent features of proposed solar energy project:

Prominent i	eature of Quald-e-Azam Solat Park
EQUITOV : 10 May 3	Rakistari (1700)
Location	Bahawalpur, Punjab, Pakistan
Status', 'gride' ste	Unicer construction (Designing Stage)
Commission date:	After I year
Owner(s)	Stamp (Hallody) : Private Concerns (1) (of
Operator(s)	America (4) Local Representator
	Marketing and Control of the Control
-Solat paik	



Tvoe	CIT Pat-panel RV
Sife area	487 acres 4 Kanal Footsing
Power generation	
Nameplate capacity	THE OO MW.
	1000 MW/(planned)

# **Environmental and Social Baseline Conditions**

Pakistan's desert named Cholistan, locally known as Rohi, is the largest one of the four deserts of Pakistan. It is a hot and sandy desert with a mean annual rainfall of 100 to 150 mm usually falling during the monsoon season (July to September) and in winter and spring (January to March). There is no river or canal flowing through the desert area due to which area has hyper-arid climate. Main activity in the area is livestock rearing. Agricultural farming is not practiced due to unavailability of irrigation water and low rainfall. The soil of Cholistan desert is generally unfertile, lacking organic matter, saline alkaline, gypsiferous and often dunned land. Air quality of the area is fine. No industry exists in or near Project area therefore ambient air is clean and there is no noise pollution as well. Windblown dust can be observed during strong winds. Project area fall under silence zone i.e. noise level is around 50 dB (A). Cholistan attracts not only the highest number of wildlife but also the highest variety that is not found anywhere else in Pakistan. Most famous variety of local wildlife; *Parah* (hog deer), *Neeli Gaee* (blue bull), and Black Buck are still available in the areas near Indian border.

As project area falls under the unfavorable climatic conditions, so no permanent community settlements are present in the area.

Features of Cholistan Desert (Project Area)

Ŝ#	Particulars	:Units
	Area	26300 km2
2	Area spread (kms)	480 x 32-192
	Area in acres	66,55,360
4	Bahawalnagar	10,11,200 acres
i di Sala	Bahawalpur	40,28,217 acres
6	R Y Khan	16,15,965 acres
7	Lesser Cholistan	33,00,000 acres
8.5	Greater Cholistan	17,55,360 acres

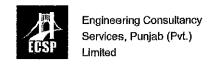
9 1 1	Human Population	1,55,000 heads
fo <sub>t</sub>	Livestock population	13,18,000 heads
M. T	Cholistani Cattle	6,67,000 heads
(2)	Camel	80,000 heads
13	Goats	2,20,000 heads
4	Sheep	3,51,000 heads
15	Temperature range	6-50°C
1612	Ground water	Mostly brackish
7	Latitude	28.25
118	Latitude (DMS)	28° 15'0 N
19	Longitude	70.75
20	Longitude (DMS)	70° 45'0 E

# **Environmental Impacts and Mitigation Measures**

IEE enables the identification of impacts; their mitigation and determination of associated environmental and social costs.

The permanent positive impacts/benefits of implementation of Solar Power generation unit in Cholistan are more prominent than temporary adverse impacts, which include:

- It will reduce greenhouse gases emissions as compared to the Coal fired Power Plants; hence project may qualify for Clean Development Mechanism (CDM).
- It will also decrease the reliance on Conventional sources of energy.
- It is a source of renewable, environmental friendly, clean energy and its 10-25 years sustainability sounds beneficial.
- Besides positive impacts there are some under mentioned adverse but temporary impacts that may arise during various phases mainly in construction and operational phase, however, these could be easily mitigated.
- During pre-construction phase; large number of trees and shrubs can be cut; which is an adverse impact of the project.
- During construction phase there can be impacts of noise from construction machinery, nuisance and disturbance to community; impact on air quality and water quality from emissions and accidental spillage.



- There may also be some impacts due to solid waste produced by construction activities, labor staying at site during operational phase as well as solar panel hazardous solid waste.
- In the operational phase, there will be few adverse impacts which can easily be mitigated, for instance, light pollution, high atmospheric temperature, and chance of electric shocks.

The adverse environmental impacts during construction and operational phases will be minimized by strictly complying with the measures suggested in Environmental Management Plan (EMP). There will be proper tree plantation plan, solid waste disposal system at the site, and appropriate sewage system will be provided to the labour and engineers at site. Mitigation measures will be taken to reduce noise and nuisance as well as health and safety issues of the labor by awarding the contract of construction work to a company which is ISO certified.

# **Environmental Management and Monitoring Plan (EMMP)**

An environmental management and monitoring plan provides a delivery mechanism to address the Potential environmental impacts of a project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works.

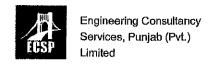
This process requires proper monitoring in order to report any performance of any mitigation measurement. The StormHarbour is the proponent of this Project. The proponent will ensure the proper implementation of mitigation measures for the concerned operation and maintenance phase through adequate monitoring.

A tree plantation plan is also discussed for the proposed project because a total number of 79 trees will be cut in the area to clear the land for Solar Project construction.

## Stakeholder Consultation

Public consultation plays a vital role in studying the impacts of any development project on stakeholders and in its successful implementation and execution.

The stakeholder consultation is comprised primarily of a social survey and consultation initiated by ECSP. The findings are based mainly on key informant interviews.

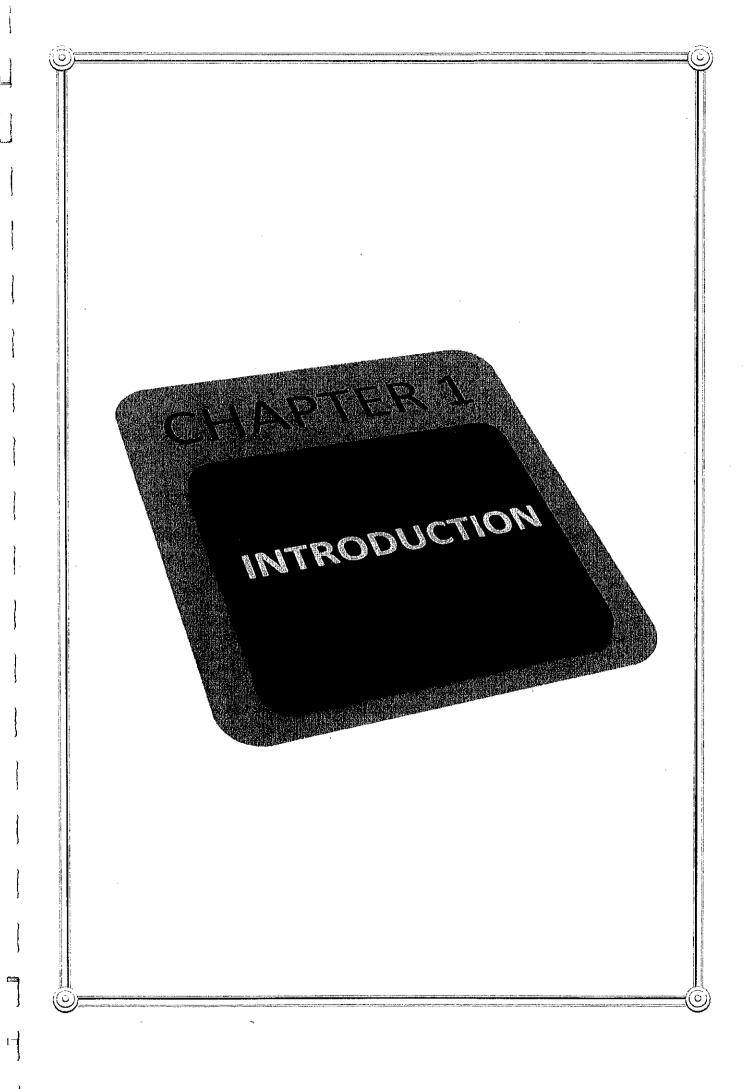


### **Conclusions and Recommendations**

The Project is a renewable energy project which uses solar energy for power generation. Renewable energy projects are considered to be cleaner compared to fossil fuel based energy projects.

Both the developed and the developing countries have realized that the key to attaining and maintaining prosperity and sovereignty is to have independence and self-reliance in access to and subsequent use of energy. This project also falls under the category of Clean Development Mechanism projects.

There are certain recommendations to cater for the aforesaid issues and adverse impacts of the proposed project. 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.





#### 1. INTRODUCTION

#### 1.1 Background

Energy resources are the backbone of social economic development of Pakistan. It is essential for the production, manufacturing of goods and other things, which contribute a lot of revenue in the budget of Pakistan.

The power situation in Pakistan is critical due to industrial development, increase in population, an increase in the manufacturing of households and enhancement of living standards; long periods of 'load-shedding' are having adverse economic and social impacts across the country. To meet this shortfall, power generation from burning of fossil fuels is being expanded, which causes harm to the environment. Fossil fuels are non-renewable and will run out one day. Burning fossil fuels generates greenhouse gases and relying on them for energy generation is unsustainable. Hence, there is a need to find more renewable and sustainable ways of generating energy.

Solar energy is one the alternative energy source that is used widely across the globe. About 70% of the sunlight gets reflected back into the space and we have only 30% of sunlight to meet up our energy demands. Solar energy can be extracted either by Solar Thermal or using Photovoltaic (PV) Cells. Photovoltaic (PV) solar panels are a mean of converting sunlight directly in to electricity via the usage of solar cells.

Solar energy does not create any pollution and is widely used by many countries. It is renewable source of power since sun will continue to produce sunlight all the years. Solar energy advantages are much more than its disadvantages which make it as a viable source of producing alternative energy. Global investments in clean energy (solar energy) generation are continuing to increase and arguably the world is undergoing a clean energy revolution. According to the analysts Pakistan has a potential of generating electricity more than 100,000 MV with the help of solar energy in Pakistan. Keeping these advantages of solar energy in mind Government of Punjab has initiated for Solar Power Plant in 'Bahawalpur' named as Quaid-Azam Solar Park.

The Quaid-e-Azam Solar Park is planned to be a 1,000 Megawatt (MW) Photovoltaic Power Station in Bahawalpur, Punjab Pakistan. The first 100 Megawatt (MW) has been constructed in Bahawalpur (100% owned by the government of Punjab, Bank of Punjab and the contractor for the Project is TBEA Xinjiang Sun Oasis Co Ltd. / Tebian Electric



Apparatus Co Ltd) inaugurated by Prime Minister of Pakistan on 26 April, 2015. The installation of the plant was completed within a record time and it is currently in operational phase.

The government has invited investors to invest here for the balance 900 megawatts, in response; Crest Energy Pakistan Limited, Best Energy and Apollo Solar Development came up for investment on IPP (Independent Power Producer) basis. The Initial Environment Examination (IEE) of above three companies (100 MW of each) has been completed and NOC has been awarded from the EPD to these companies for the completion of Projects.

As per Punjab's foreign investment policy, Storm Harbor Company being the main holding company of United States of America is ready to invest for 100MW in Quaid-e-Azam solar park, Bahawalpur, Block H + K.

This Initial Environment Examination (IEE) report is prepared to initially assess potential impacts likely to occur from the Project's entire life cycle on the local environmental quality and communities. The assessment came up with a set of impact mitigation measures as well as monitoring programs for the Project to pursue in order to ensure minimized adverse impacts on the environment and communities nearby.

Engineering Consultancy Services Punjab (Pvt.) Limited (ECSP) has been engaged by StormHarbour Company to carry out Initial Environmental Examination (IEE) process as a part of above mentioned services to fulfill the environmental regulatory requirements.

#### 1.2 Project Location

The proposed Project is located in Cholistan desert, some 11 km south of Bahawalpur City in an area of about 500 acres, and is in shape with following coordinates:

Table 1.1: Coordinates Showing Project Location \*

	North		
Corner	3248269.9351	772260.8132	7149485, 2918237
Gorner III & -	3246467.3052	772260.8132	7148782, 2918628
Corner III	3246467.3052	773520.2710	7149485, 2918237
Corperaly	3248269.9351	773255.5169	7148782, 2917422

**Table 1.2: Coordinates Provided by Client** 

Longitude [E]	Latitude [N]
71.48.244 <sup>0</sup>	29.20.063 <sup>0</sup>
71.48.844 <sup>0</sup>	29.20.063 <sup>0</sup>
71.48.244 <sup>0</sup>	29.19.524 <sup>0</sup>
71.48.844 <sup>0</sup>	29.19.574 <sup>0</sup>
71.48.989 <sup>0</sup>	29.19.574 <sup>0</sup>
71.48.989 <sup>0</sup>	29.19.524 <sup>0</sup>
71.48.244 <sup>0</sup>	29.19.524 <sup>0</sup>
71.48.989 <sup>0</sup>	29.19.524 <sup>0</sup>
71.48.244 <sup>0</sup>	29.19.085 <sup>0</sup>
71.48.989 <sup>0</sup>	29.19.085 <sup>0</sup>

The solar radiation map of Pakistan & surrounding is given and blow-up of the Project Area is shown in the Figure 1.1. The satellite imagery of location of Cholistan Desert and blow-up of the Project Area are shown in the (ANNEX-F).

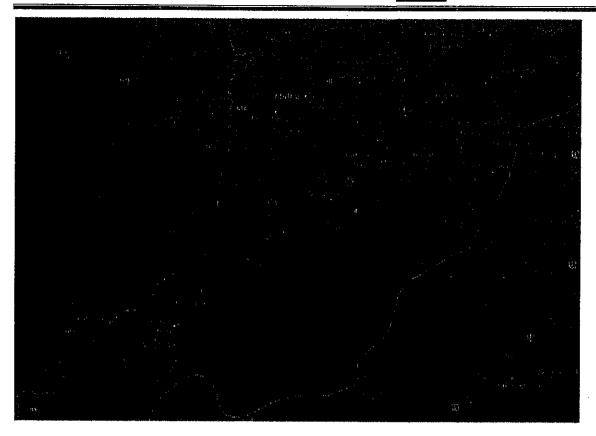


Figure 1.1: Intensity of Solar Radiation at proposed Project

### 1.3 Scope of the IEE Study

The scope of this IEE is based on Government of Punjab Pakistan requirements. Based on the likely types, sizes, locations and positive or adverse impacts of sub-Projects, the Project has been classified as environment category C.

The purpose of this IEE is to assess potential environmental, health, safety and social impacts of the proposed area; and to propose suitable mitigation measures accordingly where required.

The IEE followed a number of steps:

- Conduct field visits to collect primary or secondary data relevant to the Project area to establish the baseline environmental condition;
- Assess the potential impacts on environmental attributes due to the location, design, construction and operation of the Project through field investigations and data analysis;



- Explore opportunities for environmental enhancement and identify measures;
- Prepare an environment management plan (EMP) outlining the measures for mitigating the impacts identified including the institutional arrangements;
- Identify critical environmental parameters required to be monitored subsequent to the implementation of the Project and prepare an environmental monitoring plan.

This IEE study is conducted based on primary and secondary data collected from literature review, site visits, field surveys and stakeholder consultation.

#### 1.4 Objectives of Study

- To identify the impacts on physical (including land, water, and air), biological/ecological, and socio-economic environment and suggesting mitigation measures thereof for the proposed Project.
- To design the Project which meets the environmental standards.
- To conduct the safety audits of the proposed design in order to highlight the impact of the Project on the workers of Solar Power Plant; in term of electric shock.

#### 1.5 **Key Features of Site**

Following are key features of proposed 100MW Solar PV Project Block (H + K)

- The location falls under the 'hot and dry' climatic zone of Pakistan and experience extreme weather conditions of hot desert.
- The Project location has well accessibility.
- There are no shading elements; large sand dunes, trees are available on the site. Entire area is shadow free.
- Soil condition of project area consists of hard sand and surface is almost flat; hence limited land work is needed to level the land as per the requirements of solar PV Power Plant.
- In Project area there is only one village, so resettlement issues do not exist.

#### 1.6 **Environmental Sensitivity of the Project**

Solar facilities may interfere with existing land uses, such as grazing, livestock animals and burro management, military uses, and minerals production. Solar facilities could impact the use of nearby specially designated areas such as wilderness areas, areas of critical environmental concern, or special recreation management areas. Proper siting



decisions can help to avoid land disturbance and land use impacts. Cultural and paleontological artifacts and cultural landscapes may be disturbed by solar facilities.

Photovoltaic panels may contain hazardous materials, and although they are sealed under normal operating conditions, there is the potential for environmental contamination if they were damaged or improperly disposed upon decommissioning.

Concentrating Solar Power (CSP) systems could potentially cause interference with aircraft operations if reflected light beams become misdirected into aircraft pathways. Operation of solar facilities, and especially concentrating solar power facilities, involves high temperatures that may pose an environmental or safety risk. Like all electrical generating facilities, solar facilities produce electric and magnetic fields.

It is estimated that the proposed Project falls in the environmental category 'C' which translates into the fact that the proposed Project will pose insignificant adverse impacts on the environment, i.e. minimal or even nil. As the proposed Project will pose insignificant adverse impacts on the environment so there is no need to carry EIA of the proposed Project.

#### 1.7 Limitations of Study

Under the clean Development Mechanism Projects (CDM) solar power generation is new in the Pakistan. There is no environmental guideline or regulations in Pakistan which is available with the PEPA related to Solar Power Plant. PEPA regulations for thermal power generation are suitable for solar power generation which may be referred/ used in this report as this is closest reference available in the PEPA regulations. This regulation (PEPA Act 2000) states that thermal power generation up to 200 MW needs to conduct an IEE study before applying for environmental approval to Punjab-EPA. The environmentally benign nature of Solar Energy has compelled the Client to request the Consultants for carrying out an IEE study of 100 MWp photovoltaic power generation unit and the Proponent may not go for EIA study.

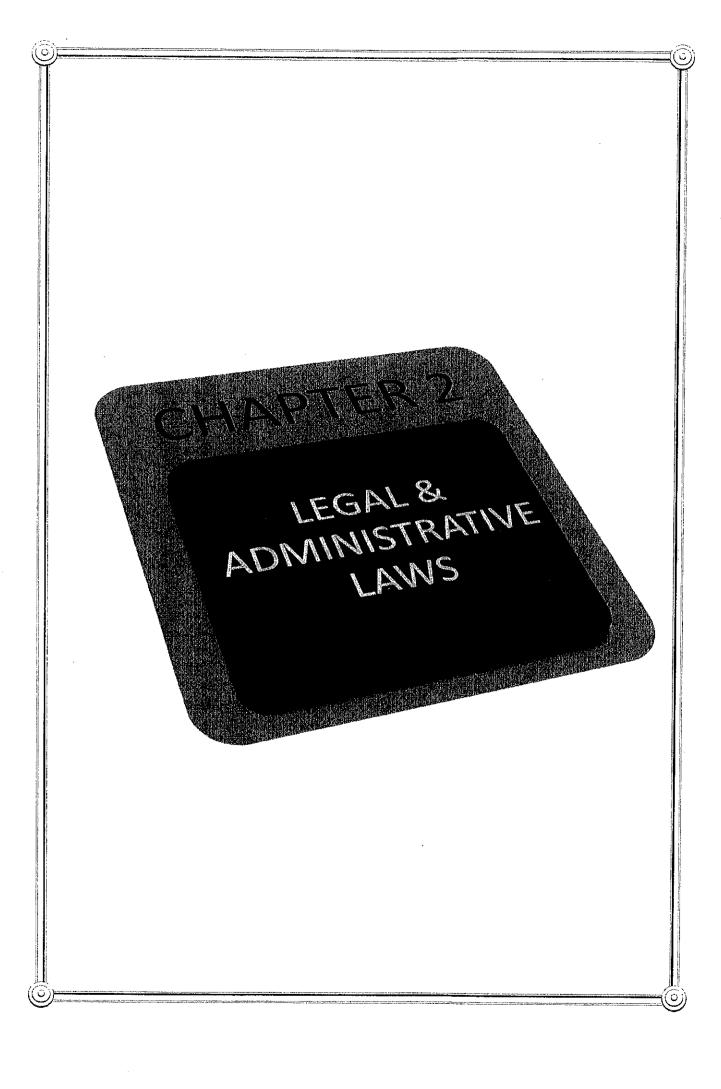
Professional judgment and subjective interpretation of facts has been applied for interpretation of various aspects. All information and inferences presented herein are based on the details currently available as per the scope of work, information provided by the Client or its representative, existing 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 and propose mitigation measures for the expected impacts that are likely to occur due to implementation of this Project. The proposed Project must verify compliance with both the EPA regulations and PEPA prior to issuing a permit for the Proposed Project.

The main purpose of 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 as per EMP.





### 2. LEGAL & ADMINISTRATIVE LAWS

In this section, the environmental and social regulations are described which are applicable to the proposed solar power Project. In this section, the main focus is on the institutional framework, health and safety and also social legislative.

Under Clause 12 of the Pakistan Protection Act 1997 (PEPA, 1997), it has been mentioned that it is obligatory for the Proponent of the Project to arrange Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) before the start of the Project. Recently, Pakistan Environment Protection Agency (Pak-EPA) has no regulation for generation of solar power mentioned in their Schedule I or Schedule II (PEPA Regulations 2000). The closest energy which can be quoted for generation of solar energy is Thermal power generation. After the implementation of the 18th Amendment which was 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, the experts of the consultants are preparing an EIA document plan which will follow this document shortly.

### 2.1 National Policy and Administration Framework

In March 1992, the Federal Cabinet approved the Pakistan National Conservation Strategy (NCS), is the major principal policy document on the environmental issues. The NCS is the document which outlines the country's major approach towards conserving natural resources, to encourage sustainable development, and to improve efficiency in the use and management of resources. The NCS has detailed particular programs in main areas in which policy intervention is considered vital for preserving of natural and physical environment of Pakistan. Prevention of pollution and its reduction, to support forestry and plantations and biodiversity conservation are the basic areas that are important in the context of the proposed Project.

### 2.1.1 Organization Structures

In 1997, the Government of Pakistan publicized "Pakistan Environmental Protection Act (PEPA) in 1997. There are two organizations, the Pakistan Environmental Protection Council (PEPC) and the Pak-EPA. They are primary responsible for administering the provisions of the act at the Federal Level. PEPC member's include the Government representatives, industry, non-governmental organization and also the private sector. The



PEPC is responsible for overseeing the functioning of the Pak-EPA. The Pak-EPA is required to ensure compliance of the National Environmental Quality Standards (NEQS) and for establishing evaluation and monitoring systems. The Pak-EPA was authorized to delegate powers to its provincial counterparts, the provincial EPAs. 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.

### 2.1.2 Pakistan Environmental Protection Act, 1997

The Pakistan's Environmental Protection Act, 1997 empowers the Pak-EPA to:

- Develop environmental emission standards for parameters such as air, water and noise pollutants
- Develop procedures for conducting IEE and procedures for the review and approval of the same.
- Identify categories of the Projects to which the environmental examination/ impact assessment provisions will apply.
- To Develop plans for conducting IEE and procedures for the review and approval of the same.
- Delegate powers including those of environmental examination/ assessment to the provincial EPAs/ EPD.
- Implement the provisions of the Act through environmental protection orders and environmental tribunals which are headed by magistrates with wideranging powers, including the right to fine violators of the Act.

Under the provisions of the 1997 Act, the Pak-EPA has authorized five provincial EPAs/EPD (including AJK) for managing 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 essential to review and approve IEEs/EIAs of all the development Projects.

### 2.1.3 National Environmental Quality Standard, (NEQS) 2000

The NEQS 2000 specify the following standards as under:

- Allowable noise levels from vehicles.
- Allowable air concentration



Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to land waters, sewage treatment facilities, and the sea.

### 2.1.4 Interaction with Other Provincial Agencies

It is the main responsibility of the Proponent of the Project to affirm that the Project complies with the laws and regulations controlling the environmental impacts at preconstruction conditions, operation and construction stages of the Project.

#### 2.1.5 Provincial Departments of Forest and Wildlife

In case of clearing of vegetation and trees in the concerned Project area, the Project contractor will be responsible for acquiring "No Objection Certificate" (NOC) from concerned Provincial Department. Application for NOC will need to be authorized by the Proponent. As the construction is to be carried out in close proximity of protected forests and wildlife areas, the Proponent is required to coordinate with other departments to ensure that the impact on flora and fauna species are minimized. StormHarbour is the Proponent of the Project and is responsible for receiving an approval for the environmental clearance from the Punjab-EPA.

#### 2.1.6 Punjab Environmental Protection Department

The Proponent will responsible for providing the complete documentation required by the Puniab 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.

#### 2.1.7 Provincial Revenue Departments

Under the National laws, the matters relating to land acquisition 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. For those purposes, the lead department must lodge an application with the concerned provincial government to depute a Land Acquisition Collector (LAC) and revenue staff, which will be responsible for handling matters relating to land in case of any issue arise.

#### 2.2 Some Other Departments

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



relating to the affected vegetation resources, such as trees and crops. In case of some public buildings/infrastructure is involved, Proponent will approach the building department for relocation/assessment of compensation.

#### 2.3 Coordination with District Government

The Project Proponent will coordinate with all concerned Government Departments 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.

### 2.4 Other Relevant Acts

#### 2.4.1 Punjab Wildlife Protection Act, 1974

The Punjab Wildlife Protection Act, 1974 was approved 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.

### 2.4.2 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.

### 2.4.3 Protection of Trees and Brushwood Act, 1979

This Act forbids 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.

#### 2.4.4 Clean Air Act, (1990)

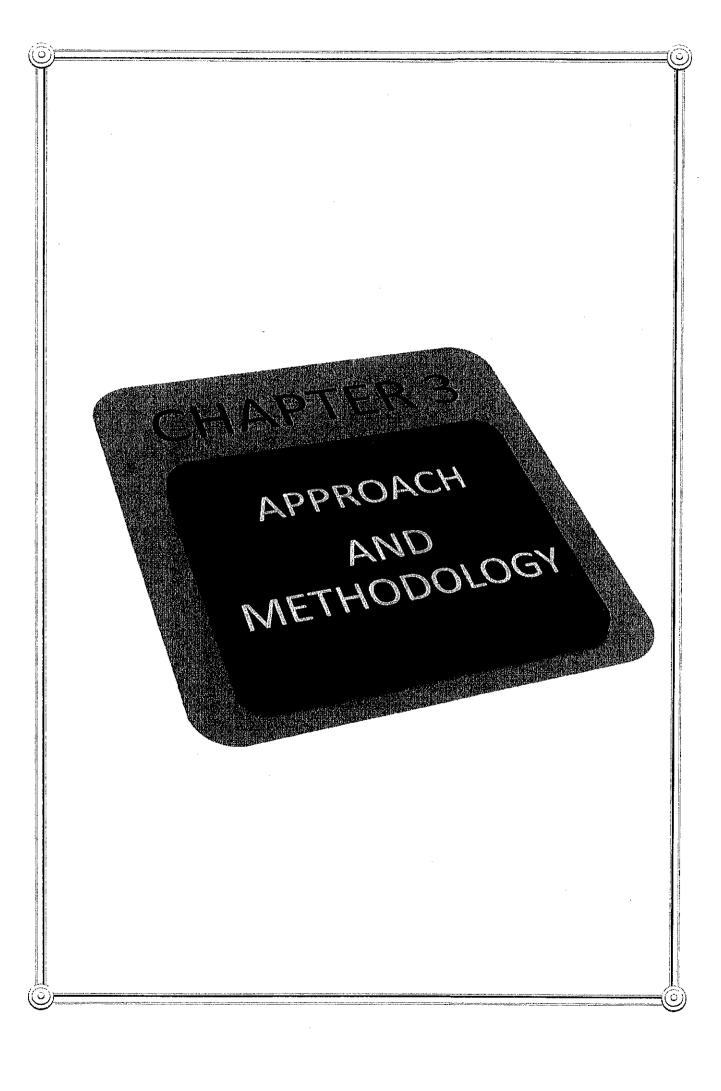
This law sets the release of pollutants into the air. It sets standards for air quality and to enforce regulations to protect the environment from airborne pollutants, which are known to be dangerous to human health.

### 2.4.5 Migratory Bird Treaty Act (MBTA)

The Migratory Bird Treaty Act of 1918 (MBTA), is a United States federal law, which was first enacted in 1916. The act makes it unlawful without a waiver to pursue, hunt, take,



capture, kill or sell birds as listed therein ("migratory birds"). The statute does not discriminate between live or dead birds and also grants full protection to any bird parts including feathers, eggs and nests.





### 3. IEE STUDY APPROACH AND METHODOLOGY

#### 3.1 General

Environmental impact study is a formal procedure for investigating, analyzing and presenting the environmental implication of a proposed development and identifying mitigation measures required to trim down the effects of environmental impact by dint of construction of proposed solar power Project to acceptable levels. In so much that Initial Environmental Examination (IEE) shall have to be carried out to ensure issues associated with the Projects anticipated and potential benefits brought to light prior to implementation in an objective way, considering regional development issues, as well legislative and institutional aspects. The Environmental Protection Department is required to prepare Initial Environmental Examination (IEE) report to award the NOC to the client before implementation of proposed Project. To facilitate Proponent, the consultant shall prepare a Terms of Reference (ToR) in the format as indicated in EPA, 1997. The consultant is required conducting IEE study based on approved Terms of Reference. Objective of ToR and Guidelines for preparing ToR and IEE Report are mentioned in the succeeding subsections which are required to be considered while doing IEE study

### 3.2 Purpose and Objective of Initial Environmental Examination

An IEE of the proposed solar Project is necessary in order to assess the environmental consequences of the proposed construction activities of the solar Project and suggest appropriate, practical and site specific mitigation and enhancement measures. An IEE of an Energy Project is a legal requirement according to Clause 12 of Pakistan Environmental Protection Act, 1997 (PEPA). Besides the legal requirement, the IEE can be helpful to incorporate the development work with environmental conservation necessities in such a way that the anticipated benefits will be obtained without causing serious environmental problems. The underlying objective of IEE is therefore to gear the Project as it evolves and takes shape to "Make it environmentally sound, modify it to and help fit in the local environment and integrate it in the social and instructional context." The main objective of the IEE study is to identify the impacts of physical, biological, socioeconomic and cultural environment of the Project area. As the Solar power Project does not lie within any environmentally sensitive or protected area, preparation of IEE report by the proponent and approval of IEE report by the Environment Protection Department is considered sufficient to meet Pakistan's legal provisions. This IEE report of



solar power Project in Cholistan is prepared based on the Terms of Reference (ToR) by the StormHarbour. The findings and conclusions of the report are based on the analysis of the information collected during May, 2015 from the field by undertaking a walk-through environmental survey, public consultancy and desk information in the Project site.

### 3.3 Clean Development Mechanism (CDM)

The UN's Kyoto protocol established binding greenhouse gas emissions reduction targets for 37 industrialized countries and the European community. To help achieve these targets, the protocol introduced three "flexible mechanisms" international emissions trading (IET), joint implementation (JI), and the clean development Mechanism (CDM).

To date the CDM has arguably been the most successful of the three flexible mechanisms. It has two main goals:

- 1. To assist countries without emissions targets (i.e. developing countries) in achieving sustainable development
- To help those countries with emission reduction targets under Kyoto (ie developed countries) in achieving compliance by allowing them to purchase offsets created by CDM Projects.

A broad range of Projects are eligible for CDM accreditation, with the notable exceptions of nuclear power and avoided deforestation Projects. They vary from hydropower and wind energy Projects, to fuel switching and industrial efficiency improvements. Crucially, to qualify for accreditation the Project developers must prove 'additionally', defined as emissions reductions that are additional to what would have otherwise occurred. This is calculated by using an approved methodology to subtract the estimated emissions of a given Project from a hypothetical 'business-as-usual' emissions baseline.

#### 3.4 Criteria for CDM Projects

Pakistan shall allow unilateral, bilateral and multilateral CDM Projects preferably in the following areas:

- Energy including renewable energy, energy efficiency, energy conservation and fossil-fueled cogeneration;
- Land use, Land use Change and Forestry (e.g. biodiversity protection, soil conservation, watershed maintenance and sustainable forest/rangeland management);



- Agricultural and livestock practices;
- Waste Management (e.g. landfills, solid waste management, recycling, animal/livestock wastes);
- Transportation (e.g. alternative fuel vehicles, mass transit systems, cleaner engines, Compressed Natural Gas); and
- Industrial processes

The CDM Steering Committee may, however, include any other sector on the request of local / foreign investor provided it is in line with the objectives of the CDM. To be eligible for national approval under CDM, the Project in the above listed areas must meet the National Sustainable Development Criteria.

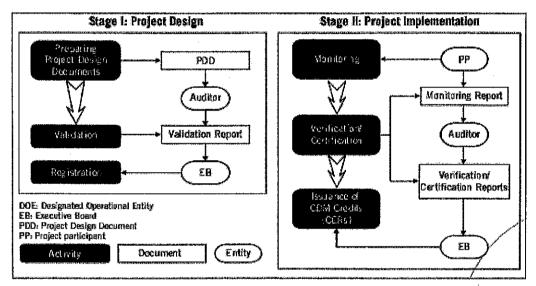


Figure 3.1 CDM Process Cycle

#### 3.5 Method Adopted

The IEE approach, methodology and procedure were generally followed according to the provisions of the PEPA, 1997. Data collection was done in May, 2015 by the Environment Team of ECSP study.

- · Collection and review of secondary sources of information from various sources
- Collection & review of Primary Data
- Compare and analyze the Primary and secondary data
- Laboratory samples were collected



### 3.6 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, the anticipated environmental impacts and practical mitigation measures while implementing the specified activities.

Following team of professionals responsible for data collection, field study, analysis and writing of report was composed along with description of their brief responsibilities:

- 1. Dr. Sultan Mahmood, Chief of Section, Environment, supervised the field team in Cholistan desert and guided them to use correct methodology of data collection process, as well as interviewed the district and town authorities of Bahawalpur including Rangers.
- 2. Engr. Athar Aslam, HSE Expert and Resettlement Specialist, emphasized on the status of the affected families for their resettlement options, as well as planned for the future construction activities.
- **3. Ms. Mehvish Javed, Head Survey Team, leading** the survey team, guided the team to collect data; measure coordinates and also conducts the stakeholder consultation.
- 4. Mr. Saad A. Sheikh, Integrated Communication Specialist, participated in field work, received and discussed the present drawings to build a census among the team members, also helped out other team members in record keeping, and photo-basking.
- **5. Mr. Mohammed Amir, Senior Sociologist,** provided the details of the land acquisition record as prepared by the design team of the consultants.
- 6. Ms. Alishba Inayat, Sociologist, designed socio-economic questionnaires and conducted focus group discussions and social survey which include identification of proposed sites and study area.
- 7. Mr. Muhammad Usman Maqsood, Junior Sociologist, recorded field truths through Social Impact assessment checklist, focused 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 tabulate 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.

#### 3.7 Public consultation and Information Disclosure

In order to ensure the public involvement, the following procedures were followed during IEE report preparation:

- A 15 days public notice was published on National Daily Newspaper seeking written opinion from concerned VOs, DEO, schools, health posts and related local organizations. A copy of the public notice was also affixed in the above mentioned organizations and deed of enquiry was collected.
- Written responses from relevant stakeholders on the public notice were also reviewed and documented in the report.
- 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. Solar Power Project Office, Lahore, Punjab
- 2. ECSP Office, Lahore, Punjab
- 3. Environment Protection Department, Lahore, Punjab



### 3.8 Mitigation Measures and Monitoring Plan

Mitigation is an integral part of impact assessment especially when these are adverse environmental impacts. A realistic approach was applied for the application of the mitigation measures in the local context. Environmental monitoring plan was developed to assess the effectiveness of the mitigation measures and implementation status.

### 3.9 The Final Report

The IEE report was prepared by with support from study team. After reviewing the final IEE report according to TOR, it was submitted to Environment Protection Department through client for approval.





### 4 Project Description

As every Project has its phases, principles and procedures, solar energy Project has also its own phases including planning, design, construction, operation, maintenance, decommissioning and reclamation. The proposed Project and its salient features are described as below:

### 4.1 Need of the Project

The recent electric power shortage crisis in Pakistan is affecting economy and various people and the situation is getting worse day by day. Although only 46 % people of the country is getting facility of electricity but government is not still able to manage a steady power to them. Poor planning, recent climate change, oil prices and politics are the major causes of today's situation of electricity shortfall. Economy and subsequently people are badly affected by this crisis with loss of huge capital and degrading health. The solution of current crisis is energy conservation at all level on publically and to launch different more Projects of solar power plants by government. So the use of alternative sources of energy like solar power plant can be utilize to immediately reduce the shortage, while electricity generation Projects from coal and large dams can provide a long term solution to electricity shortage.

Pakistan has suffered crippling "load shedding" or electricity shortages for years that can leave households across the country without power for up to 18 hours a day.

According to a World Bank Report, around 44 per cent of Pakistan's households are not connected to the grid, most of which are in rural areas.

Temperatures particularly in central Pakistan can reach up to 50 degrees Celsius during the summer; rising demand for electricity skyrocketing and leaving a shortfall of approximately 4,000MW. The geographical conditions make Pakistan a place with lot of solar potential. Bahawalpur, for example, with very little rain and a lot of sunshine, is a very feasible and economical place for the utilization of solar energy.

### 4.2 Methodological Details of PV Technology

The solar power generation units will consist in a set of solar photovoltaic (PV) modules, power inverters, switchgear, associated protection, control and monitoring equipment's, and associated civil works. The electricity output will be directly fed into existing



distribution network. Wherever required distribution grid will be upgraded by replacing grid assets such as cable, distribution boxes, switchgears etc.

Photovoltaic (PV) is a method of converting solar energy into direct electricity using semiconducting materials that exhibit the photovoltaic effect. The photovoltaic system employs solar panels composed of a number of solar cells to supply useable solar power. Power generation from solar PV has been long seen as a clean sustainable energy technology which draws upon the planet's most plentiful and widely distributed renewable energy source, the sun. Moreover, the environmental footprints of solar power are almost negligible.

The materials presently used for photovoltaic technology include monocrystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium gallium selenite /sulfide. Copper solar cables connect modules (module cable), arrays (array cable), and sub-fields. In this case an inverter is required to convert the DC to AC.

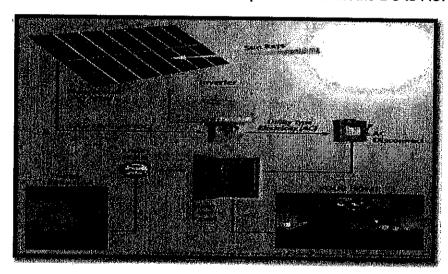


Figure 4.1 Diagram of PV System

### 4.3 Components of Solar Power Station

The main components of a PV power plant are:

- PV modules
- Mounting (or tracking) systems
- Inverters
- Transformers
- Grid connection.



### 4.4 Significant Features of the Project

The Project is being developed using poly-crystalline photovoltaic cells without any backup generators and would generate 100% clean energy to be fed into the national grid. The Project is a new one with installation of a new power plant at the site and is not a capacity addition, retrofit, or replacement of any other existing plant. The Project would be generating around 152,424 MWh/annum of electricity on average and would thus be reducing 90,570 tons of CO² from the atmosphere annually, thus generating 90,570 CERs for the relevant crediting period. The Project will not only be reducing the GHGs through its installation but would also significantly contribute to sustainable development by improving the overall economy of the region as the Project is going to be located in an economically downtrodden area.

### 4.5 Examination of Alternatives

Evaluation of different choices available for achieving an objective usually requires costbenefit analysis, life cycle assessment, and sensitivity analysis.

### 4.6 No Alternative Action

Under the No Alternative Action, the approvals of the long-term lease, right-of-way, and other permits needed for the proposed power plant and associated facilities would not be granted. Without these approvals and permits, the proposed Project would not be approved for implementation. In the case of this Project, documentation of the effects of taking no action serves as the baseline of environmental information against which impacts from the proposed Project would be predicted to occur if the necessary agency actions are taken.

### 4.7 Other Power Production Options

For many decades almost all the electricity consumed in the world has been generated from three major forms of resources- fossil, hydro and nuclear. The Renewable energy resources currently generate a relatively small share of the world's electricity, although that share is growing fast.

Figure 4.2: Detailed Salient Features of Quaid-e-Azam Solar Park (Block H + K)

Quald-e-Azam Solat Park			
coupity.	Pakistance.		
Location	Bahawalpur, Punjab, Pakistan		
Status	Under construction (Designing Stage)		
Commission date	Affor 1 year		
Owner(s)	SternjHarbetir Private Concerns of America with the plants		
Operator(s)	Local Representator		
Solatbark Lagran			
Type -	Flat-panel PV:		
Sie alea an air an air	487/acres 4 Kanal Foctorint		
Power generation			
Nameplate capacity	TODIMUV (planned)		

	Efficiency Efficiency (Conservation) Cogeneration etc.)	Wind	Blogne	Solar Thermal	Coal	Nuclear
Bushar Cost Cents/kWh*	Variable (Generally Low)	8.9	8.6	12.7	10.6-17,3	15,3
Greenhouse Gas Emissions gCO <sub>2</sub> e/kWh**	(Approactics 0)	9-10	11	Ğ.	960-1050	66
Danger of Serious Accidents and Devastation	Hinlaid	Minimal	Low	Low	Moderato	Very High***
Waste Disposal Problem	Minintal	Allidina)	Minimal	Minimal	High	Very High****
Implementation Time	Yarlable (Generally Love)	Minimal	Law	Low	Long (Years)	Very Long ≥10 Years
Private investment Available	Yes	Yes	Yes	Yes	Yes	No.

Figure 4.3: Comparison of New Energy Sources

### 4.8 Comparison of Different Energy Sources

### 4.8.1 Fossil

The power plants utilize fossil fuels such as coal, oil or gas to generate steam that drives turbines to produce electricity. These plants can generate electricity reliably over long periods of time. However, by burning carbon fuels they produce large amounts of carbon dioxide, which causes climate change. They can also produce other pollutants, such as sulfur dioxide and oxides of nitrogen which cause acid rain.

Fossil fuel plants require huge quantities of coal, oil or gas. These fuels may need to be transported over long distances. The price of fuels can rise sharply at times of shortage, leading to unstable generation costs.

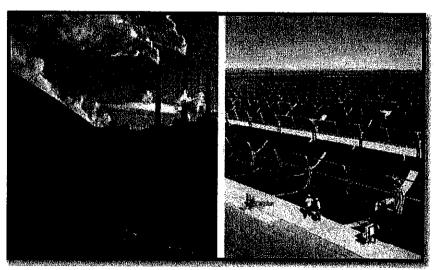


Figure 4.4: Comparison between Fossil Fuel Consuming Plant & Solar Power Plant

### 4.8.2 Large Hydro

Large hydro power plants generate electricity by storing water in vast reservoirs behind massive dams. Water from the dams flows through turbines to generate electricity, and then goes on to flow through rivers downstream.

Hydro dams can generate large amounts of electricity. However, dry periods can drain out the reservoirs. The flooding of reservoirs behind dams and slowing of the flow of the river below the dam can have a serious impact on the ecology around the dam. Moreover, the number of sites suitable for new dams is limited.

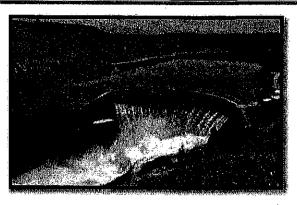


Figure: 4.5 Large Hydro Power Plant

#### 4.8.3 Nuclear

Nuclear power plants use the heat produced by nuclear fission to generate steam that drives turbines, like in fossil fuel plants. However, no greenhouse gases are produced in this fission process, and only small amounts are produced across the whole fuel cycle.

Nuclear fuel can be used in a reactor for several years. The used fuel that remains after this time must be stored and then either recycled to make new fuel or carefully disposed of. However, because the amount of fuel used to generate electricity is so much less than that used in fossil fuel plants it is much more practical to do this with used nuclear fuel than with the wastes and emissions from fossil fuels.

Nuclear power plants can run for many months without interruption, providing reliable and predictable supplies of electricity.

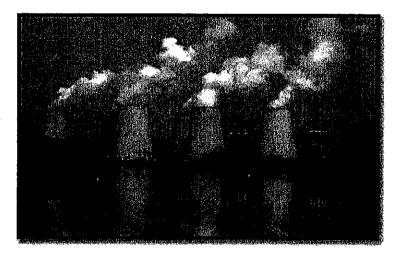


Figure: 4.6 Nuclear Power Plant



#### 4.8.4 Renewables

Renewables such as wind, solar and small scale hydro produce electricity with no greenhouse gas (GHGs) emissions at the point of generation but very low amounts of greenhouse gas emissions across their entire lifecycle.

The cost of electricity generation from many renewables, however, tends to be higher than other forms of generation, often requiring subsidies to compete with other forms of generation, although these costs are coming down.

Many renewables do not produce electricity predictably or consistently. Electricity generation from wind turbines varies with the wind speed, and if that wind is too weak or too strong no electricity is produced at all. The output of solar panels is reliant on the strength of the sunshine, which depends on the time of day and the amount of cloud cover. This means that renewables have to be backed up by other forms of electricity generation, often fossil fuel generation with their resultant greenhouse gas emissions.

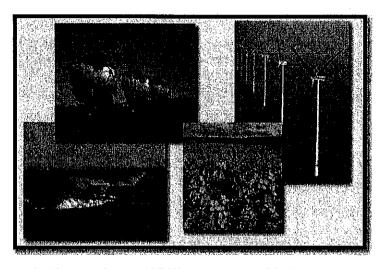


Figure: 4.7 Comparisons of Different Renewable Energy Resources

#### 4.9 CDM

The Clean Development Mechanism (CDM) allows Pakistan with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction Project. As the proposed Project has no carbon footprint, it can earn saleable certified emission reduction (CER) credits, each equivalent to one ton of CO<sub>2</sub>, meeting Kyoto-Protocol targets.



The mechanism is seen by many as a trailblazer. It is the first global, environmental investment and credit scheme of its kind, providing standardized emissions offset instrument, CERs.

The mechanism stimulates sustainable development and emission reductions, while giving industrialized countries some flexibility in how they meet their emission reduction or limitation targets.

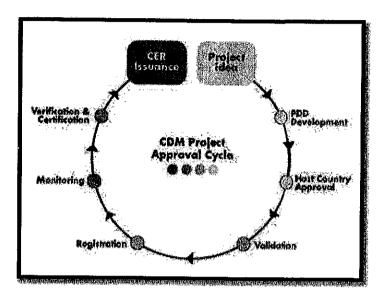


Figure 4.8: CDM Flow Chart

### 4.10 Site Options

Cholistan desert was selected instead of Thar Desert because Thar Desert has been planned for coal based power generation.

### 4.11 Construction Aspects

Typical activities during the solar energy facility construction phase include ground clearing (removal of vegetative cover), grading, excavation, blasting, trenching, drilling, vehicular and pedestrian traffic, and construction and installation of facilities. Activities conducted in locations other than the main facility site include excavation/blasting for construction materials (sands, gravels) and access road construction.

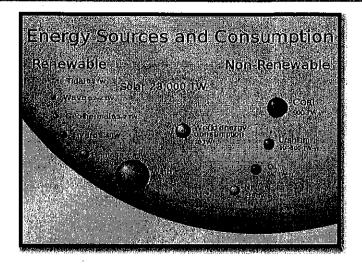


Figure 4.9: Comparison with other energy sources

### 4.12 Construction Material and Transportation

Short-term increase in the use of local roadways would occur during the construction period. Heavy equipment likely would remain at the site. Shipments of materials are unlikely to affect primary or secondary road networks significantly, but this would depend on location of the Project site relative to material source. Oversized loads could cause temporary transportation disruptions, and could require some modifications to roads or bridges (such as fortifying bridges to accommodate the size or weight). Shipment weight might also affect the design of access roads for grade determinations and turning clearance requirements.

#### 4.13 Issues with Construction

Typical issues that arise during the construction of a PV Project include:

- Foundations not being suited to ground conditions.
- Discovery of hazardous / contaminated substances during excavation.
- Incorrect orientation of modules.
- Insufficient cross-bracing on mounting structures.
- Incorrect use of torque wrenches.
- Damaging cables during construction / installation

### 4.14 Acoustics (Noise)

The primary sources of noise during construction would be equipment (e.g., rollers, bulldozers, diesel engines), other sources of noise include vehicular traffic. The exceeding



noise levels w.r.t Pakistan Environmental Protection Agency (PEPA) guidelines or local ordinances would depend on the distance to the nearest receptor. If there is residential area nearby the facility, noise levels from blasting and some equipment operation could exceed the EPA guideline but would be intermittent and extend for only a limited time.

#### 4.15 Hazardous Materials and Waste Management

Solid and industrial waste would be generated during construction activities. The solid wastes would likely be nonhazardous and consist mostly of containers, packaging materials, and wastes from equipment assembly and construction crews. Industrial wastes would include minor amounts of fuels, spent vehicle and equipment fluids (lubricating oils, hydraulic fluids, battery electrolytes, glycol coolants), and spent solvents. Hazardous materials include compressed gases used for welding, cutting, brazing, etc., dielectric fluids, heat transfer fluids and oils. These materials would be transported off-site for disposal, but impacts could result if the wastes are not properly handled and released to the environment.

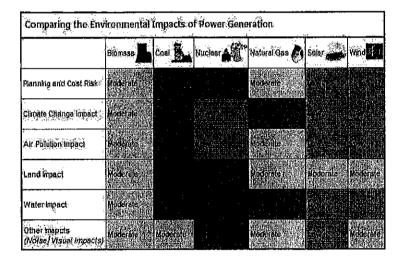
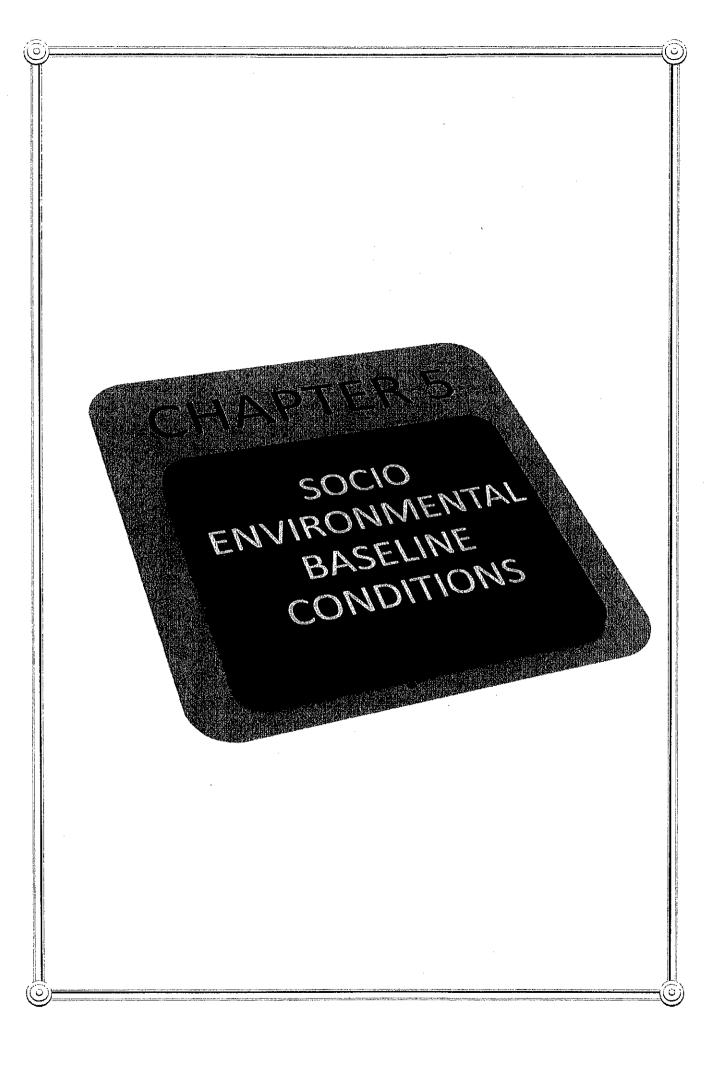


Figure 4.10 Comparing the Environmental Impacts of Power Generation





### 5. SOCIO-ENVIRONMENTAL BASELINE CONDITIONS

#### 5.1 Introduction

Deserts in Pakistan constitute a significant part of country's geography, especially in the central and south-eastern regions. The major deserts of Pakistan include Thar, Cholistan, Thasl and Kharan deserts. These areas receive very little rainfall and are characterized by large tracts of barren wastelands with formation of large sand dunes rising sometime to 150 meters above ground level.

Despite of harsh living conditions these desert areas are also inhibited by a large number of people and livestock. People of desert areas lead a semi nomadic life and keep continuously move from one place to another in search of water and fodder for themselves as well as their animals. Economic survey reveals that poverty level is at peak in these areas. Development and infrastructure in deserts is also poor or even non-existing.

This section provides baseline data (physical, biological and socio-economic parameters) related to the Project area. An environmental baseline assessment documents the pre-Project environmental conditions and is a key component in the EIA and IEE. It is important to properly assess the baseline condition before the Project takes place, so as to understand which phenomena existed before Project implementation and the associated impacts accordingly. The baseline assessment can also be used to reassure the public and decision makers that key environmental issues have been identified and will be monitored during Project implementation.

### 5.2 Physical Environment

Information placed below has been extracted from the secondary sources:

#### 5.3 Physiographic Outline of Cholistan Desert

Cholistan desert spreading over an area of 26300 km² in the southern part of Punjab province in which Bahawalpur, Rahim Yar Khan and Bahawalnagar districts fall. It is located at an elevation of 89 meters above sea level. Its coordinates are 28°15′0″ N and 70°45′0″ E in DMS (Degrees Minutes Seconds) or 28.25 and 70.75 (in decimal degrees). Towards the eastern flanks, Cholistan extends into the Indian states of Rajhistan and Punjab province of India and it joins the greater Thar Desert in Pakistan which is confronted with arid and semi-arid climate.



Cholistan Desert, locally known as Rohi, is the largest of five major deserts of Pakistan. It is bordered on the south by the Thar Desert in Sindh province and on the east by the Rajasthan desert in India. The Cholistan Desert covers about 26,300 km², which corresponds to 26% of the country's total desert area and 3% of its overall surface area.

While on the north-western front it is bordered by the irrigated plains of Indus and Sutlaj rivers. The total estimated population living in these desert districts in around 7.5 million (1998 Census). In ancient times the Hakra River use to flow through the area, along the banks of which a number of Indus Valley civilization settlements have been discovered, however the river had long dried up. Besides the unique landscape and unique nomadic culture, the major attractions of Cholistan include Lal Suhanra National Park, Drawar Fort and Annual Desert Car Rally, the biggest motor sport event in Pakistan.

Table 5.1: Features of Cholistan Desert (Project Area)

Since EGG 20 major size	= = = = = = = = = = = = = = = = = = =			
S#	Particulars	C. Units (2007)		
	Area	26300 km2		
22 10	Area spread (kms)	480 x 32-192		
	Area in acres	66,55,360		
4	Bahawalnagar	10,11,200 acres		
5 11 1	Bahawalpur	40,28,217 acres		
6 7 1	R Y Khan	16,15,965 acres		
	Lesser Cholistan	33,00,000 acres		
3	Greater Cholistan	17,55,360 acres		
9 4		1,55,000 heads		
10	Livestock population	13,18,000 heads		
	Cholistani Cattle	6,67,000 heads		
12 #		80,000 heads		
102 julija 12. stoj	Goats	2,20,000 heads		
14	Sheep	3,51,000 heads		
	Temperature range	6-50°C		
167		Mostly brackish		
	Latitude	28.25		
(9) (9)	Latitude (DMS)	28° 15'0 N		
10	Longitude	70.75		
20 2	Longitude (DMS)	70° 45′0 E		

### a) Climate/Weather Conditions

It is a hot and sandy desert with a mean annual rainfall of 100 to 250 mm usually during the monsoon season (July to September) and winter and spring (January to March). The mean temperature of the winter is 6.6°C (December and January) and the mean of the summer is 46.5°C, soaring up to 51°C. Aridity is the most striking feature of this desert with wet and dry years occurring in clusters.



#### b) Geology

One of the important geological features of the Cholistan is the old Hakra River, which is dried out about 600 years ago. The Hakra riverbed forms the dividing line between the two eco-regions of the desert. The Lesser part forms the northern portion of the desert margin and includes areas north of the Hakra along the bank of the Satluj River, while the Greater part is found to the south of the riverbed. The Greater Cholistan extends from the most recent course of the extinct Hakra River to the border with India. As such there is no major geology features. Topography, soil type and texture, and vegetation structure divide this desert into two distinct regions: the northern region (Lesser Cholistan) covers about 7,770 km² and the southern region (Greater Cholistan) about 18,130 km².

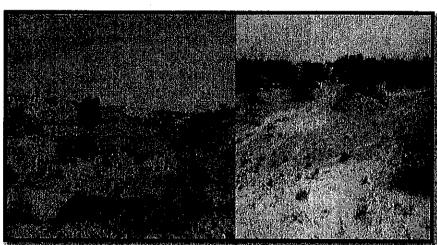


Figure 5.1 Geology of Cholistan

#### c) Land Use

The area of Cholistan Desert is 2.6 million hectares (ha). The desert measures 480 km in length and between 32 and 192 km in breadth. Human and livestock population in the desert is 0.1 and 2.0 million, respectively. There is no river or canal flowing through the desert area. The main land use in the area is livestock rearing. Agricultural farming is not practiced due to unavailability of irrigation water and low rainfall. More than 81% of the desert is under small and big sand dunes, while 19% consists of alluvial flats and sand hummocks. The area is affected by severe to very severe desertification due to poor vegetation cover, severe wind erosion and very severe soil salinity. The Pakistan Council of Research in Water Resources (PCRWR) has converted the severe desertified land into productive land as a model on more than 100 ha at Dingarh Cholistan through sand dune



fixation and stabilization by mechanical and vegetative means. Once desertified, the area is now under forest trees like orchard of grafted *zizyphus* and date palm, fodder crops and grassland grown with collected rainwater and saline groundwater. Now the area is fully secured from desertification and its micro-climate has been transformed into pleasant and friendly environment.

#### d) Soil

The soils of Cholistan desert are generally poor, lacking organic matter, saline alkaline, gypsiferous and often dunned. The dune reaches up to an average height of 100-150 m. Soil analysis was conducted in the Analytical chemistry laboratory of the Department of Chemistry, the Islamia University of Bahawalpur, Pakistan. Soil pH, electrical conductivity, total nitrogen, organic matter, sulphur, phosphorus, carbonates, bicarbonates and exchangeable cations, i.e., sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) contents were determined by using standard procedures (Anon., 1984). Each analysis was done in triplicate to verify the results and averages were used for further steps.

#### e) Air Quality, Noise & Water Quality:

Air quality of the area is fine. Ambient air is clean and there is no noise pollution at present because of no anthropogenic, industrial or other source of air pollution exists in the project area. Three samples were collected for the analysis from different locations at different time. Carbon Mono-Oxide (CO), Sulphur Dioxide (SO<sub>2</sub>), and Nitrogen Dioxide NO<sub>2</sub>) results were below detectable limit (BDL). Particulate Matter value was detected below from NEQS. Values of Humidity, Wind Velocity and Temperature are moderate (ANNEX-D). Windblown dust can be observed during strong winds. Project area falls under silence zone i.e. average noise level is around 46 dB (A) (ANNEX-D).

The population of the area is 0.155 million and 1.5 million livestock. Ground water is mostly brackish and main source of drinking water is rain water that is stored in Tobas and kunds. Since 2005, four water supply pipelines were laid. The standard of drinkable water is gradually on decline in Bahawalpur and its outskirts and citizens are facing threat of harmful diseases. According to Chemical Analysis Test Report by GEL, most of the parameters of drinking water are detected below the limit like Fluoride, sulphate and Nitrate etc. and some are analyzed above the limits declared by the WHO. Parameters of drinking water above the limits are Total Dissolved Solids (TDS), Chlorides, and Sodium ions (ANNEX-D). To this effect, the Punjab government has been initiating efforts to



supply potable water to Bahawalpur City and Cholistan through pipeline. The IUB is also ready to cooperate with public and private sector organizations in all aspects.

Rainwater collected in low-lying areas or dug-out ponds (Tobas) which is used by the humans and their livestock. Underground water is mostly brackish containing salts (9000 - 24000 mg/l). Unpredictable rainfalls support only leafless and spiny scrub jungle with stunted and half nibbled shrubs with a few trees. These plant species, though very slow growing, respond very well to the favorable climatic conditions and provide ample biomass for consumption by livestock and wildlife. The average annual rainfall in the desert ranges from 100 to 200 mm. Consequently, freshwater availability is very limited. There are no perennial or ephemeral streams, and most of the groundwater is saline with a medium to high range of dissolved solids that make it generally unfit for drinking. To make the best use of this potential, the herders have found ponds known locally as tobas. These store runoff water for use during the dry periods. Harvested rainwater is also stored for household use in large circular or rectangular tanks called kunds.

#### 5.4 Biological Environment

Cholistan desert, being a very unique eco-zone of Pakistan, enjoys a very special status of its own kind. Its biological resources are confronted with multiple stresses of long droughts, increased salinity, high temperature, a very low rainfalls ratio and enhanced grazing pressure. Therefore, the plant species have developed very typical xeric genetic adaptation to cope with these highly stressed environmental conditions. After sufficient rains, this desert flourishes into a good grazing ground and becomes an incredibly good supply line of animals and their by-products reaching to all major cities of the country, as well as neighboring states. To alleviate the sufferings of poor inhabitants of Cholistan desert, the Islamia University of Bahawalpur has established the Cholistan Institute of Desert Studies (CIDS) in 1982-83. The major object of this institute is to undertake useful scientific planning and research, to restore and rehabilitate the dwindling biological resources and minimize the sufferings of the peoples of desert area. The institute comprises of a Biological Division, Physical Sciences Division and Socio-economic Division. The Institute initiated a number of useful Projects pertaining to the exploration and utilization of desert's inherent genetic resources as no credible benchmark of this type was already available.



#### 5.4.1 Flora

A floristic survey of Cholistan desert was carried out during 2009-2011 and total of 38 families, 106 genera and 154 species were documented from the area. Among families, 33 families belong to Di-Cotyledons of 79 genera and 115 species, while the 38 species of 26 genera belong to 4 families of Monocotyledons and 1 family of gymnosperms with 1 genus and 1 species. The largest family was Poaceae with 34 species followed by Papilionaceae and Zygophyllaceae with 10 species while Asteraceae with 9 species respectively. The life form of plant species was determined by following the Raunkier's method. Therophytes comprised of 74 species (48%), Chamaephyte 40 species (26%), Hemicryptophyte 18 species (12%), Phanerophyte 19 species (12%) and Cryptophytic 3 species (2%) of the flora of the area.

Important genera of perennial grasses and sedges include Lasiurus, Cenchrus, Panicum, Ochthochloa, Sporobolus, Aeluropus, Cymbopogon and Cyperus. Forage shrubs include Calligonum, Haloxylon, Salsola, Suaeda, Acacia, Leptadenia and Capparis. Prosopis, Tamarix, Acacia and Zizyphus are notable forage tree species of the area. These plant species are very site specific, based on availability of soil moisture, salinity and plant characteristics (Arshad&Rao, 1994; Arshad et al., 1999) Genetic variability in forage range grasses is mostly scattered in arid and semi-arid areas of Pakistan, especially in Cholistan desert. Cenchrusciliaris L. is an important perennial range grass species of Cholistan desert. Because of heavy grazing pressure and prolonged droughts of many years this grass is going to be rare in the rangelands of this desert. It is one of the highly palatable and nutritious perennial grasses of the area. It is very well distributed in sandy and sandy loam areas of this desert.

#### 5.4.2 Wealth of medicinal plants of Cholistan desert

Medicines prepared from the local plants are extensively used by the inhabitants of Cholistan desert to cure various diseases. This paper deals with the wealth of medicinal plant resources of Cholistan desert and their possible conservational strategies. All the information regarding the medicinal uses of plants in Cholistan desert is collected from the local people, professionals and available concerned literature. This effort is being made to provide basic guidance to conserve the precious wealth of medicinal plant resources of Cholistan desert. Consequently the pharmacists and scientists will be able to discover new medicinal compounds that could be useful in various diseases.



#### 5.4.3 Wildlife in Cholistan Desert (Fauna)

Cholistan attracts not only the highest number but also the highest variety of wildlife that is not found anywhere else in Pakistan. Most of the 'honored guests' come from north. Most famous variety of local wildlife (Parha (hog deer), Neeli Gaee (blue bull), and Black Buck) are still available in the areas near border. Majority of these creatures is nocturnal and shy, so watching of these requires endurance and good pair of binocular. Wild cat, jackal, wolf, mangoes, squirrel, field rat, over 200 types of insects and as much as sixty varieties of snakes are found in 10400 square miles of this rain less tract.

Table 5.2:- Fauna of Cholistan

S# -, +	Gommon Name	Scientific Name
11	Mild boor	Susscrofacristatus
12	Wolf	Canis lupus
3 (2) 2 (2) 5 (3)	Hare	Lepusnigricolis
4 4 4	Porcupine	Hystrixidica
<b>50%</b>	Honey Badger	Mellivoracapensis
60	Nili gai	Boselaphostragocamelus
	Chinkara	Gazellabennetti
8 17 18 9 18 7	Hedgehog	Hemiechnusauritus
	Fox	Vulpesvulpes
	Jakal	Canisaureus
	Desert cat	Felislibyca
1124 4 1 1	Indian Mongoose	Herpestesedwardsi
	Indian Mongoose Jungle Cat Indian Caracal	Felischaus
例外翻點面影	Indian Caracal	Felis caracal

Table 5.3:- Reptiles and Amphibians found in Cholistan

S#	Common Name	Scientific Name
	Tiger bull frog	Ranatigrina
2	Spiny tailed lizard	Uromastrixhardwicki
48 mar 1914	Spotted Indian house geko	Hemilacytylus b rooki
4	Indian monitor lizard	Varanusbengalensis
6	Black cobra	Najanaja
16 4 7	Common crate	Bungaruscaereleus
	Saw scaled viper	Echiscarinatus
8		Eryxconicus
8 1		Typholops b raminus
约0周	Brahminyblid snake	Typholopsbraminus

Table 5.4:- Birds found in Cholistan

S#	Common Name	Scientific Name
		CONTRACTOR OF THE PROPERTY OF
1.06	Grey partridge	Francolinuspondicerianus
2	Indian Desert Finch – Lark Common Indian	Ammomanesdesertiphoenicuroides
	Common Indian	Starling Sturnus vulgaris
4	Hobara bustard	Chiamydotis undulate
	Great Indian bustard	Choriotisnigriceps
6 - 4	Imperial sand grouse Indian gray shrike	Pteroclesorientalis
7.1	Indian gray shrike	Laniusexcubita
84.25 (64)	Spotted owl Lagar falcon Saker falcon Falco Desert buzzard	Athenebrama
9 marking	Lagar falcon	Falco biarmicusjugger
	Saker falcon Falco	Biarmicuscherrug
	Desert buzzard	Buteobuteovulpinus
	Indian sparrow hawk	Accipiter nisus melaschistos
10.	Tawny eagle	Aquila rapoxvondhiana
	Harrior	Circus macrourus
	Indian ring dove	Streptopeliadecaocto
46-2	Little egret Pond heron Golden backed wood pecker	Egrettagarzetta
# 76 L BA	Pond heron	Aredeolagrayii
600	Golden backed wood pecker	Dinopiumbenghaleuse
	Warblers	Sylvia nana nana

The Insects include Scorpions, spiders, ants, bees, wasps, moths and beetles have a long history within the region. Scarab beetles, members of the family Scarabaeoidea, consume dung and plant material and are the most numerous group of beetles in the area. The vectors are flies, mosquitoes, fleas and sand flies. Habitat management is the key to prevention of disease through control of such vectors.

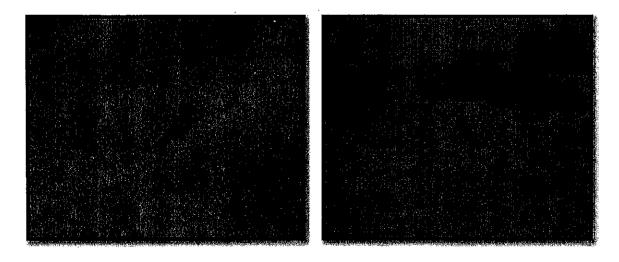


Figure 5.2 Wildlife of Cholistan Desert



#### 5.5 Social Environment

The Project area lies at the entry point of Cholistan Desert from Bahawalpur side and its entry point is bifurcated before the entry of already constructed 100MW PV Project. The Project area has an extension of village Noor Shah called Tibba Badwani where settlement is further divided in two parts. There are 54 families are settled with a total number of 277 persons or Project Affected Persons (PAP). They are considered under the category of PAP because they need to get assistance from the government at the time of relocation as soon as Project will become under construction stage. Unfortunately, LAA 1894 does not protect their rights so it is strongly apprehended that they will be dislocated forcefully.

As mentioned above that small unit of settlement, that is Tibba Badwani, is present in the Project area which will be dislocated to some other nearby place as soon as the Project will take a launch. These settlements are permanent and categorized as kachi abadi. Following is the detail of their assets:

Table 5.5: Details of Social Community Assets

8r #	Type of Structures	Quantity
	Peter pumps / 5 hp tube- well	3
2	Kacha houses	56
9	Mosque	1
4	Livestock	
4.4	Buffalo	3600
42	Cow	150
4.3	Goats with kids	2400
44	Camel	15





#### 6. Environmental Impacts and Mitigation Measures

The development of any Project certainly brings changes in the indigenous environment in terms of physical, biological, socio-economic aspects. The impacts generated may be beneficial or adverse. As in all development activities, this Project is likely to cause environmental impacts as a result of changes in physical, biological and socio-culture environment. The key environmental impacts have been identified for a number of issues based on the analysis of environmental baseline data and activities that are to be undertaken by the Project. Most of the identified impacts have been quantified to the extent possible on the value judgment. Each of the environmental issues has been examined in terms of their current conditions, likely impacts during construction and following operational phases. The impacts have been predicted in terms of their magnitude, extent and duration. The proposed Project is a renewable energy Project which uses solar energy for power generation. Renewable energy Projects are considered to be cleaner compared to fossil fuel based energy Projects. In accordance to ADB classification, the Project has been categorized as Category B for Environment, Category C for Involuntary Resettlement and Indigenous People.

Measures are suggested to avoid, remediate or mitigate (reducing) the adverse environmental effects. Ideally; the adverse effects should always be avoided and only if they are unavoidable then should be remediated or mitigated.

#### 6.1 Impact Identification Methodologies

Several techniques can be used in predicting the impacts. The choices should be appropriate to the circumstances. These can be based on:

- Professional judgment with adequate reasoning and supporting data. This technique requires high professional experience;
- By assessing sensitivity and magnitude of impacts;
- Experiments or tests. These can be expensive;
- Past experience
- Numerical calculations & mathematical models. These can require a lot of data and competency in mathematical modeling without which hidden errors can arise;



- Physical or visual analysis. Detailed description is needed to present the impact;
- Geographical information systems;
- Risk assessment, and
- Economic valuation of environmental impacts.

#### 6.2 Mitigation and Impact Management

Mitigation is done to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system. For each potential adverse impact the plan for its mitigation at each stage of the Project should be documented and costly assessed, as this is very important in the selection of the preferred alternative.

The objectives of mitigation are to:

- Find better alternatives and ways of doing things
- Enhance the environmental and social benefits of Project
- Avoid, minimize or remediate the adverse impacts; and
- Ensure that residual adverse impacts are kept within acceptable levels

All the issues such as acquisition of land, ecology, influx of people during construction phase, shelter, sanitation, equipment's and machineries, environmental health and safety, occupational hazard, social and environment management and monitoring plan have been dealt in detail in the respective sections of the Report. However these are briefly enumerated below to have a quick assessment of the situation.

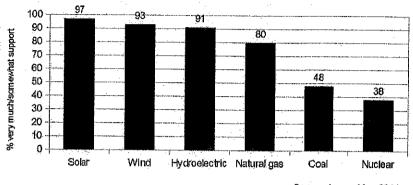
**Table 6.1: Design of Mitigation Measures** 

Approach	Examples
Avoid	Change of route or site details, to avoid important ecological or archaeological features
Replace 1994	Regenerate similar habitat of equivalent ecological value in different location
Reduce	Filters, precipitators, noise barriers, dust, enclosures, visual screening, wildlife corridors, and changed time of activities
Fe (i)(F	Site restoration after construction
Compensate	Relocation of displaced communities, facilities for the affected communities, financial compensation for the affected individuals etc.

The possible impacts (positive and negative) from the proposed Project during construction and operation are presented in the following sub-sections.

## Global public support for energy sources

"Please indicate whether you strongly support, somewhat support, somewhat oppose, or strongly oppose each way of producing energy"



Source: Ipsos, May 2011

Figure 6.1 Global Public Support for Energy Source

#### 6.3 Construction stage

#### 6.3.1 Beneficial Impacts

The activities during construction and operational period of the Project will create some positive impacts on the local environment. These are discussed below:

#### a. Employment opportunity to local people

The majority of population in the Project area is poor & somehow dependent on Livestock. Since opportunities are low, they have to supplement their livelihood from other occupations like labor works, collection of herbs, medicinal plants and small level business of livestock animals. They also earn money in breeding season of migratory birds by helping the hunters to ask them about the areas of migratory birds. However, the economy of the whole area is dependent. This Project is expected to create additional source of occupation and income to local residents, which is a positive effect of the Project. The impact will be direct, high, local, short term and hence very significant.

#### b. Impact on local economy due to increased economic activities

The employment opportunities and income sources generated by the Project construction will be short term in nature. These will cease once the construction



phase is completed. The local economy will experience gradual increase during construction phase, which will go down in operational phase. As the sales of materials that are required in daily use will increase, more grocery shops, tea stalls and restaurants will be established. Such activities will help to boost local economy and services in the Project area. Furthermore, this will somehow reduce unemployment ratio.

#### 6.3.2 Adverse Impact

The activities during construction and operation phases of the Project will create a number of adverse impacts on the local environment. These are discussed below with their mitigation measures.

## a. Possible impact on law and order

Increased number of construction workers and construction activities require additional reinforcement of social security system in the Project area, since there may be increase in events of theft, quarrel and conflicts. Similarly, some problems may arise due to lack in cultural respect of other communities. There will be a lot of foreigners involved in the Project; so adequate security arrangements will be required for them. The impact will be indirect, high, local, short term and hence very significant.

#### Mitigation

Jobs for the construction and operation of the Plant should be offered to the local people to avoid conflict between Project admin and the local people.

#### b. Possible impact on social, cultural and religious practices

The Project construction will attract a large number of workers, job seekers, entrepreneurs and their dependents to the Project area. The entry of new people, mostly consisting of young males, will change the population structure in the area. This could result changes in social and cultural norms and values, and loss of community spirit, which is strong in small and homogenous society. Various communities are residing near & in the Project area. The people of Cholistan lead a semi-nomadic life, moving from one place to another in search of water and fodder for their animals. They have their own social/cultural norms, values and rituals. Influx of construction workers from outside may influence the local social/cultural norms,



values and rituals to some extent. The impact will be indirect, low, local, short term and hence insignificant.

# c. Possible impact on existing facility and resources such as health, education, water resources

The Project area has limited local level institutions for services delivery. Agriculture sub-center, veterinary services, health post, post office and secondary schools are located near Project area. The existing situation of these service centers is not adequate even to cater the existing population of proposed Project area and these centers suffer from lack of human and material resources and currently local people are suffering from inadequate service facilities. In the process of Project construction, large number of labor force is likely to be employed. In addition to these, there will be influx of people from adjoining districts in order to seek employment or to start some trade in the Project area. Most of the workforce and those who establish trade in the area may also bring their dependents with them. This kind of added population will likely to exert tremendous stress on the existing local services. Sharing of limited resources and public facilities with locals may create problems and conflicts between outsiders and the locals. Provision of medical facilities for the workers in contract will mitigate this impact hence it can be considered as insignificant.

## Nature of impact

The impact will be indirect, low, local, short term and hence insignificant.

#### <u>Mitigation</u>

The system of basic services should be well mannered by the Government and then availability of basic services should be provided to the local people of proposed area as well as employees of Project.

#### d. Impacts on occupational health, safety and sanitation

Construction activities such as using heavy equipment and working in Desert under severe conditions may cause accidents and injuries. The most common injuries are; lifting large equipment by hand; due to dropped equipment or other structures; injuries due to other construction equipment; collapse of structures or excavations and traffic accidents. The victims will most probably be construction workers

although injuries to local people are also possible. Construction related accidents are common in Pakistan, primarily because of unsafe construction practices including improper training of construction workers and unavailability of safety equipment. Sand storms are also common in the proposed Area, especially during the highly unpredictable Monsoon season. Provision for third party insurance will mitigate this problem. Most of the vehicles accidents occur due to the untrained drivers. The impact will be direct, low, local, short term and hence insignificant. Arbitrary movement of vehicles can lead to congestion and accidents. Moreover, improper parking of vehicles used by workers and for movement of material can lead to discomfort to other users.

#### **Mitigation**

Drivers should be trained about the road safety techniques. Vehicle movement and parking within the Project premises shall be managed properly to avoid accidents. Traffic management plan for the construction related traffic should be formalized to minimize impact on community activities. Declared route path within the site for exclusive entry and exit of the construction vehicles to be provided.

## 6.4 Impacts on Physical Environment

## 6.4.1 Disturbance and change in landscape

Construction of proposed PV Solar power Project includes various types of construction activities such as site clearance, earthwork excavation, spoil disposal, quarrying and burrowing. Site clearance involves removal of soil and debris from the construction site, which might disturb natural slope stability. Construction work will certainly generate spoil during excavation and site clearing, etc. Uncontrolled and haphazard disposal of these wastes can result in slides, water quality degradation, vegetation loss and degradation of air quality. Hence possible impacts are erosion of top soil especially when combined with unmanaged surface water runoff, slope overloading and resultant failure and mass wasting, disruption of natural drainage pattern, causing scouring, erosion, damage and destruction of rare existing floral life.

#### Nature of Impact

The impact will be direct, low, site specific, short term and hence insignificant.



#### **Mitigation**

QASPP has considered all aspects of siting and design prior to selection of the sites. Use of existing roads for transport of man and material to the extent possible. All construct ion material to be kept within the footprint of the area acquired. Loose construction material to be covered to avoid being carried into adjoining areas by wind. Painting of panels, switchyard structures to be undertaken after covering the land beneath with a sheet of impervious material.

Tree cutting will be limited to those directly affecting the solar panels. Workforce to be instructed to avoid any other activity likely to affect the local flora & fauna. High noise generating activities to restricted to day time with proper mitigation measures. Transportation to be undertaken along identified paths.

# 6.4.2 Possibility of air and noise quality degradation due to construction activities

Construction activities will produce noise and deteriorate air quality at the Project site. The main activities that cause these impacts are use of batching plants and movement of heavy equipment's such as drilling, vibrators, dozers, loaders, rollers, cranes, generators, and pumps. This will disturb the peaceful environment that currently exists in the Project area. The impacts will, however, be site specific and limited to construction period only.

#### **Nature of Impact**

The impact will be direct, medium, local, short term and hence significant.

#### Mitigation

Dust generating activities to be avoided in conditions of very high wind and covers to be provided for loose construction material at construction site. It is to be ensured that construction equipment's are properly maintained to minimize smoke in the exhaust emissions. The impact of emissions from vehicles bringing construction material should be minimized by proper maintenance of vehicles, sprinkling of water on unpaved roads at the construction site and planned movement of such vehicles. Trucks / dumpers to be covered by tarpaulin sheets during offsite transportation of friable construction materials and soil. All the vehicles entering the site to be asked to have updated PUC (Pollution under control) certificate. Generator to be optimally



used with proper orientation and adequate stack height. Use of inherently quiet plant and equipment as far as reasonably practicable and regular maintenance to ensure noise emissions are maintained at design levels. Provision of rubber paddings/ noise isolators at equipment /machinery used for construction. Construction vehicles to be well maintained and should be idle when not in use. Noise prone activities will be restricted to the extent possible during night time 2200 to 6000 hours to reduce the noise impact.

Site workers working near high noise equipment should use personal protective devices to minimize their exposure to high noise levels.

#### 6.4.3 Physical impact due to construction labor and work force in camps

Two types of solid wastes will be generated by the Project; domestic and construction wastes. Improper handling and management of these wastes can result in production of unpleasant odors, deterioration of water quality, visual impacts and public health hazards. Domestic wastes will be generated by the people who are directly and indirectly involved in Project construction. The amount of waste generated will depend upon the number of people working in the Project and more importantly, the number of people who have temporarily migrated to the Project area during construction including construction crew, members of their families and people who supply goods and services to the workers. At this moment, it is difficult to predict actual amount of solid waste to be generated, which can be specified during detailed Project design phase.

#### **Nature of Impact**

The impact will be direct, medium, site specific, short term and hence insignificant.

#### **Mitigation**

A workable and proper waste management plan should be formulated by the site engineers while planning for construction.

#### 6.4.4 Impact on groundwater

Fuel leakages, haphazard spoil of various hazardous materials such as paints, emulsion, bitumen, batteries etc. may degrade the underground water quality if no care and adequate regulation mechanisms are in place. During construction and



operational phases, the demand of water supply will affect groundwater level. The impact will be direct, low, local, short term and hence insignificant.

#### Mitigation

Water for construction to be arranged by the construction contractors through authorized tanker water suppliers. Domestic water requirement of the workers at site to be met through irrigation canal. Optimal utilization of water to be ensured throughout the construction phase. Curing chemicals to be used to reduce water requirement.

#### 6.4.5 Impacts on cultural, religious and archeological sites

The Survey team did not found any cultural or religious sites that might be affected by the Project activities. Since there will be no impact regarding cultural, religious and archeological sites.

#### 6.4.6 Provision of fuel for workers

Large number of construction workers will be engaged in construction activities. Construction camps will be established in various places within the Project area. They have to depend upon fuel wood for cooking purposes; which will be purchased from the local nearby forests.

#### Nature of Impact

The impact will be direct, low, local, short term and hence insignificant.

#### **Mitigation**

The Project has to consider about alternative fuel sources in order to reduce their dependency on forest.

#### 6.5 Impacts on Biological Environment

#### 6.5.1 Change in water quality and soil quality due to use of oil, chemicals

The smaller water bodies around the Project site will likely to effect by fuel leakages, haphazard spoil of various hazardous materials such as paints, emulsion, bitumen, batteries etc. and these materials may degrade the underground water quality and soil quality if no care and adequate regulation mechanisms are in place.



#### Nature of Impact

The impact will be direct, low, site specific, short term and hence insignificant.

#### 6.5.2 Disturbance and threat on wildlife, flora and fauna

The cutting down the rare trees & other construction activities may cause loss of habitat that will create the problems for wild animals. The possible adverse impacts on species diversity of local wildlife population will be minimal. Though "Lal Sohanra" National park is located near the proposed Project area but the frequency of some wildlife species visiting the Project site area is very low due to sparse vegetation and frequent human interference. However, there will be limited disturbance to wildlife habitats in the Project area due to mobility of people and heavy transportation. Noise and vibration produced by Project activities during night time operations and hunting/poaching by Project labor force may affect the population of wildlife to some extent. Hunting and trapping of wild life by workforce may increase and disturbances may take place by the increase in population, in the Project area. This will have local and short term impacts to wild animal populations.

#### Nature of Impact

The impact will be direct, low, local, short term and hence insignificant

- 6.6 Operation stage
- 6.6.1 Beneficial Impact
- 6.6.2 Impacts on Social and Economic Environment
- a. Employment opportunity to local people

Livestock forming & grazing requires certain number of manpower. Local people can get employment opportunities for this purpose. More local people will be also employed as Labor for Construction work.

#### Nature of Impact

The impact will be direct, high, local, long term and hence very significant.

#### b. Socio-Economic benefits

Most of the people living within the Project area have livestock as their main means of livelihood. Their main sources of income also come from selling of livestock animal products. Significant increase in livestock production due to increase in



agriculture yield will also raise the living standards of local people in proposed Project area by providing them better living condition because of production work.

#### Nature of Impact

The impact will be direct, high, local, long term and hence very significant.

#### c. Appreciation of Land Value

The Development of Solar power system leads to appreciation of land values. The land price would increase due to the availability of facilities in to & near the proposed Project area. There will be rapid increase in the commercial markets & Housing Schemes which is also a major factor to raise the land value. This activity would likely uplift the economic condition of the local people.

#### Nature of Impact

The impact will be direct, high, local, long term and hence very significant.

## d. Enhancement of Technical Skill

Although many people in the Project area are untrained now but the construction of proposed Project is likely to improve their skills and large number of people will get practical or hands on trainings. Furthermore, the Project management will also organize training on health & safety rules and maintenance to construction workers. This will enhance the technical skills of local people. The skills and knowledge acquired from the Project during construction will enhance employment opportunities and such trained manpower can earn livelihood from similar Project in futures.

#### Nature of Impact

The impact will be indirect, medium, local, long term and hence significant.

## 6.6.3 Impacts/Issues on Biological Environment

## a. Provision of Water facility to culture nursery herbal plants

Various herbal plants can be grown in the Project area and with the availability of domestic waste water. In this way, we can grow there a number of trees & best utilize the waste water of local community & workers. Nursery of herbal plants can be established.



#### Nature of Impact

The impact will be direct, medium, local, short term and hence significant.

#### b. Conservation of Catchment Area

Compensatory plantation by the Project in degraded and barren areas will increase tree cover of the overall Project area. This will contribute for the conservation of local land use and vegetation.

#### **Nature of Impact**

The impact will be indirect, low, local, long term and hence significant.

#### 6.7 Adverse Impact

#### 6.7.1 Impacts on Social and Economic Environment

# 6.7.2 Population pressure and impact due to new settlement along the canal alignment

People are found to be settled in public land along or near the proposed Project area. Similarly, people tend to settle in the area where water is easily available for domestic use. So, there is expansion of settlement area and development of market centers which will also result in population pressure. This may trigger the practice of encroaching Right of Way (RoW). Consequently, this will reduce road capacity and increase road accidents. The increasing trend of roadside settlement is likely to increase household waste as well as wastewater on the road.

#### **Nature of Impacts**

The impact will be direct, medium, local, long term and hence significant.

#### 6.7.3 Changes in social behavior

Increased economic opportunities due to rise in expected livestock production may influence the changes in the social behavior. People may leave their family in their villages to dwell near the new spots for economic incentives. This will ultimately affect the traditional bonds, norms and functions of the family. This will also cause impact on social and cultural transition.

#### Nature of Impact

The impact will be indirect, low, local, long term and hence significant.



#### 6.7.4 Impacts on Cultural and Physical Environment:

#### 6.7.5 Impact on water resources and water sharing

Solar energy power plant produces no air or water pollution and no GHGs, but does have some indirect impacts on the environment. For example, there are some toxic materials and chemicals, and various solvents and alcohols that are used in the manufacturing process of photovoltaic cells (PV), which convert sunlight into electricity.

#### **Nature of Impact**

The impact will be direct, low, local, long term and hence insignificant.

#### <u>Mitigation</u>

Water management for proposed Project will be done by Project manager & committees of local people. There could be disputes on equitable use of and sharing of water for Domestic purposes.

#### 6.7.6 Impact due to air pollution

Almost minimum impact is expected on air quality due to operation of proposed Project. The impact will be indirect, low, local, long term and insignificant.

#### 6.7.7 Impact on cultural and religious activities

Though local people have their own various kinds of cultural and religious activities, so impact would be minimum due to construction and operational phase of proposed Project.

#### Nature of Impact

The impact will be indirect, low, local, long term and hence insignificant.

#### 6.8 Decommissioning

According to the PV panel supplier, all PV panels are scheduled to be replaced every 25 years. Longer operation time will result in efficiency reduction of the power generation to be lower than 80 percent. The decommissioned or expired panel sets, if without proper management, are expected to become waste and be discarded in landfills, resulting in significant environmental concern from its significant amount of silicon. Realizing this concern, the Project has contacted REC, the supplier of PV panels, to take all the PV panels after expiring to its recycling facilities. REC



(Renewable Energy Corporation ASA) is a full member of PV Cycle Association – a solar industry alliance that is pooling resources to collect and recycle solar modules from customers of member companies when the products reach the end of their useful life, Thus, there is minimal impact from decommissioning practice of the Project.

#### 6.8.1 Impacts on Biological Environment

## 6.8.2 Disturbance to wildlife movement/corridor

Vehicle movement, noise, vibration and light along the proposed Project area may disturb the home range of certain wild fauna. The possible adverse impacts on those species home range will be minimal. The frequency of some wildlife & domestic animals visiting is low due to fences around the proposed Project area and frequent human interference. In addition, large solar thermal power plants can harm desert ecosystem if not properly managed. Birds and insects can be killed if they fly into a concentrated beam of sunlight, such as that creates by a "solar power tower." Some solar thermal systems use potentially hazardous fluids (to transfer heat) that require proper handling and disposal.

#### **Nature of Impact**

The impact will be indirect, medium, local, long term and hence significant.

#### 6.9 Impacts on Chemical Environment

## 6.9.1 Change in water quality and soil quality due to use of chemicals

The small water bodies around the Project site; haphazard spoil of various hazardous materials such as paints, emulsion, bitumen, batteries etc. may degrade the underground water quality and soil quality if no care and adequate regulation mechanisms are in place.

#### Nature of Impact

The impact will be indirect, low, local, long term and hence insignificant.

#### 6.10 Enhancement Issues

#### 6.10.1 Maintenance and enhancement of public utilities

With the execution of proposed Project, several public utilities within the vicinity of Project will be also repaired and rehabilitated.



## **Nature of Impact**

The impact will be indirect, low, local, long term and hence insignificant.





# 7. ENVIRONMENTAL MANAGEMENT AND MONITORING SYSTEM (EMMS)

## 7.1 Environmental Management Plan

The proposed Project is formulated by StormHarbour. And their consultant has developed an Environmental Management Plan (EMP) manual which covers quality systems, Environment, Health & Safety Management Systems and Social Management Systems. The EMMS manual has been developed in compliance with the requirements of International ISO 14001: 2004 and is being amended to include requirements of ADB's Safeguard Policy Statement, 2009 as well. The EMMS manual developed by the consultant is a three tier document with the policies being the umbrella document which defines the commitment of the management for addressal of EHS and social issues associated with the operations, apex manual which lays the objectives, programs, resource management, product realization, measurement, analysis improvements. Operational control procedures and (instructional) checklists are defined as second and third tier document. The Management systems has been developed to provide generic guidelines to all future and present solar Projects of government, irrespective of specific site or Project conditions. It provides the answers to the following important questions:

- 1. What are the likely environmental issues for your site?
- 2. What likely impacts these issues can cause to the surrounding environment?
- 3. How will you manage these issues to minimize impact to the environment?

## 7.2 Objectives of EMMP

This EMMS provides the delivery mechanism to address the adverse environmental and social impacts of the proposed Project during its implementation, to enhance Project benefits, and to introduce standards of good practices to be adopted during all Project stages. The primary objectives of the EMMS are to:

- Facilitate the implementation of the mitigation measures identified in this report;
- Define the responsibilities of the Project proponents, contractors, and environmental issues among them;

- Define a monitoring mechanism and identify monitoring parameters in order to ensure complete implementation and effectiveness of identified mitigation measures; and
- Provide a mechanism for taking timely action in the face of unanticipated environmental or social situations

The supervisor consultants (SC) will designate the EHS Officer. He will ensure that all personnel adhere to general environmental protection as reflected in the ESMP are properly implemented. He will also be responsible for the EHS activities at the field level; field Technical Officer will support the EHS Officer during construction and operation of the Project. The Contractor will be subjected to certain liabilities under the environmental laws of the country and under its contract with StormHarbour Pakistan Company.

## 7.2.1 Prepare your EMP following these steps:



Figure 7.1: Steps for EMP preparation



## 7.3 Environmental Monitoring Plan

An Environmental Monitoring Plan (Compliance and Effect Monitoring Plan) provides a delivery mechanism to address the adverse environmental impacts of a Project during its execution, to enhance Project benefits, and to introduce standards of good practice to be adopted for all Project works. An environmental monitoring program is important as it provides useful information and helps to:

- Assists in detecting the development of any unwanted environmental situation, and thus, provides opportunities for adopting appropriate control measures,
- Defines the responsibilities of all the stake holders like Project proponents, contractors and environmental monitors and provides means of effectively communicating environmental issues among them.
- Define monitoring mechanism and identify monitoring parameters.
- Internal Auditing System
- Evaluate the performance and effectiveness of mitigation measures proposed in the Environment Management Plan (EMP) and suggest improvements in management plan, if required,
- Identify training requirement at various levels.

Table 7.1: Recommended Environmental Monitoring Protocol

#### **Pre-construction Phase**

Receptor		Monitoring Mechanism	Monitoring and Reporting Frequency
Ambient Air Quality	At Project Location	Monitoring NO <sub>X</sub> , SO <sub>2</sub> , SPM, RPM, CO and HC	Twice a week for a month prior to drilling
Surface water Quality	Water bodies within the radius of 1 km of the Project site	pH, conductivity, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS), heavy metals, Biological Oxygen Demand (BOD), COD	At least three samples prior to drilling

Groundwater Quantity	Within the radius of 1 km the of Project site. Water sources used for construction purposes and dug wells within 500 m from wastewater and mud ponds	Physico-chemical parameters, heavy metals and toxic organic compounds	At least three samples from one location prior to drilling. The monitoring should be done for minimum four locations, one location on each direction
Noise Levels	At Project location	For Background Noise Levels (using Noise meters)	Daily for a month prior to drilling
Physical Infrastructure	At Project Site	Lining of waste ponds, drill cutting ponds with 1 mm HDPE sheets layer	During site preparation
		Oil & grease traps on outlets; storm water runoff points.	
		3.Presence of impervious liners in place for fuel, lubricants storage area and drains with oil entrapment provision	
	·	4.Mud and work associated system is separated from rain/storm drainage system	
		5. Separate run off routes for non-contaminated and contaminated run off. Treatment facilities for the contaminated	
		run off	
		6.Septic tank & soak pits of adequate size and presence of bunds around the pit	
,		7.Suitable covering of soak pit to arrest fly and rodent nuisance covered and imperviously lined	
		8.Impervious flooring in fuel storage and refueling areas	
		9.Chemical storage should be suitability	
Clearance of Trees	At Project Location	Inventory of trees likely to be cut and number of	During site preparation
		trees to be planted as part of Compensatory Tree Plantation program	



## Table 7.2: Recommended Environmental Monitoring Protocol-

## **During construction Phase**

Receptor	Location	Menitoring:Mechanism	Menitoring and Reporting Frequency
Natural Resource	At Project site	1.Quantity of each type of material used including water consumption 2.Quantity of fuel used for power 3.Quantity of fuel used by transportation to/from rig location & base 4.Percentage of material used that have been reused or recycled from waste	Daily during drilling phase
Ambient Air Quality	At Project Location	Monitoring $NO_{X_i}$ $SO_{2_i}$ SPM, RPM, CO and HC	Twice a week for 24 hours
Surface Water Quality	Water bodies within the radius of 1 km of Project site that will be utilized for consumption and disposal	pH, conductivity, TSS, TDS, heavy metals, BOD, COD etc	Every fortnight. The monitoring should be done on the same location where monitoring was done in pre
Groundwater Quantity	Water sources used for construction purposes and dug wells within 1km m from wastewater and ponds	Physico chemical parameters, heavy metals and toxic organic compounds	Every fortnight. The monitoring should be done on the same location where monitoring was done in predrilling phase
Noise & Vibration	At Rig Site, near DG Sets and drilling pumps.	Noise level monitoring Machineries maintenance No machinery running when not required Use of ear plug by workforce .Presence of minimum 10ft high barrier around the well site	Hourly during drilling operation  Weekly during drilling



Drilling wastes	At drilling site	1.Drill cuttings wash water: its quantification, characteristics (TSS, TDS, organic compounds, heavy metals, oil	Daily during drilling phase
		& grease), its treatment and safe disposal	
		2.Cutting are dried to maximum extend in Hi-G	
		drier system and dried cutting are disposed in separate waste pits	
		3.Drill cuttings: Categorization for parameters given in EPA disposal standards prior to disposal, quantification and storage	
		4.Spent drilling fluid: its treatment and reuse	i
		5.Un used drilling mud: its categorization, storage, transportation and safe disposal	
Solid waste Generation	At Project Location	Waste segregation and disposal as per waste management plan	Daily during drilling phase
Wastewater Generation	At Project Site	1.Waste water generation rate     2.Treatment of wastewater by clariflocculator and treated water meeting the wastewater discharge standard (SPCB)	Daily during drilling phase
		Integrity and maintenance of the septic tanks and soak pits.	
Oil wastes	At Drilling Site	1.Generation, collection, processing, storage facilities, reuse and safe disposal	Daily during drilling phase
		2. Facilities to control the accidental oil spill	
Oil Spills	At Drilling Site	1.Inventory of all oil spills/leakages and quantity of each spill	Daily during drilling phase
}		2.facilities according to oil spill contingency plan	
		3.Availability of shovels, sands and native soil at camp sites and well site	



Soil Erosion	At Project Location	Visual observations	Daily during routine monitoring by Contractor and reported on a weekly basis by Project
Socio- Economic	At Project Location	Local people recruited for all manual labor and other job for which local skill are available	During drilling operation

Table 7.3: Recommended Environmental Monitoring Protocol

#### Post construction

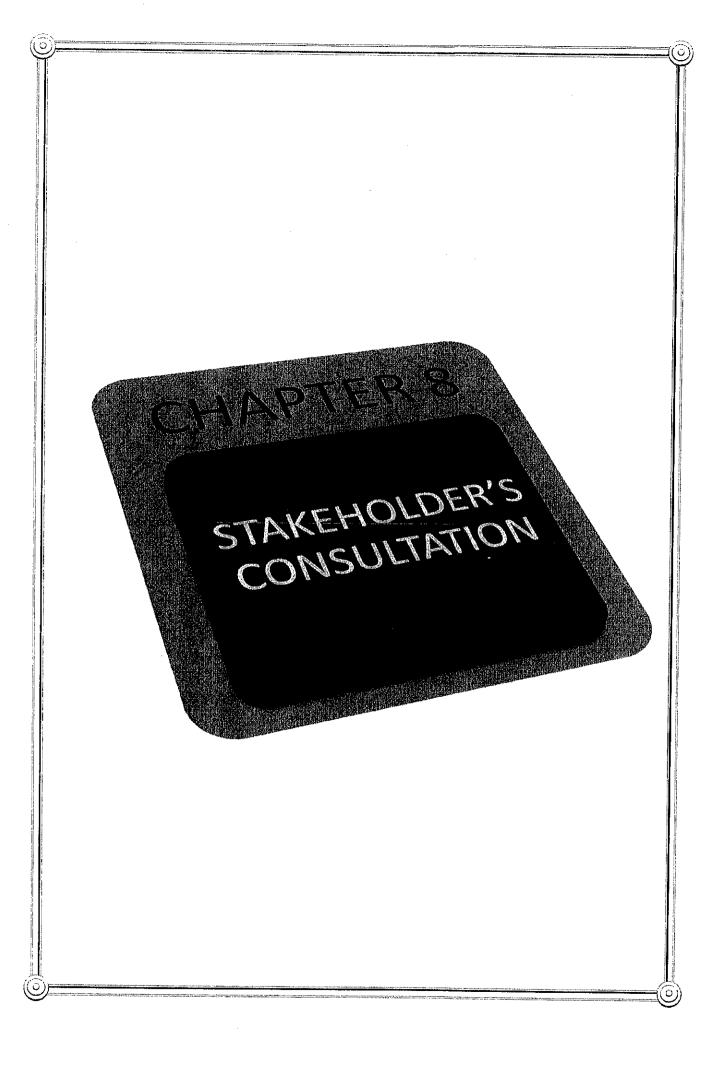
Receptor	Location	Monitoring Mechanism	Monitoring and Reporting Frequency
Drilling waste	At Project Location	Quantification of Drill cuttings, its transportation and safe disposal	At the end of the drilling operation
Land	At Project Location	Restoration and rehabililation through: Wellhead and casing string should be cut off to minimum depth of 3 m below ground level Demolition of concrete structures and disposal of debris as per regulatory requirements Treatment and disposal of waste products, solids and liquid in accordance with regulatory requirements Removal of fencing and gates Backfilling and closing of all on site disposal pits as per legal requirements	At the end of the drilling operation
Surface Water Quality	At Project Location within radius of 1 km	pH, conductivity, TSS and TDS, and BOD, COD	At the same location where pre and during drilling phase monitoring was done. Once a week for one month after drilling is complete.
Groundwater Quantity	Water sources used for construction purposes and dug wells within 1km from wastewater and mud ponds	Physico chemical parameters, heavy metals and toxic organic compounds	At the same locations where pre and during drilling monitoring was done, once in pre and post monsoon season for 3 years
Soil Erosion	At drilling site and along the aligned	Visual observations	Monitored by Contractor and reported by PEO at the end of



Receptor	Location	Monitoring Mechanism	Monitoring and Reporting Frequency
Habitat Disturbance	Within the Project site boundary	Visual Observation	At the end of the drilling operation
Compensatory tree plantation	Tree plantation locations	Survival rate of tree saplings	Once in a year for three years.

## 7.4 Institutional Arrangements and EMMP

Environmental management is basically the institutional arrangement which delegates some specific assigned responsibilities and those responsibilities are to be monitored properly. For this purpose a good and functional institute must be present in order to reduce adverse socio-environmental effects of the proposed Project. This process requires proper monitoring in order to report any performance of any mitigation measurement. The StormHarbour is the proponent of a solar power plant. So all the mitigation measures will also be proposed by them and so the monitoring will be their responsibility too. The EMC will be coordinating with the StormHarbour in the preconstruction and construction phase. 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 consultation is an essential part of IEE process for the familiarization of local people or stakeholders as the proposed plan. Leads to better environmental assessment, and thus to the formulation of Projects that deliver more social benefits, fewer environmental costs and greater economic and financial benefits. Upon the initiation of the IEE study, major public consultation meetings were held on May 18 to 20th, 2015 to understand and identify the real issues of concerns of people/stakeholders related to the QASP Project. The consultative meetings were organized with the representation from stakeholders.

Involving stakeholders in decision-making processes is not confined corporate social responsibility (CSR) processes. It's a tool used by mature private and public sector organizations, especially when they want to develop understanding and agree to solutions on complex issues or issues of concern.

An underlying principle of stakeholder engagement is that stakeholders have the chance to influence the decision-making process. This differentiates stakeholder engagement from communications processes that seek to issue a message or influence groups to agree with a decision that is already made.

- Stakeholders should have a say in decisions about actions that could affect their lives or essential environment for life.
- Stakeholder participation includes the promise that stakeholder's contribution will influence the decision.
- Stakeholder participation seeks input from participants in designing how they participate.

The practitioners in stakeholder engagement are often businesses, non-governmental organizations (NGOs), labor organizations, trade and industry organizations, governments, and financial institutions.

According to ADB Safeguard Policy, public consultation and information disclosure activities have been carried out by ECSP during the initial stages of the development. The aim of the process is to understand the viewpoint of the public about the Project and respond to their apprehensions and propositions during the early stage of the Project. Incorporation on the environmental concerns to the decision making process through the public consultation will avoid or reduce conflict



situation during the implementation process. Public consultation also helped informing the IEE in terms of sensitive environmental and social aspects.

Public consultations were conducted in Project-affected area between 18 to 20th May 2015. The community aired their opinions freely on the Project, its impact, and suggestions for mitigating adverse impacts. Stakeholders participated in voluntary public consultation sessions to express their views about the proposed Project.

Public consultation plays a vital role in studying the impacts of any development Project on stakeholders and in its successful implementation and execution. It provides an opportunity to exchange knowledge with those who as members of the society are concerned with the Project, immediately or remotely. Referring particularly to a Project related to environmental assessment, involvement of public is all the more essential, as it leads to better and more acceptable decision-making. Anyhow, some basic tools of the stakeholder's consultation are briefly mentioned below to understand the sessions held with some of the stakeholders. They are the legalities, stages of the consultation, techniques and tools used in consultation process and the outcome.

#### 8.1 Introduction

Stakeholder consultation involves the development of constructive, productive relationships over the long term. It results in a relationship of mutual benefit; it enables us to identify trends and emerging challenges which are currently or will in the future impact on the organization. Listening to stakeholder concerns and feedback is a valuable source of information that can be used to improve Project design and outcomes, and help a corporation to identify and control external risks. It can also form the basis for future collaboration and partnerships.

Consultation enables us to identify and monitor trends, challenges and perceptions over time with specific groups of stakeholders. It therefore helps us to:

- Identify and track needs and expectations
- Identify and track perceptions and attitudes
- Provide feedback on specific planned developments
- Evaluate implementations and actions
- Establish the brand values and positioning of the corporation as seen by others



The internal and external stakeholder contribution can be vital to the effective allocation of resources, the success of individual developments, and the longer-term success and direction of the corporation.

Consultation usually takes on two forms:

- Consultation on specific developments, Projects, ventures
- Ongoing consultation to track and monitor stakeholder perceptions within the broader operating environment

Specific Project-based consultation is widely used for both commercial and social Projects. In the public sector, it is often termed "public engagement" or "public consultation", and is usually related to local service developments within specific communities, and policy development at all levels.

The community should not only be consulted they should be actively involved in environmental matters. The International Union for the Conservation of Nature (IUCN) promotes the concept of Primary Environmental Care whereby farmers, for example, with assistance from extension services, is directly involved in environmental management. The earlier the public are involved, the better. Ideally this will be before a development proposal is fully defined. It is an essential feature of successful scoping, at which stage feedback will have the maximum influence. Environmental Care whereby farmers, for example, with assistance from extension services, are directly involved in environmental management. The earlier the public are involved, the better.

#### 8.1.1 CDM

To explain about Clean Development Mechanism (CDM) process to the stakeholders; the carbon levels in the atmosphere are increasing and the efforts that are required to reduce the greenhouse gas emissions. As power is mostly generated from fossil fuels, it leads to emission of Green House Gases. These gases are trapped by the atmosphere and lead to heating up of the earth's temperature, known as Global Warming. This could lead to melting of glaciers and lead to an undue increase in the water levels of the rivers, seas, etc.

Global response for combating the climate change impact and CDM process is one of the mechanisms of Kyoto Protocol.



# 8.2 Legitimacy of Stakeholder Consultations

According to the IEE and EIA Review Regulations 2000, public consultation is mandatory for any socio-environmental study. It is also mandatory for all the Projects classified as category A to C.

# 8.3 Stakeholder Engagement and Information Disclosure

Stakeholder engagement is a key part of corporate social responsibility (CSR). ECSP engage their stakeholders in dialogue to find out what social and environmental issues matter most to them about their performance in order to improve decision-making and accountability. Engaging stakeholders is a requirement of the Global Reporting Initiative (GRI), a network-based organization with sustainability reporting framework that is widely used around the world. The International Organization for Standardization (ISO) requires stakeholder engagement for all their new standards.

During the IEE studies, well informed persons (local politician, head of a government departments and/or social activists) related to the Project Area were interviewed and all necessary information pertaining to the Project Area was recorded during data collection process. This process also supported the understanding of the Consultants as a lot of information was exchanged during interviews. Please refer to Table 9.1.

# 8.4 Stakeholder Identification

The stakeholders for the Project were prioritized by identifying the direct and indirect stakeholders. The key stakeholders that were consulted as part of the study included the following:

 Consultations were conducted the various stakeholders by a professional team from ECSP.

# 8.4.1 Monitoring and Evaluation of PC&D

Most IEE Projects usually have no monitoring systems of PCs built into their structure. Monitoring and Evaluation (M&E) assess the quality of public consultations in the IEE process. Techniques for monitoring and evaluating PCs include confirmation that participants understood the consultation content (correct language, level of technicality), and assessment of stakeholders" opinions of PC effectiveness



and PC impact on Project design and implementation. Through appropriate use of M&E, public consultation strategies can be adjusted during the Project cycle to improve stakeholder participation, information dissemination strategies, and mechanisms for integrating participant feedback into Project design and implementation.

# 8.5 Methodology Adopted

### a. Identification of Stakeholders

- 1. Local inhabitants
- 2. Participants from industry
- 3. Participants from local NGO's (not mandatory)

# b. Invitation

- The local stakeholders had been invited to the event through an announcement in the 10 days before the event.
- Selected stakeholders have been invited through personal calls.

# c. Fixing time and venue for the meeting

The time and venue were chosen such that it allowed maximum participation from the identified stakeholders.

# d. Conducting the meeting

The stakeholder meeting was conduct in Bahawalpur. The venue was carefully selected as being appropriate for the planned event, both from the logistical point of view and due to the size of the expected audience.

# e. Seeking comments from the stakeholders

Stakeholders were invited to make oral comments during the open round of comments/suggestions during the stakeholder consultation event. Each query/comment was noted, along with the details of the stakeholder asking.

# 8.6 Legal Requirements of Public Consultation

To make the discussion unbiased and fruitful, prominent people from local community were given the authority to conduct the local stakeholders' consultation process.

Pamphlet and summary of Projects were distributed among the public.



- The meeting started with the presentation made by Quaid-e-Azam Solar Park officials about the company followed by the process of electricity generation using solar technology.
- Local stakeholders' were informed about the Project execution, social and environment impacts due to Project especially during construction phase and utilization of local resources by Quaid-e-Azam Solar Park during construction phase.
- The local stakeholders were informed about the benefits of the Project along with environment and social impact especially during construction phase.

# 8.7 Techniques and Tools used for Public Consultation

There are techniques for getting information to the public:

- One-way e.g. press releases newsletters etc. getting it from the public
- One-way e.g. polls
- Survey
- Questionnaire
- Exchanging information
- Interaction between the proponent and the public e.g. public hearing
- Workshops
- Meetings
- Advisory groups/task forces etc.

When selecting a technique, it is always wise to build on existing communication channels that are familiar with the community or public involved. There is no public participation technique that will work in all circumstances. When people talk about highly successful public participation programs they are talking about programs where the techniques matched the purpose of the program, reached the interested stakeholders, and resulted in a clear linkage between the public participation process and the decision-making process.

It is worth noting that "making a decision" in public participation is not a single moment in time, but an accumulation of many smaller decisions. There are decisions being made at every step in the consultation process regardless of the technique.



# 8.8 Consultation with Stakeholders

The consultation was in the Bahawalpur; list is mention below who attended the consultation. Community participants included people from different walk of the society. Participants included local villagers, NGOs, State revenue department officials, Teachers, employees, etc. It was attended by some prominent people of the locality as well as common villagers also.

- The Project being coordinated by a Review Reference Group;
- A series of three stakeholder consultation; and
- Key discussions with a range of individual stakeholders.

Table 8.1: Consultation with Local Stakeholders

Sr. #	Name of Stakeholder	Designation	Comments on the Project
	Amir Irshad	DO (E)	The DO (E) was briefed; he was informed that no fossil fuels will be used for energy production. Moreover, its benefits as to the carbon emission reduction where also discussed. He was satisfied and of the view that Project will go a long way toward electricity production and sustainability.
	Dr. Amir Raza	DCO Office	A briefing session was also conducted to inform the DCO about the Project and its benefits. HE was also convinced and optimistic over the matter.
<b>3</b>	Malik Muhammad Mahi	Private	Mr. Mahi informed us that significantly strong winds are blown in the area which can wash out local structures (huts) causing nuisance and inconvenience.

Engineering Consultancy Services Punjab (Pvt.) Ltd. Dr. Sultan Mahmood opened the meeting. He introduced everyone the aim of the meeting, informed about the Project and briefly explains about the Project itself.

Dr. Sultan Mahmood discussed the main issues of design, its alternatives, importance and expected consequences.

He mentioned that the Project consists of 10 stages, Phase-I to Phase-X. At first, it is planned to implement the works of Phase-I of 100MWp completed.

Taking into consideration all the above-mentioned details, the design of construction of 100MWp Solar Photovoltaic Project facility of energy in Bahawalpur is ecologically acceptable and its implementation will not create any danger to the environment and



local population after performing the mitigation measures described in IEE report and on the base of environmental management plan terms.

**Table 8.2 Public Consultation** 

	Records of Meeting
Job Tille	Initial Environmental Examination for the Quaid-e-Azam Solar Park Project (Phase IV)
Meeting Title	Public Consultation
Venue , was	Bahawalpur
AMGINORINO EL TRADO	✓ Malik Muhammad Mahi s/o Malik Jan Muhammad
	✓ Muhammad Essa s/o Haji Bahoo
	✓ Muhammad Aslam s/o Malik Jan Muhammad
	✓ Allah Wasaya s/o M Essa Raqh
	✓ Dilshad s/o M Essa
	✓ Hafiz Bashir Ahmad s/o Ghulam Muhammad
	✓ Haji Muhammad Sharif s/o Ghulam Rasool
	✓ Ibrahim s/o Allah Ditta
	✓ Malik Ashiq s/o Ghulam Haider
	✓ Yaseen s/o Allah Ditta

# Contents of the Meeting

A huge environmental benefit that should not be overlooked is that simple and non-polluting concentrated solar power technology can be deployed relatively quickly and can contribute substantially to reducing carbon dioxide emissions

What is the material that is designed to be used during the construction and from where it will be disturbed environment?

The materials will be used for construction purposes it will never ruined environment.

ii) Will it cause some problems to the environment?

It will be taken from the riverside from selected quarry. It will not cause any damage to the environment,

iii) What is the distance between the protective structures?

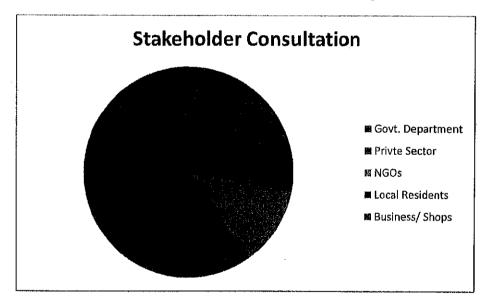
The distance is different in different places. Average distance is 200-250m etc.

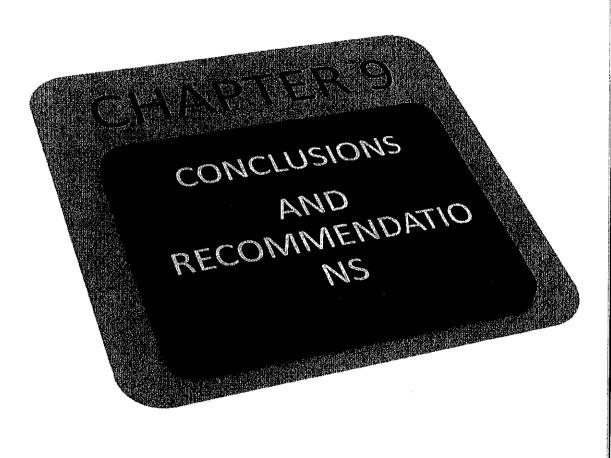


Table 8.3 Stakeholders Contacted in the Project Area

Sr.#.	Stakeholder Category.	(Percentage
	Govt. Departments	20%
y (v en Prij Gestaar e	Private Sectors	8%
	NGOs	12%
	Local Residents	60%
	Business/ Shops	0%

Figure 8.1 Stakeholders Contacted in the Project Area







# 9. CONCLUSIONS AND RECOMMENDATIONS

# 9.1 Conclusion

This IEE report, both benefits and address the adverse impacts anticipated as a result of the proposed Project. An environment and social analysis has been carried out looking at various criteria such as topology, air, noise, water resources and water quality, ecology, demography of the area, climate and natural habitat, community and employee health and safety etc.

Solar energy is the most abundant energy resource on earth. But it is of poor competency in economic currently in the starting stage of Solar PV electricity generation. Taking the life cycle cost and a reasonable payback of investment into consideration, price of on-grid PV power vary with several factors, such as the local solar resource, efficiency of PV system, technical lifetime of PV plant, price of PV modules and so on, most of which are improvable by technological innovation. There is no doubt that Solar PV electricity generation is expanding very rapidly due to dramatic cost reductions. PV is a commercially available and reliable technology with a significant potential for long-term growth in nearly all world regions. Achieving this will require more concerted policy support, and a long-term focus on R&D to reduce costs and ensure PV readiness for rapid deployment, while also supporting longer-term technology innovations.

The proposed Project has undergone a fairly exhaustive environmental screening process, which involved site visits, consultations with Project stakeholders, review of documents etc. It is believed that the process has been sufficient to determine all possible interactions between the Project and the environmental and social conditions at the site. Several factors preclude any significant adverse environmental and social impact associated with the Project. These are:

- · Absence of any significant sensitive terrestrial habitats in the Project area;
- Construction of a building with provision of basic and allied facilities for the operational staff; and
- Improvement in the existing landscape.



# 9.2 Beneficial Effects

Solar energy is the most economical, cleanest, and also environmentally friendly. In case of resource conditions, especially land use; the bio-energy and wind energy demand relatively harder conditions, but comparatively for solar energy the conditions are very flexible and broad. For example, if solar power takes up a land area of 1km, the area for wind will be 8-10km; and for bio-energy it will be even 100 times more. Building a large dam often requires tens to hundreds of square kilometers of submerged land. In contrast, solar power does not take up that much land. In our country, we can also use our vast desert for the construction of solar power in the desert base, thus directly reducing the solar radiation to the surface of the desert area. This in turn will reduce the surface temperature and evaporation, and thereby will make the plants/vegetation survival and growth to a certain extent possible, secure and reduce the sand dunes, and also obtain a clean and renewable energy we need from the nature.

# 9.3 Adverse Effects

There is no adverse impact of the construction of solar plant on the environment nor does it cause any pollution to the environment. The adverse impacts to the environment appear temporary because they are limited to the construction period and can be minimized by taking effective engineering measures.

# 9.4 Recommendations

There is no doubt that Solar PV electricity generation is expanding very rapidly due to dramatic cost reductions. PV is a commercially available and reliable technology with a significant potential for long-term growth in nearly all world regions. Achieving this will require more concerted policy support, and a long-term focus on R&D to reduce costs and ensure PV readiness for rapid deployment, while also supporting longer-term technology innovations. There are few recommendations:

 It is recommended that the Proponent should obtain an environmental approval NOC (No Objection Certificate) from the Punjab-EPA before proceeding further into the construction activities.



# **ENVIRONMENT PROTECTION DEPARTMENT**

Government of the Punjab National Hocky Stadium, Lahore.



To

NO. DD (EIA)/EPA/F-870(IEE)/2511/2015//074/ Dated: 30/12/2015

Mr. Sohail Khan,
Managing Principal / Proponent,
M/s STORMHARBOUR Project Developer,
24-DD, Phase-IV, DHA,
Lahore

Subject:

DECISION OF EPA PUNJAB FOR THE INSTALLATION OF 100-MW SOLAR PHOTO – VOLTAIC PROJECT AT BLOCK-C, QUAID-E-AZAM SOLAR PARK, (EXTENSION) CHISHTIAN, BAHAWALNAGAR

(Under Section 12 of PEPA, 1997 (Amended 2012) read with IEE/EIA Regulations, 2000)

Reference: Board of Revenue Punjab letter No. 3339-2015-1220-CS(III) dated 13.10.2015, PPDB letter No. PPDB/1437/2015 dated 01.10.2015

1. Description of Project:

Installation of 100-MW Solar Photo-Voltaic (PV) Power

Project.

2. Location of Project:

The site is located at Block-C, Quaid-e-Azam Solar Park,

(Extension) Chishtian, Bahawalnagar

3. Date of filing of IEE:

29.09.2015

- 4. After careful review of Initial Environmental Examination (IEE) Report, Site Inspection Report of District Officer (Environment), recommendations of Committee of Experts constituted under Regulation 11(2) of IEE / EIA Regulations, 2000 read with Section 12 of the Act ibid on 11.11.2015 and other relevant record, the Environmental Protection Agency, Punjab has decided to accord its approval for the installation of the above mentioned project to safeguard the environmental issues subject to the following conditions:
  - i. The proponent shall ensure compliance of National Environmental Quality Standards (NEQS).
  - ii. Mitigation Measures suggested in the IEE report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.
  - iii. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on monthly basis.
  - iv. Camping sites shall be located at suitable distance away from any settlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks.
  - v. The proponent shall take measures to control dust,
  - vi. The area around the project site shall be kept clean.
  - vii. The proponent shall dispose of solid waste, electronic waste, discarded solar panels and condemn batteries etc. in a proper scientific way in consultation with TMA / District Government.
  - viii. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.
  - ix. The proponent shall avoid cutting of trees.
  - x. The proponent shall plant at least 5000 trees of indigenous species of minimum height 6 to 7 feet around the project area in consultation with District Officer (Environment) on available space within six months and shall take measures for the protection of these trees.
  - xi. The proponent shall do proper landscaping after completion of the project.
  - xii. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.
  - xiii. The proponent shall care about noise issues during construction and operation stage of the project.
  - xiv. The objections / complaints of the locals / stakeholders (if any) shall be redressed on priority basis Qual

P.T.C

- xv. The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the rates that are agreed upon. All conflicting issues regarding compensation, etc. shall be settled amicably before the start of the project activities.
- xvi. The proponent shall obtain NOC / clearance from all other concerned departments before commencement of work.
- xvii. The proponent shall appoint Environmental Manager having (at least qualification of B.S. Environmental Sciences / B.Sc. Environmental Engineering) for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.
- xviii. Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environmental friendly way at a suitable disposal facility.
  - xix. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of workers backed by a comprehensive emergency response system while working on super structure.
  - xx. At least 90% unskilled and to the extent possible skilled jobs shall be given to locals after providing them proper training.
- xxi. The proponent shall take effective measures for safe transportation of Photovoltaic Cell / Solar Panel.
- xxii. The proponent shall dispose of wastewater after treatment.
- xxiii. The proponent shall adopt latest techniques for the cleanliness of the solar panels to minimize water use as much as possible.
- xxiv. The proponent shall ensure all necessary measures for the protection of sensitive / protected areas in the vicinity.
- xxv. The proponent shall prepare a Community Development Plan and implement it for the benefit of communities of the project area.
- xxvi. The proponent shall follow the SOPs regarding dengue larvae eradication and shall ensure removal of stagnant water on daily basis.
- xxvii. The proponent will adopt the technology after carrying out feasibility of concentrated solar power (CSP) and its comparison with photovoltaic technology for harvening solar power.
- 5. The proponent shall be liable for correctness and validity of information supplied to this department by the environmental consultant.
- 6. The proponent shall be liable for compliance of Regulations 13, 14, 18 and 19 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.
- 7. This approval is accorded only for the construction phase of the project. The proponent shall apply for confirmation of compliance under Regulation 14 of IEE / EIA Regulation, 2000 by submitting Environmental Management Plan for operational phase along with compliance status report of the Environmental Approval of the construction phase of the project.
- 8. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.
- 9. This approval shall be treated as null and void if all or any of the conditions mentioned above, is/are not complied with. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force and is subjudice to legal proceedings in any legal fora / court.
- 10. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under Regulation 17 of IEE / BIA Regulations, 2000.
- 11. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest. Que

(AMEN HANIF)
ASSISTANT DIRECTOR (ELA)

for Director General, EPA, Punjab

Ph: # 042-99232228

### NO. & DATE EVEN.

A copy is forwarded for information to:

The District Officer (Environment), Bahawalnagar w.r.t his letter No.4634/DOE/HWN, dated 06.11.2015. He is requested to ensure compliance of the above mentioned conditions / measures under intimation to this office.

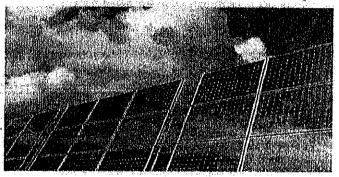
(AMEN HANIH)
ASSISTANT DIRECTOR (FIA)



# INTERCONNECTION STUDY

For

# 100 MW Solar Power Project by Storm Harbour Solar at Quaid-e-Azam Solar Power Park near Chishtian, Punjab



Draft Report (September 2015)

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# Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client Storm Harbour Solar PP has been validated.
- The expected COD of the project is the third quarter of 2016. Therefore, the month of September 2016 have been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load forecast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-300/2261-62 dated 28-05-2015.
- The nearest substation of MEPCO is Chishtian-New 132 kV. The following scheme of interconnection of Solar Power Plant by Storm Harbour Solar to evacuate maximum power of 100 MW is envisaged and studied in detail:
  - Two loops with two 100 MW solar power plants each have been proposed to be connected to Chishtian-New.
  - The first loop comprises of Storm Harbour and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
  - The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian
     New 132 kV grid station.
- Detailed load flow studies have been carried out for the peak load conditions of September 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 100 MW of the plant under normal and contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Storm Harbour 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

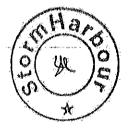
of fault current from the Storm Harbour Solar Power Plant



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The maximum short circuit level of 132 kV bus bar of Storm Harbour Solar Power Plant 132 kV is 5.70 kA and 4,52 kA for 3-phase and 1-phase faults respectively for September 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 September 2016. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Storm Harbour 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 relain its stability and recover with fast damping. The stability of the system for far end faults of 3-phase occurring at Chishtian New 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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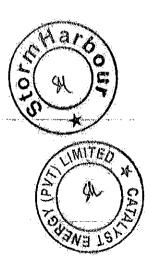
Appendices

Appendix -A: Maps & Sketches for Chapter 4

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

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





### Introduction 1.

### 1.1 Background

Storm Harbour Solar (Private) Limited is setting up a 100 MW solar power plant at Quaid-e-Azam Solar Power Park near Chishtlan - New, Punjab. The site of the proposed project is located in the concession area of Multan Electric Power Company Limited (MEPCO). The peak AC net output planned to be generated from the project is about 85 MW which will start commercial operations by the third quarter of 2016. The electricity generated from this project will be supplied locally to the Chishtian - New Grid Station and to the MEPCO 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 Storm Harbour Solar Power Project and MEPCO network, for stable and reliable evacuation of 85 MW of electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives are:

- 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 loadflow analysis.
- 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 Storm Harbour 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 MITED 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).





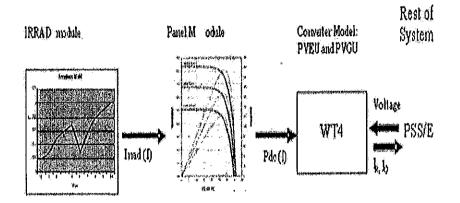


# 2. Assumptions of Data

The detailed electrical parameters would be designed at the EPG-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.

# Steady State data:

2 x 20 MVAR SVCs will be used to provide reactive compensation for Appolo Solar-PP

Net Output of Solar PP 85 MW

# Dynamic Data:

Converter time constant for IQcmd seconds = 0.02 s



(1)

Converter time constant for IQcmd seconds = 0.02 s

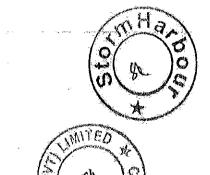
Voltage sensor for LVACR time constants = 0.02 s

Voltage sensor time constant = 1.1.s

# 2.2 Network data

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

The latest generation, transmission plan and load forcast provided by NTDC has been used vide data permission letter no, GMPP/CEMP/TRP-300/2261-62 dated 28-05-2015.





# 3. Study Approach and Methodology

# 3.1 Understanding of the Problem

The 100 MW Solar Power Plant by Storm Harbour Solar (Pvt.) Limited is going to be a Photovoltale (PV) based solar project embedded in the 132 kV distribution network of Chishtian - New, 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 station available for interconnection is Chishtian - New 132 kV Substation. The addition of this source of power generation embedded in local distribution network of this area shall provide relief to Chishtian - New 132 kV substation feeding the local network. The 132 kV network surrounding Chishtian - New has significant load demand, therefore most of the power from the Storm Harbour Solar Power Plant will be utilized locally in meeting this load demand.

The adequacy of MBPCO network of 132 kV in and around the proposed site of Storm Harbour 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 September 2016 considering
  maximum AC out of 85 MW for the solar plant by Storm Harbour 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 MEPCO.
- The project is expected to be completed by the third quarter of 2016 TED.

  Therefore the month of September 2016 has been selected to carry out the study as it will allow the maximum impact of the project to be judged.
- Interconnection scheme without any physical constraints, like right of way
   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

cm A



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.





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# 4. Development of Scheme of Interconnection

# 4.1 The Existing Network

The nearest existing MEPCO interconnection facilities at the time of commissioning of Storm Harbour Solar Power Project would be Chishtian- New 132 kV Substation.

The existing 132 kV network available around the study solar power plant is shown in Sketch-1 in Appendix-A.

Given the physical proximity of Chishtian - New to Storm Harbour Solar power plant and the fact that the other facilities are at a considerable distance from the plant, the most feasible interconnection of the Storm Harbour Solar Power Plant will be with Chishtian - New 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 Storm Harbour Solar Power Plant, the interconnection scheme has been developed as shown in Sketch-2 in Appendix A. The following scheme of interconnection is proposed and studied in detail:

- Two loops, with two 100 MW solar power plants each, have been proposed to be connected to Chishtian-New.
- The first loop comprises of Storm Harbour and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
- The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian
   New 132 kV grid station.

# 4.3 Proposed additions at 132 kV in Chishtian - New 132 kV Substation

Three breaker/panels of 132 kV along with respective protection equipment would be required to be added in 132 kV switchgear hall of Chishtian - New 132 kV substation to provide connection to direct 132 kV circuits forming the proposed loops.



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# 5. Detailed Load Flow Studies

# 5.1 Load Flow without Storm Harbour Solar Power Plant, September 2016

A base case has been developed for the peak load case of September 2016, using the network data of Storm Harbour Solar-PP and MEPCO 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 the location of the study Solar Power Plant.

The load flow results show that the power flows on all circuits are within their specified normal current carrying rating. The voltages are also within the permissible limits.

For N-1 contingency conditions we have performed the following cases

Exhibit 0.1	Solar PP-1 to Chishtian-N 132 kV Single Circuit Out
Exhibit 0.2	Solar-PP-2 to Chishtian-N 132 kV Single Circuit Out
Exhibit 0.3	Solar-PP-2 to Solar-PP-3 132 kV Single Circuit Out
Exhibit 0.4	Solar-PP-3 to Dharawala 132 kV Single Circuit Out
Exhibit 0.5	Dharawala to Chishtian-N 132 kV Single Circuit Out
Exhibit 0.6	Chishtian-N to Bhawalnagar 132 kV Single Circuit Out
Exhibit 0.7	Chishtian-N to Chishtian-O 132 kV Single Circuit Out

In both cases the power flows on all circuits remain within their ratings for the contingencies covered. 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 Storm Harbour Solar Power Plant for its connectivity under normal and contingency conditions prior to its connection.

# 5.2 Reactive Power Requirements

Storm Harbour Solar Power Plant power factor is 0.90 lagging (capacitive/generating) and 0.90 leading (inductive/absorbing). Part of this reactive power will be consumed by the step-up transformers and the rest may be consumed in the MV collector cables.

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of the solar plant. However some reactive power might reach the MV bus bar of solar plant substation. That means each inverter is self sufficient to meet VAR absorption requirement of its step-up transformer with some contribution of VARs to the Solar Plant MV network.

The Grid Code Addendum No.2 requires to meet the criteria of ± 0.95 power factor at the point of interconnection with the NTDC/MEPCO grid at 132 kV (point of common coupling). Therefore Storm Harbour Solar Power Plant with its maximum output of 85 MW generating capacity is required to pump 27.88 MVAR to the grid at maximum AC power output of 85 MW. The VAR generating capability of the inverters will not be able to fully meet this VAR demand of the system because of VAR loss in step-up transformers, collector cables and the HV/MV transformers at the Solar Plant substation. In order to meet the Grid Code criteria, we have proposed the installation of two SVCs of -5/±20 MVAR each at the Solar Plant substation capable of generating 40 MVAR and delivering at 132 kV bus about 27.88 MVAR after VAR loss across transformers.

# 5.3 Load Flow with Storm Harbour Solar Power Plant, September 2016

The following scheme of interconnection is proposed and studied in detail:

- Two loops, with two 100 MW solar power plants each, have been proposed to be connected to Chishtian-New.
- The first loop comprises of Storm Harbour and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
- The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian
   New 132 kV grid station.

The results of load flow with Storm Harbour 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  $\pm$  5 % off the nominal.

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;

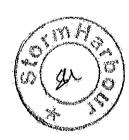
Exhibit 1.1	Sform Harbor to Chishtian-N 132 kV Single Circuit Out
Exhibit 1.2	Storm Harbor to Solar-PP-1 132 kV Single Circuit Out
Exhibit 1.3	Solar-PP-1 to Chishtian-N 132 kV Single Circuit Out
Exhibit 1.4	Solar-PP-2 to Chishtian-N 132 kV Single Circuit Out
Exhibit 1.5	Solar-PP-2 to Solar-PP-3 132 kV Single Circuit Out
Exhibit 1.6	Solar-PP-3 to Dharawala 132 kV Single Circuit Out
Exhibit 1.7	Dharawala to Chishtian N 132 kV Single Circuit Out
Exhibit 1.8	Chishtian-N to Bhawalnagar 132 kV Single Circuit Out
Exhibit 1.9	Chishtian-N to Chishtian-O 132 kV Single Circuit Out

We see that the power flows on all circuits remain within their ratings for the contingencies covered. Thus we find that after the connection of Storm Harbour Solar PP there are no capacity constraints in terms of the MW or MVAR flows in the 132 kV network available in the vicinity of the Solar Power Plant for its connectivity under normal and contingency conditions.

# 5.4 Conclusion of Load Flow Analysis

From the analysis carried out above, we conclude that the proposed interconnection scheme ensures its reliability and availability under all events of contingencies i.e. planned or forced outages.







### **Short Circuit Analysis** 6.

### 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,

# Fault Current Calculations without Storm Harbour Solar Power Plant, September 2016

In order to assess the short circuit strength of the network of 132 kV without the Solar Power Plant for the grid of MEPCO in the vicinity of the site of the Plant near Chishtian - New, 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 Storm Harbour 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 TED 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 Chishtian - New. 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 40 kA.

Table - 6.1

Substation	3-Phase fault current, kA	1-Phase fault current,
Chishtian-New 132 kV	9,63	10.36
Solar PP-1 132 kV	5,66	4.52
Solar PP-2 132 ky	4,65	3.83
Solar PP-3 132 kV	4.65	4.34
Dharawala 132 kV	4.89	4.84
Bhawalnagar 132 kV	7,90	8,60
Hota 132 kV	6.00	5.88
Noorsar 132 kV	595	5.66
Chishtian-Old 132 kV	8,57	9.47







# 6.3 Fault Current Calculations with Storm Harbour Solar Power Plant, September 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 bar of Storm Harbour Solar Power Plant itself and other bus bars of the 132 kV substations in the electrical vicinity of Chishtian - New. 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 Storm Harbour 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 slight increase in short circuit levels for three-phase and single-phase faults due to connection of Solar Power Plant on the 132 kV bus bars in its vicinity. 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 Storm Harbour Solar Power Plant 132 kV is 5.70 kA and 4.52 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 Storm Harbour Solar PP. September 2016

Culutation	3-Phase fault current,	1-Phase fault current,
Substation	kA	kA
Storm Harbour 132 kV	5.70	4.52
Chishtian-New 132 kV	9.79	10.53
Solar PP-1 132 kV	5.70	4.52
Solar PP-2 132 kV	4.73	3.89

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Solar PP-3 132 kV	4.73	4,41
Dharawala 132 kV	4.97	4,91
Bhasvalnagar 132 kV	8,00	8.72
Hota 132 kV	6.06	5.94
Noorsar 132 kV	6.03	5.74
Chishtian-Old 132 kV	8.71	9,62

# 6,5 Conclusion of Short Circuit Analysis

The short circuit analyses results show that for the proposed scheme of interconnection of Storm Harbour Solar Power Plant with the Chishtian - New 132 kV distribution network, 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 Storm Harbour Solar Power Plant is 5.70 kA and 4.52 kA for 3-phase and 1-phase faults respectively for September 2016. Therefore an industry standard switchgear of the short circuit rating of 40 kA should be installed at 132 kV switchyard of Storm Harbour Solar Power Plant leaving enough margin to accommodate fault current contribution from any future reinforcements taking place in that area.





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### **Transient Stability Analysis** 7.

### Assumptions & Methodology 7.1

# 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 September 2016 given the COD of the subject Solar Power Plant in the third quarter of the year 2016.

The following scheme of interconnection is proposed and studied in detail:

- Two loops, with two 100 MW solar power plants each, have been proposed to be connected to Chishtian-New.
- The first loop comprises of Storm Harbour and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
- The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 grid station.

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

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.

# 7.14 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 normal clearing time for 132 kV i.e. 180 ms, followed by permanent trip of 132s kV single circuit connected to this substation.

# 7.2 <u>Transient Stability Simulation Results, September 2016</u> Fault at 132 kV Storm Harbour

We applied three-phase fault on the Storm Harbour 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of 132 kV circuit between the Storm Harbour to Chishtian 132 kV. We monitored different quantities for one second pre-fault and nine 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 voltage of 132 kV bus bars of Storm Harbour, Solar-PP-1, Chishtian-New, Dharanwala, Solar-PP-2 and Bahawalnagar are plotted. The results show quick recovery of the voltages after cleaning of fault.

### Fig. 1.2 Frequency

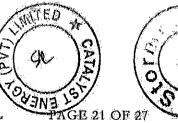
We see the system frequency recovers back to normal quickly after fault clearance.

# Fig. 1.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Storm Harbour Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

# Fig. 1.4 Voltage Sensor for LYACR

The value for LVACR is restored to its pre-fault value after the fault clears,



**(** 

Fig. 1.5 MW/MVAR flow from Chishtian-New to Solar-PP-1 132 kV Followed by clearing of fault, the trip of 132 kV circuit between the Chishtian-New and Storm Harbour causes the entire output of Storm Harbour to flow through the intact 132 kV circuit between Chishtian-New to Solar-PP-1. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

# Fig. 1.6 MW/MVAR Output of Solar-PP-1

The pre-fault output of Solar-PP-1 was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

# Fig. 1.7 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Engro-Energy 220 kV, Guddu 220 kV and Foundation-P 220 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles gets back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

# 7.2.2 Fault at 132 kV Storm Harbour (Stuck Breaker Case)

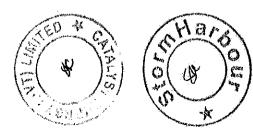
We applied three-phase fault on the Storm Harbour 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132 kV circuit between the Storm Harbour to Chishtian-New. We monitored different quantities for one second pre-fault and nine seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – D and discussed as follows;

# Fig. 2.1 Bus Voltages

The bus voltage of 132 kV bus bars of Storm Harbour, Solar-PP-1, Chishtian-New, Dharanwala, Solar-PP-2 and Bahawalnagar are plotted. The results show quick recovery of the voltages after clearing of fault.

# Fig. 2.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.





# Fig. 2.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Storm Harbour Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 2.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 2.5 MW/MVAR flow from Chishtian-New to Solar-PP-1 132 kV Followed by clearing of fault, the trip of 132 kV circuit between the Chishtian-New and Storm Harbour causes the entire output of Storm Harbour to flow through the intact 132 kV circuit between Chishtian-New to Solar-PP-1. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast,

Fig. 2.6 MW/MVAR Output of Solar-PP-1

The pre-fault output of Solar-PP-1 was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

Fig. 2.7 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Engro-Energy 220 kV, Guddu 220 kV and Foundation-P 220 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles gets back after the first swing and damps down quickly. The system is strongly stable and very strong in damping the post fault oscillations.

# 7.2.3 Fault at 132kV Chishtian-New (Stuck Breaker Case)

We applied three-phase fault on the Chishtian-New 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of 132 kV circuit between the Storm Harbour and Chishtian-New. We monitored different quantities for one second pre-fault and nine 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 voltage of 132 kV bus bars of Storm Harbour, Solar-PP-1, Chishtian-New, Bahawalnagar, Dharanwala and 220 kV bus bar of Chishtian are plotted. The results show quick recovery of the voltages after clearing of fault.

# Fig. 3.2 Frequency

· We see the system frequency recovers back to normal quickly after fault clearance.

# Fig. 3.3 MW/MVAR Output of Solar Power Plant

The pre-fault output of Storm Harbour Solar Power Plant was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

# Fig. 3.4 Voltage Sensor for LVACR

The value for LVACR is restored to its pre-fault value after the fault clears.

Fig. 3.5 MW/MVAR flow from Chishtian-New to Solar-PP-1 132 kV

Followed by clearing of fault, the trip of 132 kV circuit between the Chishtian-New and Storm Harbour causes the entire output of Storm Harbour to flow through the intact 132 kV circuit between Chishtian-New to Bahawalnagar. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

# Fig. 3.6 MW/MVAR Output of Solar-PP-1

The pre-fault output of Solar-PP-1 was 100 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. Similarly MVAR output acquires equilibrium at a same value.

# Fig. 3.7 Rotor Angles

The rotor angles of the generators of Liberty Power 132 kV, Engro-Energy 220 kV, Guddu 220 kV and Foundation-P 220 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angles gets back after the first swing and damps down quickly. The system is strongly stable and very strong in damping 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 and far and far and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near and far are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near are severest possible faults of 132 kV systems near ar

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away from the Solar Power Plant of Storm Harbour Solar 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.







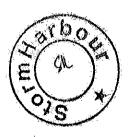
### **Conclusions** 8.

- \* The study objective, approach and methodology have been described and the plant's data received from the client Storm Harbour Solar PP has been validated.
- The expected COD of the project is the third quarter of 2016. Therefore the month of September 2016 have been selected to carry out the study as it will help determine the maximum impact of the project.
- The latest generation, transmission plan and load foreast provided by NTDC has been used vide data permission letter no. GMPP/CEMP/TRP-300/2261-62 dated 28-05-2015.
- The nearest substation of MEPCO is Chishtian-New 132 kV. The following scheme of interconnection of Solar Power Plant by Storm Harbour Solar to evacuate maximum power of 100 MW is envisaged and studied in detail:
  - Two loops with two 100 MW solar power plants each have been proposed to be connected to Chishtian-New.
  - The first loop comprises of Storm Harbour and another 100 MW Solar Power Plant (named Solar-PP-1 for future reference).
  - The second loop comprises of two 100 MW Solar Power Plants (named Solar-PP-2 and Solar-PP-3 for future reference) and Chishtian - New 132 kV grid station.
- Detailed load flow studies have been carried out for the peak load conditions of September 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 100 MW of the plant under normal and confingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at the Storm Harbour 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 Storm Harbour Solar Power Plant.

The maximum short circuit level of 132 kV bus bar of Storm Harbour Solar Power Plant 132 kV is 5,70 kA and 4,52 kA for 3-phase and 1-phase faults respectively for September 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 September 2016. The stability check for the worst case of three phase fault on the 132 kV bus bar of the Storm Harbour 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 Chishtian New 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.



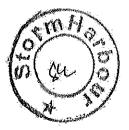




**Appendices** 

# Appendix - A 1- Maps & Sketches 2- Generation Transmission & Load Forecast For Chapter 4





Power Planners International Interconnection Study of Storm Harbour Solar PF Sketch-1 Without Storm Harbour Solar Power Plant, September 2016 132kV Network Near Chishtian-New Solar PP 1 MNCHNAbad Solar PP 2 **Bahawalnagar** Solar PP 3 Chishtian-New Chishtian-O Dharanwala Proposed 132 kV Legend 132 KV 220 KV いたのか

