BEFORE
THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY (NEPRA)

APPLICATION FOR A GENERATION LICENSE FOR SOLAR POWER GENERATION FACILITY

PURSUANT TO ENABLING PROVISIONS OF NEPRA ACT 1997 READ WITH ENABLING PROVISIONS OF RULES MADE THEREUNDER, LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS AND LICENSING (GENERATION) RULES 2000

ON BEHALF OF

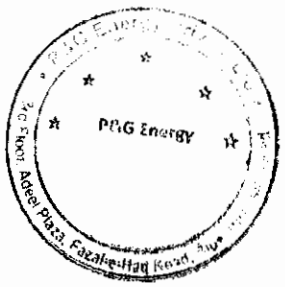
P&G ENERGY (PRIVATE) LIMITED

FOR NEPRA'S GRANT OF GENERATION LICENSE FOR
P&G ENERGY (PRIVATE) LIMITED

FOR A POWER PROJECT OF 50 MWP (THE **PROJECT**)

AT

GWADAR, PROVINCE OF BALOCHISTAN, PAKISTAN



DATED: 29/08/2019

LEGAL & REGULATORY CONSULTANT

HAIDERMOTABNR & CO.

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APPLICANT

P&G ENERGY (PRIVATE) LIMITED
REGISTERED OFFICE
3RD FLOOR, ADEEL PLAZA,
FAZAL E HAQ ROAD, BLUE AREA,
ISLAMABAD, PAKISTAN
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P&G Energy

P&G ENERGY PRIVATE LTD, 3RD FLOOR ADEEL PLAZA, FAZAL-E-HAQ ROAD, BLUE AREA, ISLAMABAD

THE REGISTRAR,
National Electric Power Regulatory Authority,
NEPRA Tower, Ataturk Avenue (East),
G-5/1,
Islamabad,
Pakistan.

DATE: 29/08/2019

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3rd Floor Adeel Plaza, Fazal-e-Haq Road, Blue Area
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Directors
Anton Milner
Carl Von Braun
Salar Khan Sanjrani

Subject: Applicaiton for Generation License for 50MW AC ~ 62.2MWp P&G Energy Pvt Ltd

I Adeel Ahmed, Manager Business Development ibvogt GmbH and fully Authorised representative of P&G Energy Pvt Ltd by the virtue of Authority Letter dated 22/02/2019, hereby apply to the National Electric Power Regulatory Authority for Grant of Generation License to the P&G Energy Pvt Ltd. persuant to section 15 of the regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the docuemnts in support with this applicaiton are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Applicaiton and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confrim that the information provided in the attached documetns-in- support is true and correct to the best of my knowledge and belief.

A BANK DRAFT / PAY ORDER in the sum of PKR 438180.00/- (Pakistani Rupees Four Hundred Thirty Eight Thousand, One Hundred and Eighty Rupees only,) being the nonrefundable license application fee calculation in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

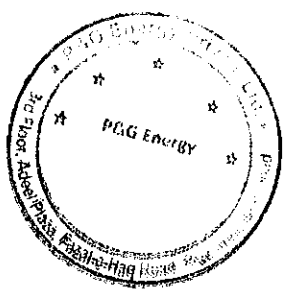
The applications is flied in triplicated with all the annexures appended with each set of the application.

Your Sicerely,

.....
Adeel Ahmed
Authorised representative
P&G Energy Pvt Ltd

P&G Energy Private Ltd
P&G Energy
3rd Floor, Adeel Plaza, Fazal-e-Haq Road, Blue Area, Islamabad

COPY OF EXTRACT OF RESOLUTION PASSED BY BOARD OF DIRECTORS OF P&G ENERGY (PRIVATE) LIMITED



EXTRACTS OF THE RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF P&G ENERGY (PRIVATE) LIMITED ON 14/02/2019

BOARD RESOLUTIONS

"It is hereby unanimously resolved that:

(A) **P&G ENERGY (PRIVATE) LIMITED** (*a private company duly established and existing under the laws of Pakistan with its registered office located at 3rd Floor, Adeel Plaza, Fazal-e-Haq Road, Blue Area, Islamabad, Pakistan*) (the **Company**), having obtained a Letter of Interest in favour of its sponsors for the development of a 50MW AC – 62.2 MW DC solar power project to be located at Gwadar, Balochistan, Pakistan (the **Project**) from the Balochistan Power Development Board, dated February 23, 2018; and having made steady progress in respect of the development of the Project;

BE AND IS HEREBY AUTHORIZED to prepare, finalize, deliver, file, apply and submit, pursuant to the applicable laws of Pakistan, including the '*Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997*' (the **NEPRA Act**) and the rules and regulations made thereunder (including regulation 10(2) of the '*National Electric Power Regulatory Authority Licensing (Application & Modification Procedure) Regulations, 1999*' and the '*National Electric Power Regulatory Authority Licensing (Generation) Rules, 2000*') (the **Applicable NEPRA Laws**), an application (together with all documents attached thereto) (the **Generation License Application**) before the **NATIONAL ELECTRIC POWER REGULATORY AUTHORITY** (the **Authority**) for the Authority's approval of the Generation License Application and to, *inter alia*, enter into and execute all required documents, make all filings, attend all hearings, provide all required information and pay all applicable fees, in each case, of any nature whatsoever.

(B) **FURTHER RESOLVED THAT,** in respect of the matters relating to the Generation License Application, **MR. CHARLES ANTON MILNER** (being the Director of the Company and having Passport No. 525622078) is **HEREBY** singly appointed as authorized representative of the Company and is **HEREBY** authorized and empowered for and on behalf of the Company, as the Company duly appointed **AUTHORIZED REPRESENTATIVE,** to address, perform, negotiate, decide, execute, implement and/or undertake all matters of any nature whatsoever in relation to the Generation License Application including, without limitation:

(i) review, execute, submit, and deliver the Generation License Application and any related documentation required by the Authority for its approval, including any contracts, documents, powers of attorney, affidavits, statements, letters, forms, applications, deeds, guarantees, undertakings, approvals, memorandum, amendments, letters, communications, notices, certificates, request 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 the 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, execute and deliver, for and on behalf of the Company, all necessary documentation (including any contracts, documents, powers of attorney, affidavits, statements, letters, forms, applications, deeds, guarantees, undertakings, approvals, memorandum, amendments, letters, communications, notices, certificates, request statements and any other instruments of any nature whatsoever), pay the necessary fees, appear before any entity (including the 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), as required from time to time, and do all acts necessary for processing and approval of the Generation License Application, by the Authority;

(iv) further sub-delegate any or all of the aforementioned powers and authorities to one or more officers of the Company or any other person or persons, singly and/or jointly; and

(v) do all such acts, deeds and things as may be necessary for carrying out the purposes aforesaid and give full effect to the above resolutions.

CERTIFICATION
CERTIFIED TO BE TRUE COPY

CERTIFIED, that, the above resolutions were duly passed by the board of directors of **P&G ENERGY (PRIVATE) LIMITED** (*a private company duly established and existing under the laws of Pakistan with its registered office located at 3rd Floor, Adeel Plaza, Fazal-e-Haq Road, Blue Area, Islamabad, Pakistan*) on 14/02/2019.

FURTHER CERTIFIED, that the afore-stated resolutions have not been rescinded and are in operation and in full force and effect as at the date hereof and that this is a true copy of the same.

.....
COMPANY SECRETARY

P&G Energy
3rd Floor, Adeel Plaza, Fazal-e-Haq Road, Blue

1. BACKGROUND TO GENERATION LICENSE APPLICATION

1.1 PROCESS OF ISSUANCE OF LETTER OF INTENT, LEADING TO GENERATION LICENSE APPLICATION

1.1.1 ISSUANCE OF "LETTER OF INTENT"

The sponsors of the project IB VOGT GMBH (the **Main Sponsors**) were issued a LETTER OF INTENT by the Balochistan Power Development Board (the **BPDB**) on February 23, 2018 *vide* its letter No. BPDB/Energy(13)/2018/957-66 (the **LOI**) to develop and establish a 50 MWp solar power project to be located at Gwadar, Balochistan (the **Project**). The Main Sponsors had also submitted a bank guarantee for an amount equal to US$ 50,000/- (United States Dollars Fifty Thousand only) issued by Askari Bank Limited.

1.1.2 ESTABLISHMENT OF SPECIAL PURPOSE VEHICLE

After issuance of the LOI, the sponsors of the Project incorporated a special purpose vehicle that is, P&G ENERGY (PRIVATE) LIMITED'S (a company duly organized and existing under the laws of Pakistan, with its office located at 3rd Floor, Adeel Plaza, Fazal-e-Haq Road, Blue Area, Islamabad, Pakistan) (the **Project Company**). A copy of the Project Company's Certificate of Incorporation is attached hereto as ANNEXURE - A for NEPRA's perusal.

1.1.3 SUBMISSION OF INITIAL ENVIRONMENTAL EXAMINATION.

The Project Company hired consultants, [Conformity, Assessment & Sustainability Services Company], who completed the initial environmental examination for the Project (the **Initial Environmental Examination**) and the Project Company submitted the same to the Environmental Protection Agency, Balochistan (the **EPA**) on 03/01/2019.

After careful review and analysis of the Initial Environmental Examination, the EPA accorded its approval for the Project through its decision (Ref: No. DG (EPA)/6592/2018-19 dated *27 / 05/ 2019* (the **IEE Approval Decision**). A copy of the IEE Approval Decision is attached hereto at ANNEXURE - B for NEPRA's perusal.

1.1.4 GRID INTERCONNECTION STUDIES

The Project Company has engaged independent consultants, ARCO Energy Consultants, who have conducted the grid interconnection studies (the **Grid Interconnection Studies**). The Grid Interconnection Study approval was received from Quetta Electric Supply Company (**QESCO**) on *21/03/2019* and is attached herewith as ANNEXURE C for NEPRA's perusal.

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1.1.5 SUBMISSION OF THE FEASIBILITY STUDY

Pursuant to the relevant provisions of the Balochistan Power Generation Policy, 2007 (the **Balochistan Power Generation Policy 2007**) and the LOI, the Project Company hired technical consultants, ARCO Energy Consultants, who completed the detailed technical feasibility study for the Project, (including geo-technical investigation, topographic survey) and the Project Company submitted the same to BPDB for its approval on 31/12/2019 (the **Project Feasibility Study**). A copy of Project Feasibility Study is attached hereto as ANNEXURE – D for NEPRA's perusal. A copy of Balochistan Power Development Board for Project Feasibility Study approval process is attached hereto as ANNEXURE- E.

1.1.6 REQUEST FOR GRANT OF A GENERATION LICENSE

Based on the matter provided in Section 1.1.1, 1.1.2, 1.1.3, 1.1.4 and 1.1.5. above whereby the Project Company, on its part, has undertaken and completed all activities required for procurement of approvals of the relevant matters from various stakeholders it is submitted that the requirements of the regulatory process for applying to NEPRA for grant of a generation license for the Project Company are complete.

1.2 SUBMISSION

1.2.1 Under the Regulation of Generation, Transmission and Distribution of Electric Power Act (XL of) 1997 (the **NEPRA Act**) and the National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, the National Electric Power Regulatory Authority (**NEPRA**) is responsible for and has the authority to, *inter alia*, grant licenses for the generation of electric power and other terms and conditions for the supply of electricity through generation.

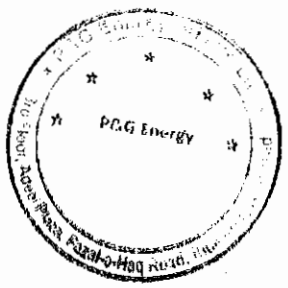
1.2.2 **PURSUANT TO** the NEPRA Act, the National Electric Power Regulatory Authority Licensing (Application & Modification Procedure) Regulations 1999, National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, **AND** in accordance with the Balochistan Power Generation Policy 2007: **P&G ENERGY (PRIVATE) LIMITED HEREBY SUBMITS,** for NEPRA's kind and gracious consideration, the application for the grant of a generation license along with supporting documents (the **Generation License Application**) for its 50 MW AC power generation facility to be located at Gwadar, Balochistan, Pakistan.

1.2.3 [In order to highlight the advance stage of the progress made by the Project Company with regard to the 'self-EPC' mode, financing arrangements and other activities necessary to culminate the generation facility to its commercial operation, the Project Company hereby encloses as ANNEXURE F a copy of the 'Project Progress Report' dated 31/12/2018 submitted by the Project Company to the BPDB.

1.2.4 Given the advance stage of the Project, NEPRA is kindly requested to process this Generation License request at the earliest, thereby enabling the Project Company to proceed further with the development process.

1.2.5 This Generation License Application is submitted in triplicate.

1.2.6 The generation license fee, payable by the Project Company, in respect of this Generation License Application is also enclosed in the form of a pay order for an amount of PKR 438180.00/- (Pakistani Rupees Four Hundred Thirty-Eight Thousand, One Hundred and Eighty Rupees only,) dated 22 August 2019 drawn in favor of NEPRA.



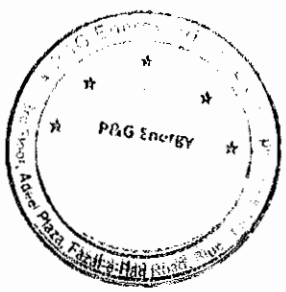
2. APPLICANT – P&G ENERGY (PRIVATE) LIMITED

2.1 The Project Company, being the applicant under this Generation License Application, is a private limited company incorporated under the laws of Pakistan and has been specifically established to undertake power generation business and activities in Pakistan.

2.2 The Project Company (following grant of a generation license and approval of the Project Company's reference generation tariff by NEPRA) proposes to design, engineer, construct, insure, commission, operate and maintain the Project constituting of a 50 MW AC solar power generation facility (the **Facility**) to be located at Gwadar, Province of Balochistan, Pakistan (the **Site**).

2.3 The following supporting documents relating to the Project Company are attached herewith as follows:

DOCUMENTS	ANNEXURE
Shareholding Pattern	ANNEXURE G
Memorandum and Articles of Association	ANNEXURE H
Certificate of Incorporation	ANNEXURE A



3. FACILITY UTILIZATION

3.1 ELECTRICITY DEMAND

3.1.1 Pakistan is a developing economy having a constant growth in industrialization, coupled with a constantly rising demand for electricity. The long standing gap between demand and supply of electrical power has resulted in excessive and frequent load shedding, resulting in determinant and loss to the economy and socio-economic development in the country.

3.1.2 The demand for electricity has continued to increase by out pacing the growth rate of the economy. In the past years, shortfall at times crosses 5000 MW and this is the time when urban areas have [8-12] hours of load shedding and small cities/ rural areas have [18] hours of load shedding. While it may be arguable that the demand and supply gap in electricity it is soon to be bridged, however the same does not account for the fact that a developing economy, coupled with growing consumption and demand could result in another cycle of shortfall in potential supply, which could be the major cause for stunned growth in the industrial sector in Pakistan. The industry, having its self- generation on gas, has a suspended supply of gas for 2-3 days a week during winters. Pakistan's major electricity sources at present are thermal and hydro generation, meeting approximately 97% of the country's annual electricity demand. The primary thermal generation fuels employed are furnace oil and gas. While both fuels are produced domestically, demand for them already outstrips supply by a considerable amount. Oil imports are already a significant burden on the national exchequer and the increasing import bill continues to exert further pressure on the foreign exchange reserves. Therefore, securing alternative fuels and the technical management should be strengthened to solve these problems and solar power, a cleaner source of energy can play a very important role in overcoming Pakistan's growing energy crisis.

3.1.3 In light of compliance by the Project Company of all requirements under the Balochistan Power Generation Policy, 2007 for eligibility of an application for a generation license and following grant of a generation license and approval of Project Company's reference generation tariff, in each case, by NEPRA, the Project Company will finance, design, engineer, procure, construct, install, test, complete, commission, insure, operate and maintain the Project at Site.

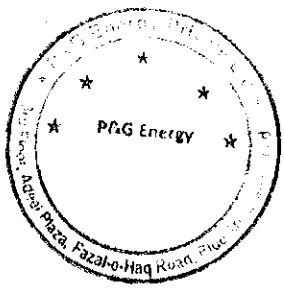
3.1.4 The proposed Project will, following its completion, contribute towards relieving the shortage of electric power in the country and continuing to ensure that the supply of electricity continues to meet the growing demand.

3.1.5 Based on a thorough analysis of the national electricity generation structure and in light of technical parameters, it is anticipated that the Project shall operate as one of the most competitive independent power producers in Pakistan.

3.2 POWER OFF-TAKE

3.2.1 Following commercial operation date of the Project, the electricity generated will be sold to the Central Power Purchasing Agency (Guarantee) Limited, as an agent of the ex-Wapda distribution companies (the **Power Purchaser**) pursuant to an energy purchase agreement (the **EPA**), which in turn will distribute and modulate the electricity generated by the Project Company.

3.2.2 The EPA will be finalized and executed by and between the Project Company and the Power Purchaser following NEPRA's approval of the Project Company's [twenty-five (25) years] reference generation tariff, the grant of a generation license to the Project Company and the issuance by the Government of Pakistan of the Letter of Support.



4. THE SPONSORS

4.1 AN INTRODUCTION

4.1.1 The Main Sponsor, IB VOGT GMBH intends to be a major player in developing projects in the energy sector with particular emphasis on development of renewable energy projects through investment in efficient and profitable projects.

4.1.2 The Main Sponsor of the Project has established two subsidiaries, which are the major shareholders in the Project Company: IBV GWADAR HOLDCO 1 LIMITED [established in United Kingdom under the laws of England and Wales] and IBV GWADAR HOLDCO 2 LIMITED [established in United Kingdom under the laws of England and Wales] (collectively the **Major Shareholders**).

4.1.3 Whereas Pakistan Testing Service (PTS) is an Islamabad based developer, who develops solar projects for the end investors. The successfully developed solar projects portfolio of PTS is above 100MW.

(The Major Shareholders and PTSL are collectively referred to as the **Sponsors.**)

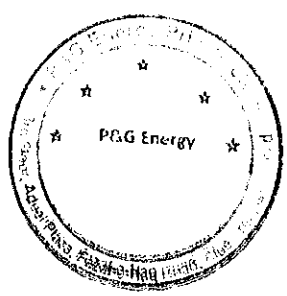
4.2 FINANCIAL HIGHLIGHTS

The Main Sponsors financial highlights for the year ended December 31, 2018 include a collective turnover of > 200 Million Euros. A summary of each Sponsors' financial highlights are attached herewith as ANNEXURE I.

4.3 COMMITMENT TO PROJECT

4.3.1 The Sponsors are committed to playing their part in the development of Pakistan's various sectors. Realizing the role of clean energy, the Sponsors endeavor to play a positive role in the development of renewable energy in Pakistan and through the Project, the Sponsors intends to promote technological development, construction, operation and maintenance of solar power plants.

4.3.2 The unmatched standards of corporate governance, efficiency, safety and operations established by the Sponsors in projects around the globe are now expected to be replicated in its solar power generation venture in Pakistan – thus raising the bar for all future solar power projects.



5. RESOURCES

5.1 SENIOR MANAGEMENT & PERSONNEL

5.1.1 Given the Sponsors' long standing engagement in the solar industry, the Project Company has access to and has engaged the highly qualified personnel for the development of the Project. The Project Company is presently under the process of appointing various personnel and details of the same will be provided upon finalization of the terms and conditions of their appointment.

5.1.2 In addition, the curriculum vitae of the following individuals currently engaged by the Project Company are attached herewith at ANNEXURES J, K, L AND M:

	NAME OF INDIVIDUALS	POSITION	ANNEXURE
1.	**ANTON MILNER**	Director	**J**
2.	Carl Von Braun	Director	**K**
3.	Murad Can	Director Eurasia And Latin America	**L**
4.	Adeel Ahmed	Manager Business Development	**M**

5.3 LEGAL ADVISER

5.3.1 **HAIDERMOTABNR & CO.** has been selected by the Project Company to provide legal support on all legal aspects of the Project including Project documentation, regulation and financing matters. HaidermotaBNR & Co. has been actively involved in the power sector and projects and has advised various project companies and sponsors, lenders and the Government of Pakistan on various transactions and matters. It is ranked by Chamber & Partners as a "*Band 1*" firm in Pakistan for Projects, Banking & Finance and Corporate & Commercial.

5.4 FINANCIAL ADVISORS

5.4.1 **ERNST & YOUNG (FORD RHODES SIDAT HYDER) (E&Y)** has been selected by the Project Company to provide support on all financial aspects of the Project. E&Y has been actively involved in the power sector and infrastructure projects in Pakistan.

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6. CAPITAL BUDGET

6.1 The estimated total Project cost (the **Total Project Cost**), expressed in United States Dollars, has been calculated after thorough analysis, evaluation and understanding of the dynamics that affect the development and operation of a solar power plant. The Total Project Cost comes to approximately US$ 56158298/- (United States Dollars).

6.2 The capital structure of the Project is proposed as follows:

	USD
DEBT	42,118,723.5
EQUITY	14,039,574.5
TOTAL PROJECT COST	56,158,298.0

7. FINANCIAL PLAN

7.1 The Total Project Cost of US$ 56,158,298/- (United States Dollars Fifty-Six Million One Hundred Fifty-Eight Thousand, Two Hundred and Ninety-Eight only) is to be financed in a debt to equity ratio of 75% - 25%.

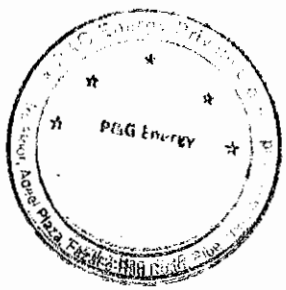
7.1 DEBT

7.1.1 It is expected that the debt for the Project (the **Debt**) will be secured from **BANK/DFI** which will provide foreign financing in United States Dollars to the Project Company.

7.2 EQUITY

7.2.1 Based on the Debt to Equity ratio of 75% - 25%, the equity required to be injected by the Sponsors (the **Equity**), amounts to USD 14,039,574.5/- (United States Dollars Fourteen Million, Thirty Nine Thousand Five Hundred and Seventy Four). The Sponsors will subscribe to the total amount of the Equity required for the Project from time to time.

7.2.2 The financial strength and net worth of the Sponsors is illustrated by the attached ANNEXURE I. Further, the recent financial statements of the Project Company are also attached hereto at ANNEXURE I.



8. THE FACILITY

8.1 TECHNOLOGY

8.1.1 Technology Selection Criteria

The technology for the Project has been shortlisted after detailed analyses of various power generation technologies available internationally for the purposes of power generation through solar. Various factors were considered in selection of equipment and technology which included:

(a) equipment to be of latest proven technology, megawatt class and high efficiency;

(b) safe transportation of equipment to the Site;

(c) maintainability of the equipment and availability of personnel;

(d) energy output with warranted power curve and performance warranty;

(e) grid compatibility with proposed energy yields and grid code requirements; and

(f) suitability of operation and maintenance concept for the size and location of projects with suitable availability of spare parts, consumables and main components.

8.1.2 The Selected Technology

The Project Company has selected the following equipment for the Project:

No.	Equipment	Brands
1	PV modules	Tier 1 (Hanwah Q-Cells, Jinko, Trina, Longi solar or similar)
2	Single Axis Tracker	Leading global supplier (Arctech, Soltec, Schletter)
3	Inverters	ABB, GE, Sungrow, HUAWEI
4	DC/AC brand	Faber or Huawei
5	Step – up transformers	Siemens, ABB, TBEA, QRE, Chint
6	Medium voltage switch gear and 132KV substation	Siemens, ABB, Chint
7	SCADA	Gatner, ABB, Schneider

Additional Plant Technical Details

Plant Configuration:

1. Installed Capacity: 50 MW (AC) ~ 62.2 MWp (DC)
2. Capacity at Operating Conditions: 55.81 MWp @ 50^{O} C
3. Auxiliary Consumption approx.: 600 KvA
4. Net output (MSC): 49.4 MW(AC)
5. Life of facility 25 years

The Project will be set up using bifacial monocrystalline PV modules, which will be installed in arrays, and their DC output will be converted in to AC through inverters. Thereafter, a group of arrays/inverters will be routed to step-up transformer(s)/switchgear(s) for connecting to the system as per the interconnection scheme.

Detailed plant configuration is provided in ANNEXURE N and O Schedule Part I and Schedule Part II attached hereto.

8.2 THE PROJECT SITE

8.2.1 The Site of the Project is located, Gwadar, Balochistan. The area has been extensively surveyed and due to its predominantly flat topography has been identified as having strong potential for the proposed solar project. The following other parameters have also been considered for the implementation of the Project at the proposed Site:

(a) Forecasted power output;
(b) Access to the proposed site (materials and equipment transport feasibility study);
(c) Suitability for the surrounding environment;
(d) Utility connections for electric, gas and water supply; and
(e) Grid Station connection a 132KV grid station is located approximately 0.4 km from the Site.

8.2.2 The Site is located at 31m above sea level. The size of the whole solar farm is about 202 acres.

8.2.3 The coordinates of the Site are as follows:

P&G Energy

S.No.	Entry	Details
1	Site Name	Gwadar Solar Farm Site
2	Site Coordinates	P1= Lat 25.3213, Long 62.6368 P2= Lat 25.3239, Long 62.6369 P3= Lat 25.3268, Long 62.6369 P4= Lat 25.3302, Long 62.6369 P5= Lat 25.3302, Long 62.6312 P6= Lat 25.3302, Long 62.6252 P7= Lat 25.3277, Long 62.6245 P8= Lat 25.3277, Long 62.6359 P9= Lat 25.3260, Long 62.6257 P10= Lat 25.3260, Long 62.6286 P11= Lat 25.3266, Long 62.6286 P12= Lat 25.3264, Long 62.6322 P13= Lat 25.3224, Long 62.6318 P14= Lat 25.3199, Long 62.6320
3	Altitude	33 m (Highest recorded value) 23 m (Lowest recorded value)
4	Proposed AC and DC capacity	50 MW AC ~ 62.2 MW DC
5	Global irradiation levels	2200 KWh / m^2 (Solar GIS)

Table 1 showing site coordinates and irradiation levels

FIGURE 1: SITE OVERVIEW

Fig 1 showing the location of Gwadar site

9. ENVIRONMENTAL AND SOCIAL SOUNDNESS

9.1 INVESTIGATION SUMMARY

9.1.1 The investigations at Site have shown that in general the realization of the Project is possible at the Site from an environmental point of view and no adverse impact on the existing flora and fauna at Site is expected. The Facility will not emit any solid, liquid and gaseous waste during the entire life of the Project and thus the power will be generated without polluting the environment of the surroundings.

9.1.2 A data collection survey that included geology, meteorology, hydrology, ambient air quality, water quality, soil characteristics, noise levels, shadow forecasting, flora and fauna, land use pattern, and socioeconomic conditions was undertaken based on available secondary information or data collected in the field. Primary data was collected to establish baseline conditions for the soil, water (surface and ground) quality, flora and fauna, and noise. Secondary data was collected for land, ecology, climate, and socioeconomic factors.

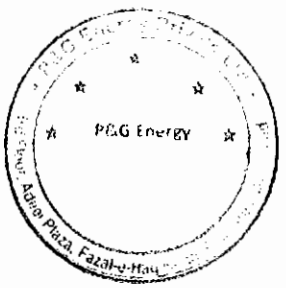
9.1.3 It was observed that the area is highly underdeveloped and there is no industrialization in the area and thus the baseline emissions are very low. The nearest settlements of human habitats are located [four (4)] Km away from the Project Site. There is very sparse vegetation in the forms of herbs and shrubs, there being no reserved forest site or sanctuary located within the Project land area that needs to be demolished. The Site is located in remote areas with very little social and commercial activity and thus limiting the long term social impact.

9.1.4 Noise impacts will be around 60DB(A) at 10m which are within the range as per National Environmental Quality Standards (NEQs) of Pakistan. But at distance of 100m from the noise impact will also be negligible. There are no exceeds of shadow from the permissible limits calculated for all WTG type scenarios. The environmental disturbance normally associated with construction activities will be minimized through an Environment Management Plan (EMP), implementation of which will continue during Project operation and which includes monitoring arrangements.

9.1.5 There exist high potential of solar energy at the Site and the proposed Project will help in tapping this potential without impairing the environmental conditions of the area.

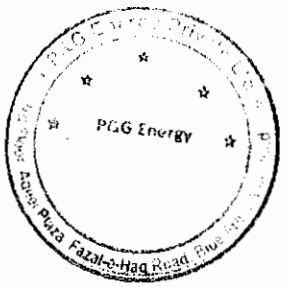
9.2 IEE REPORT APPROVAL FROM THE ENVIRONMENTAL PROTECTION AGENCY, BALOCHISTAN

9.2.1 As already submitted in Section 1 (*Background to Generation License Application*) above, the Balochistan EPA has already accorded its **approval** to the IEE Report for the Project through its decision dated 27/05/2019. Attached here as Annexure B.



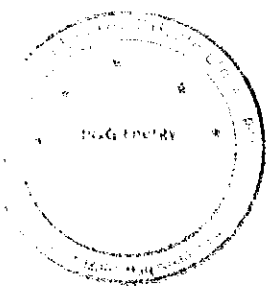
10. SAFETY

10.1 The Project will be implemented in accordance with internationally accepted health and safety standards and in-line with the acclaimed practices and procedures. The Sponsor's, entails introducing and establishing its unmatched safety standards and procedures in the business operations of the Project Company, so as to establish an enviable benchmark in the country's solar energy sector.



11. TRAINING AND DEVELOPMENT

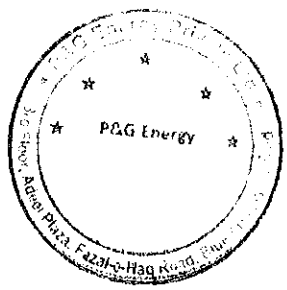
11.1 Periodic environmental and HSE trainings willbe given to employees working in the project area. The management of P&G Energy Pvt. Limited understands the requirement of diligence and care in this respect and will develop strict SOPs for the health and safety of workers. Various sessions of in-house trainings will also be conducted in the Project.



12. PROJECT FEASIBILITY STUDY

12.1 The Project Company engaged leading technical consultants for elaborating the Project Feasibility Study and for supervising the solar measurements and preparing conceptual design of the Facility.

12.2 A copy of the Project Feasibility Study is attached hereto at ANNEXURE D.



13. IMPLEMENTATION SCHEDULE

13.1 The following provides the key milestones and dates for the Project's development to date:

MILESTONES ACHIEVED TO DATE	
ACTIVITIES	COMPLETION DATE
Issuance of Letter of Intent	February 23, 2018
IEE approval by EPA	May 27, 2019
Approval of Grid Interconnection Study	March 21, 2019
Feasibility study approval process letter BPDB	August 29th, 2019

13.2 The following provides the key upcoming milestones and dates for the Project's development:

MILESTONES TO BE ACHIEVED	
ACTIVITIES	COMPLETION DATE
Grant of Generation License	Upon NEPRA's approval
Execution of major supply contracts	Upon NEPRA's determination
Reference Tariff Determination	Upon NEPRA's determination
Submission of Performance Guarantee by Project Company for issuance of LOS	15 days after Tariff determination by NEPRA
Issuance of LOS to Project Company by Government of Pakistan	7 days after submission of Performance Guarantee
EPA Signing with CPPA(G)	Within the time period allowed under the LOS
IA Signing with Government of Pakistan	Within the time period allowed under the LOS
Project Financial Close & ordering of equipment	Within the time period allowed under the LOS
Commercial Operation Date	18 months following Financial Close
Adjustment of reference tariff by NEPRA	Following Commercial Operations Date

14. CONCLUSION

14.1 In light of the submissions, the relevant financial analysis and information contained in this Generation License Application, along with the Annexures attached hereto, this Generation License Application is submitted for NEPRA's kind consideration and grant of the Generation License to the Project Company.

Respectfully submitted for and on behalf of:
P&G ENERGY (PRIVATE) LIMITED

.....

MR. ADEEL AHMED
AUTHORIZED REPRESENTATIVE OF
P&G ENERGY (PRIVATE) LIMITED

S.No.	Activities	2018				2019				2020							
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	**Stage 1 LOI**																
2	Issuance of LOI by BPDB																
3	SPV Incorporation																
4	Grid suitability																
5	Land Acquisition																
6	**Stage 2 Feasibility**																
7	Submission and approval of IEE																
8	Submission and approval of Grid interconnection study																
9	Submission and approval of feasibility study																
10	**Stage 3 Tariff petition**																
11	Submission and approval of generation license																
12	Submission and approval tariff																
13	**Stage 4 LOS, EPA and Financial Close**																
14	LOS, EPA and Negotiation with banks																
15	Execution of Financial Docs																
16	**Stage 5 Construction**																
17	Ground Breaking																
18	Mobilization of EPC contractor and construction completion																
19	**Stage 6 Commission & Testing**																
20	Commissioning and Testing																
21	**Project COD**																
22	COD																

Figure showing timeline for the project COD

Note: The timeline is as per BPDB Policy 2007, with Govt. support project time line can be improved.

Ph: No. 081-9201840

No. DG (EPA)/6592/2018-19
GOVERNMENT OF BALOCHISTAN
Environmental Protection Agency,
Wood Cock Spanl Nursery Sumangli Road, Quetta.
(Technical Wing)
SAY NO TO CORRUPTION

Dated: 27/5/2019.

ENVIRONMENT APPROVAL

To,

M/S Conformity Assessment & Sustainability Service Company (CASSCO)
Suite # 203, 2nd Floor, Mashriq Center Block-14,
Gulshan-e-Iqbal, Karachi.

1.	Name of Project & Description:	**GRANT OF ENVIRONMENT APPROVAL FOR 50 MW SOLAR POWER PLANT IN GAWADAR BALOCHISATN.**
2.	Location of the Project:	**MOUZA KARWAT GAWADAR.**
3.	Date of filing of IEE:	**09-01-2019.**

4. After careful review of the Initial Environmental Examination (IEE) report submitted to the Balochistan Environmental Protection Agency (BEPA) by **M/S Conformity Assessment & Sustainability Service Company (CASSCO)** Suite # 203, 2nd Floor, Mashriq Center Block-14, Gulshan-e-Iqbal, Karachi, under section 15 of Balochistan Environmental Protection Act 2012, the Balochistan Environmental Protection Agency has desired to occurred its approval / No Objection Certificate in favour of **M/S Conformity Assessment & Sustainability Service Company (CASSCO)** subject to the following conditions:-

i. The **M/S Conformity Assessment & Sustainability Service Company (CASSCO)** ensure mitigation measures and Environment Management Plan (EMP) included in IEE report will be strictly implemented.

ii. Complete code of health safety and environment (HSE) shall be developed which should include efficient parameters at specific work place. For this purpose (HSE) setup should be established and supervise by a designated (HES) officer at senior level with sufficient administrative and technical authority to perform the designated function. Proponent will make sure that the operating instructions and emergency actions are made available to every worker / labour / commuter at the site.

iii. Proponent shall comply with National Environmental Quality Standard (NEQS) for air emissions, noise and waste water to be generated during construction as well as operation activities of the project.

iv. All environmental and safety instructions shall be displayed in bold, at a number of places of the sites. Warning boards shall be erected at appropriate places. The 24 hours emergency response team should have placed to cater any incident at the site.

v. The proponent should locate developments away from sensitive habitats for species, especially those that are threatened or have restricted ranges, and are collision-prone or vulnerable to disturbance, displacement and/or habitat loss.

vi. To cope up with any untoward emergency situation, **M/S Conformity Assessment & Sustainability Service Company (CASSCO)** must share with BEPA its emergency preparedness plan within 90 days of the issuance of Environmental Approval by this agency.

vii. Date of commencement / completion of the activities, shall be intimated to the Environmental Protection Agency Balochistan.

0542
27/5/19

viii. All precautionary measures should be strictly adhered to minimize any negative impacts on soil, groundwater ambient air quality and wildlife in the project area.

ix. Solid Waste Management Plan should be developed through a contractor before operation and such a plan must be shared with BEPA to know the exact process of solid waste disposal.

x. The proponent should monitor the relevant fauna including invertebrates, birds and bats and other animals to be undertaken during pre and post project development.

xi. Performance should be given regarding electric supply in the project are to stimulate and support the expansion of local industry and service business.

xii. 02% CSR funds should be targeted and spent on sectors local community is in dire need of, such as education, maternal health, sports and drinking water.

xiii. All conflicting issue regarding compensation etc, should be settled before commencement of the developmental activities.

xiv. Off-road travel be strictly avoided; if inevitable, then slow driving and water sprinkling should ensured to reduce excessive dust billowing.

xv. Camp-site selection should be once for all, unless there is inevitability, and movement of equipments should be limited to existing routes possible.

xvi. The success of the project is probable, mean uncertain; in case project is not successful, a satisfactory mechanism be devised for the restoration of the baseline conditions to avert untoward disturbance to the ecosystem / flora-fauna of the area. Such measures may include establishment of a fund etc for the purpose.

Local community should be given much priority in the project jobs.

In case of any contravention penalties described in BEPA Act 2012 will be imposed on the proponent and prosecution will be initiated before the Environmental Protection Tribunal Balochistan.

xix. In case of any verifiable damage the compensation will invariably be paid by the proponent to the community having legal ownership.

xx. Quarterly Environmental Report of the project activities generated by the **M/S Conformity Assessment & Sustainability Service Company (CASSCO)** site health, safety and environment (HSE) coordinator and its sub-contractor should be shared with BEPA for verification on regular basis.

xxi. Contamination of soil, groundwater due to seepage of fuel, oil and chemical should be prevented by installing proper septic system.

xxii. There should be no disturbance during and after construction phase in the flow of traffic on main highway which is situated 20 meter away from the project site.

xxiii. Packing materials of PV Modules, Inverter modules should be disbursed of in the light of "Solid Waste Management Rules".

xxiv. Regarding top soil cover (Earth, Crust, cutting and pits must be leveled after construction phase).

xxv. The proponent shall ensure to develop one public park with green belt, rest area, washroom, etc through Deputy Commissioner Quetta.

xxvi. The proponent shall ensure that record of sighting of wild animals and reptiles (if any) should be maintained so that it could be evaluated by wildlife expert.

xxvii. Vehicular traffic noise pollution such as Dozer, Scrappers and Generators should be within NEQS (National Environmental Quality Standard) i.e 75-90 DB.

xxviii. The proponent M/S **M/S Conformity Assessment & Sustainability Service Company (CASSCO)** shall be liable to incur all costs involving the dismantling, shipping and recycling of all hazardous including (Solar PV Panels, Power plant etc).

xxix. To minimize the impact on the surrounding ecology, public health and scenic beauty spoilage should be recovered through a proper disposal mechanism.

xxx. The proponent shall liable for compliance of section 13, 14 17 and 18 of EIA/IEE regulation 2000 which direct for conditions for approval, confirmation of compliance, entry, inspection and monitoring.

xxxi. The proponent shall not in any case utilize resettlement budget of Rs 15 million without prior consultation with Balochistan Environmental Protection Agency.

xxxii. Since the land has not been allotted in the name of proponent they must get the allotments orders from Deputy Commissioners / Board of revenue within three months of the issuance of the NOC otherwise this NOC will be deemed to have been withdrawn unless extended.

xxxiii. This approval shall be treated as null and void if the conditions mentioned in this approval are not complied with or any violation of BEPA Act 2012, Rules, Regulations, Guidelines and instructions there under is committed by the proponent or his/he agent or employee. In case of any contravention penalties described in BEPA Act 2012 will be imposed on the proponent and prosecution will be initiated before the Environmental Protection Tribunal.

xxxiv. The proponent shall appoint an independent environmental monitor (IEM) who is not an employee of **M/S Conformity Assessment & Sustainability Service Company (CASSCO)** and shall be an environmental consultant, responsible to ensure / monitor compliance of commitments made in IEE who will also give quarterly reports to Balochistan Environmental Protection Agency.

xxxv. The proponent shall ensure to plant five (1000) thousand Groasis box trees in and around the project area through coordination with Balochistan Environmental Protection Agency and Deputy Commissioner Quetta.

xxxvi. This approval will not absolve the proponent from obtaining any other approval that may be required under any law.

xxxvii. This approval shall be treated as null and void if the conditions are not complied with.

xxxviii. EPA Balochistan reserved the right of cancellation this approval at any time without mentioning any reason.

xxxix. The approval accorded by this department under section 15 read with regulation 12 shall be valid for commencement of project for a period of three years.

6592
27/5/19

DIRECTOR GENERAL
(EPA)

Copy for information:-

1. P.S to the Secretary Environment Department, Government of Balochistan, Quetta.
2. Office file.
3. Master file.

DIRECTOR GENERAL
(EPA)

WAPDA

QUETTA ELECTRIC SUPPLY COMPANY LIMITED

OFFICE OF THE CHIEF EXECUTIVE OFFICER
QESCO, ZARGHOON ROAD, QUETTA CANTT:

No. CEO/QESCO/CE (P&E)/ 15782-87 Mar 2019

21 MAR 2019.

To: Mr. Adeel Ahmed,
Manager Business Development
Ibvogt Gmbh, Flat No.22-A, Bolan Arcade Plaza,
Model Town, Quetta.

Subject: - **Issuance of Consent for Evacuation of Power From ibvogt GmbH 50MW Gwadar Solar Power Project At Gwadar**

1. QESCO has no objection to evacuate power from 50MW Solar Power Project i.e. ibvogt GmbH located at Gwadar.

2. Furthermore, it is also mention that the current infrastructure of QESCO is reliable for this project.

Chief Executive Officer
QESCO Quetta

C.c.to:

1. General Manager Power System Planning National Transmission & Dispatch Company LTD, WAPDA House Lahore.
2. General Manager (Tech:) QESCO Quetta.
3. Chief Engineer/Operation Director QESCO, Quetta.
4. Secretary Energy Govt of Balochistan.
5. ARCO Energy Pakistan, Office No.515, Eden Tower, Main Boulevard, Gulerg, Lahore.

WAPDA

QUETTA ELECTRIC SUPPLY COMPANY LIMITED

OFFICE OF THE CHIEF EXECUTIVE OFFICER
QESCO, ZARGHOON ROAD, QUETTA CANTT:

No. CEO/QESCO/CE (P&E)/ 26312-17 **12 June 2019**

To:

Mr. Adeel Ahmed,
Manager Business Development
Ibvogt Gmbh, Flat No.22-A, Bolan Arcade Plaza,
Model Town, Quetta.

Subject: - **Issuance of Consent for Evacuation of Power From ibvogt GmbH 50MW AC Gwadar Solar Power Project At Gwadar**

In the continuation of this office letter no. CEO/QESCO/CE(P&E)/15782-87 dated 21 Mar 2019, the subject may be read 50MW AC instead of 50MW.

Chief Executive Officer
QESCO Quetta

C.c.to:

1. General Manager Power System Planning National Transmission & Dispatch Company LTD, WAPDA House Lahore.
2. General Manager (Tech:) QESCO Quetta.
3. Chief Engineer/Operation Director QESCO, Quetta.
4. Secretary Energy Govt of Balochistan.
5. ARCO Energy Pakistan, Office No.515, Eden Tower, Main Boulevard, Gulerg, Lahore.

No.PS/Secy:/Energy/2019/197
GOVERNMENT OF BALOCHISTAN
ENERGY DEPARTMENT

SAY NO TO CORRUPTION

Dated Quetta, the 29th August, 2019

To

Mr. Adeel Ahmed
Manager Business Development
Ibvogt GmbH
Helmholtzstr.2-9
10587 Berlin

Subject : FEASIBLILITY STUDY APPROVAL FOR 50 MW AC GAWADR SOLAR PROJECT

Reference is made to the following correspondence:

1. No.ED/SO(A/E)-18/2017/2050
2. No.DAE/Solar/120/219

With reference to the (1) dated 29th of may 2019 and (2) a Panel of Experts meeting held on 31st of may 2019 by the Energ Deptt Directorate of Alternate Energy; the Sindh Energy Deptt. Panel of Experts through letter No.DAE/Solar/120/2019 dated 27th of June, 2019 sent some observations on feasibility study for Gwadar Project submitted by ibvgot GmbH.

M/S ibvgot GmbH vide letter No. 2706PO-E submitted revised feasibility study/response to the observations raised by the POE of sindh Energy Department.

The same is under process with the Energy Deptt, GoB for review/approval in the light of the provisions of the Balochistan Power generation Policy, 2007.

Regards!

(PASSAND KHAN BULEDI)
SECRETARY

CERTIFIED TO BE TRUE COPY
COMPANY SECRETARY
P&G ENERGY PRIVATE LIMITED

ibvogt

TECHNICAL FEASIBILITY STUDY

GWADAR SOLAR PROJECT – BALOCHISTAN - PAKISTAN

FOR P&G ENERGY PRIVATE LTD.

JUNE 17, 2019

Contents

Glossary / List of Abbreviations

Acronym or keywords	Definition
BPDB	Balochistan Power Development Board
AC	Alternating Current
Corrected PV split from the combined feed-in	Share of energy fed in that is coming from the PV side, after curtailment due to energy feed-in from wind turbines and correction for data gaps
Capex	Capital Expenditure
CUF	Capacity Utilization Factor - the ratio, given as percentage, of the actual AC output from a solar plant over the year to the maximum output that would be generated if operated continuously at maximum capacity
DC	Direct Current
W.C.S.	Worst Case Scenario
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC Contractor	Engineering, Procurement and Construction Contractor - the entity that will be contracted to design, buy the necessary materials, and construct the Plant
GHG	Greenhouse Gases
GHI	Global Horizontal Irradiation - the amount of irradiation falling on a horizontal plane over a period. Usually measured in kWh of energy falling on a square meter over a set amount of time (hourly, daily , monthly or annually), e.g. kWh/m2/yr
GII	Global Inclined Irradiation - the amount of irradiation falling on an inclined or tilted plane over a period of time Effective GIi is the amount of irradiation that falls on a plane that tracks the sun such as those used in single axis tracking PV systems
HV	High Voltage
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labor Organization
IRR	Internal Rate of Return - the rate that results in the Net Present Value equal to zero
kV	Kilo-Volts (1 kV = 1000 Volts)
LCOE	Levelised Cost of Electricity
LID	Light Induced Degradation
LV	Low Voltage
MPPT	Maximum Power Point Tracker
MRA	Maintenance Reserve Account
MV	Medium Voltage

MVA	Mega-Volt-Amps , a measure of the capacity of a power line or transformer to carry real and reactive power
MWp	The nameplate capacity of PV modules on a site measured in Mega-Watt peak. Also, expressed as kWp or Wp
NPV	Net Present Value - a financial formula to calculate the potential return from an investment
O&M	Operations and Maintenance
Opex	Operational Expenditure
BEPA	Balochistan Environmental Protection Agency
P50	A value which is based on uncertainties and probabilities, has a 50% chance of being exceeded. For example, the P50 yield number is the estimate for the yield produced and the probability of the actual yield being higher is 50% and lower is also 50%
P90	A value which, based on uncertainties and probabilities, has a 90% chance of being exceeded. For instance, the P90 yield number is the estimate for which the probability of the actual yield being higher is 90% and lower is 10%
POC	Point of Connection (to the electricity grid)
PR	Performance Ratio - a measure of how well the plant performs compared to an ideal case. This parameter given as a percentage indicates the ratio between the actual and theoretically possible energy outputs. If multiplied by the GIi, this ratio gives the P50 Specific Yield of a project
PV	Photovoltaic
R.O.W	Right of Way
RE	Renewable Energy
SEP	Stakeholder Engagement Plan
SLD	Single Line Diagram
Specific yield	A measure of the energy produced by the plant over a year divided by its nominal installed capacity which allows for comparison of the performance of different sized plants Usually measured in kWh/ yr. of energy produced per kWp of PV installed
VSAT	Very Small Aperture Terminal

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Status
A	25/12/2018	AA, MC, JJ, EN, HM, CB, JM,	MC, AA	MC	1st Draft
B	17/06/2019	AA, MC, JJ, EN, HM, CB, JM,	MC, AA	MC	2nd Draft

Disclaimer

This Feasibility Study has been prepared by ibvogt GmbH (the Company) for information purposes only. The information and ideas are confidential, only intended for the recipient and may not be passed to third parties without the approval of ibvogt.

ibvogt accepts no responsibility or liability for the consequence of this document being used for a purpose other than the purposes for which it was commissioned. Any person using or relying on the document for such other purpose agrees, and will by such use or reliance be taken to confirm his agreement to indemnify ibvogt for all loss or damage resulting therefrom. ibvogt accepts no responsibility or liability for this document to any party other than the person by whom it was commissioned.

As provided for in ibvogt proposal, to the extent that this report is based on information supplied by other parties, ibvogt accepts no liability for any loss or damage suffered by the client, whether contractual or tortious, stemming from any conclusions based on data supplied by parties other than ibvogt and used by ibvogt in preparing this report.

i. Project Overview and Back Ground

P&G Energy (Pvt.) Limited (P&GEL) is a special purpose vehicle, set up to develop, build, own and operate a 50 MW AC ~ 62.2 MW DC Solar Power Plant in Gwadar, Balochistan. Thus contributing to the national development by providing self-sufficiency in power and reducing dependence on fossil fuels. P&G Energy (Pvt) Limited, is fully incorporated with Securities & Exchange Commission of Pakistan. SPV is owned by ibvogt in majority and its Partner Pakistan Testing Service (PTS) in minority.

ibvogt Established in 2002, ibvogt GmbH specializes in the development, design & engineering, financing, EPC, operation & maintenance and asset management of solar power plants. The company provides high-quality turnkey solar power plant solutions, designed and engineered in Germany, to end investors internationally.

Whereas Pakistan Testing Service (PTS) is an Islamabad based developer, who develops solar projects for the end investors. The successfully developed solar projects portfolio of PTS is above 100MW. In 2018 ibvogt Gmbh, applied for 50MW AC solar PV raw site proposal with Balochistan Power Development Board (BPBD). ibvogt was prequalified by Balochistan Power Development Board (BPDB) on 23rd of February 2018.

Letter of Interest (LOI) was awarded to ibvogt Gmbh on 23rd of January 2018 by Balochistan Power Development Board (BPDB), after submission of Bank Guarantee. ibvogt Gmbh started the feasibility study work, as per LOI and incorporated P&G Energy Pvt Ltd, the project SPV with Securities and Exchange Commission of Pakistan (SECP), as per Balochistan Power Generation Policy 2007.

The LOI is valid until February 2019, and it can be extended one time while submitting a double bank guarantee in favor of BPDB. The first feasibility study draft needs submission by February 2019 as per timelines mentioned in LOI.

ibvogt Gmbh started working on the Feasibility study and carried out Topographical Survey, Geo Tech survey, Environmental Survey, Grid interconnection survey of the site. The objective of Gwadar Solar farm study is to assess the feasibility of the project and is structured as follow:

- Project Overview; complete understanding of the solar power project.
- Site appraisal geotechnical investigation.
- Planning policy statement;
- Desktop based Environmental and Social Impact Assessment (IEE attached as Annex – I)
- Design and Access Statement
- Grid Interconnection
- Energy Yield Assessments of solar PV system on P50 basis.
- Economic analysis including total project cost estimations for the construction and operation of the plant along with various sensitivities.

1.1 Site and Works overview

Key details for the project are shown in Table 1 and the location of the proposed site is indicated in Fig 1

S.No.	Entry	Details
1	Site Name	Gwadar Solar Farm Site
2	Site Coordinates	P1= Lat 25.3213, Long 62.6368 P2= Lat 25.3239, Long 62.6369 P3= Lat 25.3268, Long 62.6369 P4= Lat 25.3302, Long 62.6369 P5= Lat 25.3302, Long 62.6312 P6= Lat 25.3302, Long 62.6252 P7= Lat 25.3277, Long 62.6245 P8= Lat 25.3277, Long 62.6359 P9= Lat 25.3260, Long 62.6257 P10= Lat 25.3260, Long 62.6286 P11= Lat 25.3266, Long 62.6286 P12= Lat 25.3264, Long 62.6322 P13= Lat 25.3224, Long 62.6318 P14= Lat 25.3199, Long 62.6320
3	Altitude	33 m (Highest recorded value) 23 m (Lowest recorded value)
4	Proposed AC and DC capacity	50 MW AC ~ 62.2 MW DC
5	Global irradiation levels	2200 KWh / m^2 (Solar GIS)

Table 1 showing the site coordinates, altitude, capacity and GHI value

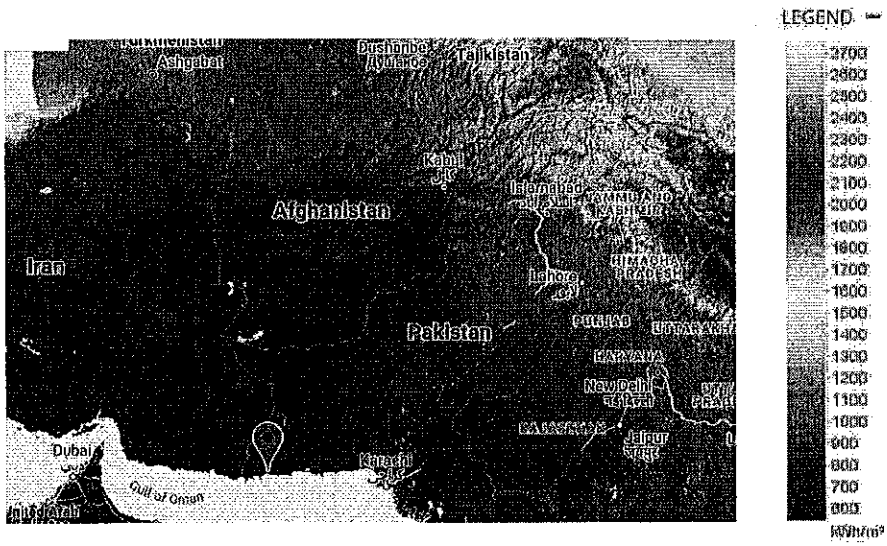


Figure 1 showing GHI value for the site

Global horizontal irradiation map for Pakistan can be seen in Figure 1 with the location of the proposed site. (ESMAP, Solar GIS).

The proposed layout is for a ground mounted single axis tracker system using Bankable Tier 1 monocrystalline modules and European central inverters. A drawing of the proposed layout is shown in Annexure A.

An indicative timeline for the Project is shown in Annexure B Contractors will be required to comply with a prearranged schedule of works and complete the construction and installation of equipment by the required deadline. We recommend that permits, equipment, infrastructure logistics and grid application be secured for the Project prior to commencement of works.

1.2 Pakistan Power Market

Electricity is life line of any economy and most vital instrument of socioeconomic development of a country. Electricity is pivotal in running machinery in factories and industrial units, for lighting our cities and powering our vehicles. The challenge of ensuring electricity access for industries and providing increased access to the poor parts of the population is the key issue for any government.

There has been an enormous increase in the demand of energy because of industrial development and population growth, in comparison to enhancement in energy production. Supply of energy is, therefore, far less than the actual demand, resultantly crisis has emerged.

Pakistan's energy infrastructure is not well developed; rather it is underdeveloped and poorly managed. Currently the country is facing severe energy crisis. Moreover, rapid demand growth, transmission losses due to outdated infrastructure, power theft, and seasonal reductions in the availability of hydropower have worsened the situation. Consequently, the demand exceeds supply and hence load-shedding is a common phenomenon through power shutdown.

1.3 Electricity sector structure

Pakistan power sector constitutes of four major entities, Water and Power Development Authority (WAPDA), Karachi Electric Supply Corporation (KESC), Independent Power Producers (IPPs), Pakistan Atomic Energy Commission (PAEC).

Two vertically integrated public entities, i.e. WAPDA, which serves entire country except economical capital – Karachi and KESC that solely facilitates Karachi as well as its surroundings.

Under 1997 "The Regulation of Generation, Transmission and Distribution of Electric Power Act" National Electric Power Regulatory Authority (NEPRA) was formed; with a challenging charter to operate as an independent regulator and to devise a transparent, economically dynamic, competitive power sector in Pakistan. The National Electric Power Regulatory Authority ('NEPRA") is an independent regulator setup for the regulation of Pakistan' s power sector to balance the interests of consumers and power sector companies NEPRA develops the regulatory regime and future market design for the power sector. All generation transmission and distribution companies are now licensees of NEPRA and matters related to tariffs, licensing, safety, grid codes, consumer interest are regulated by NEPRA.

WPDA Power wing was further transformed into four sub tier entities GENCOs (Generation Companies), Eleven DISCOs (Distribution Companies), one NTDC (National

Transmission & Dispatch Company) and KESC (Karachi Electric Supply Corporation) later named K-Electric after privatization. Pakistan Atomic Energy Commission was than established for generation of electricity from Nuclear Power. Private Power infrastructure board was established to magnetize the investment from private sector through a one window operation. To explore the opportunities in the field of renewable energy Alternative Energy Development Board was recently established with aim of generation of electricity

through alternative resource. Provinces after the empowerment from Council of Common Interest can generate their own electricity and each province has their own power development boards including AJK.

Central Power Purchase Agency ("CPPA"), a public-sector agency. has recently become active for the centralized purchase of power from all existing and upcoming private and public sector power producers. All public-sector agencies/companies are administered/overseen by the Ministry of Water & Power, Govt of Pakistan.

1.4 Situational Analysis

The overall power generation capacity of Pakistan at the end of 2013-17 was 28,172 Mega Watt (MW) on the NTDC system and 2,709 MW on K-Electric. Against this installed capacity, the power generation was 120,692 GWh, which represents 44 per cent average capacity utilization. Seasonal variation in hydro power generation, de-rated capacity of the public-sector generating units and failure of timely supply of fuels to the IPPs are main causes of low-capacity utilization.

S.NO	Peak demand during July 2017 (MW)	Generation during July 2017 (MW)	Surplus (MW)	Short fall due to 19.4% losses (MW)
1	25717	30881 MW	5164	826

Table 2 showing peak demand and generation during July 2017 (source: NTDC)

The situational analysis for year 2017 shows that Country has now surplus generation but still due to weak transmission system there are lot of line losses and Country still faces load shedding especially in rural areas where power Generation projects are not located closer to the existing grid. To improve the situation National Transmission and Dispatch Company is supporting the new renewable energy generation projects near the load centers and to the National Grid. So that line losses can be reduced. Proposed solar project is also located near to the and exiting grid and it's less than 0.5km radius of the Gwadar Industrial grid making it closer to load center.

1.5 Current Statistics

Installed Capacity (MW)

Installed Capacity (MW)					
Description	**2013**	**2014**	**2015**	**2016**	**2017**
Hydel					
Wapda Hydel	6733	6902	6902	6902	6902
IPPs Hydel	195	195	213	213	213
Thermal					
GENCOs with PEPCO	4785	5458	5788	5788	5762
KE Own	2341	2422	1875	2295	2295
IPPs					
IPPs connected with PEPCO	8381	8793	8857	8842	12428
IPPs connected with KE	289	228	352	349	339

Nuclear					
CHANUPP (PAEC)	650	650	650	650	990
KANUPP (PAEC)	137	137	75	75	75
Renewable					
Solar	0	0	100	400	400
Wind	50	106	256	306	782
Bagasse	0	0	83	146	281
Distributed Generation Capacity / Imports				413	413
Total PEPCO	20850	22104	22849	23247	28172
Total KE	2767	2787	2302	2719	2709
Total Installed Capacity	23617	24891	25151	25966	30881

Table 3 showing generation from different sources up till 2017 (source: NTDC)

1.6 Energy Mix

Most of the power generated from Pakistan is coming from two main sources Thermal and Hydro. The installed generation capacity by June 2017 and energy mix is as follows:

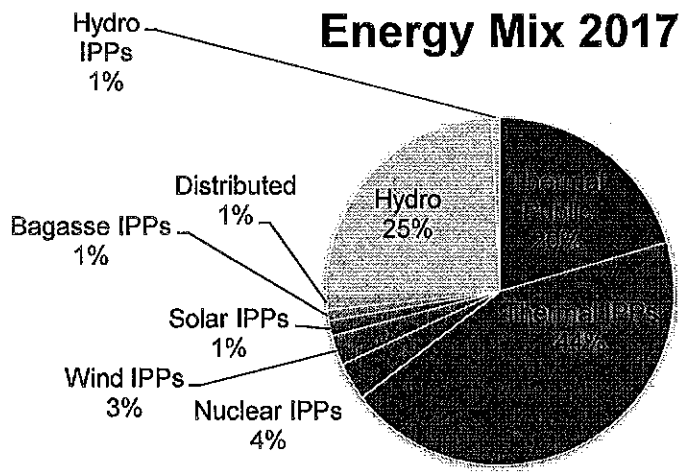


Figure 2 showing current energy mix of Pakistan (source: NTDC)

1.7 Pakistan Power Pakistan - Key Challenges

Pakistan's power sector is currently afflicted by several challenges.

1.7.1 Energy Mix

Due to poor energy mix, most of the country generation is coming from thermal fuel sources including furnace oil and high speed diesel, which results in expensive generation 12 USD cents / KWhr on average.

1.7.2 Transmission and Distribution infrastructure

High losses, in range of 19.4% is because of weak transmission and distribution infrastructure. The inefficiencies and high cost of generation are resulting in high levels of subsidies and circular debt. This also include loses due to theft as well.

1.7.3 Electricity shortfall due to losses

Due to high energy losses, still country faces load shedding problem and taking transmission losses into account, still electricity shortfall of 826.914 MW.

1.7.4 Installed and Planned Power Projects up to 2018-2019

Sr. No.	Names of projects Agency	Fuel	Location	Installed capacity (MW)
1	Quaid-e-Azam Solar Park PPDB (Phase-1)	Solar	Lal Sohnra (Cholistan), Punjab	100
2	FWEL-I AEDB	Wind	Jhampir/Gharo/Bhambore, Sindh	150
3	Nandipur (Remaining Unit-CC) GENCO	RFO	Gujranwala, Punjab	425
	Total generation addition in 2014-15			**675**
4	Sapphire Wind Power Plant AEDB	Wind	Jhampir/Gharo/Bhambore, Sindh	50
5	CHASNUPP-III PAEC	Nuclear	Chashma, KPK	340
6	Other Wind Power Plants AEDB	Wind	Jhampir/Gharo/Bhambore, Sindh	330
7	Quaid-e-Azam Solar Park PPDB (Phase-2)	Solar	Lal Sohnra (Cholistan), Punjab	300
	Total generation addition in 2015-16			**1,020**
8	Other Wind Power Plants AEDB	Wind	Jhampir/Gharo/Bhambore, Sindh	1,120
9	Neelum Jhelum Hydel WAPDA	Hydel	Nauseri/Muzaffarabad, AJK	969
10	CHASHNUPP-IV PAEC	Nucl	Chashma, KPK	340
11	Tarbela 4th Ext. Project WAPDA	Hydel	Tarbela, KPK	1,410
12	Patrind HPP PPIB	Hydel	Kunhar River, KPK/AJK	147
13	LNG Based Plants (Phase-I) PPIB	LNG	Bhikki and Baloki, Punjab	2,400
14	Quaid-e-Azam Solar Park PPDB (Phase-3)	Solar	Lal Sohnra (Cholistan), Punjab	600
	Total generation addition in 2016-17			**6,986**
15	Keyal Khwar WAPDA	Hydel	Dasu District, KPK	122

16	Coal Plant at Sahiwal PPDB	Coal	Sahiwal, Punjab	1,320
17	Port Qasim Power Plant PPIB	Coal	Port Qasim Karachi, Sindh	1,320
18	Engro Thar Coal (unit-1) PPIB	Coal	Thar, Sindh	330
19	Nooriabad Gas Plant GoS	Gas	Nooriabad ,Sindh	100
20	Engro Thar Coal (unit-2) PPIB	Coal	Thar, Sindh	330
21	LNG Based Plants (Phase-II) PPIB	LNG	Haveli Bahadur Shah (Jhang), Punjab	1,200
22	Coal Plant at Salt Range PPDB	Coal	Salt Range, Punjab	300
23	Tarbela 5th Ext. Project WAPDA	Hydel	Tarbela, KPK	1,400
24	S S R L TCEB	Coal	Thar, Sindh	1,320
	Total generation addition in 2017-18			**7,742**
25	Golen Gol HPP WAPDA	Hydel	Chitral, KPK	106
26	HUB Power Company Ltd. PPIB	Coal	HUB, Baluchistan	1,320
27	Siddiqsons Limited TCEB	Coal	Port Qasim, Sindh	350
28	Lucky Electric Power Company Ltd. TCEB	Coal	Port Qasim, Sindh	660
29	Grange Holding PPIB	Coal	Arifwala, Punjab	163
30	Gulpur Poonch river PPIB	Hydel	Poonch River/Gulpur, AJK	100
	Total generation addition in 2018-19			**2,699**
	Total addition during the Plan period			**19,122**

Table 4 showing installed and planned capacity up till 2018 - 2019 (source: NTDC).

2. Site Appraisal

Balochistan Power Development Board (BPDB) awarded the LOI to ibvogt for setting up of 50MW AC solar farm in Gwadar Balochistan. ibvogt together with its local partner PTS visited multiple solar sites and shortlisted the existing solar farm. The sites were assessed on the basis of the following factors:

1. Location
2. Access
3. Proximity to Grid
4. Terrain
5. Geo tech
6. Flood Risk
7. Shading
8. Irradiation levels
9. Land use
10. Landscape & Visual Impact
11. Availability of utilities (Gas, Water & Electricity)
12. Any National or local planning designation
13. Environmental Impact
14. Land Cost
15. Legal ownership any court litigation

After site surveys and desktop assessment Gwadar site was selected as a feasible option from financial and technical perspective. Site was further appraised while going through following steps:

- Preliminary technical and financial assessment for pre-feasibility
- Pre-Feasibility technical and financial assessment
- Site visit

2.1 Preliminary technical and financial assessment

ibvogt as a lead developer carried out an in house technical and financial assessment for Gwadar site. The project development cost component was assessed as per NEPRA guidelines. NEPRA only allows certain per MW development cost as a tariff component. It was made sure that due to cost of land the overall project development cost should not go beyond NEPRA threshold. All the numbers were put in the financial model and a suitable but competitive tariff was identified. Also our local Grid Consult Arco Energy performed a Desktop based assessment (DBA). The DBA showed that site is approx. 0.4 km away from the 132KV Gwadar Industrial Grid station and grid connection is possible at 132KV while using the existing infrastructure.

2.1.1 Pre-Feasibility

A pre-feasibility technical and financial assessment was then carried out by Lead developer ib Vogt to for in house strategic meeting and following outcomes were shared with Board.

Summary

- The Solar System appears to be extremely viable and economically attractive,
- The optimal system sizing is expected – depending on several factors (NEPRA Grid Interconnection guidelines, IRR or NPV maximization)
- At a PPA with a tariff of $ 6,0 c/kWh an IRR for such system would be expected of ~ >18% (range) assuming "normal" costs in the region
- The optimal technology choice is likely to be "Single Axis Tracker"
- There is strong potential to increase the IRR through (a) Total Cost and (b) Financial structuring
- As a further potential, installing short term battery storage to minimize short term fluctuation driven curtailments could be very beneficial and increase the overall project sizing – probably a "Phase 2".
- Information regarding the above is supplied below, together with technical team thoughts on the relevant planning assumptions
- It is recommended that a detailed Feasibility Study should be undertaken to deepen, verify and optimize potentials in the Project

2.2 Site Visit

After the submission of pre-feasibility work, a site visit was then carried out to gather the primary data from the site.

2.2.1 Site Location

The proposed project site is located almost 43 km away from the main Gwadar city center in North East direction. The propose project site is 31m above sea level.

Fig 3 showing the location of Gwadar Solar Farm site

2.2.2 Weather Data Meteonorm

Weather for the Gwadar Solar farm site is collected from the two data set sources Meteonorm and Solar GIS. Both the data sets were analyzed and data with lower expected bias value was selected for the detailed technical analysis.

2.2.3 Average Temperature Data Gwadar (Meteonorm)

The max average annual temperature recorded at the site is above 45 ^{0}C for month of July. High temperatures, can affect the efficiency of solar cells. Hence solar panels with permitted module temperature between -40 ^{o}C to +85 ^{o}C will be used for the Gwadar Solar farm site.

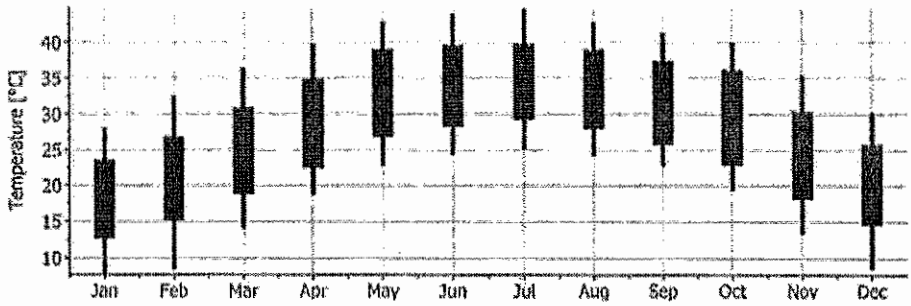


Fig 4 showing min, max monthly temperatures at Gwadar

2.2.4 Average Temperature Data Gwadar (Meteonorm)

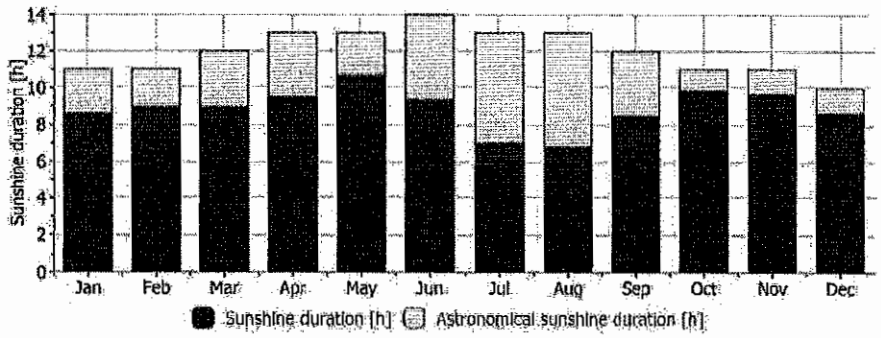


Fig 5 sowing sunshine hours at the Gwadar site

2.2.5 Average Rainfall (Meteonorm)

Weather at Gwadar site is usually dry and it only rains heavily during the wet season of Monson. The following precipitation graphs show the high values for precipitation and days from June to September.

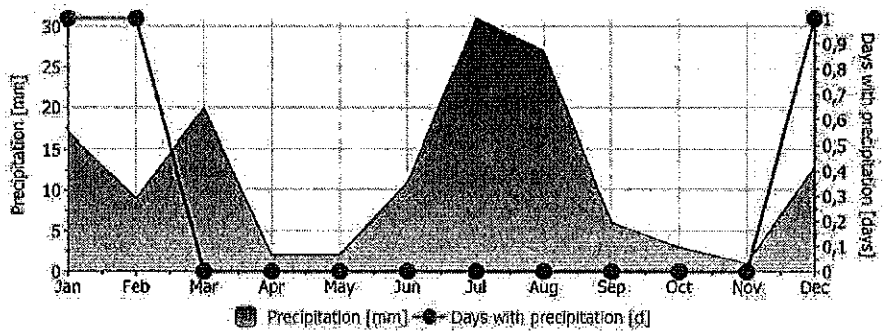


Fig 6 showing precipitation graph in Gwadar

2.2.6 Solar irradiation (Meteonorm)

Gwadar solar farm site is in Southern area of Pakistan and blessed with annual Global Horizontal Irradiation value of 2330 KWhr/^{2}m, making it suitable site for a solar farm development.

	GH	DH	TA	FF
	W/M^2	W/M^2	^{O}C	M/S
JAN	177	48	17.7	2.5
FEB	207	69	20.7	2.8
MAR	250	85	24.6	2.9
APRIL	262	111	28.9	3.4
MAY	283	128	32.9	4.0
JUNE	291	145	34.3	4.0
JULY	252	149	34.3	4.1
AUG	237	136	33.3	3.9
SEPT	252	100	31.8	3.4
OCT	228	71	26.4	2.5
NOV	202	39	29.1	2.2
DEC	160	50	24.2	2.3
ANNUAL	233	95	19.7	3.2

Table 5 showing irradiation levels at Gwadar site

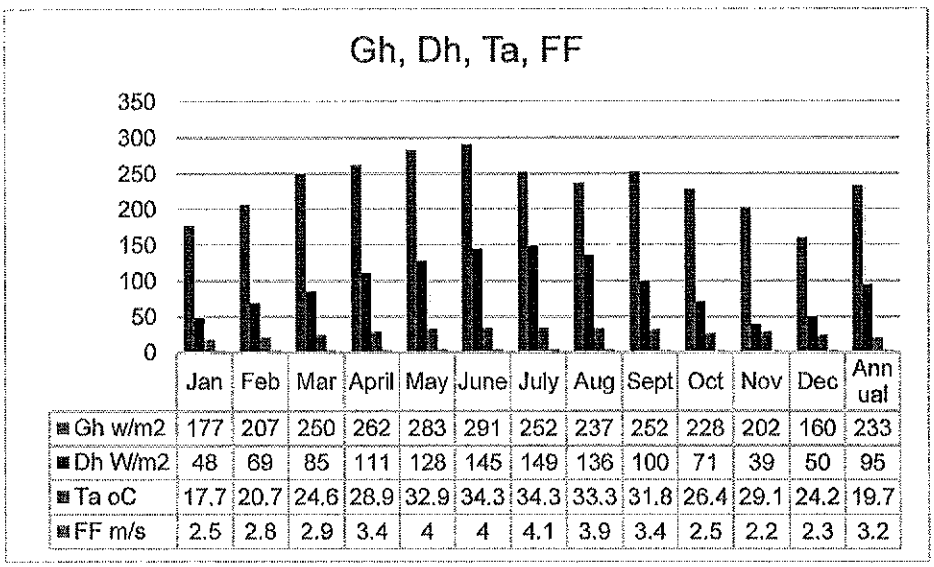
Gh: Global horizontal radiation ("GHI")

Dh: Mean irradiance of diffuse radiation horizontal

Ta: Air temperature (2 m above ground)

Td: Dewpoint temperature

FF: Wind speed (FFE, FFN longitudinal and latitudinal part of the wind speed)



	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Gh w/m2	177	207	250	262	283	291	252	237	252	228	202	160	233
Dh W/m2	48	69	85	111	128	145	149	136	100	71	39	50	95
Ta oC	17.7	20.7	24.6	28.9	32.9	34.3	34.3	33.3	31.8	26.4	29.1	24.2	19.7
FF m/s	2.5	2.8	2.9	3.4	4	4	4.1	3.9	3.4	2.5	2.2	2.3	3.2

Fig 7 showing GHI, DH and Bn irradiation levels at site

2.2.7 Solar irradiation (Solar GIS)

The weather data from Solar GIS was also analyzed, and yield assessment was carried on the basis on in house software interpolation and previous experience.

MONTH	GHM (KWHR/M.SQ.)	DHD (KWHR/M.SQ.)	DHM (KWHR/M.SQ.)	T24 (DEGREE CELCIUS)
JAN	135	1.40	43	18.7
FEB	147	1.80	50	20.6
MAR	193	2.29	71	23.7
APRIL	211	2.76	83	27.3
MAY	227	3.19	99	30.0
JUNE	204	3.43	103	30.9
JULY	178	3.52	109	29.9
AUG	178	3.23	100	28.7
SEPT	180	2.81	84	28.0
OCT	175	2.12	66	26.8
NOV	141	1.54	46	23.3
DEC	128	1.28	40	20.3
	2097	2.45	894	25.7

Table 6 showing irradiation levels at Gwadar Site

Long-term averages:

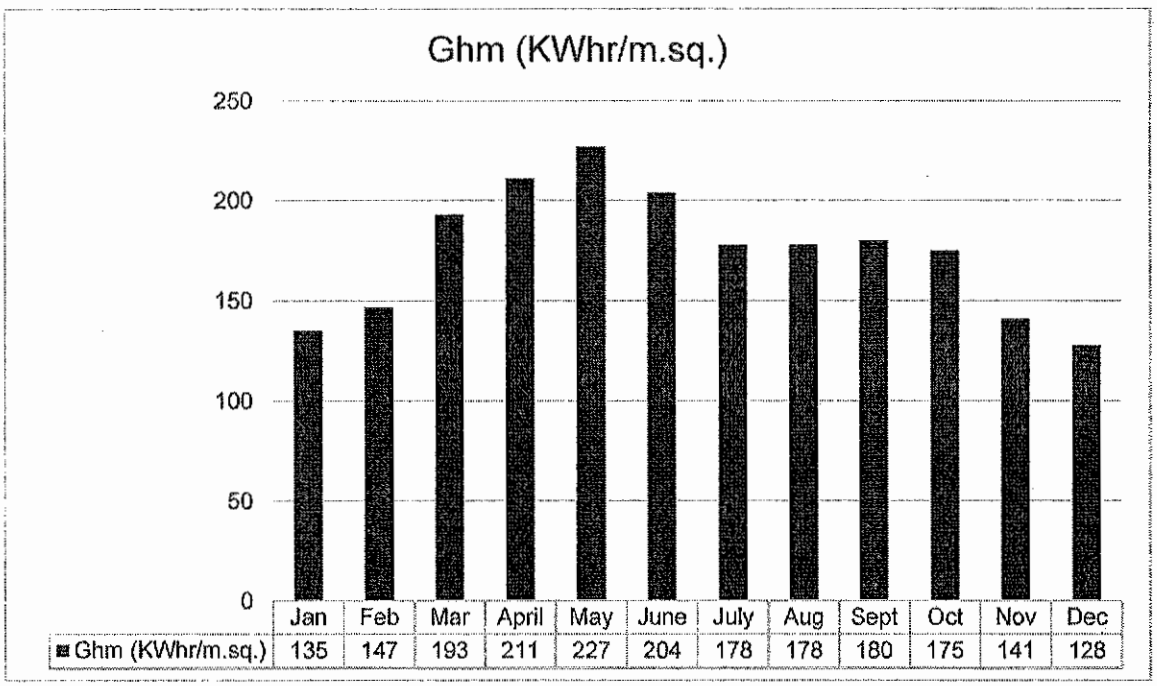
Ghm = Monthly sum (annual) of global horizontal irradiation (kWh/m2)

Dhd = Daily sum of diffuse horizontal irradiation (kWh/m2)

Dhm = Monthly sum (annual) of diffuse horizontal irradiation (kWh/m2)

T24 = Daily (diurnal) air temperature (°C)

2.2.8 Global Horizontal Irradiance (GHI) – Solar GIS



	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Ghm (KWhr/m.sq.)	135	147	193	211	227	204	178	178	180	175	141	128

Fig 8 showing GHI levels at Gwadar Site

2.2.9 Diffused Horizontal Irradiation (DHI) – Solar GIS

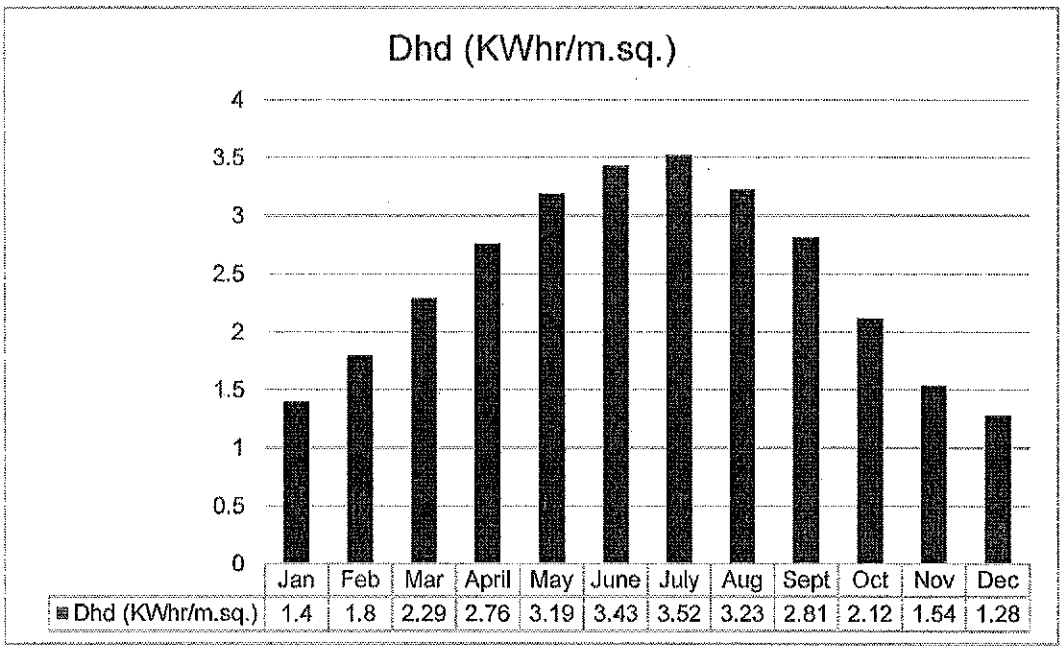


Fig 9 showing DHI levels at Gwadar site

2.2.10 Average diurnal (24 hour) air temperature at 2 m) – Solar GIS

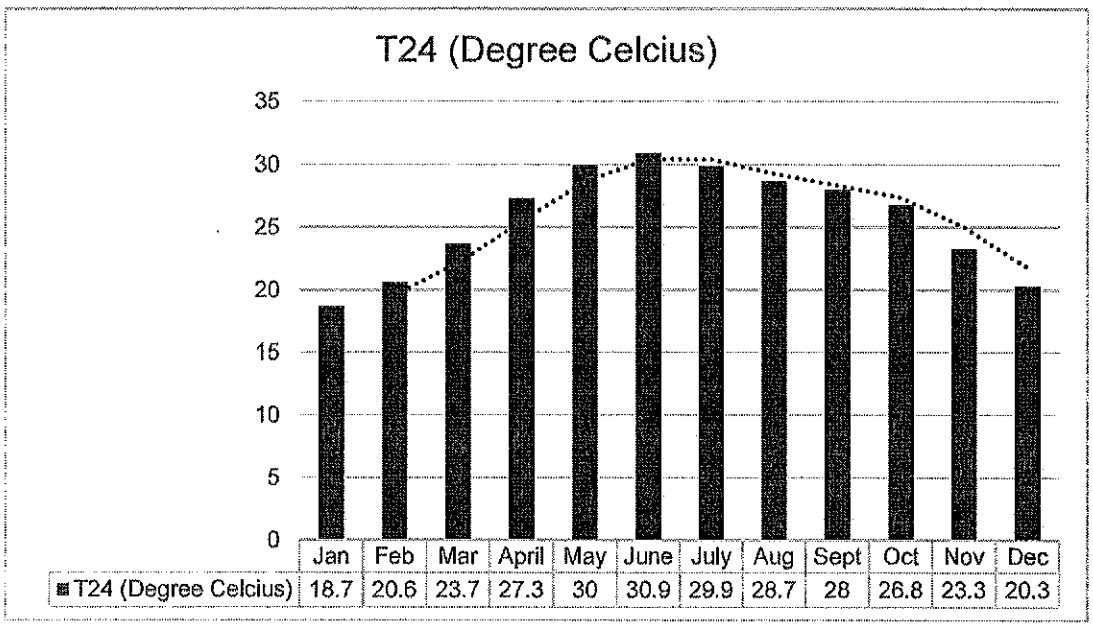


Fig 10 showing Average diurnal (24 hour) air temperature at 2 m

2.2.11 Site Access

Gwadar solar farm site is located on the Makran Coastal highway. The site can be accessed directly from the National Highway 10. A triple surface treatment road will be constructed, which will be used later during the operation and maintenance stage.

2.2.12 Road types

National Highway 10 / Makran Coastal Highway is the main artery and primary road through which site will be accessed.

S.No.	Road Type	Name
1	Primary	NH 10
2	Secondary	Access Road

Makran Coastal Highway is a single carriage way road for two-way traffic. The road width is sufficient to cater the heavy traffic vehicles.

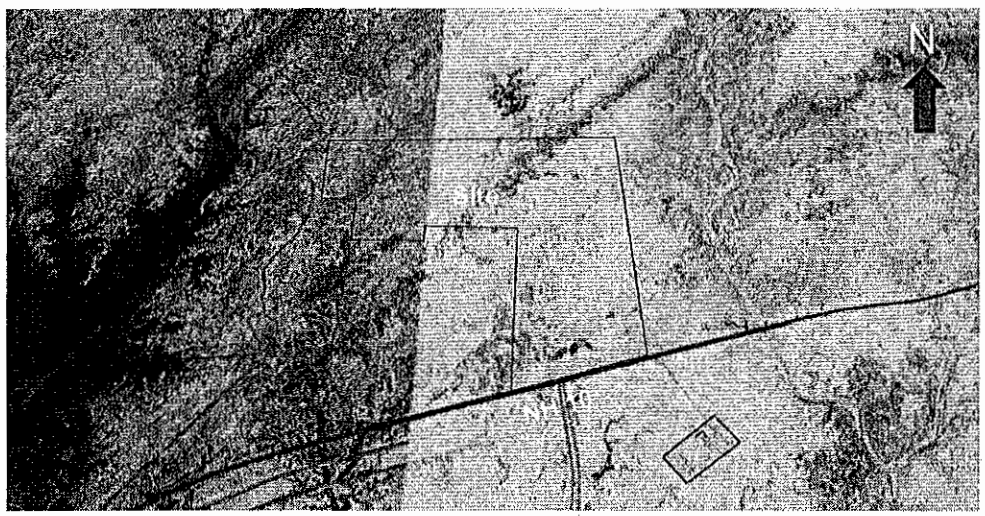


Fig 11 showing connectivity of the site through NH 10

2.2.13 Site boundary

During the Gwadar Solar Farm site visit. The identification of the red line site boundary for solar project was already done by Tehsildar Gwadar office. The first session comprised of the desktop assessment and second session comprised of:

1. Viewing solar farm site from a high surveillance point
2. Walking on the site

2.2.14 First Session

A desktop assessment (DSA) was carried out by ibvogt technical team and site was checked against all the National and local planning designations. The DSA showed that site does not lie in areas of outstanding natural beauty, green belt, National Park or located near to a site of special scientific interest. Also the site is not classified as prime agricultural land and only a low quality crop can be cultivated on the land. As the site is part of the Bare area in country landscape mapping, hence most of use surrounding solar farm is desolated or of low agricultural activity. Gwadar solar farm is also located in rural area and the project will support the rural economy. An economic analysis was carried out for the project, which showed that the solar project will create more than 150-400 jobs during the construction and 25-50 permanent jobs during operation of the solar project. Also project will have positive impact on the local construction activity as most of the raw material during the construction will be purchased from the local market. Overall project will contribute towards the growth of the rural economy.

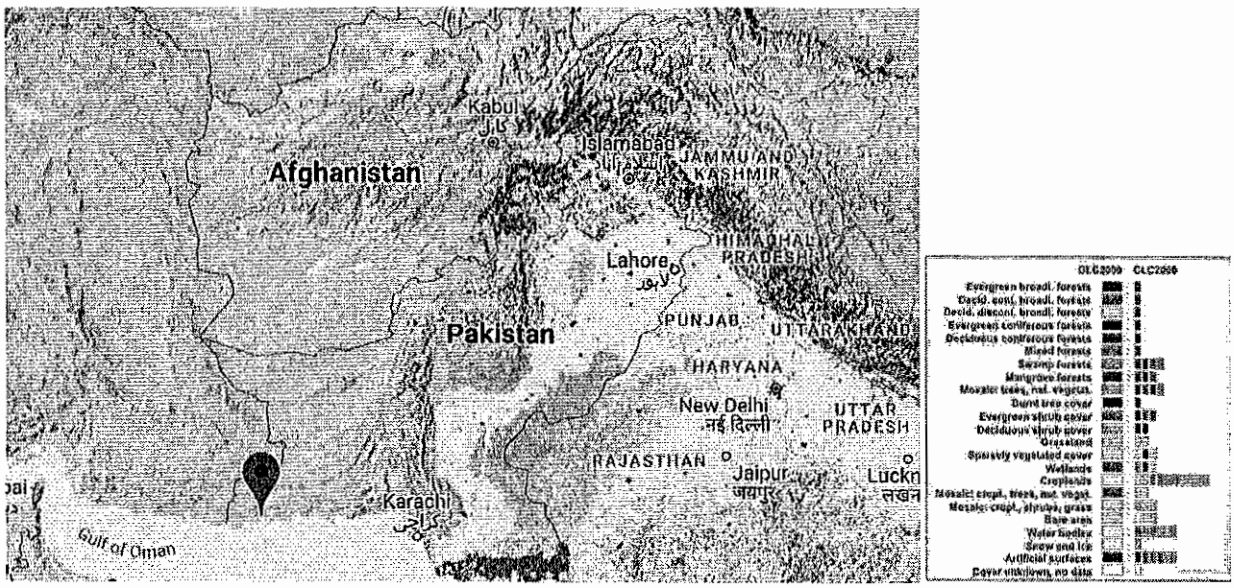


Fig 12 showing landscaping characterization of Pakistan and location of Gwadar solar farm. Proposed site is Characterized as Bare Areas, in Landscape characterization map of the country.

2.2.15 Second Session:

The second session comprised of the site visit and started in collaboration with the local Patwari (Revenue Department official). During the visit whole of the site is viewed from a high surveillance point. From that point whole site was viewed and it was noticed that site is generally flat and comprises of some undulating parcels.

Fig 13 showing the area which are relatively flat

A detailed reconnaissance survey was then carried out. Site usually has flat topography and almost no vegetation cover on the top. Topsoil shows that site is suitable for ramming of profiles but a detailed Geo Tech study would be required for detailed design of foundations.

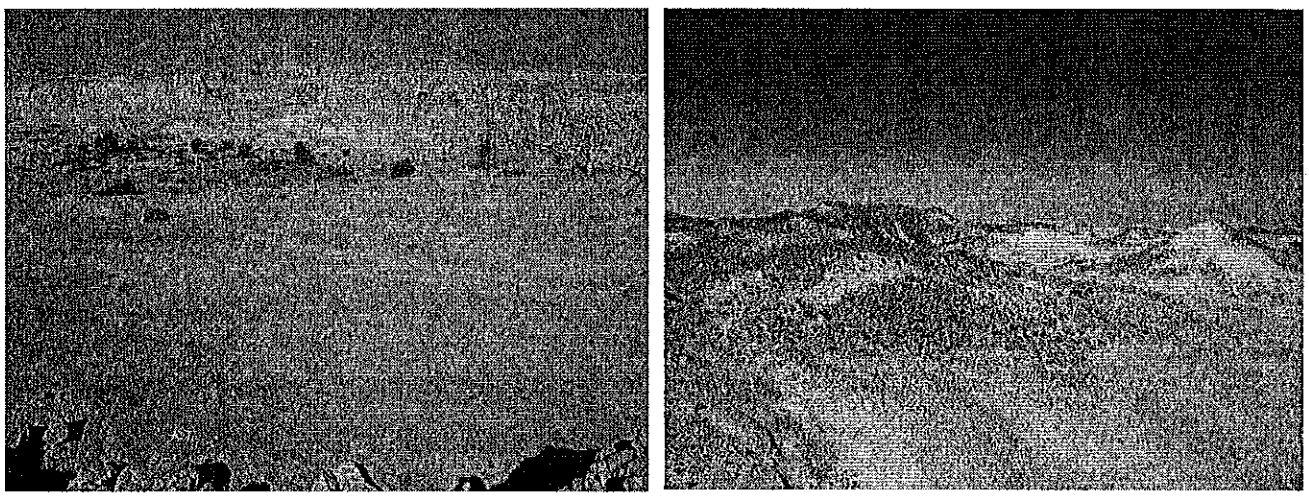


Fig 14 showing areas with undulating terrain

The site has relatively undulating terrain towards the northern boundary of the site and during construction initial grubbing along with relatively light earth work would be required, for site leveling.

As the topsoil of the site is loose, hence after levelling initial compaction would also be required, which will affect the civil works cost of the project. Comparatively higher civil costs would be expected, for which an estimated number should be kept in the civil work costs.

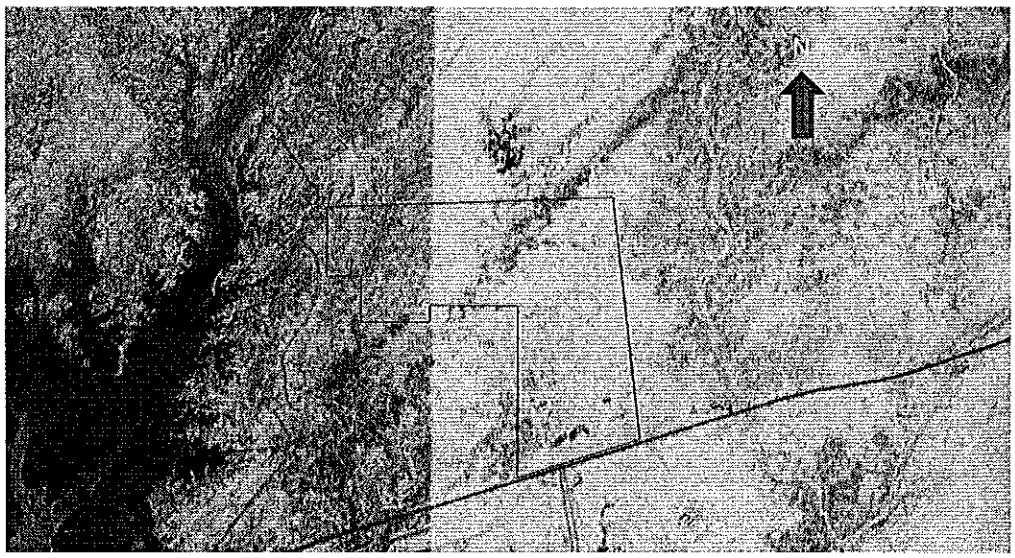


Fig 15 showing the proposed redline boundary for detailed Geotech study

2.3 Surrounding Land use

The site itself has power generation use and surrounded by Bare Area as per landscape characterization map of the Country. Gwadar Industrial Estate is located within 2.5km radius of the site toward south west direction.

A small water reservoir is located towards the western boundary of the site. 132KV grid is located towards southern boundary of the site almost 0.5 km in distance, make the site really attractive for the Grid interconnection.

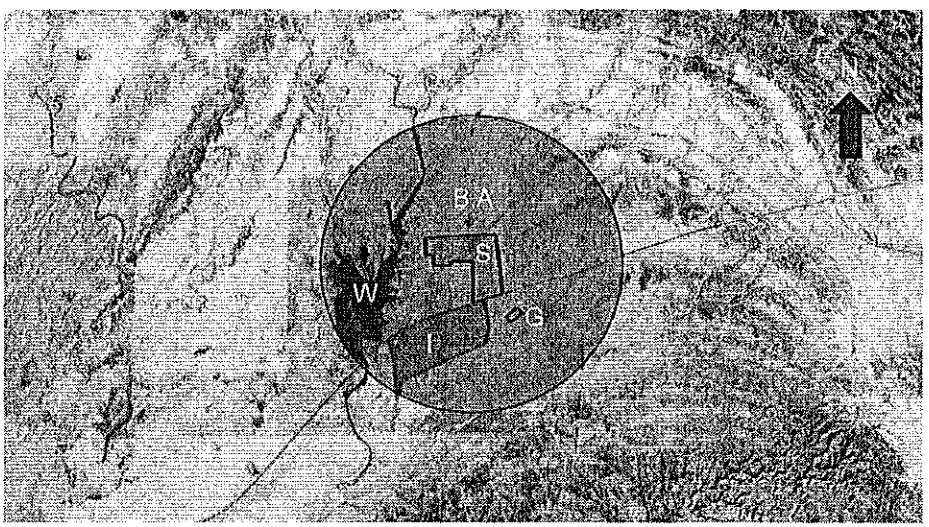


Figure 16 showing the major land uses around the site in 2.5KM radius

B.A = Bare Areas, as per Country Land Characterization Map
I = Industrial Use
W = Water Reservoir
G = 132KV Grid

The land use analysis shows that site don't have residential area in the surrounding and also not located in the area of outstanding natural beauty, which shows solar farm site will have minimum social and environmental impacts

2.4 Existing Land use

The site doesn't have any distinctive land use. In Country's Landscape Characterization Map, the land is Characterized as Bare Land which shows land doesn't have any quality use and makes it suitable for a clean energy generation project.

2.5 Topography

The topography of the site is predominantly flat which makes it suitable for development of solar farm development. The site generally slopes from North to South and very gradual slope from east to west.

A grade analysis has been carried out at points of highest level difference to check the gradient of the slope in redline boundary of the site for solar farm.

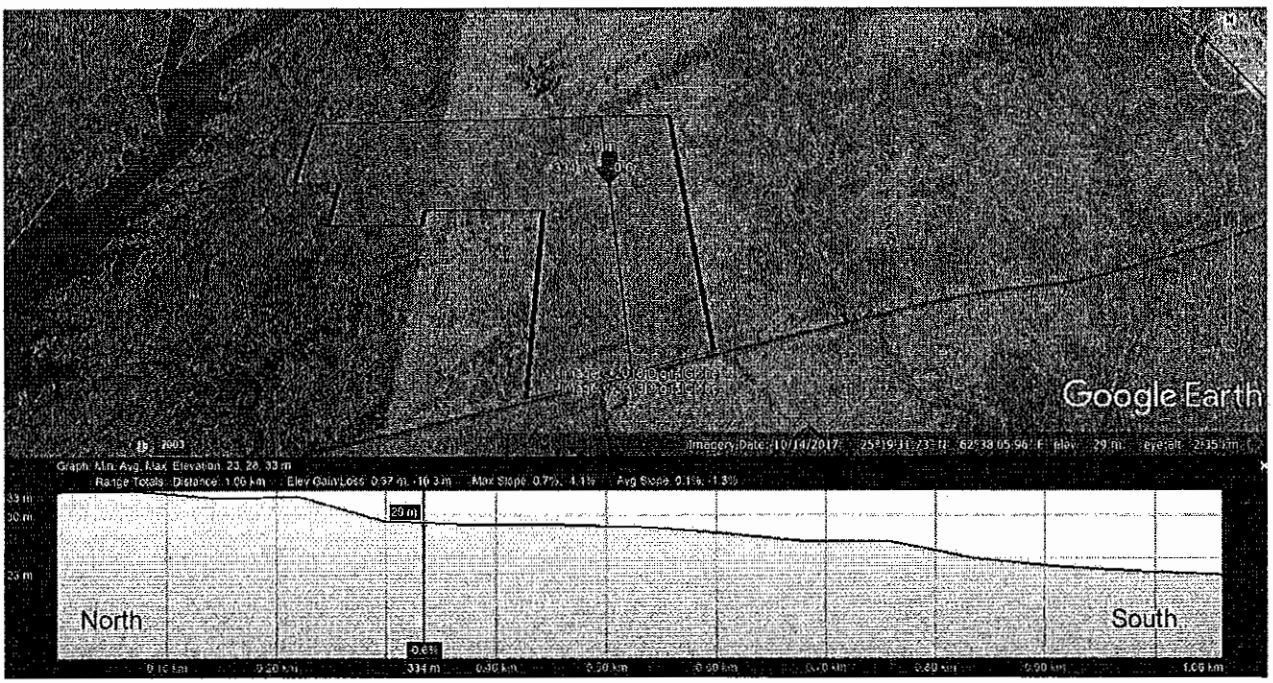


Figure 17 showing the section through site and gradual fall of terrain toward south, average slope 0.1%

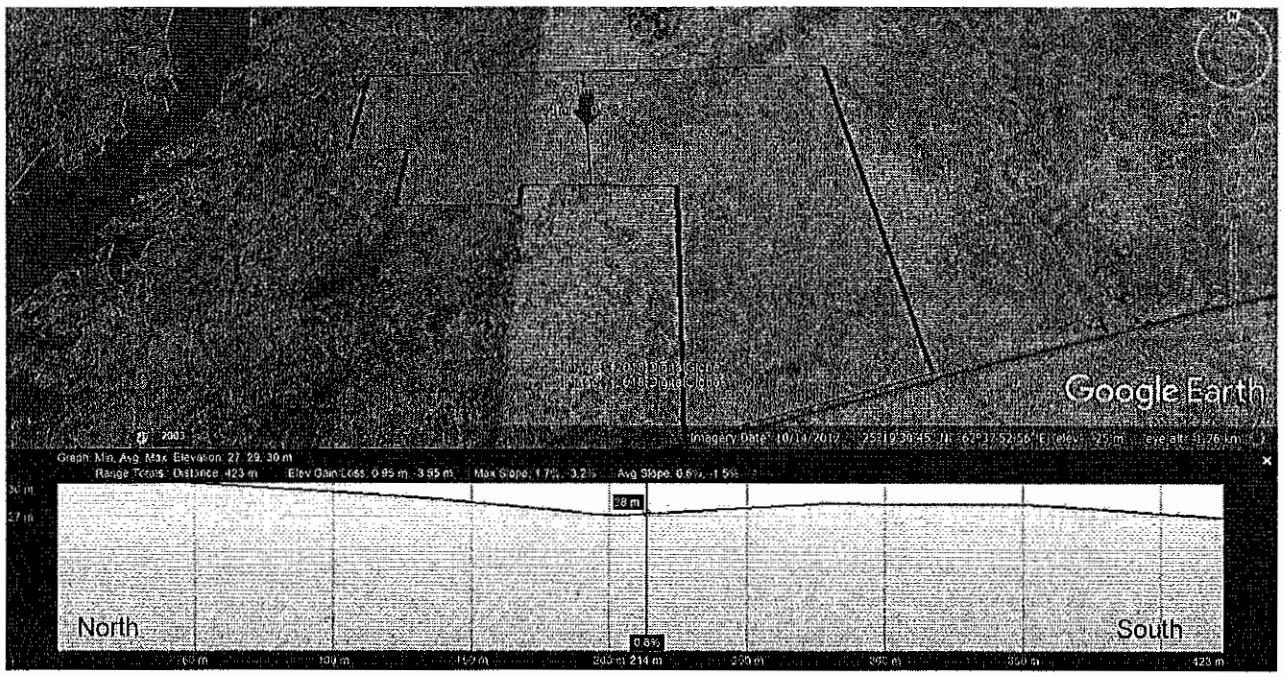


Figure 18 showing the section through the site and showing gradual fall of terrain towards south with average slope of 0.5%. Section shows a very small bit of reverse slope.

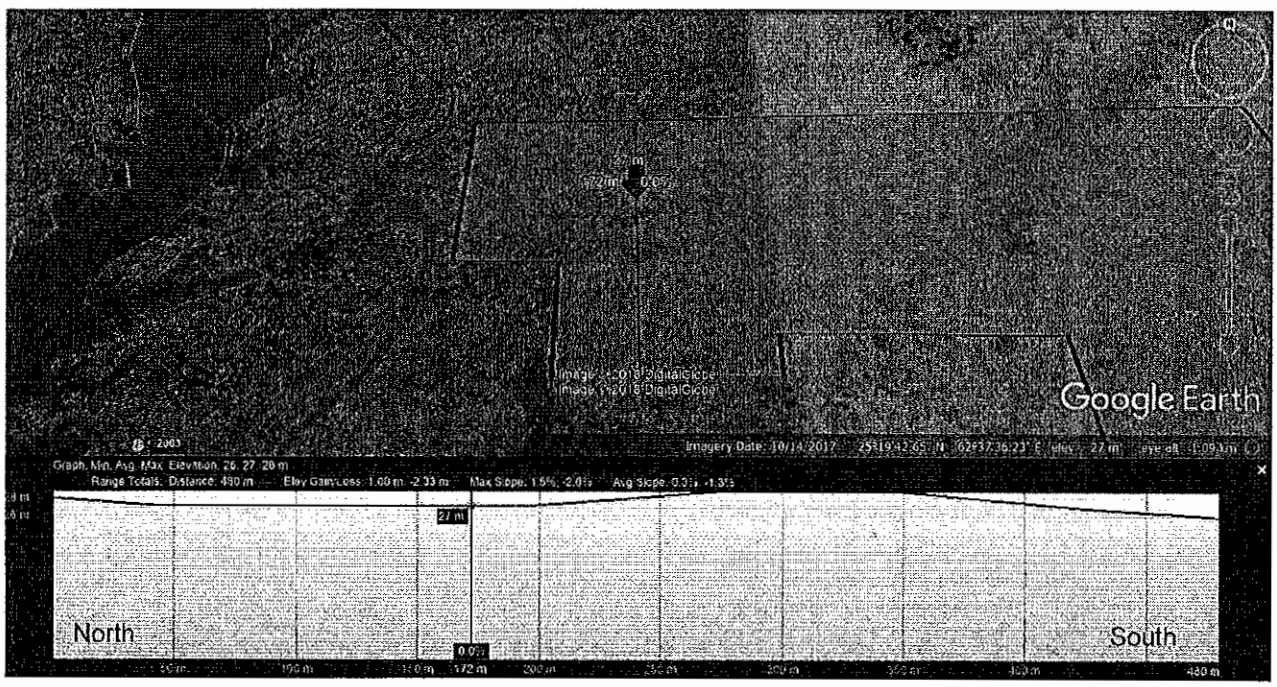


Figure 19 showing section through the site and average slope of 0.3%. Section shows site have a bit of reverse slope toward north, but as we move towards the southern boundary of the site. The terrain rises again and form a camber almost near to middle part of the section. With minor earthwork, the section can be made flat.

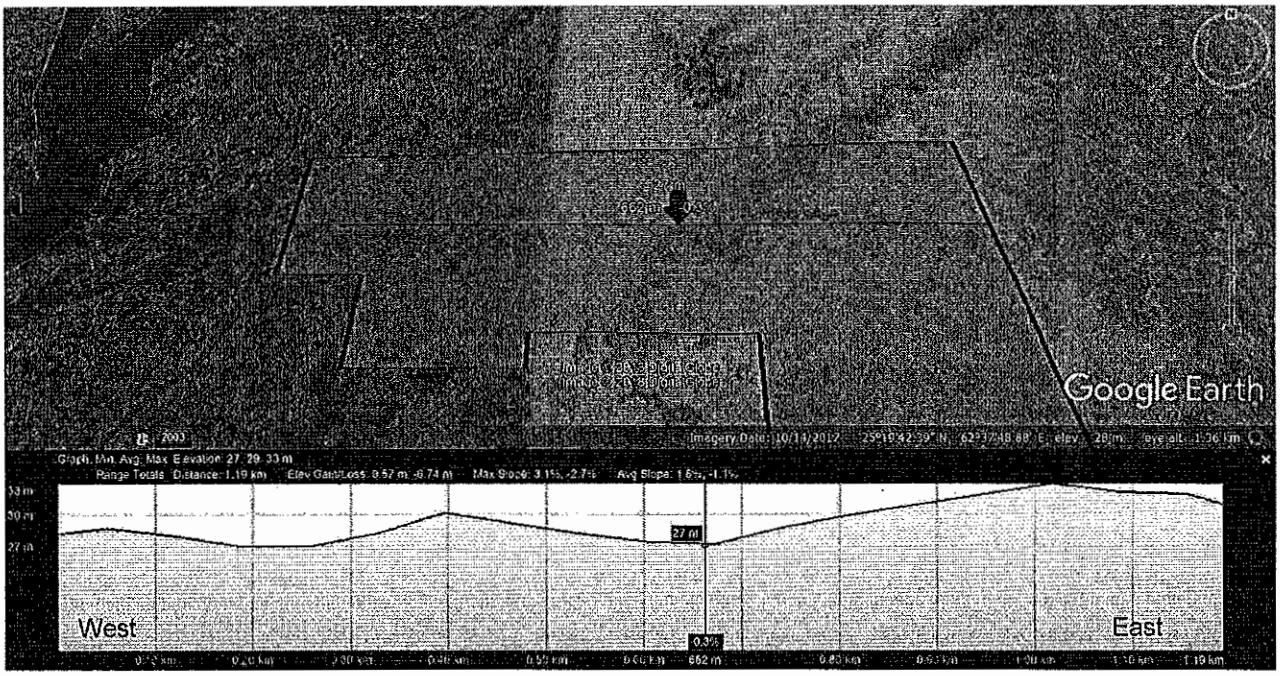


Figure 20 showing section through the site from west to east and undulating terrain which will require earth work. Average slope through the section is 1.6%.

Figure 21 showing section through the site, predominantly flat and gradual drop in terrain towards western side of the boundary – average slope 1%

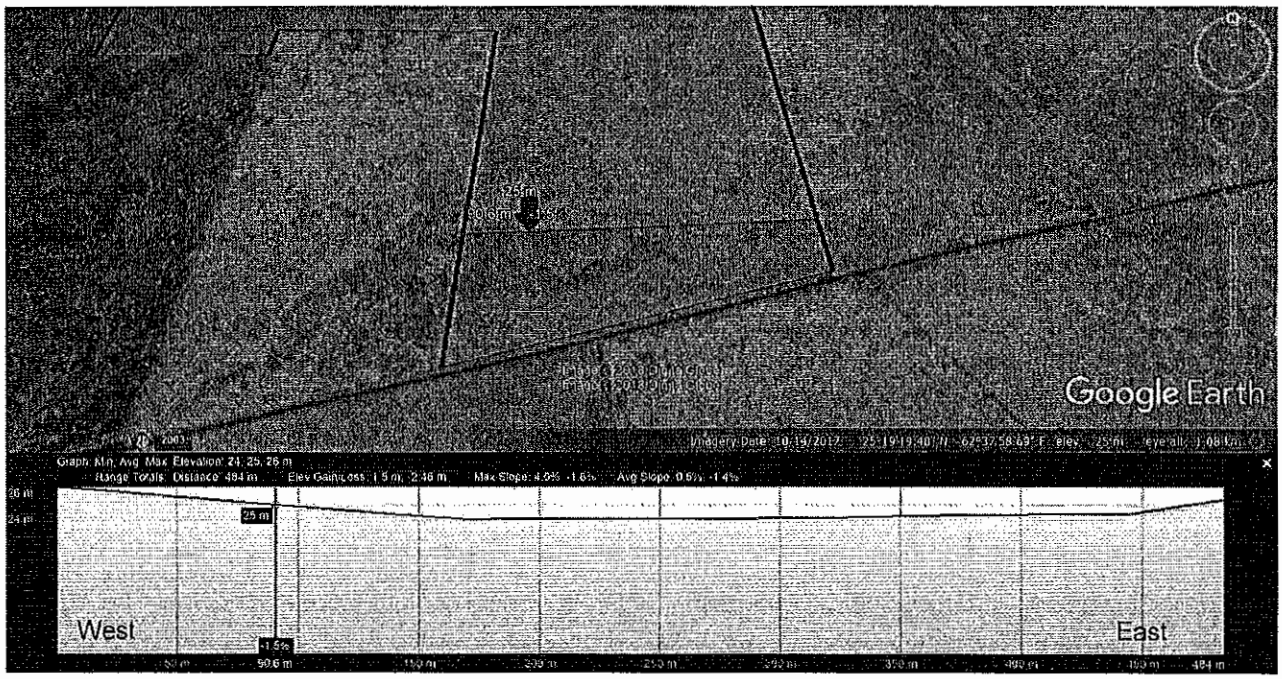


Figure 22 showing section through the site, very gradual undulation – average slope 0.5%

2.6 Flood risk

The site has its natural drainage pattern and quite few natural Nullahs / swale /rain water drains are passing through site. Incorporating the natural drainage pattern of the site into the design will reduce the risk of flooding on the site.

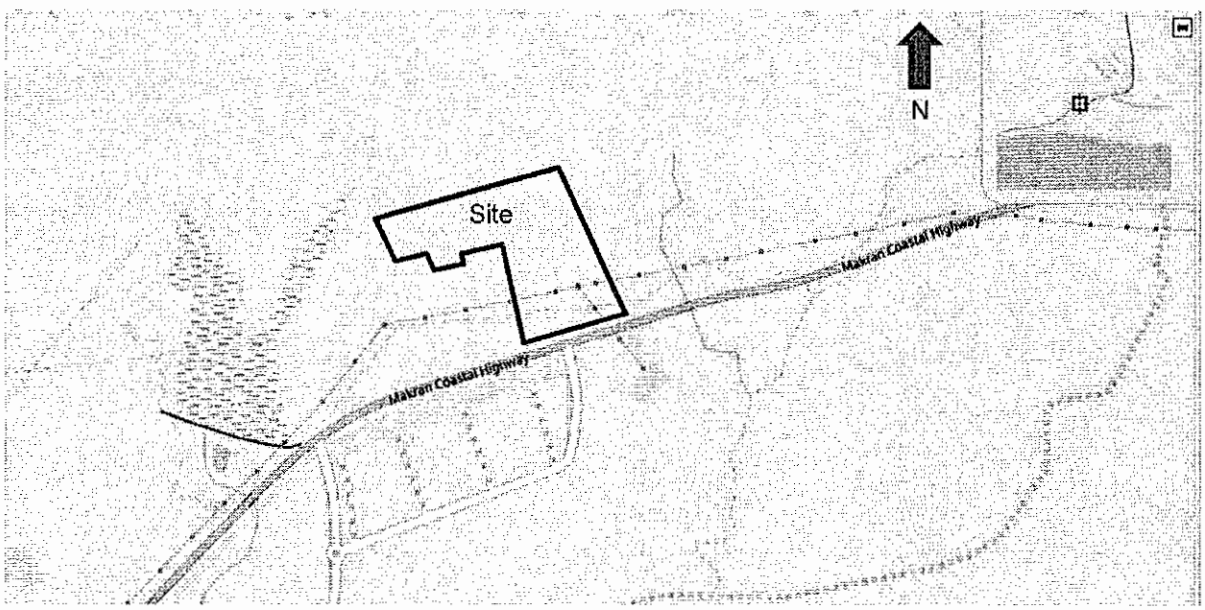


Fig 23 showing flood risk map shows Gwadar solar farm site is not located in a Flood Plain

Currently site is free from a flood risk and lies out the flood plain of Balochistan.

The National Disaster Management flook risk map shows that site is free from any risk of flooding and is located closer to the exisitng natural drains. Small natural water channels already present on the site are best suited as drainage channels during the event of rain.

Due to undulation, there is a potential of onsite ponding and the phenomenon was noticed frequently during monsoon season. As the solar farm development, usually don't have any adverse impact on the surrounding, but sometimes the angle of solar panels can increase the velocity of surface water runoff and can cause flooding somewhere else. Hence a separate flood risk assessment may be carried out before construction.

Natural drainage pattern of the site shows that most of the time the surface water runoff will be moving towards south and west along the natural slopes of the site.

The flood extent of 2010-2015 also shows that site is free from any river flooding and located out the flood plains of Balochistan.

2.7 Shading

Shading is one phenomenon which can affect the efficiency of the solar panel. Only 10% area of the panel in shade can result in 50% loss in the efficiency of the solar panel. 132KV pylons passing through the site are the only feature which can cause shading of the solar panels. A buffer zone has been kept around the 132KV pylons, to avoid the shading of the solar panels. The site topography has been considered flat, during the design, and Still to avoid the impact of the shading on to generation the solar panels with fitted by pass diode will be used for the installation.

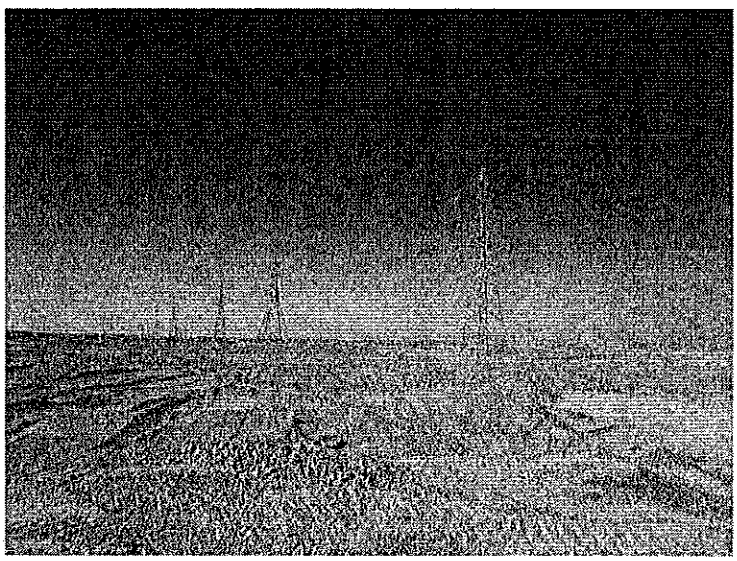


Figure 24 showing 132KV on the site as heighted features.

The other form of shading that can affect the power generation is from solar panels themselves. For large scale, solar farms, solar panels are usually arranged in two in portrait or four in landscape at an optimum tilt angle, usually 15-25 degrees depends on the angle of sun. Usually height of the solar arrays ranges between 1.5 – 2.5 m. Single Axis trackers will be used hence the array will rotate 60 degrees to the horizontal plane either way (east or west) and tilt angle for solar array will vary from 0-60 degrees depending on sun angle.

Sufficient land is available for the solar farm generation. Hence the shading distance between the arrays will be maxed out, to avoid any form of shading from the solar arrays.

2.8 Existing features

Lot of small shrubs and bushes are present on the site.132KV pylons, tracks, Trees and natural drians are the main existing features on the site. No distinct flora and fauna have been noticed on the site.

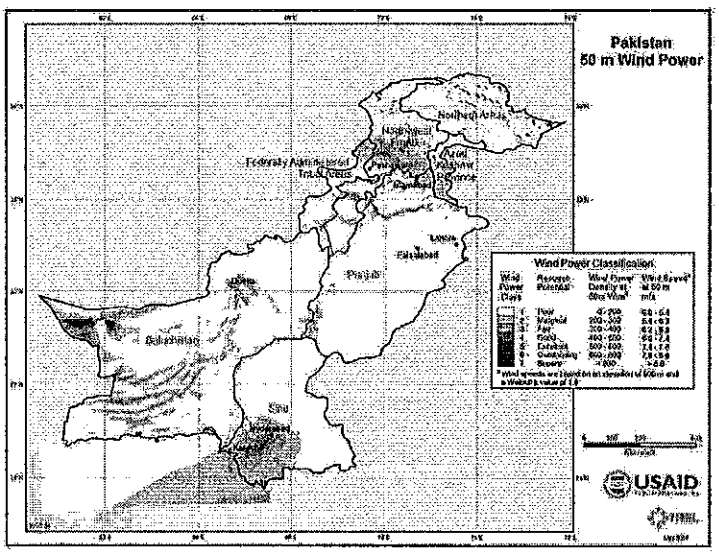
2.9 Utility connections

Electricity and gas are easily available on the site. Due to high water table, a fresh water tube well can be quarried. Same water will be used for cleaning of panels during O&M stage of the project. The site is directly located in front of the 132KV Grid, hence electricity connection will not be a problem.

2.10 Wind Direction and Speed

The predominant wind direction is South, South West. The average wind speed is 4.1 m/s. The max wind speed recorded in the area is 6.6 m/s. (Weather Data file can be seen as Annexure E)

The South, South West direction will only have a sideways impact on arrays. The tables will be facing east and west while tracking the sun. Hence the wind will not have significant pull out force, in case of any wind storm.



The mounting structure used for the site is designed in a way to withhold the wind speed of 47 m/s and above – detailed data sheet of Mounting structure also attached as Annexure F.

Figure 25 showing wind resource available in the area.

US AID Pakistan Wind Resource Map also shows that site is located in Gwadar region and wind resource is Fair in the area where Gwadar solar farm is located.

2.11 Legal status of site

Govt. of Balochistan revenue department, after approval from the Competent Authority allocated the land in Gwadar for development of Solar Farm, after the issuance of LOI from the Balochistan Power Development Board. The Akas plan issued by Tehsildar Gwadar shows the Khasra numbers allotted to the solar farm site.

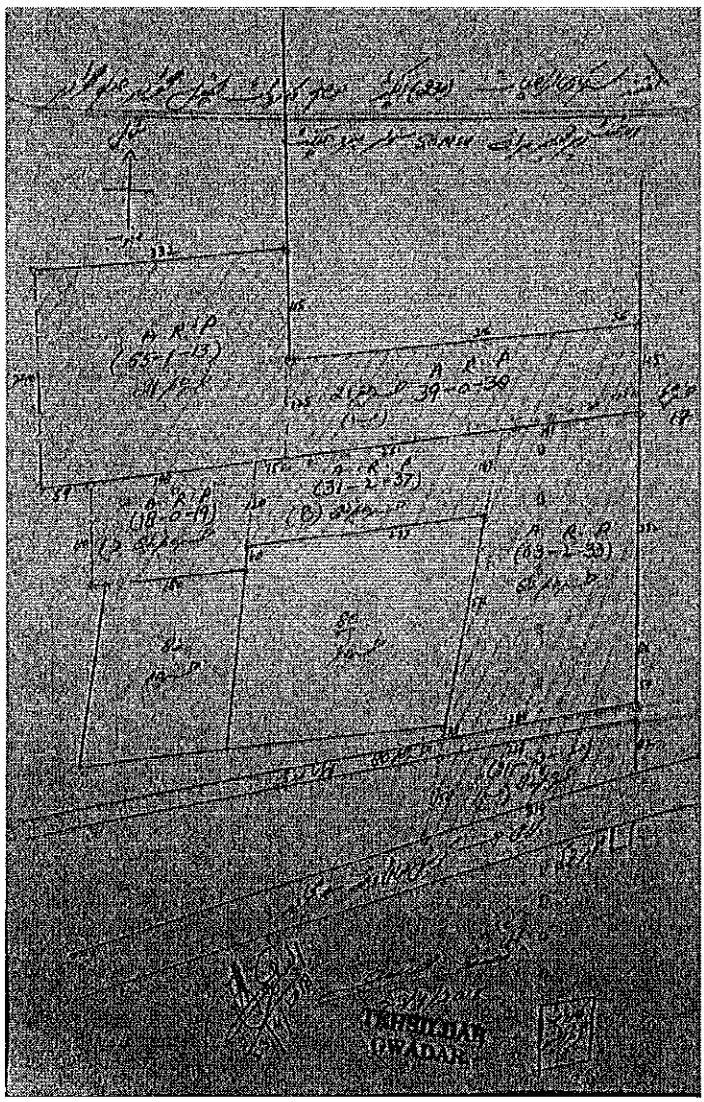


Figure 26 showing Gwadar site ownership boundary

2.12 Way leave issues

The solar power plant will be connected to QESCO network through 132KV overhead line. 132KV Gwadar industrial grid is located almost 0.4 km away from the site. Hence there will be no wayleave issues.

2.13 Underground cables and pipeline

The desktop assessment shows that site don't have any underground cables or gas pipes. The local utility will be consulted before the start of the construction to make sure, that project civil work will not cause any harm to the existing infrastructure. Proposed solar farm site is owned by Govt. of Balochistan, hence during the site visit it was shared by the Land Patwari that there are no underground oil or gas pipes passing through the site. Most of the existing features have been demarcated on the topographical survey.

2.14 Fiber optic cable

For monitoring purpose SCADA communication system will be installed in the control room. All the PV MW blocks will be connected with CR via underground fiber optic cable (F.O.C). No existing underground fiber cable encountered.

2.15 Environmental Impact Assessment

As per Balochistan Environmental Protection Agency regulations, the solar farm sites below 50MW will not require any EIA and will only be liable to submit an Initial Environmental Examination report.

Initial desktop assessment shows that, there will be no impact on the flora & fauna of the area since there is no established grazing land, national parks, protected wild life zones or bird sanctuary present near the solar farm. The site has also been examined from Noise, Shadow and Visualization Impact Angle. The results show that there would be no adverse impact of Noise, Shadow and visualization on nearby dwellings. The land is also free from resettlement issues since it is a holding of Govt. of Balochistan Revenue Department and now under use of P&G Energy Pvt Ltd.

The desktop based land use assessment also showed that there wasn't any prime use of the land and there isn't any special planning or environmental designation recorded on the site after 2008 till to date. As per Punjab EPA, IEE would be required for the project.

2.16 DNO connection

The proposed site location has been discussed and analysed with respect to power evacuation and grid Interconnectivity point of view. The Gwadar area lies in QUETTA Electric supply co. (QESCO), getting power directly from Iran. The proposed site location is opposite to 132kV Gwadar industrial grid. The Gwadar industrial grid is connected to 132kV Gwadar city grid and 132kV pasini grid but the

T/L to pasini is not yet been energized. This line will be energized probably in one to two months' time.

The 132kV line from Gwadar city and pasini grid is passing through 50MW proposed site that is very beneficial for grid Interconnectivity point of view. The 50MW solar plant will be connected to existing line via looping IN/looping OUT arrangement with feed length not more than 100 meters.

From line capacity points of view, transmission lines have enough capacity to carry this power. In-fact the thermal stress on transmission line will be reduced because this 50MW plant which will give support to active and reactive power. Hence the frequency and voltage profile will be improved.

3. Planning Policy Statement

This chapter provides a brief outline of the planning policy information applicable to the project with emphasis on renewable energy policy and climate change. The current Government have attached substantial importance to the continued development of renewable energy sources and their renewable energy policy sets the context for the determination of planning applications. The policies outlined in this statement clearly indicate that considerable planning weight should be attributed to these policies.

The Renewable Energy Policy 2006 revised in 2009 provides the support for the development of RE projects in Pakistan.

3.1 International Policy

Climate change became a prominent issue in the 1980s and in response to this the United Nations adopted a resolution on the 'Protection of global climate for present and future generations of mankind'.

The United Nations Framework Convention on Climate Change (UNFCC 1992) and the Kyoto Protocol (1997) committed parties to individual, legally binding targets to limit or reduce their greenhouse gas emissions.

The Stern Review of 200611 warned that *"Delaying action, even by a decade or two, will take us into dangerous territory. We must not let this window of opportunity close".* The review highlights the importance of acting now to reduce carbon emissions. In the short term renewable energy is one of the main options for reducing carbon emissions.

The 4th Assessment Report of the IPCC (Intergovernmental Panel on Climate Change) raised the possibility of the Earth's temperature rising well above the ceiling quoted in earlier accounts and giving rise to severe consequences such as the collapse of the Greenland ice sheet and disruption of the Gulf Stream Ocean current.

A 'roadmap' towards a new climate deal in which developed and developing countries are legally bound to reduce their carbon emissions was the agreement born out of the United Nations Climate Change Conference 2011, Durban. The terms of the agreement are to be drawn up by 2015 and come into effect by 2020.

3.2 European Policy

The European Climate and Energy Package12 (2007) aims to further improve energy security and reduce carbon emissions. The package sets out the following climate and energy targets that are to be met by 2020:

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels;
- 20% of EU consumption to come from renewable resources;
- 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency".

These targets are known as the 20-20 targets. EU leaders have agreed to increase Europe's emissions reduction target to 30% if a global climate agreement can be achieved. To achieve the EU renewable energy, target each member state has agreed to an individual target.

3.3 Asia Pacific Renewable Energy Targets

Burgeoning energy demand, limited fossil fuel reserves, and global warming concerns have forced countries in the Asia-Pacific region to increase the share of renewable energy in their energy mix. The region has made significant investment in renewable energy projects in recent years, and this is expected to continue in future. Many countries have adopted policy instruments such as Feed-in Tariffs (FiTs), Renewable Portfolio Standards (RPS), soft loans and tax incentives to promote renewable energy. Most of the government measures that have been introduced have received a positive response and have played a vital role in the development of the renewable energy industry.

Investment in renewable energy projects increased following the introduction of the Kyoto Protocol in 1997. This protocol sets binding obligations for industrialized countries to reduce greenhouse gas emissions by 5% against 1990 levels by 2012 (the first commitment period) and by 18% against 1990 levels by 2020 (the second commitment period).

Australia, Japan and New Zealand have signed the Kyoto Protocol, thereby committing to the reduction of carbon emissions. India and China, as participants in the Copenhagen Accord in 2009, pledged to work towards respective binding carbon intensity reduction targets of 20–25% and 40–45% by 2020, in comparison with 2005 levels.

China is rapidly becoming a major player in the global renewable energy industry. In recent years, the country has developed its wind turbine and solar Photovoltaic (PV) manufacturing industries. The government has shown commitment to renewable energy through the introduction of a series of new laws and financial support measures.

India and Australia have also implemented several support measures for the development of renewable energy; the efficiency with which these measures are implemented will determine future growth in both countries. The new programs related to solar power development announced in India are expected to significantly increase the share of solar power in the renewable energy portfolio. The Japanese government has shown commitment to renewables through the introduction of a FiT for renewable energy. It also announced plans to entirely rebuild its energy policy following the Fukushima nuclear disaster in March 2011. The policy now recommends gradually reducing dependence upon nuclear power while enhancing the share of renewable energy and efficient fossil-fuel power generation.

Thailand, which has announced several measures to support the growth of its renewable industry, is aiming for renewable energy to account for a 25% of overall power within the next 10 years. Pakistan currently don't have any renewable energy targets but still Govt is encouraging the installation of Wind and Solar power plants and have got a policy frame work in place to support the RE projects in Pakistan.

3.4 National RE Policy 2006

Pakistan has a tremendous renewable energy potential. Ministry of Water and Power in 2006 published RE Policy which encourages the deployment of wind, solar, hydro and biomass projects. The policy provides the detailed process and guidelines for development of RE project in Pakistan. Salient feature of 2006 RE policy are as follow:

i. It invites investment from the private sector for following categories of proposals: a. Independent power projects, or IPPs (for sale of power to the grid only) b. Captive cum grid spillover power projects. (i.e., for self-use and sale to utility) c. Captive power projects (i.e., for self or dedicated use) d. Isolated grid power projects (i.e., small, stand-alone)
ii. Except for Category (a) above, these projects will not require any LOI, LOS, or IA from the Government.
iii. Electricity purchase by NTDC/CPPA from qualifying renewable energy-based generation projects has been made mandatory.
iv. It permits an investor to generate electricity based on renewable resources at one location and receive an equivalent amount for own use elsewhere on the grid at the investor's own cost of generation plus transmission charges (wheeling).
v. It allows net metering and billing so that a producer can sell surplus electricity at one time and receive electricity from the grid at another time and settle accounts on net basis. This will directly benefit the economics of small scale, dispersed generation and optimize capacity utilization of installed systems.
vi. It delicenses and deregulates small scale power production through renewable resources (up to 5 MW for hydro and 1 MW for net metered sales) to reduce the transaction costs for such investments. This will be particularly beneficial for micro, mini and small hydro as well as solar-based electricity production.
vii. It lays down simplified and transparent principles of tariff determination.
viii. In insulates the investor from resource variability risk, which is allocated to the power purchaser.
ix. It facilitates projects to obtain carbon credits for avoided greenhouse gas emissions, helping improve financial returns and reducing per unit costs for the purchaser.

Table 7 showing salient features of RE Policy 2006

These guidelines are in line with the Government's open door policy for inviting private investment into the country." Projects with Govt. PPA are developed under same RE Policy.

The brief of development process is as follows:

S.NO.	O&M	Typical Allowance (Days)
1	Submission of proposal on raw site by sponsors	-
2	Review of proposal and qualification of sponsors by AEDB/Provincial/AJK Agency	30
3	Posting of Bank Guarantee by sponsors	15
4	Issuance of Letter of Intent (LoI) by AEDB/Provincial/AJK Agency	7
5	Initial time allowed to carry out feasibility study and term of the LoI.	Based on schedule submitted by IPP, subject to maximum of 18 months
6	Tariff negotiations with power purchaser and approval of tariff by NEPRA (the time can be significantly reduced if up-front tariff is accepted by IPP)	90
7	Submission of Performance Guarantee by sponsors upon approval of tariff by NEPRA	15
8	Issuance of LoS by AEDB/Provincial/AJK Agency	7
9	Financial close	365

Table 8 project development process as per policy 2006

Note:

LOI to proposed solar farm development was awarded by Balochistan Power Development Board. Hence project will be developed under Balochistan Power Generation Policy 2007. LOI copy attached here as Annexure L.

4. Desktop based Environmental and Social Impact Assessment

As per Environmental Protection Agency Regulation 2000, Energy project below 50MW AC will require an Initial Environmental Examination (IEE). As per regulation all the developments that require IEE or EIA are categorized into two types Schedule I and Schedule II developments. The energy project (hydro generation) above 50MW require an EIA and energy project (hydro generation) below 50MW will require an IEE. As per Schedule I development, an Initial Environmental Examination (IEE) will need to be carried out to demonstrate that the impact on the environment and local communities is acceptable and that the Project complies with national environmental laws and regulations. The proposed solar plant will require an IEE which shall be carried out by an environment expert and the IEE study approval shall become part of this Feasibility Study as Annexure I.

If the Project require at any stage, international financing than it will need to demonstrate compliance with the requirements of International Financing Institutions, such as Development Agencies and Banks. This is generally achieved by following the International Finance Corporation's (IFC) Performance Standards on Social and Environmental Sustainability, and Industry Sector Guidelines. The standards relate to various elements of social and environmental assessment and management, summarized as follows:

Performance Standard 1· Assessment and Management of Environmental and Social Risks and Impacts

Performance Standard 2 Labor and Working Conditions

Performance Standard 3 Resource Efficiency and Pollution Prevention

Performance Standard 4 Community Health, Safety, and Security

Performance Standard 5 Land Acquisition and Involuntary Resettlement

Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources

Performance Standard 7 Indigenous Peoples

Performance Standard 8 Cultural Heritage

The IFC Performance Standards are reinforced by the Equator Principles (EPs), a credit risk management framework for determining, assessing and managing environmental and social risk in Project Finance transactions. As Lenders for this type of project are generally Equator Principles Financial Institutions (EPFIs). It is likely that adherence to these Principles will be required.

A gap analysis between the IEE produced for the Project and compliance with the IFC Standards and EPs would identify additional issues that should be addressed to reduce risk to the project and to help safeguard the project against any environmental and social uncertainties. This analysis will produce an Environmental and Social Action Plan (ESAP). Listing actions are required to meet the various standards

These actions would form part of a Condition Precedent issued by the lender and can be addressed as financing proceeds. Thus, incorporating these standards is unlikely to result in delays to the project or prohibitive costs.

The principal impacts of a solar development are dictated by the specific nature of the site, and usually limited to the following key impacts and issues:

- landscape and visual impact
- Ecological impact
- Hydrological impact
- change in land use
- construction impacts
- employment opportunities

4.1 Environment

Solar farm development is temporary development in nature, and has minimal impact on surrounding. The solar panels are passive in nature and do not generate any harmful emissions. Almost 0.75m high from the front and 2.5m high from the back, make the vegetation grow well and sheep grazing is easily possible. Solar farm generates electricity by using the solar irradiations and don't require fossil fuel for most of its operation, which makes it zero carbon development. In addition, the production of electricity from a renewable source will make a significant contribution to reductions in Greenhouse Gases (GHG) emissions over the lifetime of the Project. The solar farm will have energy generating capacity of approximately 50 MW and will generate enough low carbon renewable electricity to meet the demands of more than 31374 homes a year.

Solar Project Generation in MWhr = 2162*62.2 = 134, 476.4

Combined Margin Emission Factor $_{grid, CM, y}$ = 0.6343 tCO_{2e}/MWh.

Carbon Emissions savings = Solar Project Generation X Combined Margin Emission Factor $_{grid, CM, y}$

= 134, 476.4 MWhr X 0.6343 tCO_{2e} / MWh

= 85298.3805 tCO_{2e}

The principal environmental and social aspects identified as part of our early observations are outlined below for the proposed project site, with a brief statement regarding possible mitigations that have been identified at this early stage.

4.2 Ecological Impact

The proposed solar farm site is not a prime agricultural land and don't have any record of threatened flora and fauna. Not a single endangered tree species has been found over the site, only the Native bushes are present on distant locations.

The site has mainly perforated rocky strata at and below the surface, which is not suitable for a quality green cover.

4.2.1 Flora

The flora of the area is governed by the type of soil and the amount of moisture available. As it is an open uninhabited area, so no particular flora is present. Only some bushes are present at the project site. The project site itself is a barren land but the natural vegetation around the site is comprised of few scattered bushes and trees.

4.2.2 Fauna

The wildlife in the area has been affected by colonization of the area and many wild life species have either diminished or vanished. Most of the domestic fauna are in the vicinity of the Project Site. Terrestrial fauna of the area includes cats, jackals and dogs. Domestic animals like cow, buffalo, goats, sheep, donkey and horses are also found. The bird community, found in the area, includes variety of residential birds such as sparrows, crows, parrots etc. Small squirrels, rats and snakes are also found in the area.

4.3 Cultural Heritage

The site is in Gwadar Balochistan and mostly has desolated land use in the surrounding. The site doesn't have any other historic building in the surrounding. Hence site setting will not be affected by the development of solar farm and history of land use of the site shows that site is free from any kind of archeological findings. The desktop assessment clearly demonstrates that the solar farm will not have any cultural or heritage impact.

4.4 Landscape and Visual

The site and surrounding area are characterized by an overall flat topography, with no elevated areas in the vicinity to give significant views of the development. The closest settlement to the proposed site is a residential area in south west direction of the Gwadar power plant. The closest settlement near to the solar site is located almost 3.5km away from the site in south west direction, called Barambah. Being located closer to the site, the residential area is located at low elevation and because of distance from solar plant, it is highly likely that residents will overlook the site. The undulating nature of the topography will screen the site from any potential views. As the only residence located near the site is in the south west direction, and due to topography the site will be naturally screened, hence there will not be any Glint and Glare impacts. The landscape character of the area is not outstanding and has been designated as Bare Area of in Landscape Characterization Map of the Country. Hence development of solar farm will not deteriorate the surrounding environment and landscape. With proper landscaping plan, the existing character of the area can be strengthened.

4.5 Site Land Use

Prior to development of solar farm, the site was predominantly of infertile character without having any quality agricultural activity. The development of solar farm will not result in the change of use, as site existing use is desolated land. Thus, there will be no loss of existing agricultural land or displacement of any users of the land. The installation of the solar power plant would provide income from a site which was previously unused and non-productive.

4.6 Hydrology and Water Use

The major surface water source in the area is nearby rain water reservoir. The primary source of water provided at site is though tankers. Water is obtained from tube wells, canals and underground sources. For the proposed site, contract with local supplier is already in place. However, for drinking purpose, filtrated water is used through filtration plant.

The major sources of the groundwater in the area are hand pumps, pressure pumps and tube wells. The main source of drinking water in the area is groundwater, which is pumped through hand pumps, pressure pumps and tube wells. The ground water recharge will not be affected, as only 40% of the site area will be covered with solar panels and mounting structure will not cause any stoppage of water during any event of recharge.

4.7 Transport and Access

National Highway 10 / Makran Coastal Highway is the main artery and primary road through which site will be accessed. Makran Coastal Highway is a single carriage way road for two-way traffic. The road width is sufficient to cater the heavy traffic vehicles.

Road types
Primary = NH10
Secondary = Access track that will be constructed after ground breaking

The current development of solar farm will only generate the traffic during the construction period which will last for six months' maximum. During the operation, the only small LTVs will be carrying out the maintenance jobs. After construction HTVs will visit the site in case of replacement of major part / equipment like inverter, which usually happens for once during whole project life.

4.8 Waste Management

To reduce the waste generated from the construction of the development there will be waste recycling and re-using initiatives in place. Two waste containers will be on site; one for the recycling of paper and cardboard, and the other for the recycling of wood. Several containers will be needed during the installation to store panels as they are constructed. Earthwork materials arising from the construction process will be stored and re-used on site. It should be noted these quantities will be minimal. This will avoid the need to import and export material. To minimize damage to soil structure all top and sub soil will be handled and stored carefully. It should be noted these quantities will be minimal. Site office

waste will be collected in separate bins to allow for recycling. Recycling bins will allow for cans, bottle and paper. Paint spray cans, used for surveying, will be logged when issued so that it can be ensured all are disposed of properly. Wastewater from the portable toilets and washing facilities will be discharged into sealed containment systems and disposed of by licensed contractors.

4.9 Social

The solar project should also place emphasis on Corporate Social Responsibility. Targets and commitments should be made with regards to issues such as local spend for both the construction and the operation phases, as well as commitment to a community trust, targeting further priority issues such as education or training projects.

The land on the proposed site is not currently occupied by any tenant farmers and, being located within the existing power plant security perimeter, is not in unofficial use by any of the local population. No physical or economic displacement will therefore result from the development.

4.10 Environmental and Social Management

4.10.1 Impact Assessment

Solar PV plants are not currently clearly classified in either Schedule I or Schedule II of the reviewed section 33 of the Pakistan Environmental Protection Act, 1997 (XXXIV of 1997). However, the development of the proposed Project is very unlikely to cause any negative effect on the surrounding environment and as the project size is less than 50M AC therefore it may be assumed that the Project falls within the Schedule I for which only the IEE is required as part of the planning and approval process.

The IEE provides a description of the environmental and social setting of the development, an assessment of potential impacts and recommendations for mitigation measures.

4.10.2 Environmental Management Plan

Although it is expected that the Project will be established using local financing, we recommend compliance with IFC Performance Standards which are considered industry best practice and demonstrate ongoing and responsive management of all potential social and environmental impacts throughout both construction and operational phases, in line with the principles already established at ibvogt other power plant. A key requirement in this regard is the provision of an Environmental Management Plan (EMP). The EMP for the solar project is set out in Section 6 of the IEE, describing mitigation and management measures for the development and allocating responsibilities for the measures proposed.

4.10.3 Stakeholder Engagement Plan

Stakeholder engagement is an essential element of a robust environmental and social assessment and is a key lender requirement, e.g. Principle 5 Stakeholder Engagement, of the Equator Principles, and IFC Good Practice Handbook for Stakeholder Engagement. The general stakeholder process is as follows:

- To identify people or communities that are or could be affected by the project, as well as other interested parties
- To ensure that such stakeholders are appropriately engaged on environmental and social issues that could potentially affect them through a process of information disclosure and meaningful consultation
- To maintain a constructive relationship with stakeholders on an ongoing basis through meaningful engagement during project implementation

5. Design and Access Statement

The Design and Access Statement will describe the various design elements of the proposed development in terms of use, amount, layout, scale, and appearance. It has demonstrated that the proposal has been designed in accordance with industry best practice and with the principle of good design in mind.

From the site visit it can be assumed that the soil is rammable although the presences of stones may hinder these works. A thorough geotechnical study has been carried out which shows that ramming of profiles is possible, which makes the site feasible for development of solar farms.

5.1 Introduction

This Design and Access Statement (DAS) has been prepared by ibvogt GmbH to assess the feasibility for the proposed solar farm with an installed capacity of 50 MW AC ~ 62.2 MW DC at the Gwadar site in Balochistan, Pakistan and forms an integral part of the feasibility study. The solar farm is intended to operate as Grid connected generation facility which will sell electricity to National Grid through an EPA. Specifically, ibvogt intends to develop a solar power plant located on the premises owned by the project SPV.

During the preparation of this DAS, ibvogt has leveraged decades of expertise in designing, constructing, operating and maintaining utility-scale solar power plants across the globe. Several key experts within the ibvogt team were involved in the design process to develop the best and most optimal outcome for Gwadar Solar Farm.

This DAS encompasses the design factors, issues and decisions that should be considered for any solar farm, including the design layout, type and number of components, positioning, soil and material attributes, etc.

It should be noted that this DAS should be read in conjunction with both the accompanying Planning Policy Statement, which establishes the plans for the design of the application proposal, and the supporting environmental report, which considers any potential impacts on ecology, landscape and aesthetics, transport and flood risk, among others.

5.2 Site Location

Site is located in District Gwadar. The word Gwadar is derived from Balochi words 'Gwa' and 'dar', which means the door of air. Gwadar was purchased from Oman in 1958 by Pakistan. It was given the status of district in 1977. It consists of four tehsils namely, Gwadar, Jiwani, Ormara and Pasni. The district headquarter is located at Gwadar city. It is home to Baloch tribes and Balochi is the main language spoken here. The climate is hot and humid. The district mainly produces lentil, vegetables and fodder. Major fruits include dates, papaya, coconut and chickoo. It has major deposits of limestone, bajri sand, rock salt, ordinary stone and sulphur.

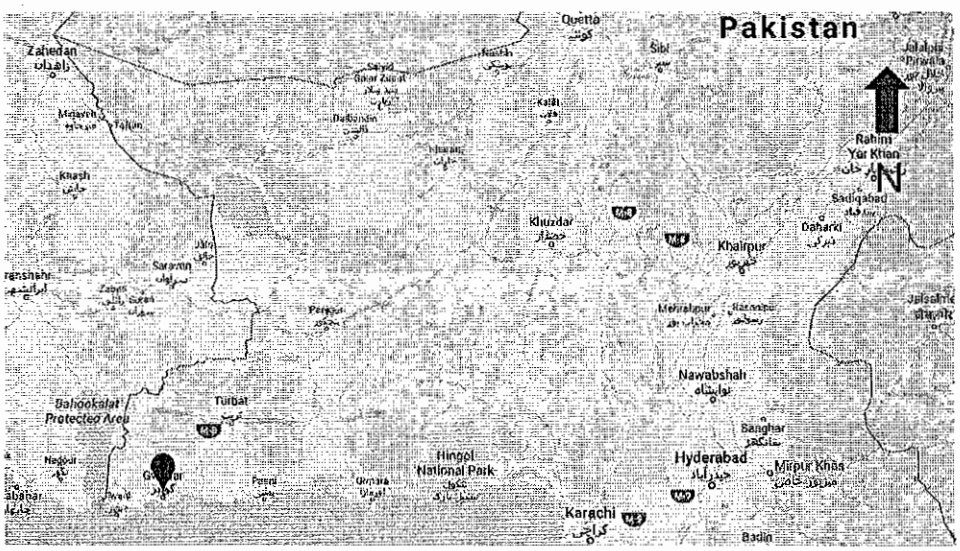


Fig 27 showing location of Gwadar solar farm

5.3 Transport and Site Access

Specifically, the project site is located on a very busy Makran Coastal Highway also know as the National Highway 10. Site is easily accessible from the National Highway 10 and a track will be constructed after the ground breaking which will be used during construction of the solar farm.

The track will be converted into a small concrete road during the construction, which will be used later during the operation and maintenance stage.

Road types Primary = Makran Coastal Highway / NH10

Secondary = Access track already present on the site

Gwadar can be accessed from two directions. From Quetta, via N25, N85, M8 and finally NH10. The other route which will be used by conduction vehicles during construction is from Karachi to Gwadar via N25 and finally to N10.

This route is more direct and most of the foreign equipment will be brought to the site through Karachi International port, until Gwadar port is fully operational.

Transportation Study attached as Annexure A to the Feasibility Study. Provides in depth information about movement of HTV's from Port Qasim to project site.

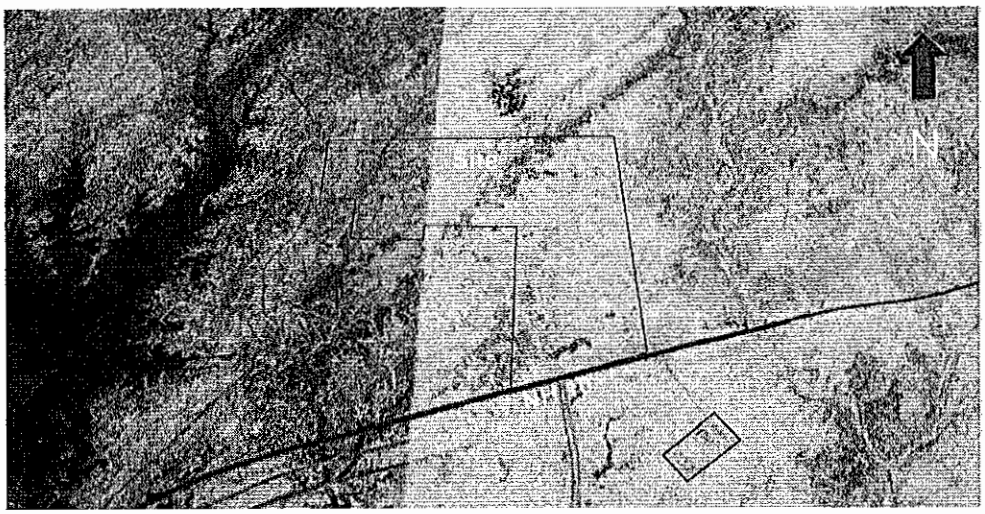


Fig 28 showing connectivity of the site through National Highway 10.

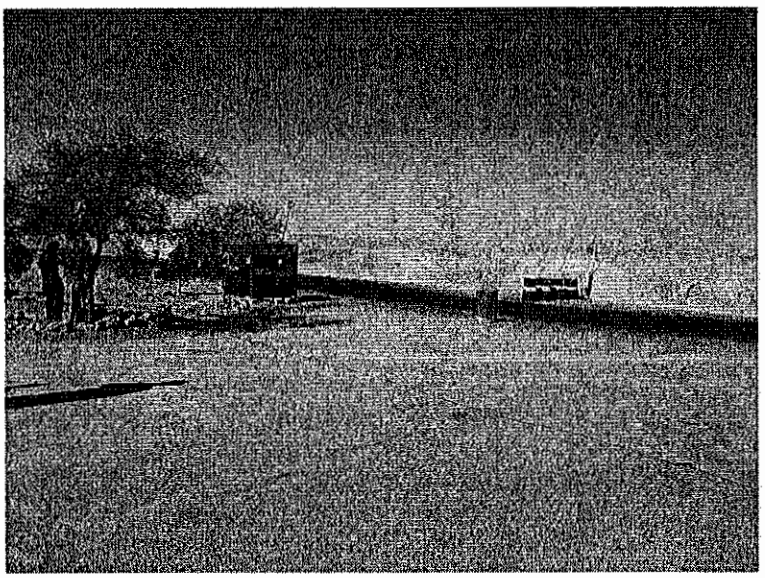


Fig 29 showing the existing road to access the site.

5.4 Proposed Development and Design Principles

With every solar farm project development, ibvogt follows a proven methodology to render the best design solutions. Extensive experience has made these design approaches and processes more effective and efficient over the years. As Per the methodology, the development and design principles are based on:

- Physical opportunities and constraints the site provides;
- Material and labor needs of the development itself;
- Policy context relevant to the development of the site, and;
- Technical input and criteria from local consultants.

In addition, from its extensive track record, ibvogt is committed to established international standards and norms applicable in the industry, including IEC as well as local standards. For example, some notable IEC standards in the past have included "IEC 61557: Photovoltaic (PV) module safety qualification" and "IEC 62446: Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection."

The key considerations and constraints as well as opportunities are outlined below.

Key Considerations and Constraints

The design must consider:

- Any potential archeological assets, wildlife habitats, precious resources or minerals at the site. The input provided by Environmental Consultants confirms that the site is not home to any protected wildlife or trees and is not subject to minerals or mining rights, archaeology finding, any local or national designation as a national park or areas of any special scientific interest, nor any special ecological features.

- Physical characteristics of the site, such as the field boundary, slopes, etc. Following the site visit and GIS analysis, the topography of the land at the site seems to be relatively flat with minimal, gradual sloping, which are not enough to significantly affect the tilting and positioning of the modules.

- Shading form nearby Trees and heighted feature. Solar power plants are prone to higher risk of losses due to shading, which can be mitigated or completely avoided through careful planning and design. Following a thorough analysis and software simulation, the engineering team at ibvogt has determined an optimal placement of the racks at sufficient distances away from every tree to avoid shading effects.

Figure 30 showing the 132KV that can cause shading

- Module soiling and cleaning. Given the dusty and windy climate of the site, soiling and cleaning of the modules requires an in-depth analysis. From projects developed in the Middle Eastern deserts, ibvogt already has experience in soiling and cleaning marginal cost and benefit calculations, where the actual and monetary values of the yield reduction due to soiling and infrequent cleaning are compared to cost of cleaning the modules. Module cleaning, whether manual or using robots, also requires water, which is a scarce resource in the area. But Gwadar solar farm site will require a tube well on the site and its water will be used for cleaning of panels. The salinity of water is low which means there will be no salt deposits on the solar panels after cleaning.

- Ramming, drilling or blasting of the ground. The project area is part of the Makran Coast which is located in stretches from Iran to Lasbela in Southern Pakistan. Makran Coastal Range is a low level mountainous range existing on the Makran Coast. The rocks of this range are predominantly sedimentary i.e. limestone silt/sandstone and shales. The project area is also surrounded by low Level mountain and rock/hard strata is observed from almost the top to a maximum depth of 2.70m. The top soil is sandy Silt and rock type is Sand/Siltstone. Refusal is considered when 50 blows of hammer failed to penetrate 10cm at any point. Chemical test reveal aggressive nature and special requirement for cement concrete in contact with soil will be required. Geo tech results shows majority of site is rammable, which drilling might be required is some areas.

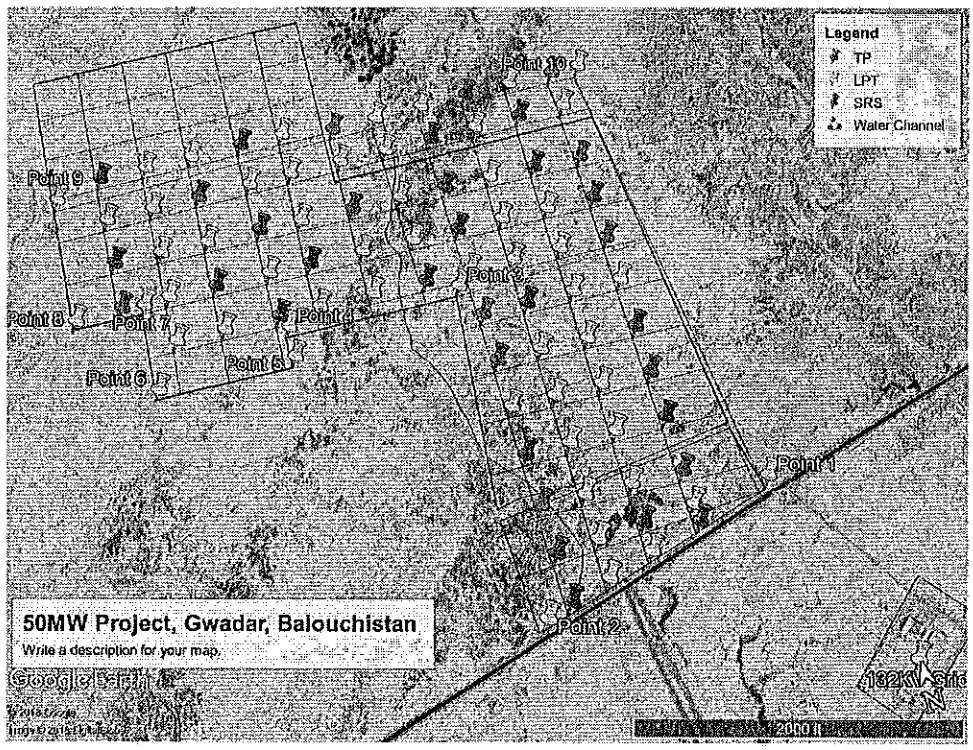


Figure 31 showing Geo Tech, test location points.

Since the sulphate and chlorides are both above the permissible limit therefore Type II Moderate Sulphate Resisting Cement / Tri-calcium. Aluminates between5% to 8% is recommended for all foundation work.The Gwadar area is situated in seismic Zone 3 as per building Code of Pakistan (Seismic Provisions -2007). This corresponds to peak Horizontal Acceleration of 0.24 to 0.32g, as such it requires special consideration in designing of foundation (Details of Seismic Data attached as Annexure H). Groundwater level was not encountered in any pit or LPT. Details of the test summary is appended to this report Attached as Annex H.

5.5 Opportunities

On a broader level, the solar farm present advantages and opportunities for positive impact, namely:

- Contribution to national renewable energy and climate change targets;
- The delivery of renewable energy at a local level;
- A positive contribution to the economic development and diversification of the area;
- Use of underutilized barren land;
- Sunlight intensity levels - the site is well located geographically for relatively high solar irradiation and flat terrain that is free of any buildings or mountain ranges that could cause shadowing;
- Relatively good road access from the east, west and south, as mentioned above;
- The site is not historically protected or environmentally sensitive, as described within the EIA Regulations;
- Area requirements - the site provides enough land to accommodate a 50 MW AC solar farm, and;
- The site is available for the entire lifetime of the proposed scheme (designed operational life span is 25 years).

5.6 Design Solution

As evidenced by the company's extensive portfolio of solar power plants, ibvogt's vast EPC and O&M track record serves as a robust indicator of the success and reliability of the design solutions and the comprehensive in-house expertise of the project development teams. This section elaborates on some of the design solutions mentioned previously and addresses important site requirements and local characteristics, specifically with respect to the proposed use of the site; amount, scale and appearance of components; site layout; location; materials requirements; and site access.

5.6.1 Proposed Use

As mentioned, the proposed development is for a ground-mounted solar farm. To ensure an optimally operating solar farm and maximize yield and earnings, ibvogt offers its EPC and O&M expertise to design, build and operate the solar farm as per proposed site layout. The solar farm will have energy generating capacity of approximately 50 MW AC and will generate enough low carbon renewable electricity to meet the demands of more than 31374 homes a year. The Carbon emissions saving calculations has been carried out and are as follows:

Solar Project Generation in MWhr = 2162*62.2 = 134, 476.4

Combined Margin Emission Factor $_{grid, CM, y}$ = 0.6343 tCO_{2e}/MWh.

Carbon Emissions savings = Solar Project Generation X Combined Margin Emission Factor $_{grid, CM, y}$

= 134, 476.4 MWhr X 0.6343 tCO_{2e} / MWh

= 85298.3805 tCO_{2e}

The solar farm is proposed for a standard operational lifetime (approximately 25 years), after which the associated equipment can be removed from the site and the land would be restored to its original condition.

Amount, Scale and Appearance of Components

The attributes of key components are as follows:

- **Modules:** out of the top technologies and brands, monocrystalline bifacial panels have been selected to generate a combined AC capacity of 50 MW. An important point is availability, which can determine the success and speed of the project during construction. As an established leader in the industry, ibvogt has prominent relationships with top module manufacturers, facilitating the procurement process.

- **Module Dimensions:** The dimensions of the selected panel would be in the range of 1.99 m x 0.99m x 0.40m. As part of an optimal arrangement that minimizes near shading, the mounted height of the panels should be no higher than 3 m above ground level and, at the lower end, at least 600 mm above ground level. The glass coated panels are coated to maximize daylight absorption, and thus minimize glare potential.

Mounting Frames:

The solar panels will be oriented towards east and west on metal mounting rack frames by using Sun tracking technology. Each rack is designed with 2 panels in portrait arrangement and 21 modules in table. To capture maximum direct irradiation, the mounting frames will adjust its angle of between 0-60 degrees from the horizontal. Rest the solar array will be able move 60 degrees from horizontal either way, east or west. Posts and beams of the supporting structure are made from galvanized steel or aluminum. The design is based on a detailed structural calculation tool developed in-house by ibvogt.

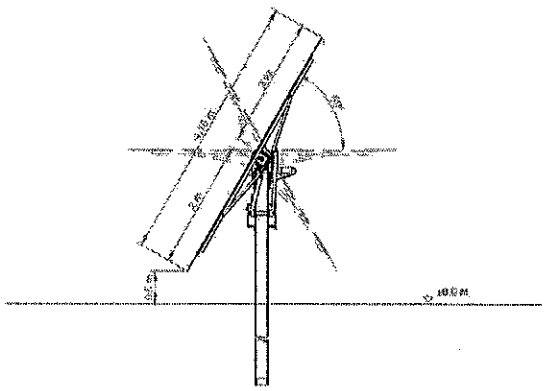


Figure 32 showing side elevation of mounting structure for Single Axis trackers

- **Module Tilt**: in past projects, ibvogt has conducted in-depth analyses on projects across the globe on the applicability of fixed tilt, seasonal tilt and tracking systems. Building upon this extensive track record, ibvogt has compared the financial and technical implications based on a preliminary analysis for each of the approaches for the solar farm site. Due to drop in the equipment prices and will higher yield output, Single – Axis tracker is the best solution for markets with low Feed in Tariff. The module Tilt usually varies between the 15-30 Degrees in different regions depending on angle of the sun. For Gwadar development the tilt angle will be adjusted automatically between 0-60 degrees depending of sun angle.

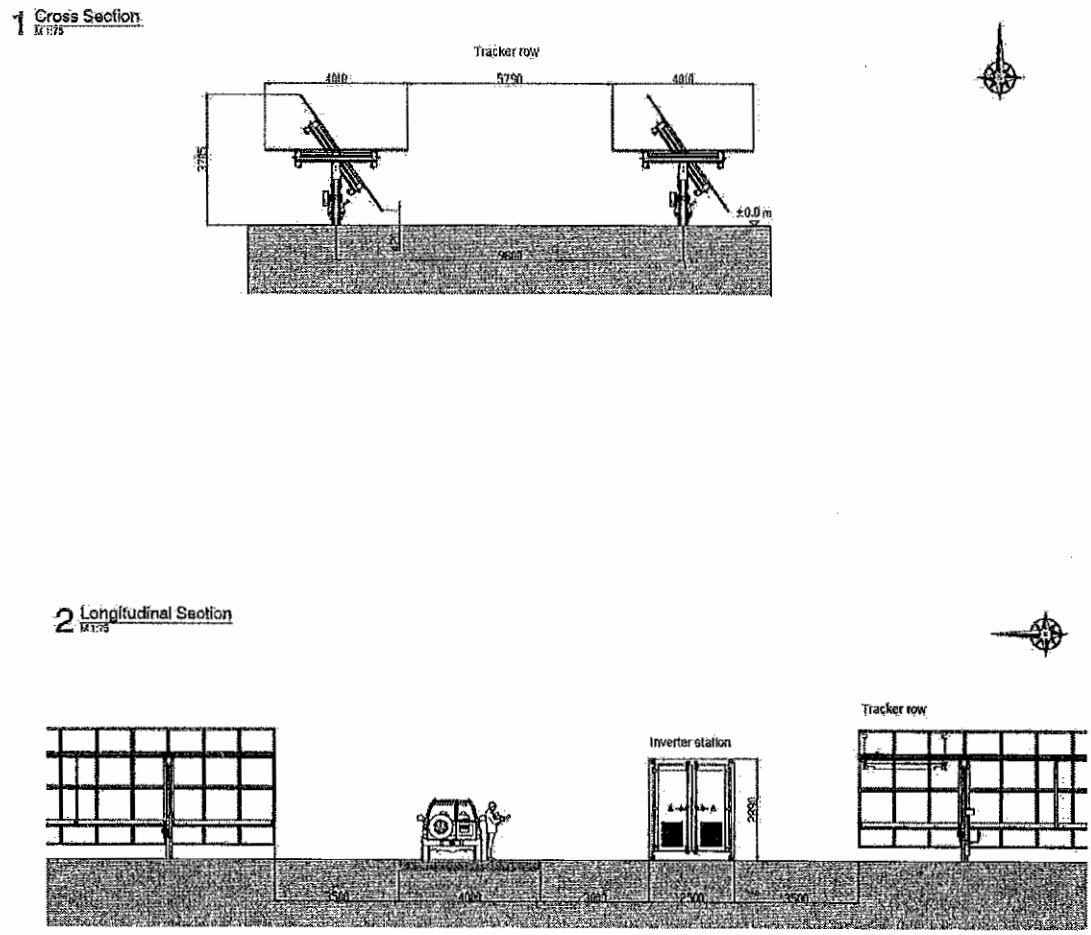


Figure 33 showing generic, side elevation of solar array and front elevation of solar array

- **Mounting Piles**: as the main supporting structure for the modules, piles serve a very important role and must be fixed properly. Piles can be driven but, ramming depth should base on a more detailed analysis of the soil at the site. The mounting frame piles are typically driven approximately 1.5 m into the ground and, contrary to other developments, no concrete foundations are required. At the end of their operational life, when the site is decommissioned, the piles are simply removed from the ground, leaving negligible ground disturbance.

- **MV / Customer Substations (Inverter/Transformer)**: the solar panels generate DC (direct current) electricity and require an inverter to convert DC into AC (alternating current) for injection into the grid. The proposed solar farm will use central inverter stations like most standard solar farms. These inverter stations will also include a medium voltage (MV) switchgear and transformer container, typically with an oil pit. The proposed site layout contains thirteen inverter transformer stations, which will be housed in an ISO 40' container cabin measuring approximately 2.59 m high x 12.19 m long x 2.44 m wide. One customer substation will be needed, with a similar specification to the MV substations, to combine all the electricity before it passes through to the DNO (grid operator) substation and the national grid. Besides a container solution, an outdoor solution is also possible, where the transformers will be allowed to dissipate heat in an open atmosphere. Appropriate protection for the junction boxes will be included. Further information on typical inverter/transformer stations, such as internal mechanisms, performance and material, can be found in the example datasheet provided in Annexure C.

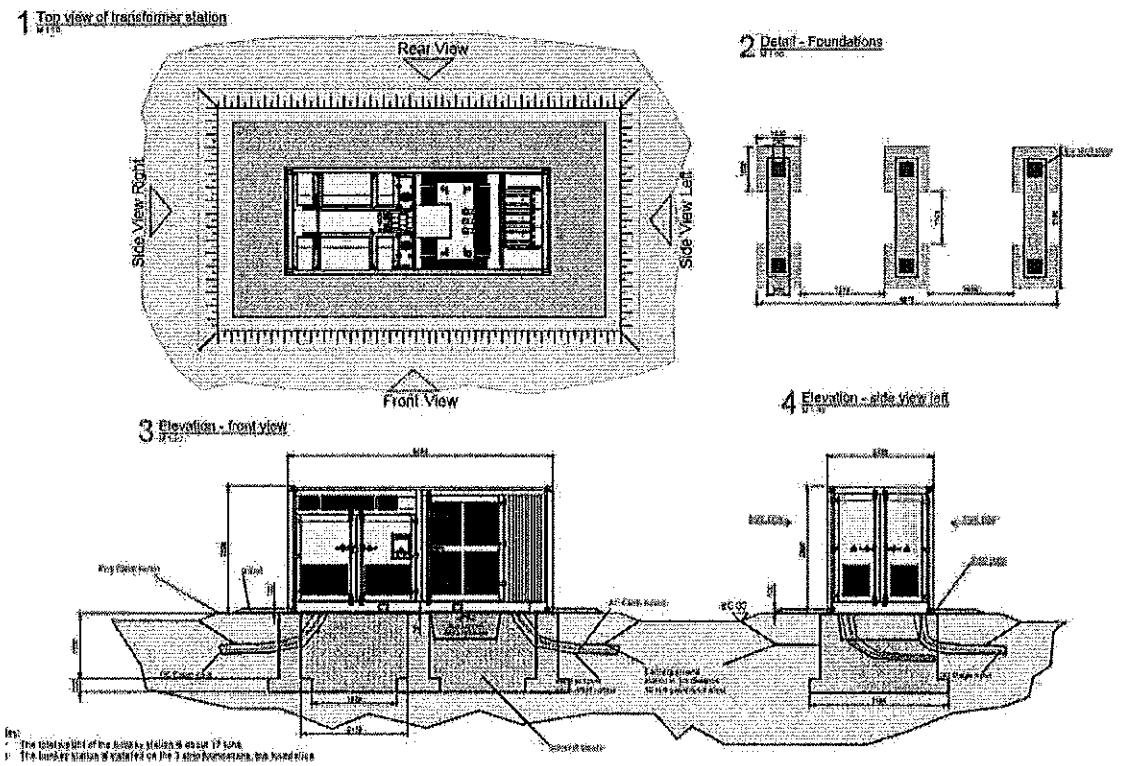


Figure 34 showing typical inverter and transformer station

- **Substation (DSO)**: a substation is required on every solar farm site as it is the point of connection from where the electricity flows into the grid network via the connection cable. The substation houses the switchgear which acts as a safety mechanism to protect the solar farm from any fault in the grid and vice versa. It automatically disconnects the electrical circuits if there is a fault in the system.

Appropriate earthing and lightning protection systems will be developed during the engineering phase of the project. Solar farm will be conencted to National Grid through a 132KV connection with N-1 contigency. More details of Grid interconection has been discussed in Chapter 6 of the feasibility study.

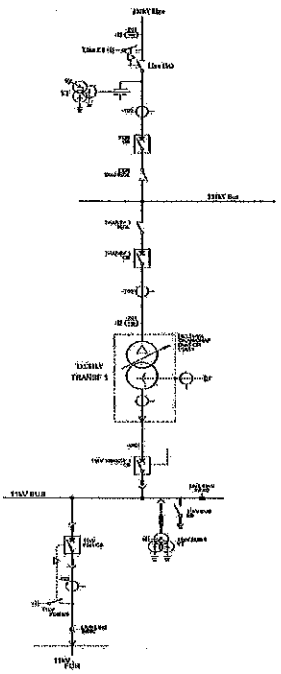


Figure 35 showing SLD of 132KV grid station

- **Communications Pole:** a communications pole will be installed on site so that the solar farm can be remotely monitored by technical operations and maintenance staff. Additional provisions, such as a very small aperture terminal (VSAT) system, tele protection and communication through a Digital Power Line Carrier (DPLC) system, can be included.

- **Spares Building**: a small storage/spares building will be installed to allow the safe storage of spare parts required from time to time as well as other maintenance equipment.

- **Perimeter Fence**: a perimeter fence must be installed to prevent wild or large animals from entering the site and damaging the panels and equipment. Additionally, it is required for security purposes to prevent vandalism and unauthorized access as well as for health and safety reasons to ensure no unauthorized personnel can access the onsite equipment.

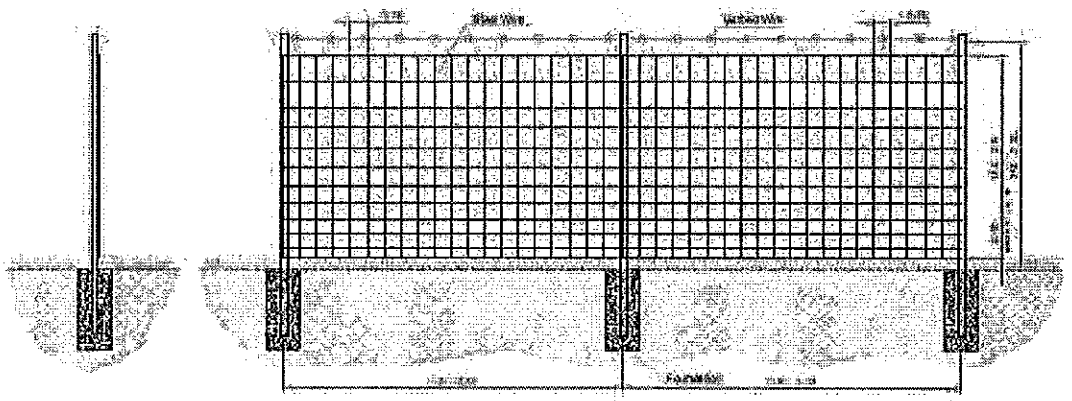


Figure 36 showing typical fence drawing

- **Security Cameras**: to monitor the site and prevent any unauthorized access motion sensor CCTV cameras will be installed along the site boundary. The CCIV cameras will be mounted on poles approximately 4 m in height. Additionally, although the cameras use infrared technology, lighting will be required according to WTG specifications.

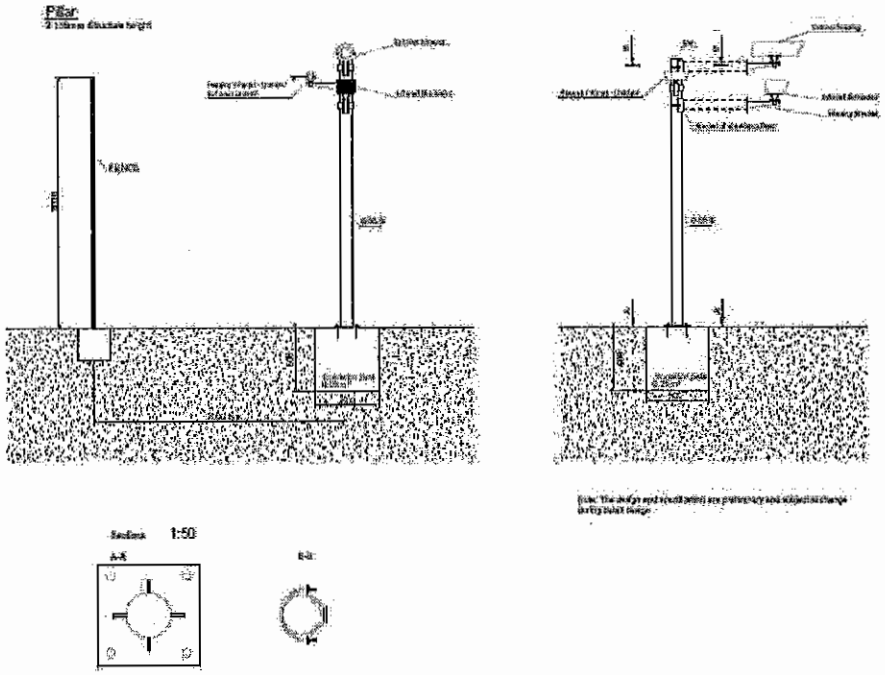


Figure 37 showing typical security camera drawing

- **Temporary Construction Compound**: a temporary construction compound or area is proposed towards the south-western end of the site. This will enable ease of access for construction staff and provide a suitable location for loading and unloading of construction materials. This area will be in temporary use whilst the solar farm is being constructed.

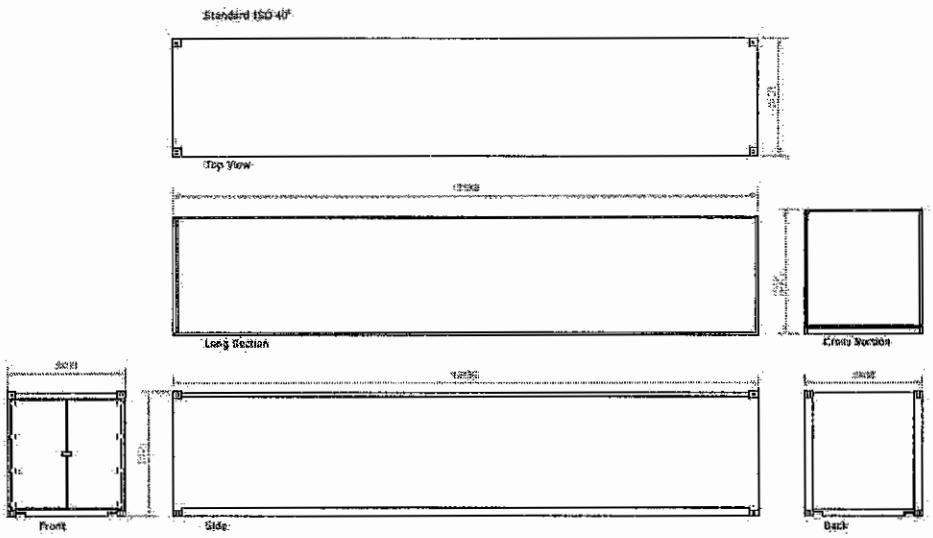


Figure 38 showing typical ISO 40' container

- **Access and Site Tracks**: The development will be connected to the public road network via the existing access road. Existing access tracks on site will be used during construction and operation with some additional sand and gravel tracks installed off the existing access tracks to allow easy access for construction, operation and maintenance.

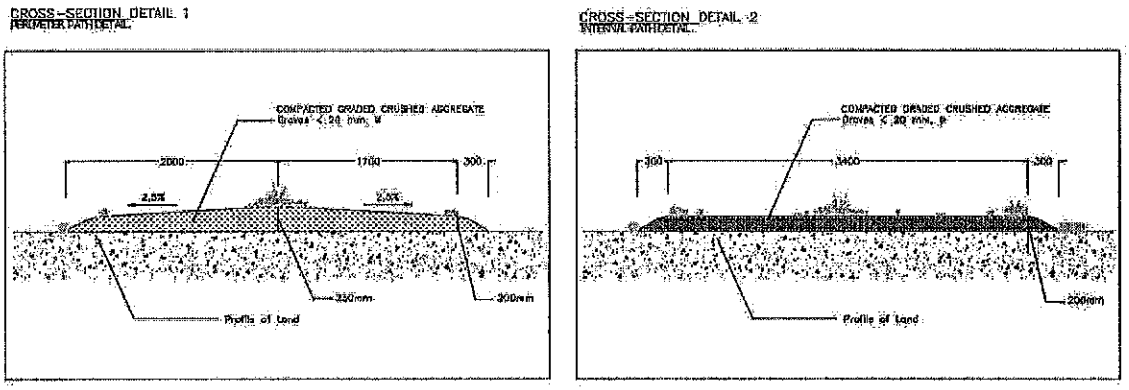


Figure 39 showing typical section of access and site tracks

5.6.2 Layout

During the design period, the layout of any solar farm is extremely important to ensure the most efficient use of the land available and prevent any unnecessary impacts on the landscape. It is also important to ensure that no shading occurs on the solar arrays so that they can produce as much electricity as possible from the daylight they receive. The proposed layout has been prepared by ibvogt's in-house technical team and has taken account of all features on site, such as wind turbines and overhead lines. More details are presented in the section on "Yield Assessment".

The total area of the site is 82.5 hectares / 202 Acres. Almost 40% of this area will be covered with the proposed solar panels. The remainder of the site will remain as steppe apart from some sand and gravel tracks that will be laid on site as shown on the site layout. The layout in high-resolution can be found in Annexure A.

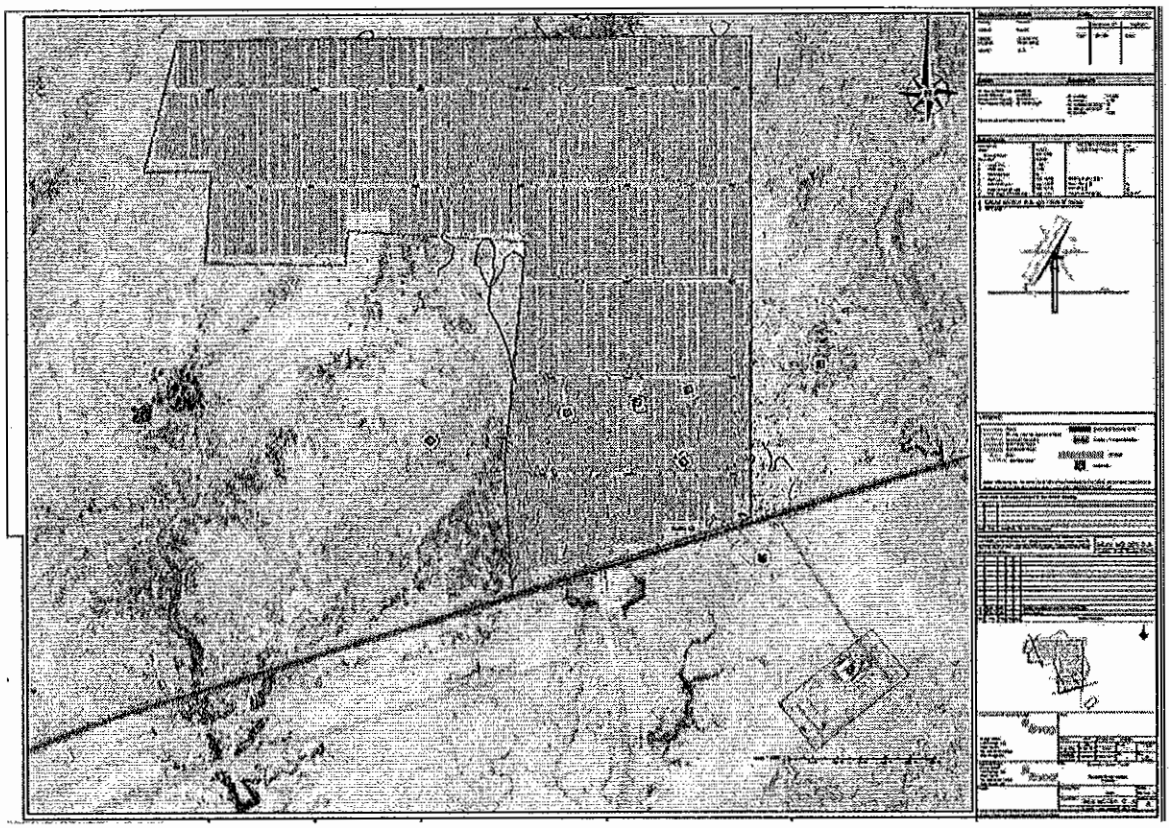


Figure 40 showing PV solar farm layout plan

5.6.3 Location

The location of the proposed solar farm has been influenced by several factors. The most important being the need to find a suitable location to support the maximum irradiation potential of the sun. Accordingly, a clear view south, south-facing or a flat site with minimal shadowing are usually considered ideal locations. An available point of connection to the electricity distribution network is also of prime importance, while also satisfying other technical and planning criteria for solar farms.

5.6.4 Construction Access

The site will be accessed from the road as shown on the accompanying Site Layout. A new gate entrance will be installed. The area already consists of a firm surface suitable for vehicles entering the site. The site access point has the benefit of being located along a straight stretch of road ensuring excellent sight visibility. During the operational period of the proposed solar farm, low levels of traffic will be generated from the following activities;

- Operations and maintenance staff will visit the site a couple of times a month in a transit van or a 4 x 4 type vehicle;
- Visits per year to clean the panels, which will involve trucking in water.

Occasional tours of the solar farm may be facilitated for educational purposes once it is fully operational. Decommissioning of the site will broadly reflect the same traffic levels experienced during the construction period.

5.7 Construction Phase

A maximum of up to 150-400 construction workers are anticipated to be on site during peak times during the construction period. A temporary construction compound will be provided on the site. This will also act as a storage area, parking for contractors and turning for heavy-duty vehicles. A comprehensive construction plan will be prepared before the start of construction. Typically, the construction plan would last up to 34 weeks in total, limited to specific hours by planning condition with limited working at weekends.

The first stage comprising preparation and installation works will take around five months. On completion, there would be a further month of testing and commissioning prior to the development becoming fully operational. A typical sequence of construction works is as follows:

- Field survey/setting out
- Preliminary earth works
- Onsite trenching and cable laying
- Piling to support framework
- Erection of support framework
- Panel Installation
- Electrical Installation
- Construction of transformer buildings
- Connection of inverters
- Security fencing
- Security installation/communication system
- Site remedial works and completion
- Off-site trenching and cabling
- Testing and commissioning

Traffic to the site following the completion of the development will be on an intermittent basis, and should not impact on the conditions of local roads and lanes. Movement of dust during construction will be mitigated via regular module cleaning, as necessary.

6. Grid Connection

6.1 Current Installation

The 132kV Gwadar and Pasni Grid Station are located in Gwadar, Balochistan. The Gwadar grid station is currently equipped with one 10/13MVA, one 20/26MVA and one 40MVA (ONAN/ONAF) power Transformer and Pasni grid station is currently equipped with one 10/13MVA (ONAN/ONAF) power Transformer. The general single line diagram of similar grid station is also shown in the figure 41. QESCO is solely responsible for maintenance, extension, augmentation and up-gradation of subject grid station. The 132kV Gwadar grid station is feeding from double transmission line of 132kV Gwadar Coal PP grid station and 132kV Pasni grid station is feeding from singe transmission line of 132kV Gwadar grid station and another single transmission line of 132kV Gwadar Industrial. An initial survey was carried out to determine capacity of 132kV Gwadar-Pasni Transmission line and for interconnection of 50MW solar power plant site that is located at a distance of approx. 18km away from Gwadar grid station and 103km away from Pasni grid station.

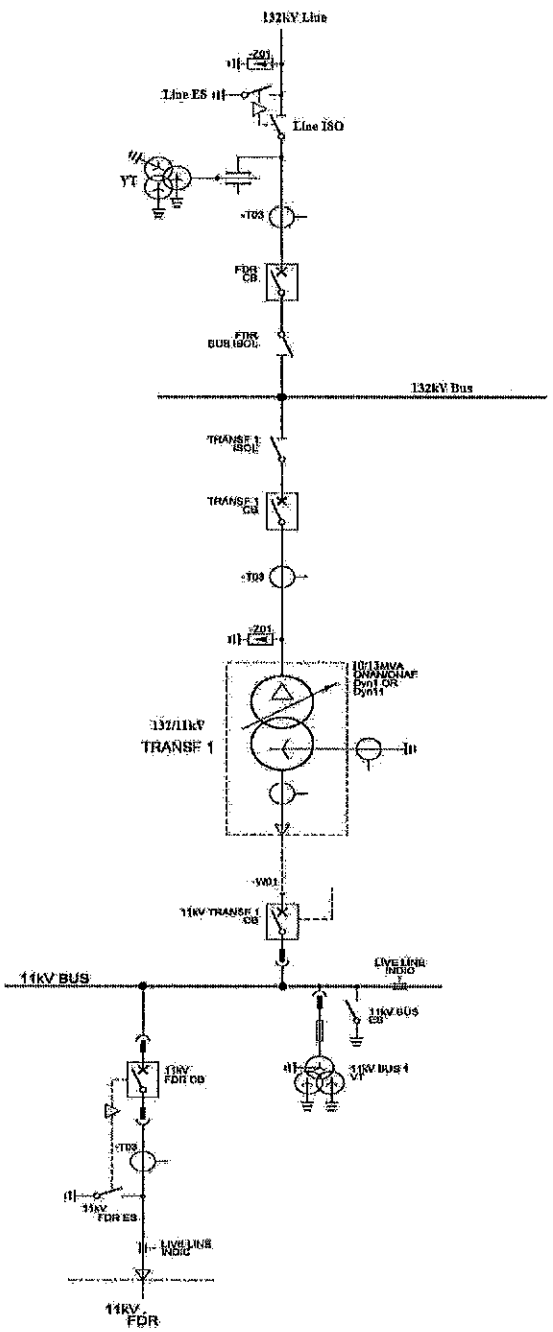


Figure 41 – SLD of 132kV Grid Station.

6.2 PV plant MV system

As per the Plant SLD, the PV plant will consist of 20 inverters having 2500kVA capacity each with following 0.4/33kV and 33/132kV transformer, to accumulate all available power from PV panels to 33kV bus bar. A XLPE insulated 400mm^2 AL cable will be used to connect the output of 0.4/33kV transformer to main 33kV bus bar to avoid losses. Each inverter of model SG2500-HV make Sungrow is connected with approx. 309 strings, each string having 8652 modules. Each module is having a capability of peak power is 360W$_p$. Furthermore, the 0.4/33kV, 2500kVA transformer is connected with each inverter. The arrangement scheme of the inverters is:

- 7 inverters 0.4/33kV are connected in series through cable with 33kV bus bar.
- 7 inverters 0.4/33kV are connected in series through cable with 33kV bus bar.
- 6 inverters 0.4/33kV are connected in series through cable with 33kV bus bar.

From 33kV bus bar all available power will be accumulated to 132kV bus bar with two transformers of 55MVA each.

The detailed block level modeling is shown in figure 42 below.

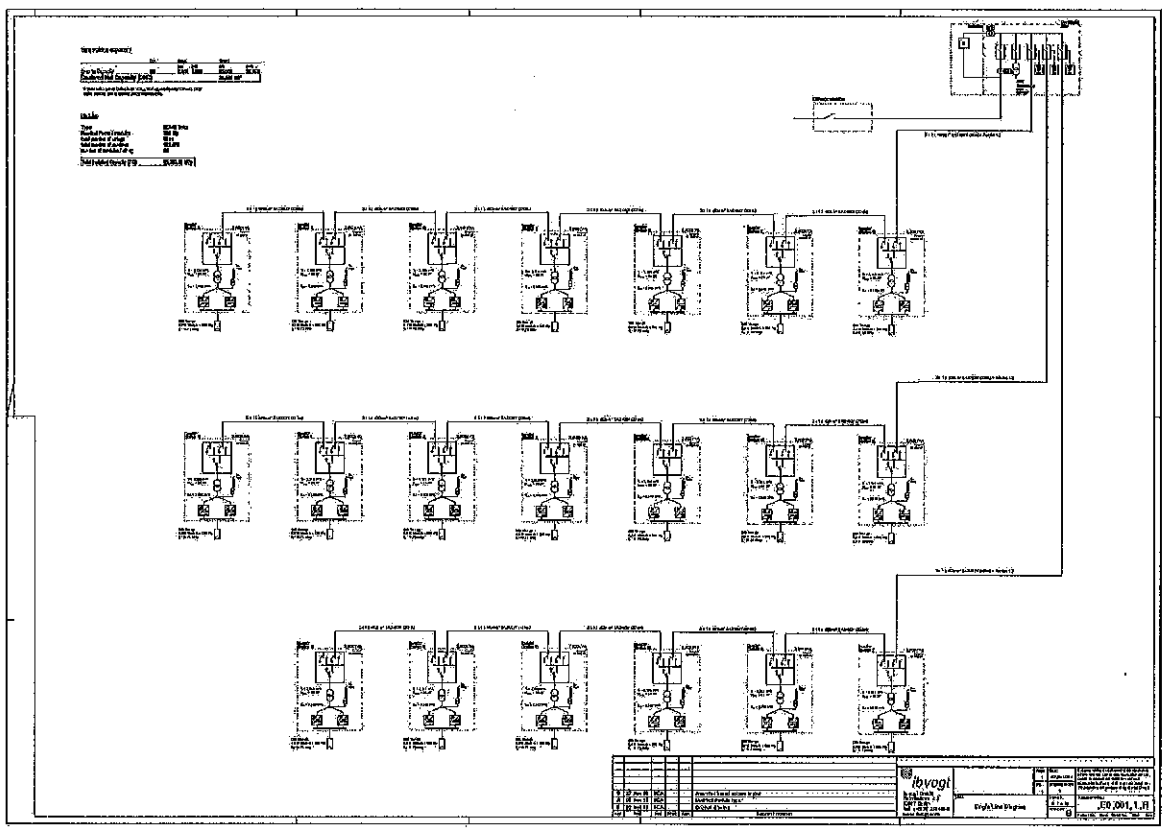


Figure 42 – Single Line Diagram (SLD) for 50MW Solar Power Plant

The maximum gross installed DC power is 62,233.92kW$_p$. The net power (AC) will be 50MW, whereas the auxiliary load will be 3000kW approx. As according to CPPA Renewable

guidelines if power that is to be evacuated is greater than 12.5MW then interconnection would be at 132kV voltage level.

Furthermore, the PV panels are also equipped with single axis tracker having a range of +/- 60.3° to track maximum available power from sun. the detailed layout plan of PV panels with single axis tracker is shown in figure 43.

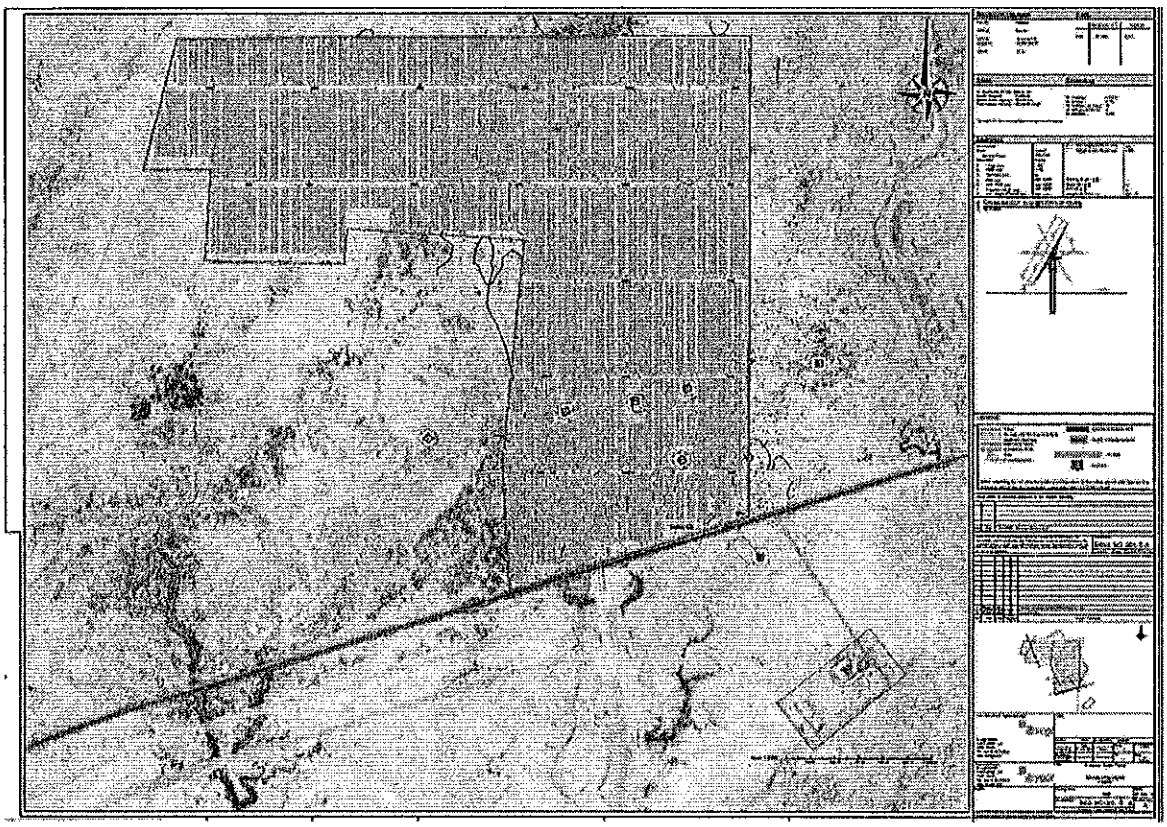


Figure 43 – Module Array Layout Tracker

6.3 Grid connection of solar plant

During the site visit, only one suitable, economical possibility of interconnection was discussed. From an engineering perspective, the possible interconnection is described below:

- Connection of the 132kV bus of PV plant will be connected by making an In/Out on 132kV CAIRO single circuit between Gwadar-Pasni grid station with a feed length of 0.5km.
- In N-1, one (01 Nos.) conductor will serve the purpose to ensure reliability of power from 50 MW solar power plant.

With interconnection of subject power plant, the key considerations must be

- That MVAR compensation if needed, to meet grid code requirement then Reactor bank will be installed.

- That the Quality of power not to be compromised means very much less THD level. Therefore, a detailed load flow, PQ capability and dynamic study would be conducted.
- That the interconnection arrangement must adhere to the local norms and standards.

Furthermore, the stringing of 33kV transmission lines on CAIRO conductor is not so much expensive. The general topology along with protection scheme, interconnection of 50MW solar plant with existing 132kV Gwadar-Pasni grid station is hereby shown in figure 44.

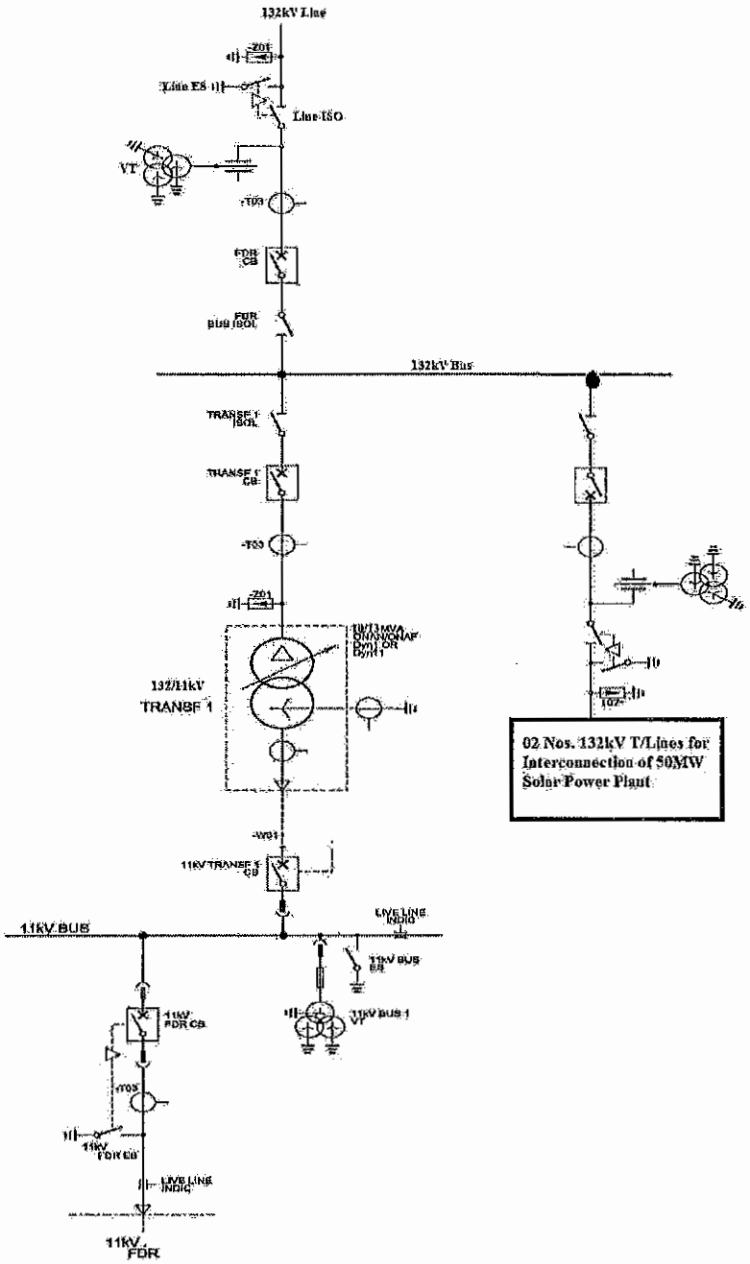


Figure 44 – General Interconnection Topology of 50MW Solar Power Plant with 132kV Gwadar-Pasni Grid Stations through 01 No. each 132kV T/L.

7. Energy Yield Assessment

A solar cell is the smallest semiconductor element within a PV module to perform the immediate conversion of sunlight into electrical energy by the photovoltaic effect. Depending on the employed technology, the degree of efficiency amounts up to 18%-20%. 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, such as inverters, 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 Solar farm considering module efficiency.

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

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

E_{AC} = energy coming from the inverter in kWh

$E_{Irradiation}$ = unshaded irradiation at module level in kWh

A_{Array} = total surface of all solar modules in m^2

η_{STC} = module efficiency at STC

The module efficiency, in contrast to the cell efficiency, considers the gross module surface and can be calculated as follows:

$$\eta_{STC} = \left[\frac{P_{Module}}{A_{Module} \times 1000}\right]$$

7.1 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.

7.2 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 13-15% in temperate zones. It is expressed by the surface factor F(A) ~ 1,13 – 1,15. The inclination angle causes an additional irradiation because the ground reflects the light onto 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 relatively low but, even so, 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%.

7.3 Description of types of technical losses:

7.3.1 Technical losses because of shading

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

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. The relatively flat terrain at and around the Gwadar site allows for minimal consideration of horizon shading effects.

Nearby shading has a temporally and spatially impact only on several parts of the generator field. Other parts of the plant remain unaffected. Objects at close distance to the modules act as cast shadows, e.g. power poles, trees but also row shading in large rack mounted solar fields. The potential shading from existing 132KV Pylons at the site was accounted for in the design.

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

7.3.2 Technical losses because of dirt

Dirt on the modules also causes shading effects which can change over time and seasonally. This shading impact on the energy yield depends for example on the surrounding landscape, cultivation and precipitation. The impact can only be appraised and is based on experience values. Consequently, the uncertainty is high.

Then again, the degree of this shading effect is quite low and amounts to 1-2% under normal conditions. The Gwadar site is characterized by a relatively dusty and windy

environment creating higher than normal soiling conditions. Thus, the shading effect from soiling would potentially reach higher percentage amounts.

7.3.3 Technical losses because of part-load operation

The intensity of irradiation in solar plants changes during the year. The conversion into electricity does not happen linearly to the changing irradiation conditions.

7.3.4 Technical losses because of temperature fluctuation

Ambient temperature and degree of irradiation have an influence on the cell temperature and so affect the energy conversion process. As per the defined STC value of 25° C, the electrical power output decreases with higher cell temperature and increases with lower cell temperature. The module model shows this characteristic by means of temperature coefficients for current and voltage. The temperature ranges at the Gwadar site would need to be accounted for.

7.3.5 Technical losses because of reflection

Inclined irradiation causes reflection of sunlight at the glass and cell surface. Although this is a small effect, it is considered by an empirically determined factor: IAM (Incidence Angle Modifier). By default, the factor is set to 0.05. With the latest anti-reflective coating, a more realistic factor of 0.04 is used as current industry standards.

7.3.6 Technical losses because of fluctuations in module performance

Due to production reasons, the module performances are subject to slight fluctuations (see data sheet„ module performance "). Because of the different manufacturing technologies, the module wiring to module strings causes the so-called mismatch effect. Further information can be found for an example module data sheet in Appendix D.

7.3.7 Technical losses because of weathering and degradation

Changes in the energy yield because of weathering are not considered in the simulation. 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 a correction value for weathering / degradation is recommended for the overall result. To varying degrees depending on the method used and frequency, cleaning of the modules may contribute to the overall degradation of the modules over time.

7.3.8 Technical losses because of cable losses

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

7.3.9 Technical losses because of DC/AC inversion

The conversion of direct current into grid compatible alternating current entails inevitable losses. The conversion losses of the inverters vary according to the chosen inverter type e.g. central inverters, sting inverters, etc.

7.3.10 Technical losses because of transformation (transformer losses)

Transformer losses depend simultaneously on several parameters and thus, unfortunately, cannot be simulated with precision. For this reason, depending on transformer quality, the performance ratio and the yields include a blanket value.

7.3.11 Technical losses because of self-consumption

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

7.3.12 Technical losses because of Light-Induced Degradation (LID)

LID or also called initial degradation is a potential slight power drop during the first few days under solar radiation that can affect some solar cells. Manufacturers of crystalline modules do not always consider potential LID effects in the power specifications on the identification plate. If a manufacturer fails to take initial degradation into account in their power classification this value is used to regard this effect within the simulation.

7.4 Configuration of the PV Generator and Irradiation

Within the solar farm, the solar modules are connected to strings. Most of these strings are collected in DC distribution boxes and generator junction boxes, where they are connected to the inverter. The result is a cascading structure.

7.5 Solar module

Standard 72 cell bifacial modules with a rated nominal power of 360Wp are used in the design. The maximum open circuit voltage of the modules is at 1500V. Considering the minimum temperatures at the site, 21 modules are connected in series to form a PV string.

7.6 Inverters

The solar farm is equipped with 3000 KVA central inverter systems inverters with a nominal active power of 3000 kW. A Data sheet of Sungrow Inverters can be seen as appendix C.

7.7 Mounting Structure

The plant design corresponds to a single axis tracking system. The titled axis is set at 0° whereas the rotation of the mounting structure is limited between 0° to 60° either way east or west.

This provided for a balance between the irradiation received on the module plane and row shading losses.

7.8 Technical losses considered for the energy yield simulation:

7.8.1 Technical losses because of shading

Shadings leading to losses due to nearby shading result from the planned installation of modules which is by means of racks arranged in rows. Distance between the rows is kept at 8m. This will lead to a shading angle of 9.7° in summer where the module tilt is 10°and during the winter at a module tilt of 30° the shading angle is 23.8°. By comparison, the lowest position of the midday sun during one year (northern hemisphere December 21st – winter solstice) is at 41.4°. Further shading results from external objects; for the site 132 KV pose external shading on the module array. For the 3D model, all possible positions of the trees were considered. The plant was simulated as 3D model in the simulation program (see Figure 45). Furthermore, the simulation calculated the annual shading ratio. This intermediate result was then factored into the actual yield simulation.

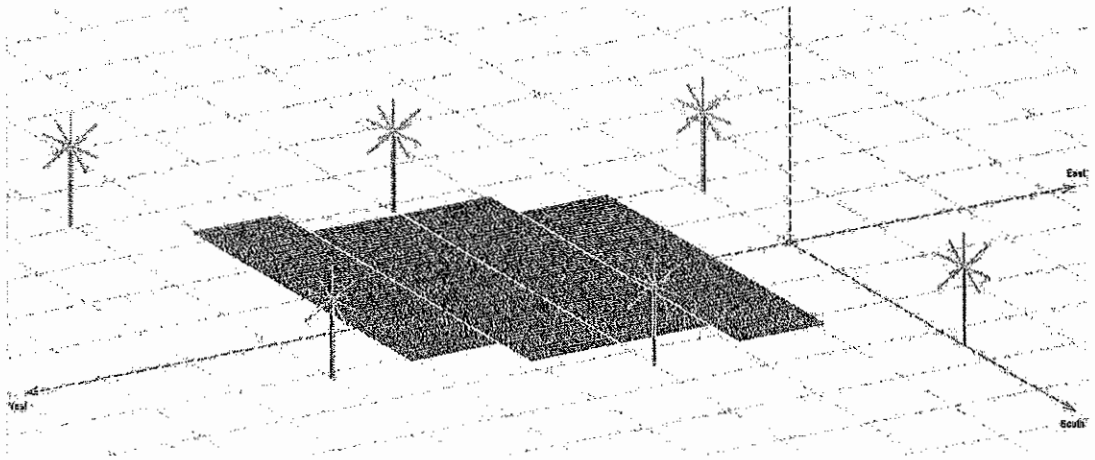


Fig 45 showing 3D Model and shading analysis carried out due to pylnons

The simulation was performed with PVSyst version 6.72, an application developed by the University of Geneva and PVsyst SA, Switzerland. The complete output of the simulation for the PV side can be found in Annexure E. The source data of the simulation is based on simulated half hourly data.

7.8.2 Technical losses because of dirt

Based on the company's extensive portfolio of plants, both those that reached the preliminary design stage and those fully constructed, ib vogt has developed a range for typical percentage losses due to dirt for certain climates. In this case, energy yield losses because of dirt on the modules were set at the higher end at 2.0% of the energy generation based on the scope of O&M, considering the prolonged dry seasons and low rainfall at the site, and scheduled module cleaning according to current operation and maintenance industry standards.

7.8.3 Technical losses because of fluctuations in module performance

Calculation models according to industry standards were applied for the modules. The current industry standard performance variation is typically at 0/+3%. To consider the gain of the positive sorting of modules the parameter 'module quality' was set to -0.5%. Losses due to mismatch effects are assumed to amount of 0.2% considering a low deviation of V_{MPP} and I_{MPP}. Accordingly the LID losses were set at 0.8%.

7.8.4 Technical losses because of cable losses

According to the proposed design specifications, the ohmic losses of the DC installations are set to 1.5% under STC conditions. The cable losses on the AC side were set at 1.0% under STC conditions. Further information on cable losses can be found in the simulation output in Appendix E.

7.8.5 Technical losses because of DC/AC inversion

Industry standard central inverters are chosen for the design and accordingly represented in the energy yield simulation. The operating characteristics of the inverter as for yield optimization by efficient MPP tracking could not be displayed in the simulation. The DC/AC ratio is 1.23. This ratio falls in line with many of the successfully operating solar farms across the globe, including solar farms commissioned by ibvogt. Short periods with overload are possible.

7.8.6 Technical losses because of transformation (transformer losses)

Losses of external transformers were set at with 0.1% for iron losses and 1.0% for resistive/inductive losses according to the widely-used industry standard equipment.

7.9 Irradiation conditions

For the simulation irradiation data from the provider SolarGIS for the years 1999 – 2018 at a resolution of 30 minutes was used. SolarGIS provides irradiation data based on calculations from satellite images. The spatial resolution is 1.5 arc-minutes (about 3 km right below the satellite at 0° N, 0° E).

The following figures shows Global Horizontal Irradiation, Diffused Horizontal Irradiation and Initial Diurnal air temperature at 2m height at Gwadar solar farm site.

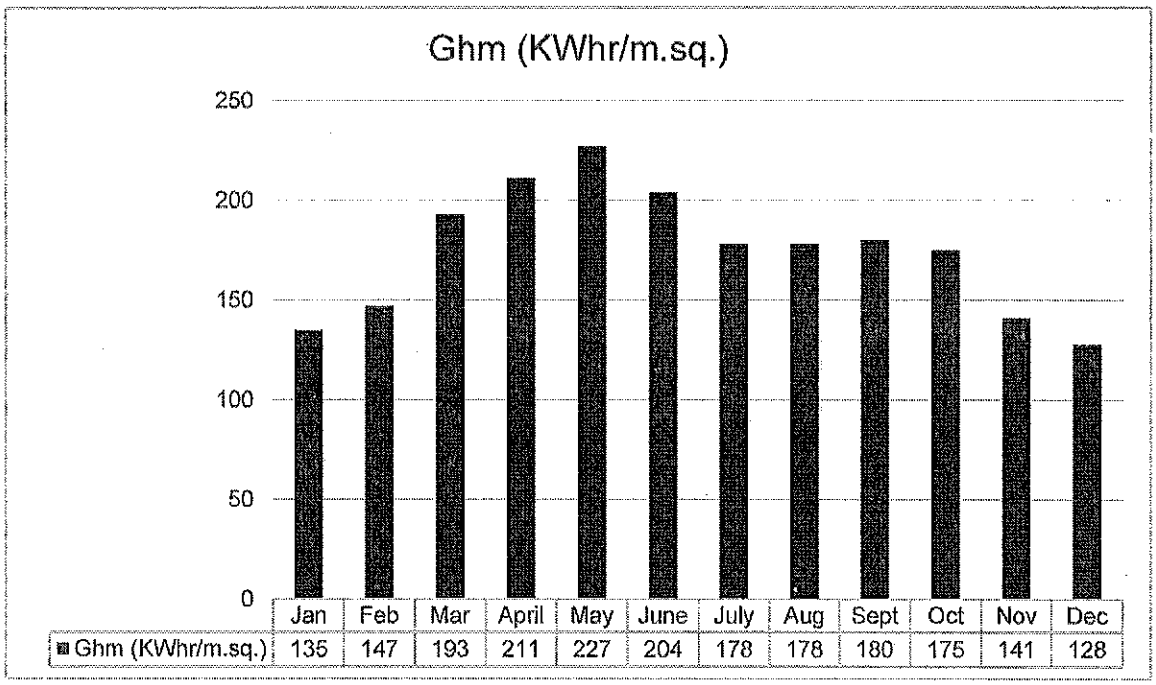


Fig 46 showing GHI values for Gwadar solar farm site

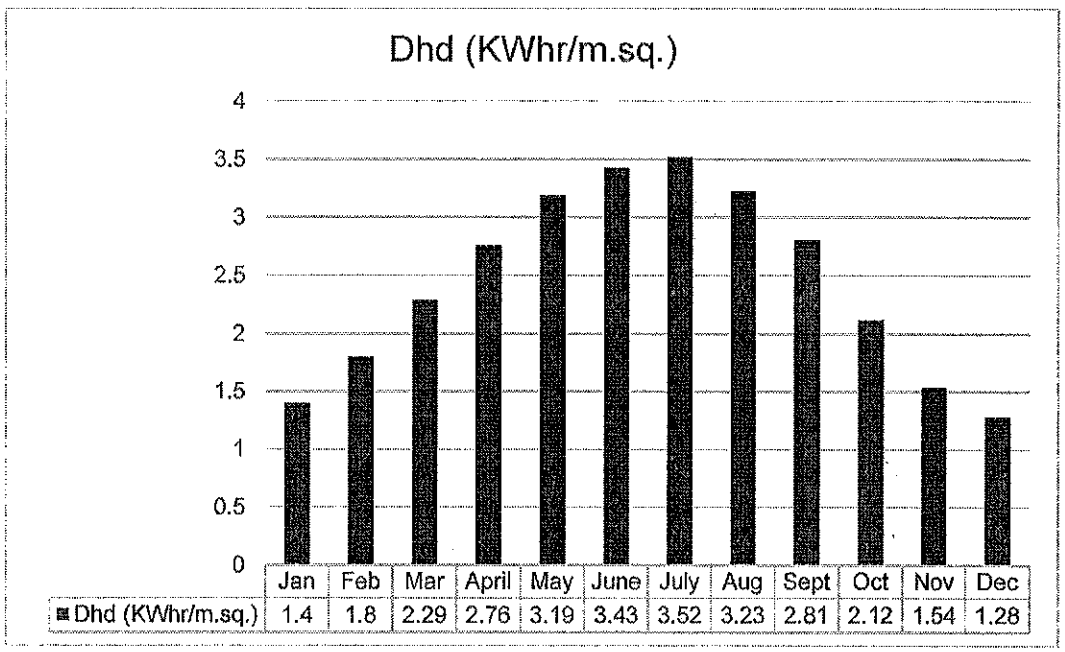


Fig 47 showing diffused horizontal irradiation values for Gwadar solar farm site

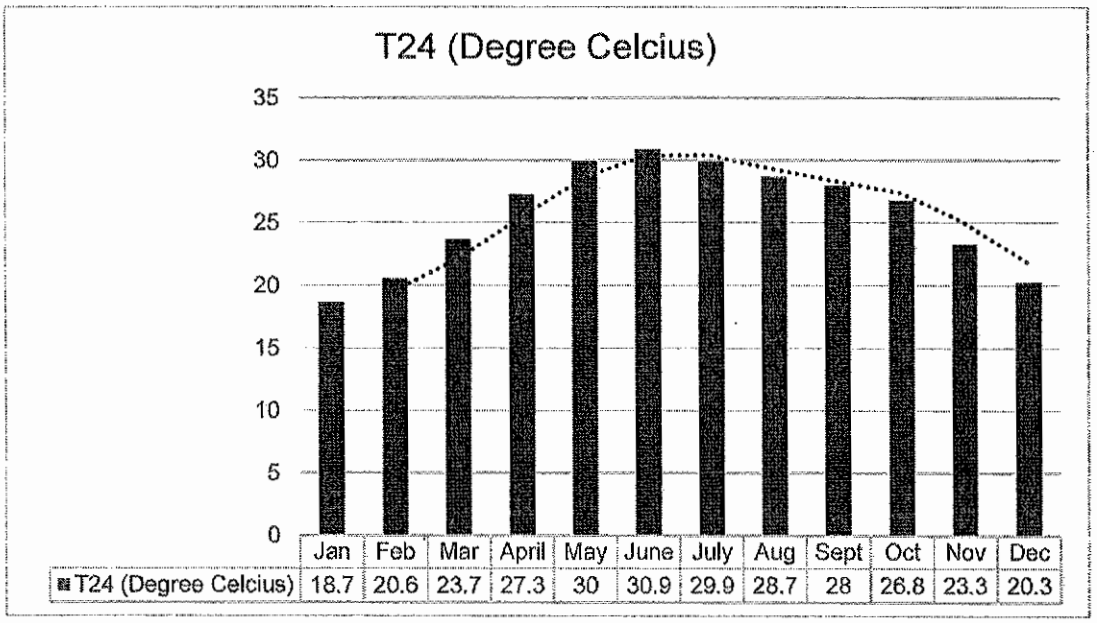


Fig 48 showing average diurnal air temperature at 2m

7.10 Energy Yield Prediction Results

The energy yield assessment was carried out using standard market software acceptable for 3rd party assessment. For yield assessment ibvogt engineers evaluate all possible solutions for system design using fixed tilt, seasonal tilt and single axis trackers.

All the specific yields were put into financial model to evaluate project feasibility and most feasible solution was than finalized for Gwadar solar farm project.

7.10.1 Fix Tilt System

As mentioned above, the energy yield calculation was performed using the software PVSyst 6.72.

To simulate the daily irradiation at Gwadar site, the percentage of diffuse radiation must be identified as per the Liu-Jordan correlations model. Then, the percentages of direct and diffuse radiation are applied to the inclination and adjustment of the solar generator as per the calculation model of Perez.

The hourly / daily variation in irradiance is based on a statistical method using daily values. This method traces back to the data evaluation of numerous weather stations worldwide. These results in a surface-factor applied for the variation in irradiance (irradiation on the horizontal or on the inclined module surface).

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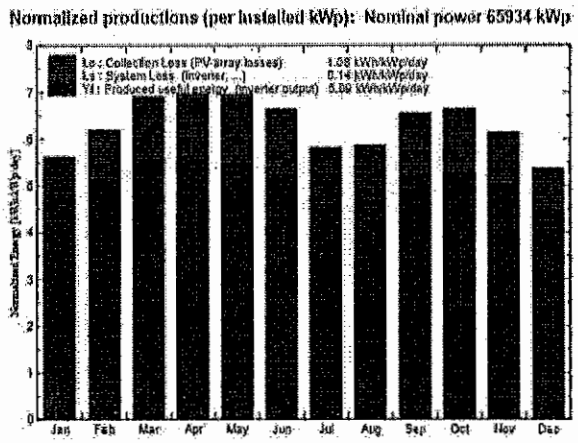
Grid-Connected System: Main results

Project : PAK_Gwadar
Simulation variant : South

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	Sheds disposition, tilt	20°	azimuth	0°
PV modules	Model	TSM-350DD14A(II)	Pnom	350 Wp
PV Array	Nb. of modules	188384	Pnom total	**65934 kWp**
Inverter	Model	SG2500HV-MV	Pnom	2500 kW ac
Inverter pack	Nb. of units	20.0	Pnom total	**50000 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results

System Production	**Produced Energy**	**122605 MWh/year**	Specific prod.	1859 kWh/kWp/year
	Performance Ratio PR	80.75 %		



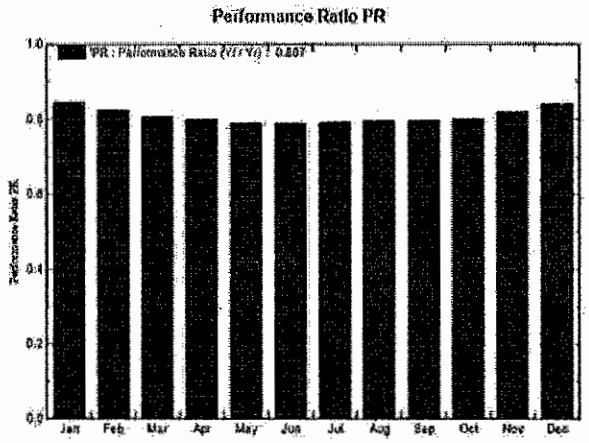


Figure 49 showing yield assessment of solar farm site for fixed tilt system

South

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	133.4	41.4	18.20	174.6	163.8	10003	9748	0.847
February	144.8	49.9	20.60	173.7	163.0	9704	9452	0.825
March	192.6	68.0	24.20	214.2	200.9	11702	11391	0.807
April	204.6	78.8	27.90	209.7	195.7	11346	11052	0.799
May	223.9	93.5	31.60	215.7	200.9	11511	11210	0.788
June	211.5	99.6	32.50	199.2	185.0	10641	10366	0.789
July	189.6	107.4	32.30	180.7	167.1	9686	9437	0.792
August	182.7	98.3	31.20	181.7	168.6	9790	9544	0.796
September	183.6	76.5	29.80	197.0	184.1	10625	10349	0.797
October	174.8	58.4	28.10	205.9	193.2	11152	10863	0.800
November	143.9	38.8	23.60	184.1	173.4	10233	9962	0.821
December	125.3	39.6	19.99	166.3	156.1	9475	9231	0.842
Year	2110.6	850.2	26.70	2302.9	2151.8	125866	122605	0.807

Legends:				
GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T Amb	Ambient Temperature	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	PR	Performance Ratio

Table 9 showing balances and main results of yield assessment for fixed tilt system

Annual Specific Yield for fixed tilt: 1859 kWh/kWp

Performance Ratio: 80.75%

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Grid-Connected System: Loss diagram

Project : PAK_Gwadar

Simulation variant : South

Main system parameters	System type	Grid-Connected		
PV Field Orientation	Sheds disposition, tilt	20°	azimuth	0°
PV modules	Model	TSM-350DD14A(II)	Pnom	350 Wp
PV Array	Nb. of modules	188384	Pnom total	**65934 kWp**
Inverter	Model	SG2500HV-MV	Pnom	2500 kW ac
Inverter pack	Nb. of units	20.0	Pnom total	**50000 kW ac**
User's needs	Unlimited load (grid)			

Loss diagram over the whole year

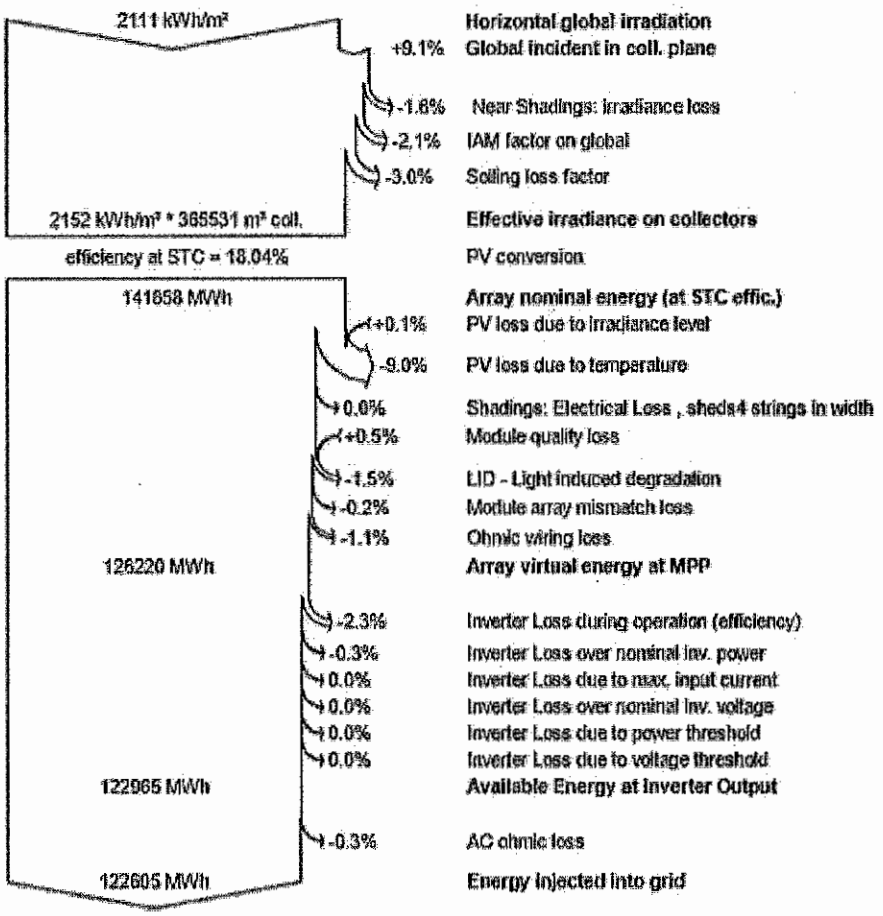

Figure 50 showing grid connected system loss diagram

7.10.2 Seasonal Tilt

To assess the suitable technical design for the site, additional seasonal tilt design was also prepared by ib vogt design team for comparison with Fixed Tilt and Single Axis tracker yields.

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Grid-Connected System: Main results

Project : PAK_Gwadar
Simulation variant : Seasonal Tilt

Main system parameters	System type	**Grid-Connected**		
Near Shadings	According to strings		Electrical effect	100 %
PV Field Orientation	Seasonal tilt: summer/winter	10°/30°	azimuth	0°
PV modules	Model	TSM-350DD14A(II)	Pnom	350 Wp
PV Array	Nb. of modules	188384	Pnom total	**65934 kWp**
Inverter	Model	SG2500HV-MV	Pnom	2500 kW ac
Inverter pack	Nb. of units	20.0	Pnom total	**50000 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**126393 MWh/year**	Specific prod.	1917 kWh/kWp/year
	Performance Ratio PR	80.43 %		

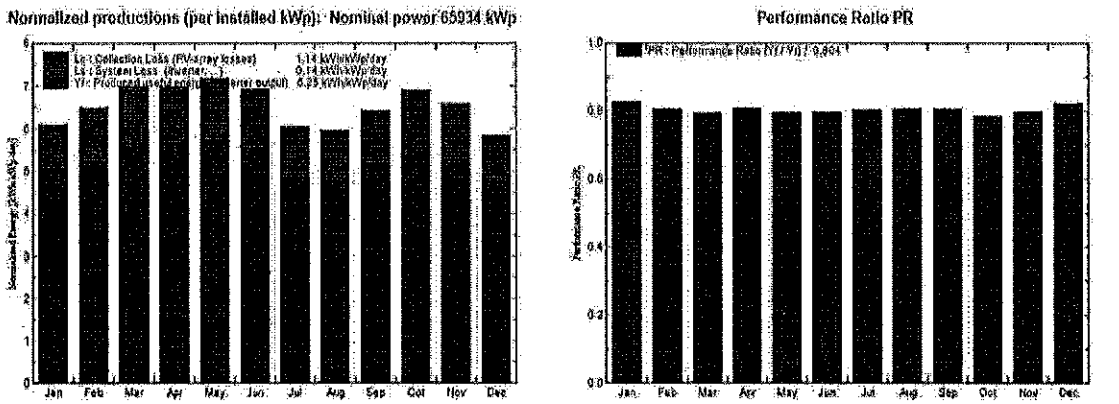

Figure 51 showing seasonal tilt, yield assessment for solar farm using manual seasonal tilt mounting structure

Seasonal Tilt

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	133.4	41.4	18.20	188.7	175.3	10559	10287	0.827
February	144.8	49.9	20.60	181.8	168.9	9931	9671	0.807
March	192.6	68.0	24.20	216.9	201.0	11685	11374	0.795
April	204.5	78.8	27.90	209.7	197.9	11479	11182	0.809
May	223.9	93.5	31.60	222.5	210.0	11997	11682	0.796
June	211.5	99.6	32.50	207.9	195.9	11232	10940	0.798
July	189.6	107.4	32.30	187.2	176.0	10177	9916	0.803
August	182.7	98.3	31.20	184.3	173.4	10062	9809	0.807
September	183.6	76.5	29.80	192.7	181.8	10526	10254	0.807
October	174.8	58.4	28.10	213.7	198.3	11375	11080	0.786
November	143.9	38.8	23.60	197.2	184.3	10685	10399	0.800
December	125.3	39.6	19.99	180.7	168.0	10061	9798	0.822
Year	2110.6	850.2	26.70	2368.4	2230.9	129770	126393	0.804

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T Amb	Ambient Temperature	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	PR	Performance Ratio

Table 10 showing balances and main results of yield assessment using manual seasonal tilt system

Annual Specific Yield for manual seasonal tilt: 2110 kWh/kWp

Performance Ratio: 80.43%

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Grid-Connected System: Loss diagram

Project : PAK_Gwadar

Simulation variant : Seasonal Tilt

Main system parameters	System type	Grid-Connected		
Near Shadings	According to strings		Electrical effect	100 %
PV Field Orientation	Seasonal tilt: summer/winter	10°/30°	azimuth	0°
PV modules	Model	TSM-350DD14A(II)	Pnom	350 Wp
PV Array	Nb. of modules	188384	Pnom total	65934 kWp
Inverter	Model	SG2500HV-MV	Pnom	2500 kW ac
Inverter pack	Nb. of units	20.0	Pnom total	50000 kW ac
User's needs	Unlimited load (grid)			

Loss diagram over the whole year

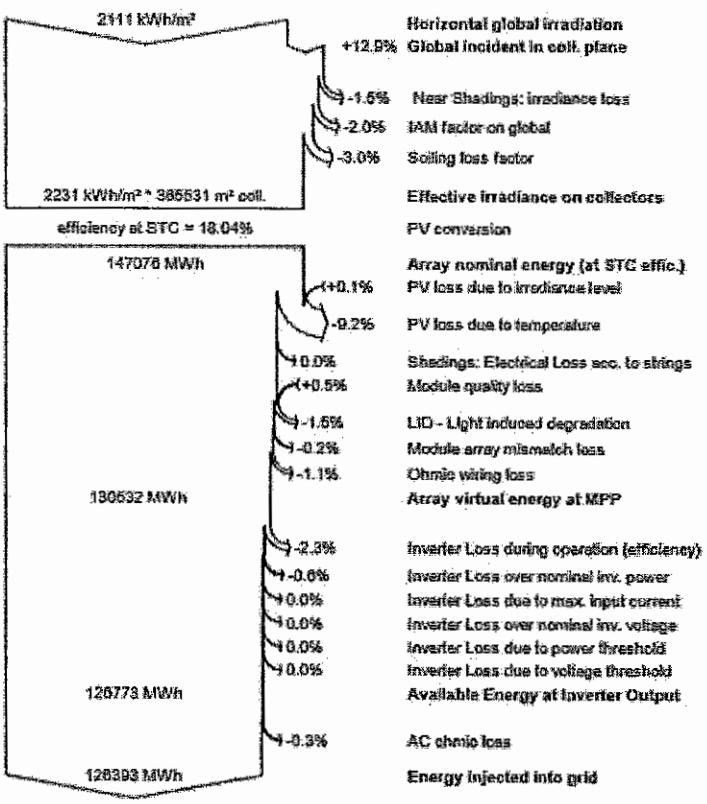

Figure 52 showing grid connected system loss diagram for Seasonal Tilt

7.10.3 Single Axis trackers

Single axis tracker design using bifacial module, was finally carried out to compare the yield output with Fixed tilt and Seasonal tilt.

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Grid-Connected System: Main results

Project : **PAK_Gwadar**

Simulation variant : **Tracker_7.5m_pitch**

Main system parameters	System type	**Trackers single array, backtracking**		
Near Shadings	Linear shadings			
PV Field Orientation	tracking, tilted axis, Axis Tilt	0°	Axis Azimuth	0°
PV modules	Model	LR6-72 BP 360 M	Pnom	360 Wp
PV Array	Nb. of modules	172872	Pnom total	**62234 kWp**
Inverter	Model	SG2500HV-MV	Pnom	2500 kW ac
Inverter pack	Nb. of units	20.0	Pnom total	**50000 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**134552 MWh/year**	Specific prod.	2162 kWh/kWp/year
	Performance Ratio PR	83.87 %		

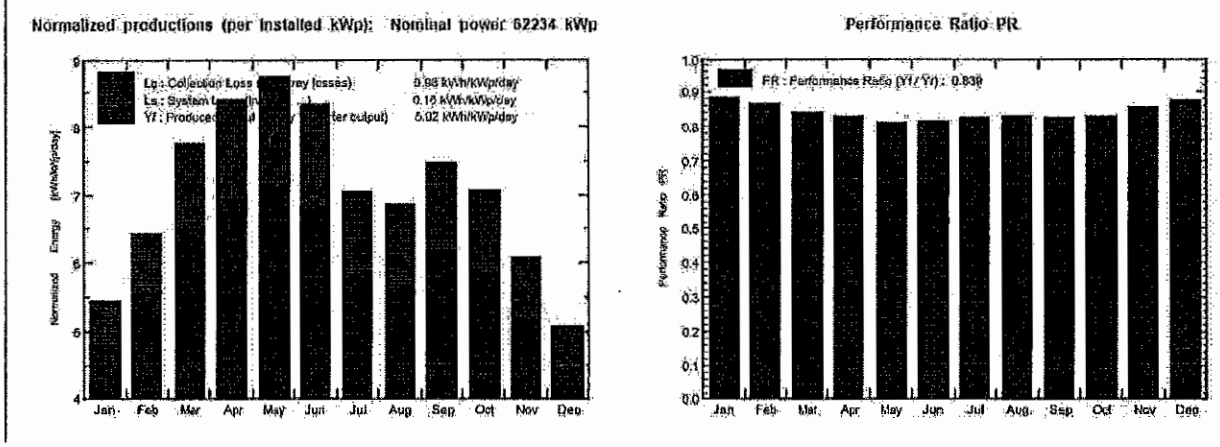


Figure 53 showing, yield assessment for solar farm using single axis trackers

Tracker_7.5m_pitch

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	133.4	41.4	18.20	169.3	156.9	9552	9315	0.884
February	144.8	49.9	20.60	180.4	167.7	9973	9713	0.865
March	192.6	68.0	24.20	240.1	223.3	12939	12591	0.843
April	204.5	78.8	27.90	252.3	234.7	13359	13007	0.828
May	223.9	93.5	31.60	271.0	251.9	14085	13711	0.813
June	211.5	99.6	32.50	260.3	241.5	13083	12740	0.818
July	189.6	107.4	32.30	218.2	200.5	11545	11246	0.828
August	182.7	98.3	31.20	212.8	195.7	11309	11023	0.832
September	183.6	76.5	29.80	224.0	207.7	11844	11536	0.828
October	174.8	58.4	26.10	219.0	203.6	11651	11351	0.833
November	143.9	38.8	23.60	182.7	169.8	9967	9707	0.854
December	125.3	39.6	19.99	157.6	145.7	8832	8611	0.878
Year	2110.6	850.2	26.70	2577.7	2389.0	138140	134552	0.839

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T Amb	Ambient Temperature	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	PR	Performance Ratio

Table 11 showing balances and main results of yield assessment using single axis trackers

Annual Specific Yield for Single Axis trackers: 2162 kWh/kWp

Performance Ratio: 83.87%

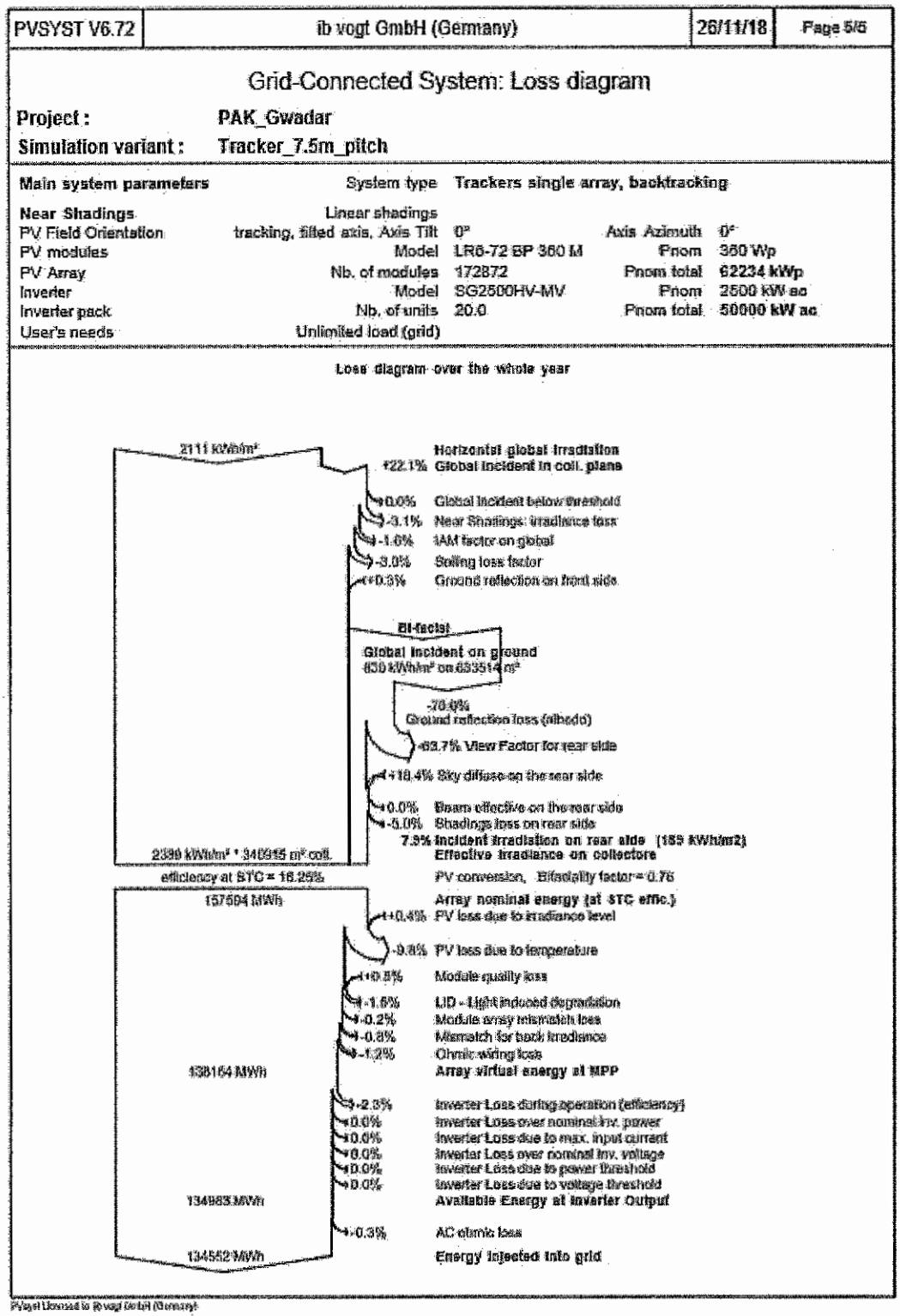


Figure 54 showing grid connected system loss diagram for single axis trackers

Summary:

The solar resource assessment for fixed tilt system, seasonal tilt and single axis tracker for Gwadar site shows that better yield can be achieved by using the single axis trackers.

Yearly yield for fixed tilt system = 1859 KWhr / KWp

Yearly yield for seasonal tilt system = 2110 KWhr / KWp

Yearly yield for single axis trackers = 2162 KWhr / KWp

From energy production point of view clearly single axis solution is more viable option, but it will also have a cost impact on the project. As mounting structure cost for single axis trackers is higher as compared to fixed tilt and manual seasonal tilt system. Also it will increase the operation and maintenance cost of the project per megawatt.

Single axis trackers can only become viable if the excess energy produced overcomes the increase project cost and gives better project IRR when compared with fixed tilt & Seasonal Tilt.

A detailed financial modeling needed to be carried out to support the better technical solution of single axis trackers.

8. Economic Analysis

The economic analysis of a project represents one of the main steps in the assessment of the project's feasibility. Based on the technical aspects of the solar farm design as well as the findings of earlier analysis, ib vogt has developed an in depth economic analysis for a Solar PV power plant to be set up at Gwadar, Baluchistan in Pakistan.

In addition to a project's viability analysis, different design options have been compared from a financial aspect, therefore optimizing the design and adding value to a potential project. During ib vogt's earlier high level analysis of the potential Gwadar project a comparison of technologies and varying system sizes had been conducted. As a solid result of the analysis, a single-axis trackers technology has been identified as optimal technology. Besides a higher financial profitability, the single-axis trackers system also has various advantages over a seasonal tilt system during both construction and operation & maintenance phase of the project.

8.1 Financial Model Assumptions

The analysis is carried out using a designated, industry standard financial model, which was designed to suit the project needs.

The figures used and the assumptions made in the economic analysis are based on ib vogt's experience with solar projects around the world, and most importantly the guidelines provided by NEPRA in order to determine the tariff. Moreover, the SBP's revised financing scheme for renewable energy projects has been thoroughly considered in regards to the debt financing terms. However, this preliminary economic assessment is provided to demonstrate the likely feasibility of the project, and the final financial parameters would emerge upon reaching the advanced stage of the project.

The installed capacity of this project is 62.2 MWp. Within the first year of operating period, the annual power production will be approx. 131,587 MWh. In the subsequent years of operation, the power production should reduce with the degradation factor of 0.5% pa (standard assumption). The construction period is considered ten months that is regarded as an ideal assumption for solar PV projects ranging from 50 MWp.

Inputs to the financial model are listed as follows.

8.1.1 Inputs

I. Total Project Costs

1. EPC Cost:

   Since the size of this project does not leverage the advantages associated to the economies of scale, for a 2019 built project modules' costs can be expected to be in the range of USD 0.30 per MW – USD 0.35 per MW. Nevertheless, the dramatic fall of EPC costs over the last few years allows a realistic assumption of EPC costs (including grid costs, inverter costs and balance of system (BOS) costs, contingency, etc.) to be at USD 0.786 per MW, when utilizing single-axis trackers technology and Tier-1 monocrystalline bifacial solar panels. Furthermore, the EPC price allows the choice of equipment and suppliers with recognized quality, performance and bankability.

   It has been noted that the Authority approved degradation factor of 0.5% in the latest cost-plus tariffs of solar technology, and hence, the aforementioned EPC costs of USD 0.786 per MW need to be adjusted for a degradation factor of 3.62% (levelized rate), either by increasing the EPC costs upfront or by making it a part of the approved total project cost based on the levelised rate of the EPC costs thereby adjusting the tariff. It is kindly requested that the authority shall consider this as a very important exercise. The table below details the components for EPC:

EPC	Costs (USD Million)
Module	21.148
Inverter	3.732
Mounting	8.9568
Monitoring	1.555
Civil	7.2152
Security	0.9952
Grid Cost	5.287
EPC Excluding Degradation	**48.89**
Degradation	1.77
Total Construction Phase (EPC) Cost	**50.66**

Table 12 showing EPC cost of project

Under the claimed EPC cost ibvogt Gmbh shall install the equipment of the following brands, however these are subject to change following the completion of project design:

No.	Equipment	Brands
1	PV Modules	Tier 1 (Hanwah Q-Cells, Jinko, Trina, Longi solar or similar)
2	Single-axis Tracker	Leading Global Supplier (Arctech, Soltec, Schletter etc)
3	Inverter	ABB, GE, Sungrow, etc
4	DC/AC brand	Faber or similar
5	Step – up transformers	Siemens, ABB, TBEA, QRE, Chint etc
6	Medium voltage switch gear and 132KV substation	Siemens, ABB, Chint etc
7	SCADA	Gatner, ABB, Schneider, etc
8	Civil works	ibvogt local entity or No limit local civil contractor
9	Project Management	Ibvogt Gmbh
10	Construction Supervision	Ibvogt Gmbh

Table 13 showing expected bankable equipment and service provider for the project

2. Land Cost:

The land for the project has already been determined at the rate of 58,128 PKR per acre amounting the land acquisition cost of approx. USD 100,000 for a total land area of 203 acres. The PKR/USD exchange rate is considered to be '120'.

3. Non-EPC and Project Development Cost:

Such costs intend to include all expenses related to development, licenses, permits, legal & tax advisor fees, due diligence costs and other establishment costs. Based on ib vogt's experience with solar projects around the world, the Non-EPC and Project Development Cost are assumed at USD 36,000 per MW (~USD 2.24 million).

4. Insurance During Construction:

As per the recently notified NEPRA Guidelines, the insurance cost during construction has been assumed as 0.5% of the proposed EPC Cost. Therefore, the total insurance cost for the construction period of 10 months is calculated as USD 0.25 million.

5. Financing Fees & Charges:

The NEPRA Guidelines suggest a financing fee to be 2.5% of debt amount. However, banks (specifically foreign lenders) levy some other charges in the form of lender's legal & technical advisor fee, upfront facility fee, commitment fee, agency fee etc. The amount under this head amounts to USD 1.19 million (at 3% of debt amount) containing the above fee. It is kindly requested that the authority shall assess the financing fee benchmark again based on actual costs.

6. Interest During Construction:

The interest during construction (IDC) is calculated as ~USD 1.7 million. This interest is determined on 6 month LIBOR 3.12% + Spread 4.5%. The financing parameters are discussed in the subsequent section.

As the above project costs under various heads is given hereunder:

Project Cost	(USD Million)
EPC Cost	50.66
Land Cost	0.1
Project Development Cost	2.24
Insurance during construction	0.25
Financing Fee & Charges	1.2
Interest During Construction	1.71
Total	**56.16**

Table 14 showing project cost breakdown

The table below details the components for Non-EPC:

Non-EPC	Costs (USD Million)
Project Development Cost	2.24
Land Acquisition	0.1
Insurance During Construction	0.25
Financial Charges	1.2
Total Non EPC Cost	**3.79**

Table 15 showing Non EPC cost breakdown

II. Capacity Utilization Factor

A capacity utilization factor of 24.15% is targeted to be achieved by installing the latest equipment including the sun tracking system. The capacity utilization factor is 6.15% higher than the NEPRA benchmark of 18% for the Southern region, this signifies the cutting edge solar technology being used in the local context.

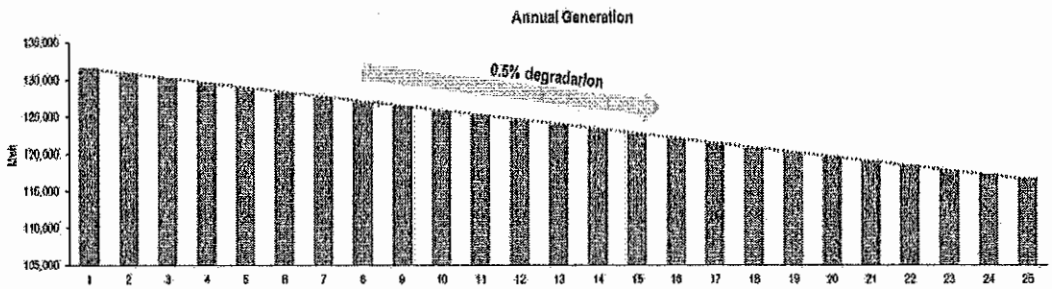
The table below details the Capacity:

Capacity/ Size	Units	Amount
Plant Size	MWp	62.2
Capacity Utilization Factor	%	24.15%
Annual Generation	MWh Year	131587

Table 16 showing Plant size, CUF and annual generation

III. Degradation Factor

The degradation factor of 0.5% has been incorporated in the workings and has been done so in light of NEPRA's approvals of past projects, and this level being allowed in different parts of the world.



The annual generation Fig 55 shows a downward trend due to 0.5% degradation per annum.

IV. Total Operating Costs

1. Operation & Maintenance (O&M) Costs:

The O&M costs here include various annual costs related to operation & maintenance, inverter/spare part reserve, asset management, accounting & legal, utilities, security, facility fee and other operating expenses. These costs commonly are one of the strongest drivers of project's annual operating expenditures and are strongly linked to country specific factors. The calculated tariff is based on annual O&M costs of USD 0.02 million/MW.

O&M Assumptions	Period	USD / MW
O&M Foreign	Per Year	7000
O&M Local	Per Year	11000
Total		**18000**

Table 17 showing O&M cost breakdown

2. Insurance During Operation:

As per the recently notified NEPRA (Benchmarks for Tariff Determination) Guidelines, the insurance cost during operation has been assumed as 0.5% of the proposed EPC Cost. Therefore, the annual insurance cost during operation is calculated as USD 0.25 million.

V. Financing Parameters

The assumed financing terms for modelling and analysis purpose are primarily based on the previous approvals by NEPRA, SBP's revised financing scheme for renewable energy projects, and upon conducting initial market study.

VI. Financing/ Debt Terms

A debt to equity ratio of 75% is assumed in the financial model. The interest rate for the debt financing is set based on LIBOR plus 4.5% per year. The loan tenor is calculated as of 14 years. Moreover, the debt is assumed 100% foreign. The premium of 4.5% has been based on the most recent cases of comparable renewable technologies.

Furthermore, as an industry standard and additional security for the lender, the required Debt Service Reserve Account (DSRA) equivalent to 6 months' debt installment will be funded from the operating cash flow of the initial years.

VII. Revenues

Based on the Capacity Utilization Factor of 24.15% for this project and the industry standard assumption on an availability factor of 98% for single-axis trackers design, the first year power production would be approx. 131,587 MWh. However, this scenario assumes the NEPRA tariff will be adjusted for the loss in production due to degradation. Consequently, the degradation is set to 0.5% to compute revenues for the plant's operating life of 25 years. The amount of USD 1.769 million has been made part of the approved project cost based on the levelized rate of 3.62% of the allowed EPC cost.

The tariff for this project has been calculated based on NEPRA tariff methodology while assuming the return on equity at 18% and determined total project costs (including the adjusted for degradation). The revenues are based on the tariff of US Cents 6.698 per Kwh during the debt-servicing period and US Cents 2.996 per Kwh thereafter, for electricity injected into the grid. **This leads to a levelised tariff of US Cents 6.0 per Kwh.** For details relating to the tariff calculation, please refer to the respective excel workbook. The authority shall kindly note that the project is located in the Southern Pakistan where solar irradiance levels are higher, thus a lower tariff shall be applied for the same.

All Cash Flows are calculated on a yearly basis and the project lifetime is fixed at 25 years. Furthermore, a corporate tax rate of 0% is assumed since profits derived from renewable electric power generation are exempt from tax in Pakistan.

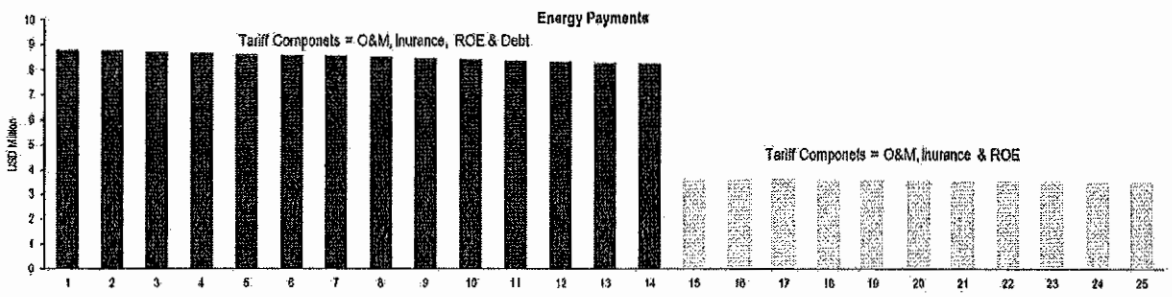


Fig 56 shows tariff loading due to debt component

For the stipulated period of year 1-14 the tariff component will be relatively higher as it contains the Debt component, however after the debt servicing period the Tariff component will fall as the Debt service period shall end.

VIII. Return on Equity

The return on equity at 18% on IRR basis has been assumed for Tariff calculation.

IX. Construction Period

The construction period has been set at 10 months. Similar sized projects also opted for upfront tariff with a construction period of 10 months. This duration has been set in light of previous approvals by NEPRA.

The following details the generation tariff alongside the terms of ibvogt Gmbh:

Tariff Components	Year 1-14	Year 15-25
[illegible]	0.8508	0.8508
[illegible]	0.1925	0.1925
[illegible]	1.78	1.78
[illegible]	3.7014	-
[illegible]	**6.5247**	**2.8233**

Table 18 showing tariff components

- Levelized tariff works out to be US Cents 6.0 per Kwh
- The aforementioned tariff is applicable for twenty-five (25) years
- Debt service shall be paid in the first 14 years of commercial operation of the plant
- Debt Servicing has been worked out using six months LIBOR (3.12%) + Spread (4.5%).
- Debt to Equity of 75:25 has been used
- Return on Equity during construction and operation of 18% has been used.
- Construction period of ten (10) months has been allowed for the workings of ROEDC and IDC
- Insurance during Operation has been calculated as 0.50% of the allowed EPC Cost.
- Reference Exchange Rates of 120 PKR/USD has been used.
- Detailed component wise tariff Schedule is attached as Annex-I of this Economic Analysis

8.2 Profitability Analysis

The table below summarizes the assumptions of the various costs determined for this project, and the aforementioned KPIs obtained as a result of financial modelling & project valuation in regards to profitability.

When analyzing the cash flows to equity on a yearly basis as graphed in the figure below, the cash flows are levelised with the first 14 years representing the years in which the higher tariff is received and the debt service payments are applicable. Furthermore, it can be observed that the real cash flows to equity are considerably higher during the first 14 years of operation (debt service period) than those in later years. It is due to the decreasing energy production over the years (0.5% degradation) and the lower tariffs post-debt servicing.

Summary

Project Company	P&G Energy Pvt Ltd	
Sponsor	Ibvogt	
Capacity	62.2 DC ~ 50MW AC	
Project Location	Gwadar, Baluchistan	
Concession period	25 years	
Capacity Factor	24.15%	
Project Cost	**USD (Million)/MW**	
EPC Cost	48.89	
Degradation	1.77	
Adjusted EPC Cost	50.66	
Project Development Land Cost	0.1	
Pre-COD Insurance cost	**Included in EPC cost figure**	
Financing fee & charges	253,295	
Interest during construction	1,708,656	
Total Project Cost	**56,158,298**	
Financing structure	Debt: 75% Equity: 25%	
Debt composition	100% Foreign	
Interest rate	6 month LIBOR + 4.5% pa	
Debt repayment term	14 years	
Repayment basis	Semi-Annual	
Return on Equity	18%	
Operations cost including insurance	**26,626,538**	
Tariff:	**PKR/Kwh**	**US Cents/ Kwh**
Year (1-14)	8.04	6.698
Year (15-25)	3.6	2.996
Levelized Tariff	**7.2**	**6**
Exchange Rate	1 USD=120 PKR	

Table 19 showing project financial overview

Tariff Sheet:

Concession period	US Cents per Kwh									Total Tariff US Cents per Kwh
	O&M - Foreign	O&M – Local	Insurance during Operations	ROE	ROEDC	Foreign Debt Service		Local Debt Service		
						Financial charges	Principal payment	Financial charges	Principal payment	
1	0.3309	0.5200	0.1925	1.78	0.175	2.3311	1.3703	-	-	6.698
2	0.3309	0.5200	0.1925	1.78	0.175	2.2284	1.4730	-	-	6.698
3	0.3309	0.5200	0.1925	1.78	0.175	2.1180	1.5834	-	-	6.698
4	0.3309	0.5200	0.1925	1.78	0.175	1.9993	1.7021	-	-	6.698
5	0.3309	0.5200	0.1925	1.78	0.175	1.8717	1.8297	-	-	6.698
6	0.3309	0.5200	0.1925	1.78	0.175	1.7346	1.9668	-	-	6.698
7	0.3309	0.5200	0.1925	1.78	0.175	1.5871	2.1143	-	-	6.698
8	0.3309	0.5200	0.1925	1.78	0.175	1.4287	2.2727	-	-	6.698
9	0.3309	0.5200	0.1925	1.78	0.175	1.2583	2.4431	-	-	6.698
10	0.3309	0.5200	0.1925	1.78	0.175	1.0752	2.6262	-	-	6.698
11	0.3309	0.5200	0.1925	1.78	0.175	0.8783	2.8231	-	-	6.698
12	0.3309	0.5200	0.1925	1.78	0.175	0.6667	3.0347	-	-	6.698
13	0.3309	0.5200	0.1925	1.78	0.175	0.4393	3.2622	-	-	6.698
14	0.3309	0.5200	0.1925	1.78	0.175	0.1947	3.5067	-	-	6.698
15	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
16	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
17	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
18	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
19	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
20	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
21	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
22	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
23	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
24	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
25	0.3309	0.5200	0.1925	1.78	0.175	-	-	-	-	2.996
	0.3309	0.5200	0.1925	1.7782	0.1746	1.3426	1.6614	-	-	**6.000**

Table 20 showing project tariff sheet

A047413

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0124703

I hereby certify that P&G ENERGY (PRIVATE) LIMITED is this day incorporated under the Companies Act, 2017 (XIX of 2017) and that the company is limited by shares.

Given under my hand at Islamabad this Fifth day of October, Two Thousand and Eighteen

Incorporation fee Rs. 2000.0/= only

(Khanda Parveen)
Joint Registrar
Islamabad

CERTIFIED TO BE TRUE COPY
30/8/19
Assistant Registrar
Regional Office Islamabad

No. ADI 43635

Dated 30/8/2019

COMPANIES ACT, 2017

MEMORANDUM OF ASSOCIATION

OF

P&G ENERGY (PRIVATE) LIMITED

1. The name of the company is **P & G ENERGY (PRIVATE) LIMITED.**

2. The registered office of the Company will be situated in Islamabad Capital Territory.

3. (i) The principal line of business of the company shall be to carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply, subject to permission of concerned authorities; and to locate, establish, construct, equip, operate, use, manage and maintain solar power plants, thermal power plants, coal fired power plants, hydal power plants, wind mills, power grid station, 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 and necessary devices, showrooms, depots, factories, workshops, plants and to provide transforming, switching, conversion and transmission facilities, subject to permission of relevant authorities.

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

(iii) Notwithstanding anything contained in the foregoing sub-clauses of this clause nothing contained herein shall be construed as empowering the Company to undertake or indulge, directly or indirectly in the business of a Banking Company, Non-banking Finance Company (Mutual Fund, Leasing, Investment Company, Investment Advisor, Real Estate Investment Trust management company, Housing Finance Company, Venture Capital Company, Discounting Services, Microfinance or Microcredit business), Insurance Business, *Modaraba*

management company, Stock Brokerage business, forex, managing agency, business of providing the services of security guards or any other business restricted under any law for the time being in force or as may be specified by the Commission.

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

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

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

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

4. The liability of the members is limited.

5. The authorized capital of the company is PKR 100,000/- (Pak Rupees One Hundred Thousand only) divided into 10,000/- (Ten Thousand) ordinary shares of PKR 10/- (Pak Rupees Ten only) each.

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

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father's/ Husband's Name in full	Nationality (ies) with any former Nationality	Occupation	Usual residential address in full or the registered/principal office address for a subscriber other than natural person.	Number of shares taken by each subscriber (in figures and words)	Signatures
IBV GWADAR HOLDCO 1 LIMITED THROUGH CARL FRIEDRICH EDLER VON BRAUN VIDE BOARD RESOLUTION DATED AUGUST 14, 2018	11357474 C84PRLM13	NA Franz Josef Von Braun	British German	Businessman	Murrell Associates Limited, 14 High Cross, Truro, Cornwall, TR1 2AJ, United Kingdom Ferdinand-Lassalle-Strasse 15, 04109 Leipzig, Germany	5100 (Five Thousand One Hundred)	-sd-

IBV GWADAR HOLDCO 2 LIMITED THROUGH CHARLES ANTON MILNER VIDE BOARD RESOLUTION DATED AUGUST 14, 2018	11357495 525622078	NA Karl Milner	British British	 Businessman	14 High Cross, Truro, Cornwall, TR1 2AJ, United Kingdom Pfalzburger Straße 60, 10717 Berlin, Germany	2900 (Two Thousand Nine Hundred)	-sd-
PAKISTAN TESTING SERVICE (PRIVATE) LIMITED THROUGH SALAR KHAN SANJRANI VIDE BOARD RESOLUTION DATED AUGUST 10, 2018	0090867 54103-7208000-1	NA Muhammad Asif	Pakistani Pakistani	 Entrepreneur	3rd Floor, Adeel Plaza, Fazal-e-Haq Road, Blue Area, Islamabad, Pakistan H.No.13-A, Street 31, Sector F-8/1, Islamabad	2000 (Two Thousand)	-sd-
		Total number of shares taken (in figures and words)				10000/- (Ten Thousand Only)	

Dated the 13 day of September, 2018

No. ADL 43635
Dated 30/9/2019

CERTIFIED TO BE TRUE COPY

Assistant Registrar
Company Registration Office Islamabad

COMPANIES ACT, 2017

ARTICLES OF ASSOCIATION

OF

P&G ENERGY (PRIVATE) LIMITED

1. The Regulations contained in "Table A" to the First Schedule to the Companies Act, 2017 (the "**Act**") shall be the regulations of **P&G ENERGY (PRIVATE) LIMITED** (the **"Company"**) so far as these are applicable to a private company.

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

   i. No invitation shall be made to the public to subscribe for the shares or debentures of the Company;

   ii. The number of Members in the Company is restricted to fifty (50) excluding the persons who are in the employment of the Company; provided that where two or more persons hold one or more shares in the Company jointly they shall be treated as a single member; and

   iii. The right to transfer the shares in the Company is restricted in the manner and to the extent appearing herein.

TRANSFER OF SHARES

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

DIRECTORS

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

a) Salar Khan Sanjrani;
b) Carl Friedrich Edler Von Braun; and
c) Charles Anton Milner;

We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a company, in pursuance of these 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 foreigner, Passport No)	Father's/ Husband's Name in full	Nationality (ies) with any former Nationality	Occupation	Usual residential address in full or the registered/principal office address for a subscriber other than natural person.	Number of shares taken by each subscriber (in figures and words)	Signatures
IBV GWADAR HOLDCO 1 LIMITED THROUGH CARL FRIEDRICH EDLER VON BRAUN VIDE BOARD RESOLUTION DATED AUGUST 14, 2018	11357474 C84PRLM13	NA Franz Josef Von Braun	British German	Businessman	Murrell Associates Limited, 14 High Cross, Truro, Cornwall, TR1 2AJ, United Kingdom Ferdinand-Lassalle-Strasse 15, 04109 Leipzig, Germany	5100 (Five Thousand One Hundred)	-sd-

IBV GWADAR HOLDCO 2 LIMITED THROUGH CHARLES ANTON MILNER VIDE BOARD RESOLUTION DATED AUGUST 14, 2018	11357495 525622078	NA Karl Milner	British British	 Businessman	14 High Cross, Truro, Cornwall, TR1 2AJ, United Kingdom Pfalzburger Straße 60, 10717 Berlin, Germany	2900 (Two Thousand Nine Hundred)	-sd-
PAKISTAN TESTING SERVICE (PRIVATE) LIMITED THROUGH SALAR KHAN SANJRANI VIDE BOARD RESOLUTION DATED AUGUST 10, 2018	0090867 54103-7208000-1	NA Muhammad Asif	Pakistani Pakistani	 Entrepreneur	3rd Floor, Adeel Plaza, Fazal-e-Haq Road, Blue Area, Islamabad, Pakistan H.No.13-A, Street 31, Sector F-8/1, Islamabad	2000 (Two Thousand)	-sd-
		Total number of shares taken (in figures and words)				10000/- (Ten Thousand Only)	

Dated the 13th day of September 2018

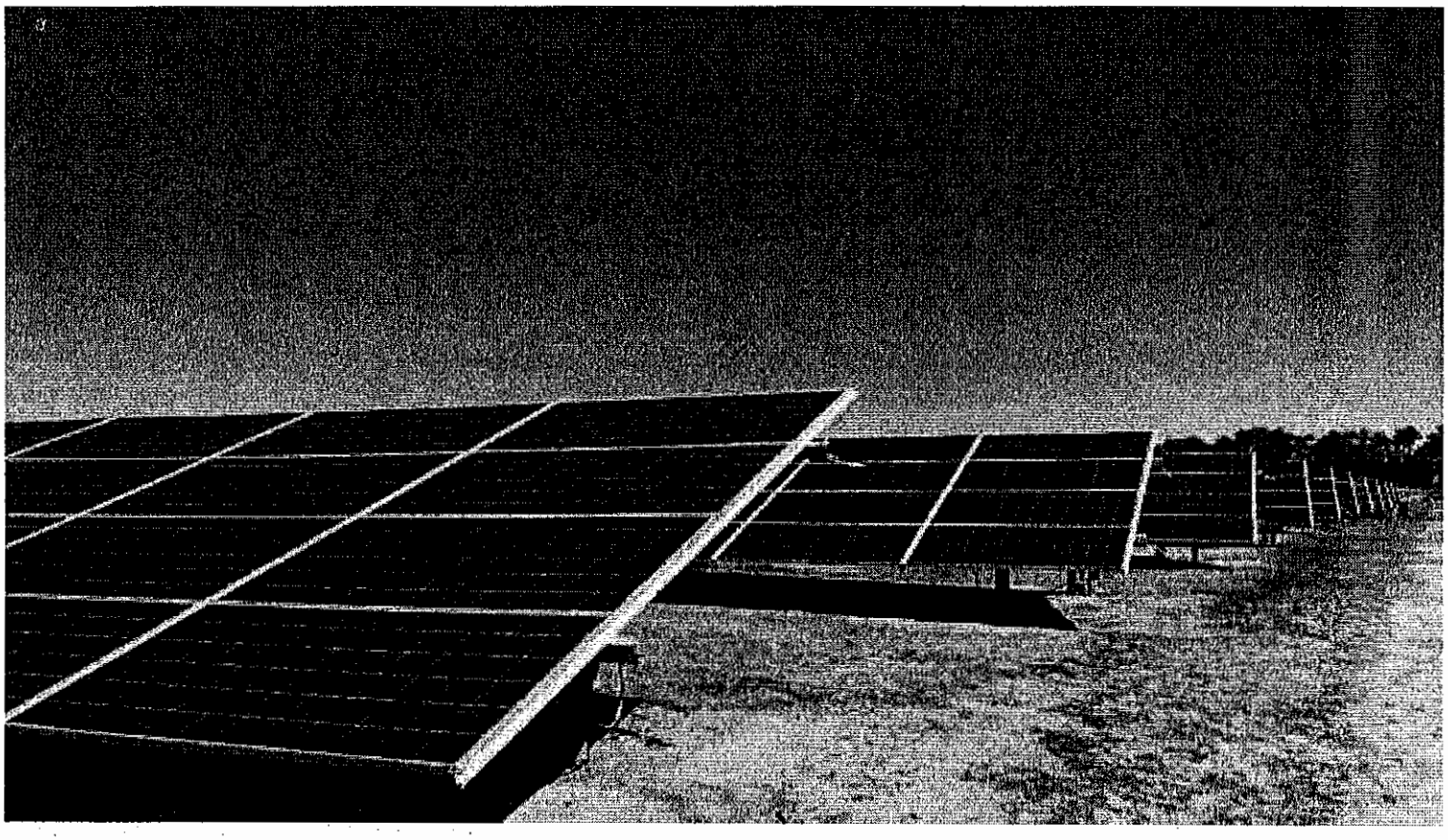
No. ADI 42335
Dated 30/10/19

CERTIFIED TO BE TRUE COPY

Assistant Registrar
Company Registration Office, Islamabad

P&G Energy

INITIAL ENVIRONMENTAL EXAMINATION (IEE) OF 50 MW AC ~ 62.2 MW DC, SOLAR POWER PROJECT IN GWADAR - BALOCHISTAN, PAKISTAN



CAS-P&G-11-2018
November, 2018

Conformity, Assessment & Sustainability Services Company

Project Proponent

P&G ENERGY (PRIVATE) LIMITED

Environmental Consultant

Conformity, Assessment & Sustainability Services Company (CASSCO)

Disclaimer

Conformity, Assessment & Sustainability Services Company (CASSCO) has documented this report in accordance with the requirement of Balochistan Environmental Protection Agency for the purpose of

seeking approval of 50 MW AC Solar PV Power Project from Environmental Protection Agency. This document and its contents remains the property of P&G Energy (Private) Limited and for it specific use. Any unauthorized use or reproduction, in full or in part is forbidden. Any persons, companies or institutions that may use any information contained herein will do so at their own risk.

Limitation

The IEE report has been prepared for P&G Energy (Pvt.) Limited, according to their instructions to support a resource consent application. The document is compiled on the basis of information provided by P&G Energy management. CASSCO has independently visited the site for assessment purposes. The provided information has relied upon it being accurate and sufficient for use in preparing the report. CASSCO accepts no responsibility for errors or omissions in the provided information

Document Authorization

Title	IEE of 50 MW AC ~ 62.2 MW DC Solar PV Power Project in Gwadar, Balochistan – Pakistan		
Doc. Number:	CAS-P&G-11-2018	Document Version:	01
Abstract:	This document is an "Initial Environmental Examination" (IEE) report of 50 MW AC ~ 62.2 MW DC Solar PV Power Project to be commissioned in Gwadar, Balochistan – Pakistan. Project proponent is P&G Energy (Pvt.) Limited, while the report has been prepared by Conformity, Assessment & Sustainability Services Company (CASSCO).		
Prepared By:			
	Dr. Hashim Zuberi Technical Advisor	**Jennifer Dean** Technical Manager	**Syed Yasir** Sr. Environmentalist
Reviewed By:			
	Dr. Amin Qureshi Technical Advisor	**Zeeshan Ansari** Operations Manger	
Approved By:			
	Project Manager	Project Head	

Date:
25th November, 2018

Project Proponent Contact Details			
Company	P&G Energy Private Limited		
Address:	3rd Floor Adeel Plaza, Fazal e Haq Road, Blue Area Islamabad Urban Islamabad Capital Territory (I.C.T.) 44000 Pakistan		
Contact Person:	Adeel Ahmed	Designation:	Manager Business Development
Telephone No.	+447419126766	Fax No.	+49 30 397440-10
Email:	adeel.ahmed@ibvogt.com		

Project Consultant Details			
Company	Conformity, Assessment & Sustainability Services Company (CASSCO)		
Address:	Suite 203, 2nd Floor, Mashriq Center Block-14, Gulshan-e-Iqbal, Karachi		
Contact Person:	Zeeshan Ansari	Designation:	Operations Manager
Telephone No.	+92 (21) 34890766	Fax No.	+92 (21) 34890001
Email:	zansari@cassco.com.pk, cas@cassco.com.pk		

List of Abbreviations

BOD	Biological Oxygen Demand
CITES	Convention on International Trade in Endangered Species
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CSR	Corporate Social Responsibility
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GoP	Government of Pakistan
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
KW	Kilo Watt
MEA's	Multilateral Environmental Agreements
MSDS	Material Safety Data Sheet
NCS	National Conservation Strategy
NEQS	National Environmental Quality Standards
NGO	Non-governmental Organizations
NIOSH	National Institute of Occupational Safety & Health
NO_x	Oxides of Nitrogen
O&M	Operations & Maintenance
OSHA	Occupational Safety & Health Administration
PEPA	Pakistan Environmental Protection Act
PH	Power of Hydrogen
PM	Particulate Matter
SDS	Safety Data Sheet
BEPA	Balochistan Environmental Protection Agency
SO_x	Oxides of Sulphur
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UNFCCC	UN Framework Convention on Climate Change

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EXECUTIVE SUMMARY

Introduction

Pakistan aims to reduce its reliance on hydrocarbons, especially imported coal, oil and gas to around 60% by 2025 from the present 87%. The country has a target to produce 10% of its total energy mix from renewables (excluding hydropower, which already constitutes 15% of the total energy mix). The current generation from renewable energy is around 1-2%.

While Pakistan contributes less than 1% to global GHG output, the country's carbon emissions are growing by 3.9% a year. By 2020 it will spew out 650 million tonnes of CO2e (carbon dioxide equivalent) if the current trend continues[1].

In the current scenario of energy crises in Pakistan, the proponent of the project i.e P&G Energy (Private) Limited has obtained a "Letter of Intent (LOI)" from BPDB (Balochistan Power Development Board) - Energy Department for establishing a project of Solar Farm in Gwadar, Balochistan – Pakistan.

P&G Energy Pvt. Ltd., is a special purpose vehicle/project company incorporated with Securities and Exchange Commission of Pakistan to undertake the solar farm business in Pakistan. P&G Energy Pvt. Ltd., is a subsidiary of ib vogt GmbH, an international solar farm developer. ib vogt GmbH started the SPV incorporation process with SECP, after pre-qualification from Balochistan Power Development Board as a prerequisite of Letter of Interest (LOI), for setting up a 50 MW AC Solar project in District Gwadar. For developing PV plants in its network, ib vogt takes all regulatory, legal, technical and economic factors into consideration, investing in local development partnerships and contributing to international expertise, from site selection and permitting to grid connection and PPA´s.

The project feasibility study will be completed shortly and the tariff petition will be filed with NEPRA. The capacity of Project's power product will be 50 MW AC ~ 62.2 MW DC. The Solar Farm's energy production will be around 132752 MWh/year. The Quetta Electric Supply Company (under Central Power Purchase Agency Umbrella) will purchase energy at a levelized

[1] said climatologist Qamar-uz-Zaman Chaudhry, the UN secretary general's special advisor for Asia with the World Meteorological Organisation

tariff i.e 6.1 USD cents/KWhr. The grid is located 1-2 Km away from site. The construction of the project will be completed in 18 months after issuance of LOS and the project's life will be around 25 years.

The total expanse of land area for establishing the solar farm is 230 Acres, while the proposed Solar Panel Installation Area is estimated to be 67.8 Acres that will be particularly covered with Solar Panels. The site excavation works will only include 1-1.5m cable trenches that will be needed for site excavation work. Financial close will be achieved after almost 9 months after issuance of LOS, while agreed terms sheet for debts (if any) will be issued at the time of financial close date.

The project cost at 52.248 Million USD. The Funding plan includes Bank financing @ 20%-80% Equity Debt Ratio. Achievement or Commercial Operation Date (COD) is November 2020. The solar power project will provide clean and sustainable energy to the national grid and will contribute to prevent air pollution from emissions by nonrenewable resources.

This report is the Initial Environmental Examination (IEE) of the proposed solar farm project for subsequent submission to Balochistan Environment Protection Agency and is documented according to the Pakistan Environment Protection Act, 1997. The IEE report reviews information on existing environmental attributes of proposed project area including background information on geological, hydrological, ecological features, air quality, noise, water resources, soils textures, social and cultural aspects etc. The report discusses probable impacts on the environment due to the proposed project activities. This IEE report also recommends environmental mitigation measures within its Environmental Management Plan.

Objectives of the Project

The main objectives of the project are:

- Contribute to meet the electricity supply deficit in project area in particular; and country in general.
- Provide electricity to stimulate and support the expansion of local industry and service businesses.
- By using amply available renewable resource of power generation, avoid depletion of natural resources for future generation and environmental stability.
- Create employment opportunities during construction and operations and also provide opportunities for developing ecotourism.
- Contribute to improved electricity supply service delivery to a limited extent specifically having a wide rural outreach.
- Improve microeconomic efficiency of the power sector by reducing fossil fuel usage.
- Reduce greenhouse gas emissions from conventional power generation and emit negligible emissions, effluent and solid wastes etc..
- Conserve natural resources including land, forests, minerals, water and ecosystems.
- Develop the local economy, particularly in rural areas and in a district that is considered as backward area, which is a priority concern of the Government of Pakistan.

Overview of Proposed Solar Farm Project of 50 MW AC – Technical details

Proposed Solar Farm project will be using LR6-72BP 355~375 Model by LONGiSolar.

Geographical coordinates

Country:	Pakistan	Latitude:
Address:	Gwadar	Longitude:
		Altitude:

Areas

Field no.	PV Area [m²]	Fenced Area [m²]	Fence Length [m]
1	845951.5	860893.2	5026.3
2	89149.8	93308.7	1398.4
Total	935101.3	954201.8	6424.7

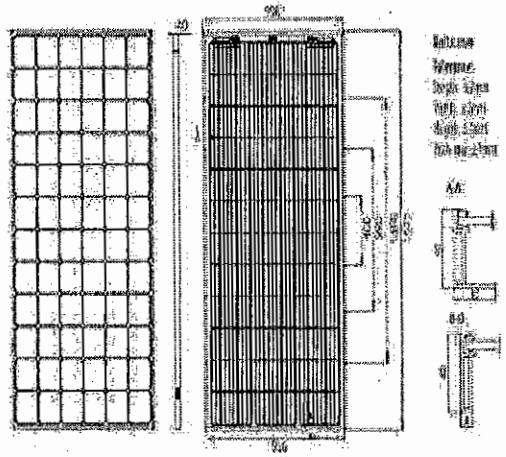
System

Field no.	No. Modules	Module power class [Wp]	No. Strings	Modules per string	Installed Capacity [kWp]	Inverter Capacity [kVA]
1	158676	360	5667	28	57123.36	2500
2	14196	360	507	28	5110.56	2500
Total	172872	360	6174	28	62233.92	2500

Substructure

Manufacturer	-	H Min. Height	

Design (mm)



Mechanical Parameters

Cell Orientation: 72 (6x12)

Junction Box: IP67, three diodes

Output Cable: 4mm², 300mm in length, length can be customized

Weight: 26.5kg

Dimension: 1977x996x40mm

Packaging: 26pcs per pallet

Operating Parameters

Operational Temperature: -40°C ~ +85°C

Power Output Tolerance: 0 ~ +5 W

Voc and Isc Tolerance: ±3%

Maximum System Voltage: DC1500V (IEC&UL)

Maximum Series Fuse Rating: 20A

Nominal Operating Cell Temperature: 45±2°C

Application Class: Class II

Bifaciality: ≥75%

Electrical Characteristics

Test uncertainty for Pmax: ±3%

Model Number	LR6-72BP-355M		LR6-72BP-360M		LR6-72BP-365M		LR6-72BP-370M		LR6-72BP-375M	
Testing Condition	Front	Back	Front	Back	Front	Back	Front	Back	Front	Back
Maximum Power (Pmax/W)	355	267	360	270	365	274	370	278	375	282
Open Circuit Voltage (Voc/V)	48.1	47.8	48.2	47.9	48.3	48.0	48.4	48.1	48.6	48.3
Short Circuit Current (Isc/A)	9.61	7.26	9.72	7.33	9.84	7.42	9.95	7.52	10.03	7.58
Voltage at Maximum Power (Vmp/V)	39.2	39.7	39.3	39.8	39.5	40.0	39.6	40.1	39.8	40.2
Current at Maximum Power (Imp/A)	9.06	6.73	9.16	6.79	9.25	6.86	9.35	6.94	9.43	7.01
Module Efficiency(%)	18.0	13.6	18.3	13.7	18.5	13.9	18.8	14.1	19.0	14.3

STC (Standard Testing Conditions): Irradiance 1000W/m², Cell Temperature 25°C, Spectra at AM1.5

Front side performance equivalent to conventional low LID mono PERC:
- High module conversion efficiency (up to 19.0%)
- Better energy yield with excellent low irradiance performance and temperature coefficient
- First year power degradation <2%

Bifacial technology enables additional energy harvesting from rear side (up to 25%)

Glass/glass lamination ensures 30 year product lifetime, with annual power degradation < 0.45%, 1500V compatible to reduce BOS cost

40mm frame design enables easy installation and robust mechanical strength

Solid PID resistance ensured by solar cell process optimization and careful module BOM selection

Advantages of PV Solar Power:

- No need for a heat conversion system which is complex and consequently generates technological risks and a heavy financial cost
- No need for operating fluid(s)
- Short installation period for solar farms
- Very limited maintenance needs
- Minimal water consumption for operational needs
- Panel production costs are falling rapidly because of current mass production, especially over the last 2 years
- Tested technology, currently several similar systems are in operation in the world
- The panels generate electricity even when it is cloudy sky
- Cheap and clean form of energy
- Reliable source of energy
- Suitable for peak demands without increasing the per KWhr cost of generation

The Proponent: P&G Energy (Pvt.) Limited – Core Business Activities

The principal line of business of the company is to carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply, subject to permission of concerned authorities; and to locate, establish, construct, equip, operate, use, manage and maintain solar power plants, power grid station, 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 centers, shops and necessary devices, showrooms, depots, factories, workshops, plants and to provide transforming, switching, conversion and transmission facilities, subject to permission of relevant authorities.

SECTION 1

1.0 INTRODUCTION AND PURPOSE OF THE STUDY

1.1 Project Background

Gwadar district is located in the coastal region on the Arabian Sea, South-West of Quetta - the provincial capital of Balochistan, District Lasbela is in the East and Kech and Awaran Districts are in the North and sharing its boundaries in the West with Iran. With the initiation of China Pakistan Economic Corridor project in 2013, Gwadar has gained immense importance in Pakistan and abroad with respect to construction of deep sea port and establishment of energy and other development projects.

Typically, in Solar Power utilization, the sunlight is converted directly into electricity using Photo Voltaic (PV). The PV system uses solar cells to convert sunlight into electrical Direct Current (DC) through a photovoltaic effect. The technology to be employed is Solar PV with a proposal to generate a maximum of 50 MW AC. Crystalline Silicon Photovoltaic (PV) will be used in the proposed project for generating electrical power by converting solar radiation into direct current, this phenomenon takes place due to photovoltaic effect exhibited by the semiconductors.

The photovoltaic effect is the creation of a voltage (or a corresponding electric current) in a material upon exposure to light. A PV system consists of cells containing the photovoltaic material, mechanical and electrical connections, mountings and means of regulating and/or modifying the electrical output. Several solar cells are combined into PV modules (solar panels) which are in turn connected together into an array.

The electricity generated can be either stored, used directly (standalone plant) or fed into a large electricity grid, typically the public electricity grid (grid-connected system). The feeding of electricity into the grid requires the transformation of Direct Current (DC) from the PV array into Alternating Current (AC) by a specialized, grid-controlled inverter. These solar inverters contain special circuitry (transformers, switching and control circuits) to precisely match the voltage and frequency of the grid and to disconnect from the grid if the grid voltage is turned off.

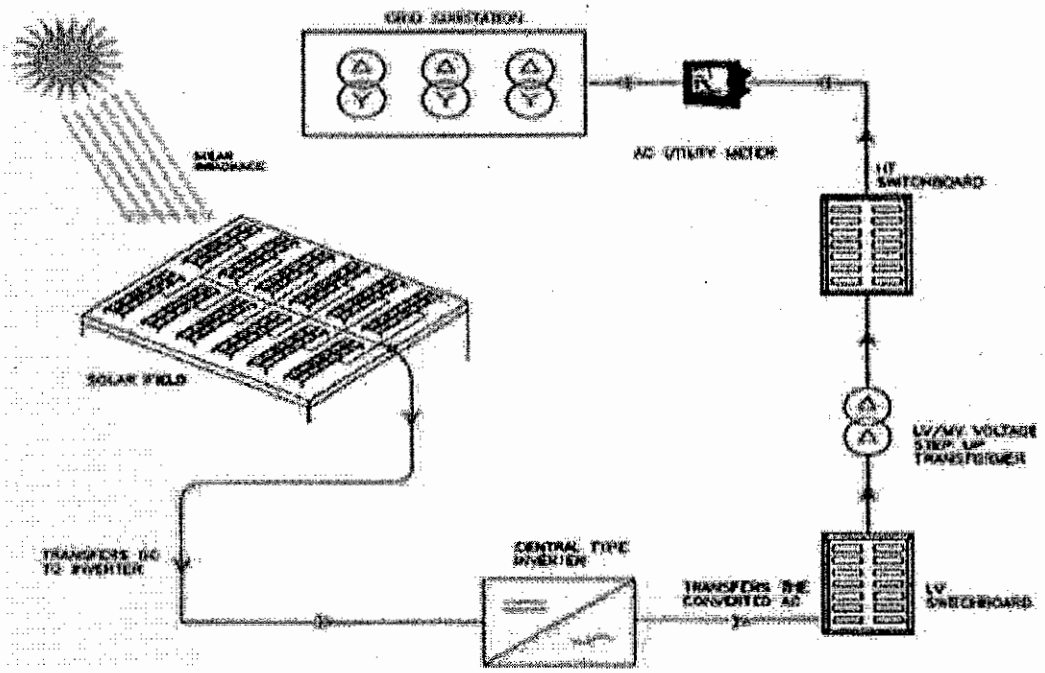


Fig. No.1: Diagram showing mechanism of Solar Power generation

1.2 Project Description

The main components of the Solar Power Generation processes include:

- Solar Panels
- Central Inverters
- Transformers
- Switch Board
- Monitoring And Metering System and
- Cables

Both imported material and local material such as Solar Panels, Inverters, Transformers and Mounting Structure and Cables will be used respectively. The solar panels will be mounted onto metal frames which are usually aluminum. Concrete or screw pile foundations are used to support panels. The arrays will be orientated at 0° North at fixed inclination of 30° to gather maximum exposure of sunlight. Panels will be between 2m above ground level.

Construction activities will involve the following activities:

- Site preparation (clearance of existing vegetation (if any), preparation of a site office and stores, fencing to avoid intrusion
- Disposal of excavation and site clearance wastes
- Landscaping, earth moving and filling
- Procurement of construction materials and delivery of the same to the site
- Civil, mechanical and electrical works
- Building works, trampling and removal of construction wastes, Storage and utilization of materials
- Installation of Cabling
- Solid waste collection and commissioning of the Solar power project

Since the area is in dry and arid zone, the agricultural activities are scarce. There is no vegetation which is dominant over the area. The land area is overall flat without any agricultural crops, buildings, cultural and archaeological objects or any recreational sites.

A perimeter fence will be installed to prevent small animals such as reptiles (if any) from entering the site and damaging the panels and equipment. Additionally, it is required for security purposes to prevent vandalism and unauthorized access as well as for health and safety reasons to ensure no unauthorized personnel can access the onsite equipment.

To monitor the site and prevent any unauthorized access motion sensor CCTV cameras will be installed along the site boundary. The CCTV cameras will be mounted on poles approximately 4 m in height. Additionally, although the cameras use infrared technology, lighting will be required according to plant specifications.

The development will be connected to the public road network via the existing access road. Existing access tracks on site will be used during construction and operation with some additional sand and gravel tracks installed off the existing access tracks to allow easy access for construction, operation and maintenance. The Project plans to be completed within 18 months after getting requisite approvals and NOCs from authorities and the transportation of parts to the site.

1.3 Project Location

The proposed project site is located almost 43 km away from the main Gwadar city centre in North East direction. The propose project site is 31 km above sea level. The site coordinates taken at various points are given in the below table:

S.No.	Points	Coordinates
1	P1	25°19'21.72"N, 62°38'12.12"E
2	P2	25°19'20.28"N, 62°38'0.96"E
3	P3	25°19'20.28"N, 62°37'56.28"E
4	P4	25°19'19.91"N, 62°37'54.48"E
5	P5	25°19'34.67"N 62°37'55.56"E
6	P6	25°19'34.67"N 62°37'42.60"E
7	P7	25°19'32.50"N 62°37'42.60"E
8	P8	25°19'32.52"N 62°37'32.52"E
9	P9	25°19'38.63"N 62°37'32.52"E
10	P10	25°19'38.64"N 62°37'27.48"E
11	P11	25°19'58.44"N 62°37'27.12"E
12	P12	25°19'58.80"N 62°37'48.72"E
13	P13	25°19'45.12"N 62°37'48.72"E
14	P14	25°19'45.48"N 62°38'9.60"E
15	P15	25°19'21.36"N 62°38'12.12"E
16	P16	25°19'17.04"N 62°38'13.20"E
17	P17	25°19'11.99"N 62°37'55.20"E
18	P18	25°19'19.19"N 62°37'54.48"E

Table 1: Site coordinates at selected points

Since the project site is in the uninhabited land of Gwadar, so there is no displacement of any human settlement due to installation and operations of the said project. Land is already under project proponent's ownership; hence no restoration and rehabilitation will be required.

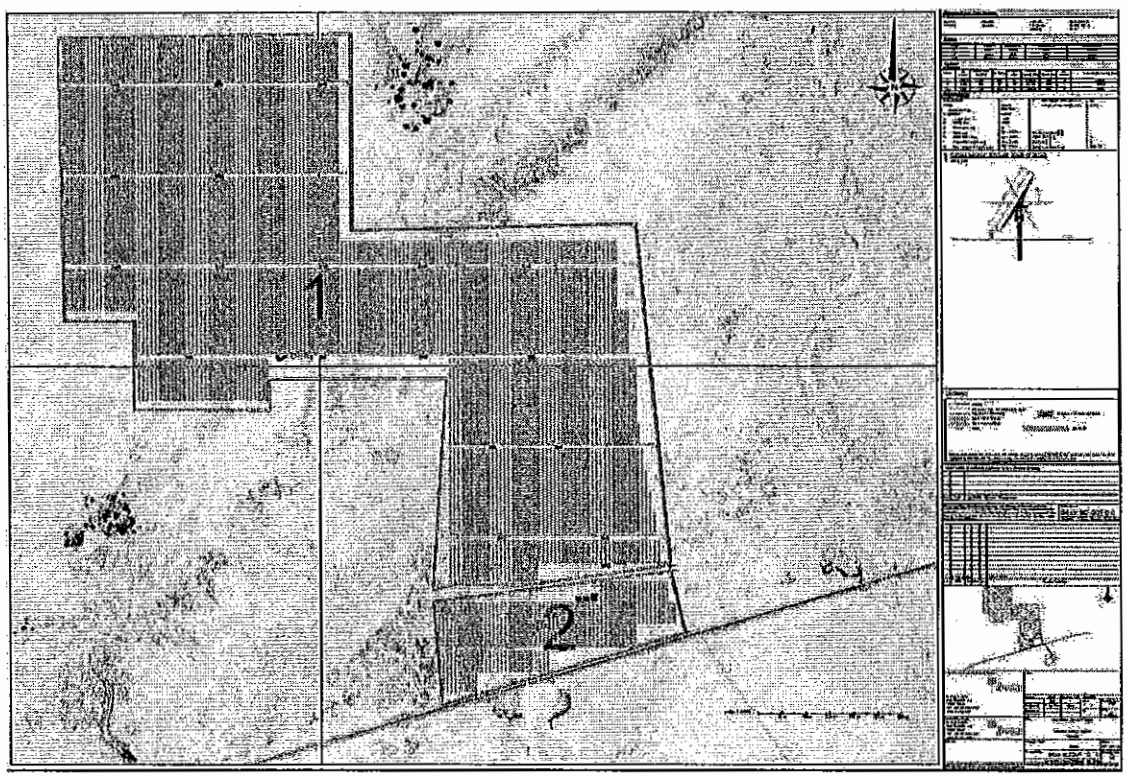


Fig. No.2: Project Site Layout Map

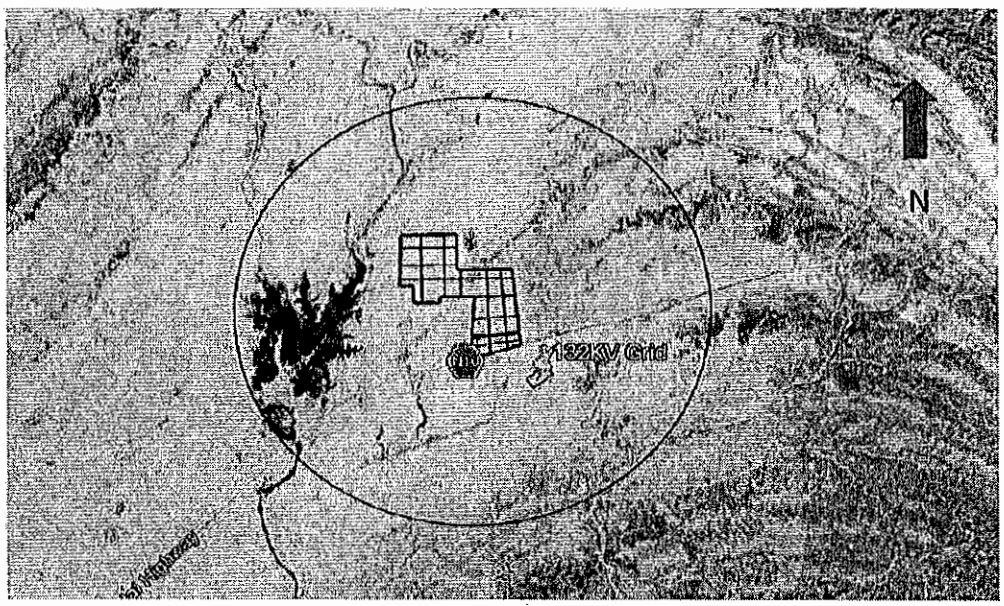


Fig. No.3: Location of proposed Solar Farm Site with its 2.5 km radius

1.4 Project Boundary

The Solar Farm site has total area of 230 Acres. The site constitutes two parts of land i.e. Part A & Part B. An old road bifurcates the two pieces of land.

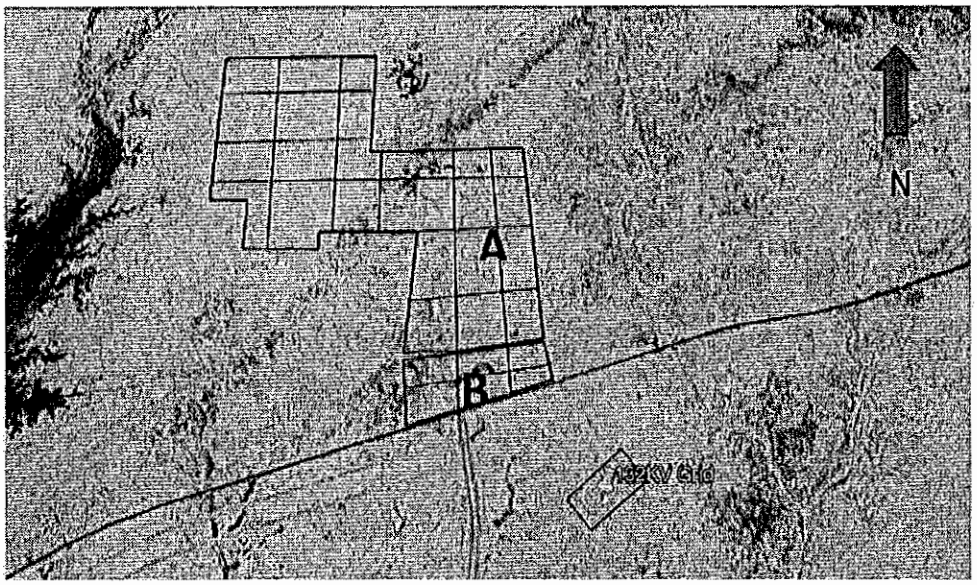


Fig. No.4: Red lined boundary of the Solar Farm Site

1.5 Legal Status of Site

The site is clear from any Court Litigations and it is owned by Government of Balochistan.

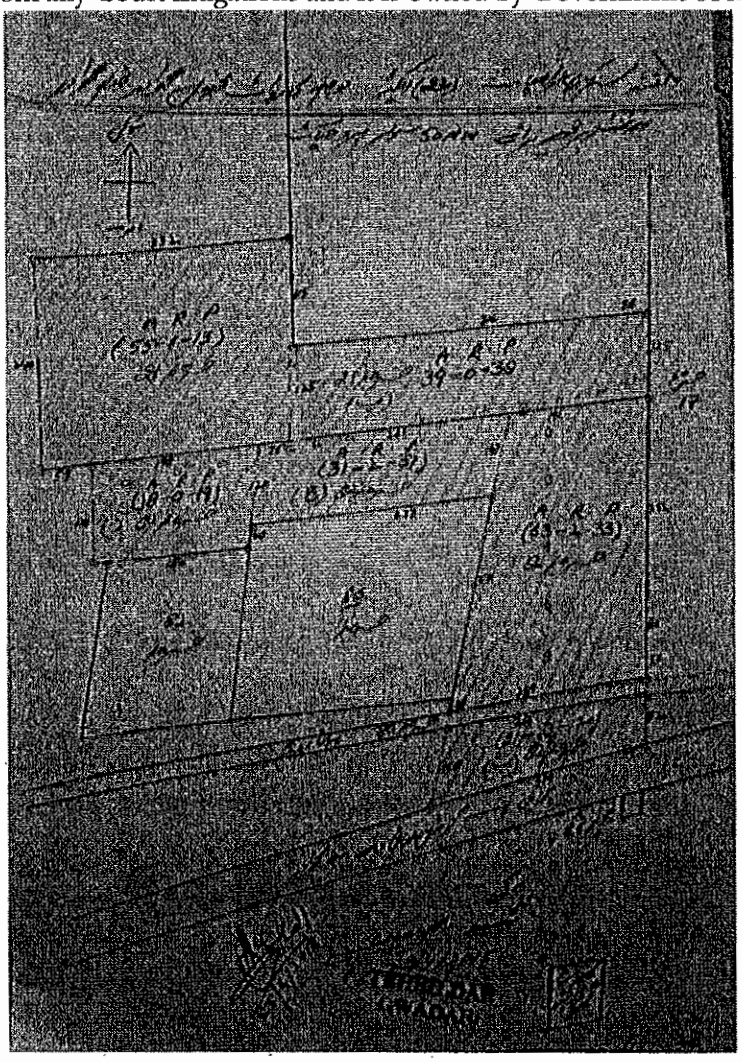
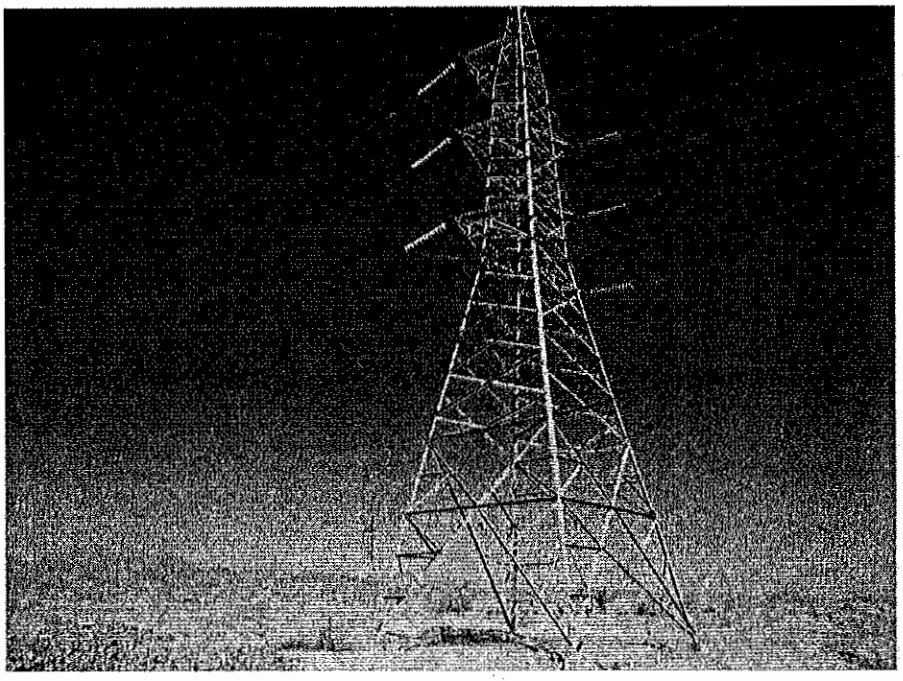


Fig. No.5: Revenue Department Lay out Plan for Solar Farm site allocation

1.6 DNO Connection

No major use of land is present around the site. A small water reservoir and one 132 KV grid is present within 2.5 Km radius. Gwadar industrial estate is also within 2.5 Km radius of the site but still in the early stage of its development.



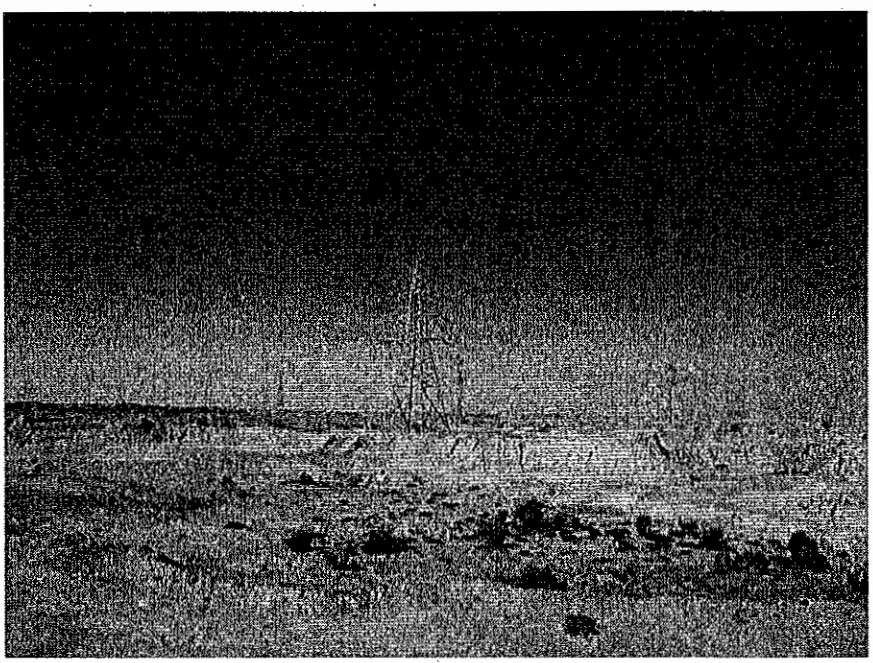


Fig. No.6&7: 132 KV grid is present within 2.5 Km radius

1.7 Construction work of the facility

The proposed solar power project site is a barren land. The proponent intends to construct and install Solar Power Project and operate it for continuous supply of energy to national grid. The following activities will be undertaken during construction phase:

S.No	Activity	Status
1.	Project Designing	Completed
2.	Site Assessment, Soil Sampling and Testing	Completed
3.	Demarcation of area	Completed
4.	Site Layout planning	Completed
5.	Location of Solar Panels	Completed
6.	Location of building and other features	Pending
7.	Excavation work	Pending
8.	Installation and Connections	Pending
9.	Pavement of cables and installation	Pending
10.	Construction of office area and other facilitates	Pending

1.8 Installation of Electrical and Mechanical Items

Once the ground work is completed, the installation of electrical and mechanical work will be initiated. This includes following activities:

- Installation of Solar Panels
- Installation and connection of Cables
- Installation of associated equipment
- Fire and Emergency Equipment
- Testing and Commissioning

1.9 Installation of Signage and Instructions

Precautionary communication means to prevent potential fire incidents are essential elements. In this preview, following well defined signage will be installed:

- Warnings and information notices
- Cautionary Notices for workers and visitors
- Record keeping

1.10 Initial Environmental Examination - Objectives

The objectives of carrying out Initial Environmental Examination (IEE) are as follows:

- Identify the reasonably foreseeable environmental and social effects that may be caused due to this project.
- Highlight baseline environmental and social conditions of the proposed project area.
- Define category of project consistent with Pakistan Environmental Protection Act, PEPA 1997.
- Identify and assess compliance to applicable environmental laws, regulations, treaties and agreements.
- Identify appropriate mitigation measures to minimize if not eliminate adverse environmental or social impacts (if any).

SECTION 2

2.0 ENVIRONMENTAL POLICY, STATUTORY & REGULATORY REQUIREMENTS

The IEE report is prepared in compliance with following main applicable legal/statutory requirements:

- Pakistan Environmental Protection Act, 1997
- The Balochistan Wildlife (Protection, Preservation, Conservation and Management Act, 2014 (Act.No. XIV of 2014)
- Balochistan Environmental Protection Act, 2012
- National Environmental Quality Standards
- Forest Act, 1927
- Land Acquisition Act, 1894

There are also several other items of legislation and regulations which have an indirect bearing on the project or general environmental measures. All applicable legislation is attached as annexures.

2.1 Framework of Environmental Legislation

The legislative powers between the federal and provincial governments are distributed by the constitution of Pakistan. In this context, there are certain areas where federal government has exclusive legislative powers. Environmental protection is under preview of both federal and provincial governments.

2.1.1 Pakistan Environmental Protection Act, 1997

The Pakistan Environmental Protection Act, 1997 is the basic legislative tool empowering the government to frame regulations for the protection of environment. The act is applicable to a wide range of issues and extends to air, water, soil, marine, noise pollution and handling of hazardous wastes. The key features of the law that have a direct bearing on the proposed project is related to the requirements for an initial environmental examination (IEE).

Section 12(1) requires that: *"No proponent of a subproject shall commence construction or operation unless it has filed with the Federal Agency an initial environmental examination (IEE) or where the subproject is likely to*

cause an adverse environmental effect, an environmental impact assessment (EIA) has been obtained from the Federal Agency approval in respect thereof. The Pakistan Environmental Protection Agency has delegated the power of review and approval of environmental assessments to the provincial environmental protection agencies.

2.1.2 Balochistan Environmental Protection Act, 2012

This Act is to provide for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. It extends to the whole Province of Balochistan except Tribal Areas. This Act entail establishment of the Balochistan Environmental Protection Agency to exercise the powers and perform the functions assigned to it under this Act and rules and regulations. The Balochistan EPA is headed by Director General appointed by Government of Baluchistan.

This Act entails established in the Province a Balochistan Sustainable Development Fund. The Government at all levels of administration and in every sector shall incorporate environmental considerations into policies, plans, programmes and strategies. Subject to the provisions of this Act and the rules and regulations no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level or is likely to cause, a significant adverse effect on the environment or human health which is in excess of the Environmental Quality Standards or, where applicable, the standards established under sub -clause (ii) of clause (f) of section 6. No proponent of a project of public and private sector shall commence construction or operation unless he has filed an Initial Environmental Examination with the Government Agency designated by Balochistan Environmental Protection Agency, as the case may be, or, where the project is likely to cause an adverse environmental effects an environmental impact assessment, and has obtained from the Government Agency approval in respect thereof.

2.1.3 Review of IEE and EIA

Balochistan Environmental Protection Act, 2012 provides legislative powers to the provincial environmental agencies to approve the following assessments:

- Initial Environmental Examination (IEE)
- Environment Impact Assessment (EIA)

EIAs are carried out for projects that have potentially "significant" environmental impacts, whereas IEEs are conducted for relatively smaller subprojects with low environmental impacts. The Schedules I, II and III attached to the Regulations, list the projects categories that require IEE and EIA. The Regulations also provide the necessary details on the preparation, submission and review of IEEs and EIAs. The following is a brief step-wise description of the approval process.

i) A project is categorized as requiring an IEE/EIA using the schedules of Regulations.
ii) An EIA or IEE is conducted following the provincial EPA guidelines.
iii) The EIA or IEE is submitted to the provincial EPA if it is located in the provinces or the Pak-EPA if it is located in Islamabad and federally administrated tribal areas. The Fee as defined in the schedule is submitted along with the documents.
iv) Accompanied by an application in the format prescribed in Schedule IV of the Regulations.
v) The EPA conducts a preliminary scrutiny and replies within 10 days of the submittal of a report, confirming completeness or asking for additional information, if needed, or returning the report requiring additional studies, if necessary.
vi) The EPA is required to make every effort to complete the IEE and EIA review process within 90 days of the issue of confirmation of completeness.
vii) Then the EPA accords their approval subject to certain conditions.

Before commencing, construction of the subproject, the proponent is required to submit an undertaking accepting the conditions and before commencing operation of the subproject, the proponent is required to obtain from the EPA, a written confirmation of compliance with the approval conditions and requirements of the IEE. In addition, an EMP is to be submitted with a request for obtaining confirmation of compliance. The EPA is required to issue confirmation of compliance within 15 days of the receipt of request and complete documentation. The IEE/EIA approval is valid for three years from the date of accord. A monitoring report is to be submitted to the EPA after completion of construction, followed by annual monitoring reports during operation of the project.

2.1.4 National Environmental Quality Standards (NEQS), 2000

The NEQS were first enacted in 1993. The approved NEQS were uniform standards applicable to all kind of industrial and municipal effluent. There are 32 parameters prescribing permissible

levels of pollutants in liquid effluent while 16 parameters for gaseous emission. The current revision was published in year 2000 and it specified revised limits for NEQS for liquid industrial effluent (mg/l) and industrial gaseous emissions in mg/Nm3.

2.1.5 National Environmental Quality Standards (NEQS), 2010

NEQS published in year 2010 defined the standards for ambient air and noise and drinking water quality. These are attached as annexures.

2.2 Other relevant Legislation

There are a number of federal and provincial laws that are relevant in the context of environmental, health and safety compliance of the project activities and are listed below:

2.2.1 Provincial Local Government Ordinances, 2001

These ordinances were issued under the devolution process and define the roles of the district governments. These ordinances also address the land use, conservation of natural vegetation, air, water and land pollution, disposal of solid waste and wastewater effluents as well as matters relating to public health.

2.2.2 Civil Aviation Rules, 1994

These rules apply to flight operations within Pakistan by aircrafts other than military aircrafts and, except where otherwise prescribed, to flight operations by aircrafts registered, acquired or operating under these rules, wherever they may be. The rules with relevant significance to the power project:

- No person shall erect any temporary or permanent structure, nor position a vehicle or other mobile object on or in the vicinity of an aerodrome (airport), that will be within the clearance area, or will protrude through an obstacle limitation surface, at that aerodrome.

- No person shall operate a light in the vicinity of an aerodrome which because of its glare is liable to dazzle pilots of aircraft taking off from or landing at that aerodrome; or which can be mistaken for an aeronautical ground light. If such a light is operated it shall be extinguished or

satisfactorily screened immediately upon notice being given to the person or persons operating the light, by the Director-General or by the Manager or by a person authorized by him.

- No person or persons shall operate a radio station or electrical equipment in the vicinity of an aerodrome or of a radio aid to navigation serving an airway or an air route in Pakistan which is liable to cause interference with radio communications between aircraft and an Air Traffic Services Unit, or which is liable to disturb the signal from a navigational radio aid.

- A Captive balloon or a kite shall not be flown at a height above 200ft within 6km of an aerodrome, and a free balloon shall not be flown at any place, except with the express permission of the Director-General and in compliance with the conditions attached to such permission.

- An aircraft shall not be flown over congested areas of cities, towns, or settlements or over an open air assembly of persons, except by permission of the Director-General, unless it is at such height as will permit, in the event of an emergency, a landing to be made without undue hazard to persons on the ground, and except when it is taking off or landing, shall not be flown closer than 500ft to any person, vessel, vehicle or structure.

2.2.3 Employment of Child Act, 1991

Article 11(3) of the Constitution of Pakistan prohibits employment of children below the age of 14 years in any factory, mines or any other hazardous employment. In accordance with this Article, the Employment of Child Act (ECA), 1991, disallows the child labor in the country. The ECA defines a child to being a person who has not completed his/her fourteenth years of age. The ECA states that no child shall be employed or permitted to work in any of the occupation set forth in the ECA (such as transport sector, railways, construction and ports) or in any workshop. Wherein any of the processes defined in the Act is carried out. The processes defined in the Act include carpet weaving, cigarette making, cement manufacturing, textile, construction and others.

2.2.4 Cutting of Trees Prohibition Act, 1975

This Act prohibits cutting or chopping of trees without permission of the Forest Department. During the site survey it was found that there are no trees at the proposed site.

2.2.5 The Antiquities Act , 1975

It ensures protection of Pakistan's cultural resources. The Act defines "antiquities" as ancient products of human activity, historical sites or sites of anthropological or cultural interest, national monuments etc. The Act is designed to protect these antiquities from destruction, theft, negligence, unlawful excavation, trade and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area that may contain articles of archaeological significance. Under the Act, the subproject proponents are obligated to ensure that no activity is undertaken in the proximity of a protected antiquity and report to the Department of Archaeology, Government of Pakistan, any archaeological discovery made during the course of construction and operation of the subproject.

2.2.6 The Wildlife Protection Act and Ordinance, 1972

It empowers the government to declare certain areas reserved for the protection of wildlife and control activities within in these areas. It also provides protection of endangered species of wildlife. The ordinance was enacted to protect the province's wildlife resources directly and other natural resources indirectly. It classifies wildlife by degree of protection i.e. animals that may be hunted on a permit or special license and species that are protected and cannot be hunted under any circumstances. The Act specifies restrictions on hunting and trade in animals, trophies or meat. The Act also defines various categories of wildlife protected areas such as National Parks, Wildlife Sanctuaries and Game Reserves.

2.2.7 Motor Vehicles Ordinance, 1965 and Rules, 1969

The Motor Vehicles Ordinance, 1965, was extended in 1978, to the whole of Pakistan. The ordinance deals with the powers of motor vehicle licensing authorities and empowers the Road Transport Corporation to regulate traffic rules, vehicle speed, weight limits and vehicle use; to erect traffic signs; and to identify the specific duties of drivers in the case of accidents. It also describes the powers of police officers to check and penalize traffic offenders at the provincial

level. At the same time, the ordinance also empowers the Regional Transport Authority to operate as a quasi-judicial body at the district level to monitor road transport, licensing requirements and compensations for death or injury to passengers on public carriers.

2.2.8 Factories Act, 1934

The clauses relevant to the proposed project are those that address the health, safety and welfare of the workers, disposal of solid wastes and effluents and damage to private and public property. The Act also provides regulations for handling and disposing toxic and hazardous substances.

2.2.9 The Forestry Act, 1927

It empowers the government to declare certain areas as reserved forest. As no reserved forest exists in the vicinity of the proposed subproject, this law will not affect proposed subproject.

2.2.10 Land Acquisition Act, 1894

The Land Acquisition Act (LAA) of 1894 is amended from time to time. It has been the defacto policy governing land acquisition and compensation in the country. The LAA is the most commonly used law for acquisition of land and other properties for development of projects. It comprises of 55 sections pertaining to area notifications and surveys, acquisition, compensation and apportionment awards and disputes resolution, penalties and exemptions.

2.2.11 Canal and Drainage Act, 1873

The Canal and Drainage Act (1873) prohibits corruption or fouling of water in canals (defined to include channels, tube wells, reservoirs and watercourses) or obstruction of drainage. This Act will be applicable to the construction and O & M works to be carried out during the proposed project.

2.2.12 Pakistan Penal Code, 1860

The Code deals with the offences where public or private property or human lives are affected due to intentional or accidental misconduct of an individual or organization. It also addresses control of noise, noxious emissions and disposal of effluents.

2.3 Asian Development Bank (ADB), Policies and Standards

The project fulfills the ADB policies and standards to manage social and environmental risks and impacts.

2.3.1 ADB Safeguard Policy Statement, 2009

ADB operational policy includes three basic safeguard policies. This safeguard policy statement applies to all ADB-financed and/or ADB-administered sovereign and non-sovereign projects, and their components regardless of the source of financing, including investment projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees (hereafter broadly referred to as projects).

- **Involuntary Resettlement Safeguards**

The Involuntary Resettlement Safeguards aims to avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre project levels; and to improve the standards of living of the displaced poor and other vulnerable groups.

The involuntary resettlement safeguards covers physical displacement (relocation, loss of residential land or loss of shelter) and economic displacement (loss of land, assets, access to assets, income sources or means of livelihoods) as a result of:

(i) Involuntary acquisition of land, or

(ii) Involuntary restrictions on land use or on access to legally designated parks and protected areas. It covers them whether such losses and involuntary restrictions are full or partial, permanent or temporary.

- **Indigenous Peoples Safeguards**

The Indigenous Peoples safeguards are triggered if a project directly or indirectly affects the dignity, human rights, livelihood systems or culture of Indigenous Peoples or affects the territories or natural or cultural resources that Indigenous Peoples own, use, occupy or claim as an ancestral domain or asset. The term Indigenous Peoples is used in a generic sense to refer to a

distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:

i. Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
ii. Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
iii. Customary cultural, economic, social or political institutions that are separate from those of the dominant society and culture; and
iv. A distinct language, often different from the official language of the country or region. In considering these characteristics, national legislation, customary law and any international conventions to which the country is a party will be taken into account. A group that has lost collective attachment to geographically distinct habitats or ancestral territories in the project area because of forced severance remains eligible for coverage under this policy.

- **Environmental Safeguards**

The ADB Environmental Safeguards aims to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process. Avoid and where avoidance is not possible minimize, mitigate, and/or offset adverse impacts and enhance positive impacts by means of environmental planning and management. Prepare an environmental management plan (EMP) that includes the proposed mitigation measures, environmental monitoring and reporting requirements, related institutional or organizational arrangements, capacity development and training measures, implementation schedule, cost estimates and performance indicators.

2.3.2 Policy on Gender and Development

Asian Development Bank (ADB) first adopted the Policy on the role of the Women in Development (WID) in 1985 and over the passage of time has progressed from WID to Gender and Development (GAD) approach that allows gender to be seen as a cross cutting issue influencing all social and economic processes. ADB's Policy on GAD will adopt mainstreaming as a key strategy in promoting gender equity. The key elements of ADB's policy will include the following:

- **Gender sensitivity:**

  It observe how ADB operations affect women and men, and to take into account women's needs and perspectives in planning its operations.

- **Gender analysis**

  To assess systematically, the impacts of project on men and women and on economic and social relationship between them.

- **Gender planning**

  To formulate specific strategies that aim to bring about equal opportunities for men and women.

- **Mainstreaming**

  To consider gender issues in all aspects of ADB operations, accompanied by efforts to encourage women's participation in the decision making process in development activities.

- **Agenda setting**

  To assist Developing Member Country (DMC) governments in formulating strategies to reduce gender discrepancies and in developing plans and targets for women's and girl's education, health, legal rights, employment and income-earning opportunities.

2.3.3 Social Protection Strategy

Social Protection consists of five major elements:

- **Labor Markets**

  Policies and programs designed to facilitate employment and promote efficient operation of labor markets.

- **Social Insurance**

  Programs to cushion the risks associated with the unemployment, health, disability, work injury and old age.

- **Social Assistance and Welfare Service**

  Program for the most vulnerable groups with no other means of adequate support.

- **Micro and Area Based Schemes**

  To address vulnerability at the community level.

- **Child Protection**

  To ensure the healthy and productive development of future Asian Workforce.

ADB adopted a commitment to Core Labor Standards (CLS) as part of its Social Protection Strategy in 2001. Since then, ADB ensures that CLS are duly considered in the design and implementation of its investment projects. A handbook for CLS has been developed with cooperation of International Labor Organization (ILO). The objective is to convince decision makers that introduction of CLS and labor standards in general will not impede development. The labor standards are simple rules that govern how people are treated in a working environment. Labor standards cover a very wide variety of subjects mainly concerning basic human rights at work, respect for safety and health and ensuring that people are paid for their work. CLS are a set of four internationally recognized basic rights and principles at work.

(i) Freedom of association and the right to collective bargaining;

(ii) Elimination of all forms of forced or compulsory labor;

(iii) Effective abolition of child labor; and

(iv) Elimination of discrimination in respect of employment and occupation

2.3.4 Public Communications Policy

The policy supersedes the provisions of the 2005 policy. The main objective of the policy is;

- To reduce poverty by promoting inclusive economic growth, environmentally sustainable growth and regional integration.
- To achieve this objective, ADB funds a variety of projects and other activities to support development.
- For its projects to meet demands and be effective, ADB must seek the views of its borrowers and clients, partners, stakeholders and keep them abreast of its activities.
- The overall objective of the policy is to enhance stakeholders' trust in and ability to engage with ADB. The policy recognizes the right of people to seek, receive and impart information about ADB operations. It supports knowledge sharing and enables participatory development or two-way communications with affected people.

ADB's public communications policy provides a framework to enable ADB to communicate more effectively. The policy aims to enhance stakeholder's trusts in an ability to engage with ADB. The policy promotes:

- Awareness and understanding of ADB activities, policies, strategies, objectives and result;
- Sharing and exchange of development knowledge and lessons learned, so as to provide fresh and innovative perspectives and development issues;
- Greater two-way flow of information between ADB and stakeholders' including project affected people, in order to promote participatory development; and
- Transparency and accountability of ADB operations.

2.3.5 World Bank Guidelines on Environment

The principal World Bank publications that contain environmental guidelines are listed below.

- Environmental Assessment Operational Policy 4.01.Washington, DC, USA. World Bank 1999.
- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross Sectoral Issues.
- World Bank Technical Paper Number 139, Environment Department, the World Bank, 1991,
- Pollution Prevention and Abatement Handbook: Towards Cleaner Production, Environment Department, the World Bank, United Nations Industrial Development Organization and the United Nations Environment Program, 1998.
- Environmental Health and Safety (EHS) guidelines, International Finance Corporation (IFC) World Bank Group, 2007.

The EHS guidelines published by IFC are technical reference documents that address IFC's expectations regarding the industrial pollution management performance of its projects. They are designed to assist managers and decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, minimizing and controlling EHS impacts during construction, operation and decommissioning phase of project or facility. The World Bank Guidelines for noise are provided below:

No.	Receptor	Day (07:00-22:00)	Night (22:00-07:00)
1.	Residential & Institutional educational	55	45
2.	Industrial & Commercial	70	70

Source: Pollution Prevention and Abatement Handbook World Bank Group (1998)

Notes: Maximum allowable log equivalent (hourly measurements) in dB(A)

2.4 Equator Principles

The Equator Principles are a set of guidelines, promoted by the International Finance Corporation (IFC) that address the environmental and social issues associated with major development projects worldwide. They provide a common baseline and framework for the implementation of internal environmental, social procedures and standards for project financing activities across all industries.

- **Principle 1: Review and Categorization (of projects)**
- **Principle 2: Social and Environmental Assessment**
- **Principle 3: Applicable Social and Environmental Standards**
- **Principle 4: Action Plan and Management System**
- **Principle 5: Consultation and Disclosure**
- **Principle 6: Grievance Mechanism**
- **Principle 7: Independent Review**
- **Principle 8: Covenants**
- **Principle 9: Independent Monitoring and Reporting**
- **Principle 10: EPFI Reporting**

- **Principle 1: Review and Categorization**

  An EPFI will categorize a project, based on the magnitude of the potential social or environmental impacts and risks of that project, in accordance with IFC classification criteria as mentioned below:

Category A:

Projects with potential significant adverse social or environmental impacts that is diverse, irreversible or unprecedented.

Category B:

Projects with limited adverse social or environmental impacts that is few in number, generally site specific, largely reversible and readily addressed through mitigation measures.

Category C:

Projects with minimal or no social or environmental impacts. Solar Energy projects, by their nature; tend to fall into Categories B or C, being medium or low risk.

Category D:

The Equator Principles apply to projects over 10 million US dollars.

The study has reviewed the National and International Laws and Guidelines on different environmental aspects and has categorized the Project in Category C (Low Hazard).

- **Principle 2: Social and Environmental Assessment**

  The IEE report has been prepared to respond to the National and International requirements and to satisfactorily address the key environmental and social issues.

- **Principle 3: Applicable Social and Environmental Standards**

  For the purpose of this IEE study, primary data on the baseline environmental and social conditions have been collected to address the requirements of National laws and regulations; applicable International Treaties and Agreements; sustainable development and use of renewable natural resources; protection of human health, cultural properties, biodiversity and other physical, ecological and socioeconomic issues required to be addressed under this Principle.

- **Principle 4: Action Plan and Management System**

  Potential environmental impacts and mitigation measures to reduce the severity of impacts have been documented. The study also includes the Environmental Monitoring and Management Plan.

- **Principle 5: Consultation and Disclosure**

  Being a project of Category C, the public consultation is limited to the scoping sessions with stakeholders. The surveys and consultation meetings have established that no settlements or temporary relocation or acquisition of land is involved in the project area.

- **Principle 6: Grievance Mechanism**

  This Principle will not apply since 'no' resettlement or temporary relocation or acquisition of land is involved. It also includes the issues related to public complaints and some other related issues. A separate register will be maintained on site during the construction phase of the project.

- **Principle 7: Independent Reviews**

  An independent review is not required since the project falls in Category C.

- **Principle 8: Covenants**

  No objection Certificates will be issued to Proponent of Project under conditions of compliance with the Mitigation and Performance Monitoring Plan during the construction and operational phase of the project. In case the proponent does not comply with the agreed terms, Sindh EPA is authorized to take corrective action.

- **Principle 9: Independent Monitoring and Reporting**

  This Principle will be applicable to the Project since it falls in category C of projects requiring an IEE.

- **Principle 10: EPFI Reporting**

  Concerned EPFI may safely commit to report publicly at least annually about its Equator Principles implementation processes and experience.

2.5 IFC Performance Standards on Social and Environmental Sustainability

International Finance Corporation (IFC) applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Together, the eight Performance

Standards establish standards that the Proponent is to meet throughout the project. The objectives of Performance standards are given below:

- To identify and assess social and environment impacts, both adverse and beneficial in the project's area of influence.
- To avoid, or where avoidance is not possible, minimize, mitigate or compensate for adverse impacts on workers, affected communities and the environment.
- To promote improved social and environment performance of companies through the effective use of management systems.

Performance Standard 1: Social & Environmental Assessment and Management System

This Performance Standard seeks to:

- Identify and assess social and environment impacts in the project's area of influence;
- Avoid, minimize, mitigate or compensate for adverse impacts on workers, affected communities and the environment;
- Ensure that affected communities are appropriately engaged on issues that could potentially affect them; and
- Promote improved social and environment performance of the project through the effective use of management systems.

Under this Standard, the project is required to establish and maintain a social and environmental management system appropriate to the nature and scale of the project and in accordance with the level of social and environmental risks and impacts. The management system is required to incorporate the following elements:

- Social and Environmental Assessment
- Management program
- Organizational capacity
- Training
- Community engagement
- Monitoring and
- Reporting

This IEE study has been conducted to respond to requirements of national legislation and international Guidelines as well fulfills the above requirements of the IFC Performance Standards PS1.

- **Performance Standard 2: Labor and Working Conditions**

This PS seeks to establish, maintain and improve the worker-management relationship; promote fair treatment, non-discrimination and equal opportunity for workers and compliance with national labor and employment laws; protect the workforce by addressing child labor and forced labor issues and promote occupational safe and healthy of workers. The proposed project and their contractors will be required to adhere to this PS, in particular with regard to compliance with national labor and employment laws; employment of child labor, and promoting occupational safety and health of workers.

- **Performance Standard 3: Pollution Prevention and Abatement**

The PS 3 seeks to avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities, and to promote the reduction of emissions that contribute to climate change. The Standard requires the project to consider during its entire lifecycle ambient conditions and apply pollution prevention and control technologies and practices that are best suited to avoid or, where avoidance is not feasible, minimize or reduce adverse impacts on human health and the environment while remaining technically and financially feasible and cost-effective. PS 3 will be applicable to all stages of the Project.

- **Performance Standard 4: Community Health, Safety and Security**

The PS 4 seeks to avoid or minimize risks to and impacts on the health and safety of local community during the project lifecycle from both routine and non-routine circumstances, and to ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security. The PS requires the project to evaluate the risks and impacts to the health and safety of the affected community during the design, construction, operation and decommissioning of the project and establish preventive measures to address them in a manner commensurate with the identified risks and impacts. The Environmental Management Plan addresses community aspects.

- **Performance Standard 5: Land Acquisition and Involuntary Resettlement**

This PS aims to address the adverse impacts associated with land acquisition and involuntary resettlement caused by the project. The PS seeks to:

- Avoid or at least minimize involuntary resettlement wherever feasible by exploring alternative project designs.
- Mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by:
- providing compensation for loss of assets at replacement cost; and
- Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation and the informed participation of those affected.
- Improve or at least restore the livelihoods and standards of living of displaced persons.
- Improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

The project site has no permanent settlement within the designated area or its surroundings.

- **Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management**

The PS 6 seeks to protect and conserve biodiversity and promote sustainable management and use of natural resources through adoption of practices that integrate conservation needs and development priorities. The IEE addresses the potential impacts of the proposed project on the biodiversity. This IEE has recommended measures for the conservation of flora, fauna and other natural resources.

- **Performance Standard 7: Indigenous Peoples**

The PS 7 seeks to address the impacts of the project on the indigenous people. The objectives of the PS are to:

- Ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of Indigenous Peoples.
- Avoid adverse impacts of projects on communities of Indigenous Peoples or when avoidance is not feasible; to minimize, mitigate or compensate for such impacts and to provide opportunities for development benefits in a culturally appropriate manner.

- Establish and maintain an ongoing relationship with the Indigenous Peoples affected by a project throughout the life of the project.
- Foster good faith negotiation with and informed participation of Indigenous Peoples when projects are to be located on traditional or customary lands under use by the Indigenous Peoples.
- Respect and preserve the culture, knowledge and practices of Indigenous Peoples.

No indigenous people - with a social and cultural identity distinct from the existing dominant society that makes them vulnerable to being disadvantaged in the development process of the proposed project are known to exist in and around the proposed site. No such people were found in the area during the assessment. Therefore, this PS is not applicable for the proposed project.

- **Performance Standard 8: Cultural Heritage**

The objectives of this PS-8 are to protect cultural heritage from the adverse impacts of project activities and support its preservation, and to promote the equitable sharing of benefits from the use of cultural heritage in project activities. No sites of cultural heritage are known to exist at or in the immediate vicinity of the project location. There are also no indications of any old settlement in the area, nor is there any site covered under the listing of cultural heritage sites. This PS will therefore not be applicable to the Project.

2.6 Obligations under International Treaties

Pakistan is signatory of several Multilateral Environmental Agreements (MEAs), including:

(i) Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal
(ii) Convention on Biological Diversity
(iii) Ramsar Convention on Wetlands
(iv) Convention on International Trade in Endangered Species (CITES)
(v) UN Framework Convention on Climate Change (UNFCCC)
(vi) Kyoto Protocol
(vii) Montreal Protocol on substances that deplete the ozone layer
(viii) UN Convention to Combat Desertification

(ix) Convention for the Prevention of Pollution from Ships (MARPOL)

(x) UN Convention on the Law of Seas (LOS)

(xi) Stockholm Convention on Persistent Organic Pollutants (POPs)

(xii) Cartina Protocol

These MEAs impose requirements of varying degrees upon the member countries to meet the objectives of these agreements. The implementation mechanism for most of these MEAs is weak in Pakistan and institutional setup is non-existent.

In order to address this state of affairs, the GoP has recently approved a PC1 for the establishment of the National MEA Secretariat under the Ministry of Environment in Islamabad. The Secretariat will handle and coordinate activities, develop action plans for each MEA vis-à-vis the country's obligation under these agreements.

The Secretariat will then be responsible to ensure implementation of these action plans and will evaluate future MEAs and advise the Government for acceding (or otherwise) these agreements.

SECTION 3

3.0 APPROACH & METHODOLOGY

3.1 Project Alternative

3.1.1 Fossil/Conventional Fuels Situation

Pakistan has domestic reserves of coal with most of the reserves being located in one area i.e. Thar Desert. Coal currently makes up a very small proportion of total generation. Exploiting the coal reserves would require huge and costly upfront investment in local infrastructure including provision of water supplies, development of mines, housing/related facilities and investment in transmission lines before power plant development could commence.

Setting up of a solar power project involves selection of environmentally and techno economically suitable site, land characteristics, meteorology, infrastructure, grid availability, water availability, rail and road connectivity, accessibility and shading aspects etc.

3.1.2 Without Project Option

Pakistan's major electricity production sources are through thermal and hydel power which is meeting approximately 70% and 28% respectively of the country's annual electricity demand. For thermal generation, fuels employed are furnace oil and gas. While both are produced domestically, demand already exceeds supply by a considerable amount. Oil import is a significant burden on the national exchequer and the increasing import bill continues to exert further pressure on the foreign exchange reserves.

Alternatives to further fuel imports for electricity generation are the use of domestic coal, or generation from hydro-electric or other renewable sources, such as wind and solar power. These options will assist in reducing Pakistan's reliance on imported oil, and consequent vulnerability to changes in global oil prices which will in turn have a positive effect on the current trade deficit and inflating import bill. Exploiting the coal and oil reserves would require huge and costly upfront investment in local infrastructure (including provision of water supplies), development of mines, housing and related infrastructure, and investment in transmission lines before power plant development could commence. Hydroelectric power already supplies almost 30% of electricity, and numerous sites for future investment exist, but due to their locations, this would

also require significant investment in transmission to meet the expected power needs. Moreover, there are varying political stands on hydro-electric power options.

The development of solar power generation projects could reduce dependence on fuels for thermal power generation, increase diversity in Pakistan's electricity generation mix, and reduce greenhouse gas (GHG) emissions avoiding thermal power generation. The project will also add to the power generation from Renewable energy resources and help in meeting target of Government.

In this preview, the "Without Project" option is not a preferred alternative.

3.2 Emissions Savings - With Project

Solar farm development is temporary in nature and has minimal impacts on surroundings. The solar panels do not generate any harmful emissions. Almost 0.75m high from the front and 2.5m high from the back, makes the vegetation grow well and animal grazing is easily possible (if needed).

Solar farm generates electricity by using the solar irradiations and don't require fossil fuel for most of its operation, which makes it zero carbon development. In addition, the production of electricity from a renewable source makes a significant contribution to reduction in Greenhouse Gases (GHG) emissions over the lifetime of the Project. The solar farm will have energy generating capacity of approximately 50MW and will generate enough low carbon renewable electricity to meet the demands of more than 25000 homes a year.

3.3 IEE Study Methodology

The overall methodology and main phases specifically adopted for conducting the IEE comprises of assessment of project site's baseline data or existing conditions of physical/biological environment and social factors, identification of foreseeable environmental impacts and proposing their respective mitigation measures. The approach of IEE study includes the following steps:

- Describing the project and details of proponents.
- Review of applicable legal and statutory requirements.

- Establishing environmental baseline conditions through surveys and consultation with local stakeholders.
- Scoping the issues and establishing the boundaries of assessment.
- Review of project alternatives.
- Assessing the potential environmental and social impacts of the project including residual impacts.
- Identifying mitigation measures to eliminate or minimize the potential adverse environmental and social impacts.
- Environmental and Social Management & Monitoring Plan.

3.3.1 Scoping

The key activities of this phase included:

- **Data Compilation**

  A generic description of the proposed activities relevant to environmental assessment was compiled through Primary and Secondary data collection by reviewing literature, EHS guidelines, national and international standards and conducting on ground Surveys. A list of potential environmental & as well as social issues was developed.

- **Review of Published Literature**

  Secondary data on weather/climate, soil, water resources, wildlife and vegetation were collected from internet, published literature and books.

- **Review of Legislative Requirements**

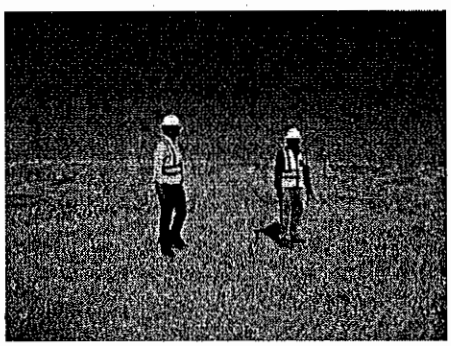
  Information on relevant or applicable legislation, regulations, guidelines and standards was reviewed and compiled.

- **Identification of Potential Impacts**

  Potential environmental and social issues were identified.

- **Baseline Data Collection**

A field visit was conducted to verify and collect primary data on the site. Views of local inhabitants were taken about the solar power project. A reasonable data of baseline information on the Project area was taken from resources including existing literature and information, internet, field surveys and associated departments.



Photographs of Visit of a Proposed project site

3.3.2 Impacts Assessment

The environmental and socioeconomic information collected was used to assess the potential impacts of the proposed project. Potential impacts were considered on environmental or social components such as:

- Geomorphology

- Surface and Groundwater quality
- Ambient Air and Noise Pollution
- Ecology of area - Flora and fauna
- Local communities

Wherever applicable, the discussion covers the following aspects:

- The present baseline conditions
- The potential change in environmental parameters likely to be effected by project related activities
- The identification of potential impacts
- The evaluation of the likelihood and significance of potential impacts
- The definition of mitigation measures to reduce impacts to as low as practicable
- The prediction of any residual impacts, including all long-term and short-term; direct and indirect; beneficial and adverse impacts
- The monitoring of residual impacts
- An Environment Management Plan (EMP) for the mitigation measures identified during the project

3.3.3 Impacts Assessment Categorization

Impacts are broadly categorized as physical, biological and social. Following categories depicts the level of impact on the environment.

• Highly Negative	Adverse impact
• Low Negative	Insignificant impact
• High Positive	Beneficial impact
• Low Positive	No impact

The negative impacts identified through this process are the 'unmitigated' impacts. Appropriate mitigation measures are recommended as part of this assessment, thus reducing the occurrence, possibility and severity of the potentially adverse impacts.

Once the potentially adverse impacts were identified as discussed above, these impacts were characterized. Impact characterization includes following types:

- Nature (Direct/Indirect)
- Duration (Short Term, Medium Term, Long Term)
- Timing (Project phase: Before, During or After construction)
- Reversibility (Reversible/Irreversible)
- Likelihood (Certain, Likely, Unlikely, Possibly, Rare)
- Consequence severity (Major/Severe, Moderate, Mild, Negligible)

Following table further describes the impact categorization:

Types/Categories	Characteristics	Description
Nature	Direct	Environmental parameter will be directly changed by project activity.
	Indirect	Environmental parameter changes as a result of change in another parameter.
Duration of impact	Short Term	Lasting only for the duration of project e.g. noise during construction activities.
	Medium Term	Lasting for a period of few months to a year after the project before naturally reverting to the original condition e.g. loss of vegetation due to site clearing, soil or water contamination by waste fuels or oil.
	Long Term	Lasting for a period much greater than medium term impact before naturally reverting to the original condition e.g. loss of top soil/soil erosion.
Timing	Project Phase	Construction/Operation/Decommissioning.
Reversibility of impact	Reversible	When a receptor resumes its pre-project condition.
	Irreversible	When a receptor does not or cannot resume its pre-project condition.
Likelihood of impact	Certain	Impact expected to occur under most circumstances
	Likely	Impact will probably occur under most circumstances

	Possibly	Impact may possibly occur at some time
	Unlikely	Impact could occur at some time
	Rare	Impact may occur but only under exceptional circumstances
Consequence severity	Major	When an activity causes irreversible damage to a unique environmental feature; causes a decline in abundance or change in distribution over more than one generation of an entire population of species of flora or fauna; has long term effects (period of years) on socioeconomic activities of significance on regional level.
	Moderate	When an activity causes long term (period of years), reversible damage to a unique environmental feature; causes reversible damage or change in abundance or distribution over one generation of a population of flora or fauna; has short term effects (period of months) on socioeconomic activities of significance on regional level.
	Minor	When an activity causes short term (period of a few months) reversible damage to an environmental feature; slight reversible damage to a few species of flora or fauna within a population over a short period; has short term (period of months) effects on socioeconomic activities of local significance.
	Negligible	When no measurable damage to physical, socioeconomic, or biological environment above the existing level of impact occurs.
Significance of impact	Categorized as High, Medium or Low	Based on the consequence, likelihood, reversibility, geographical extent, and duration; level of public concern; and conformance with legislative of statutory requirements.

Impact characterization uses all attributes of an impacts particularly the likelihood of occurrence and consequence severity, in order to assess the impact to be of 'High', 'Medium' or 'Low' significance. Each environmental impact of proposed project has been assessed and identified through the assessment criteria.

Impacts with 'High' significance are proposed to bring to 'Medium' or 'Low' category significance through appropriate mitigation measures. Similarly impacts with 'Medium' significance will be brought to 'Low' significance. Consequently, environmental monitoring will be necessary for impacts to ensure that these do not transform to 'High' significance impacts. The impacts with 'Low' significance do not usually need any mitigation.

3.4 Determination of Mitigation Measures

Corresponding to each impact characterization and assessment result, appropriate mitigation measures were identified to minimize if not completely eliminate, the adverse impacts associated with project activities. The hierarchy of the mitigation measures is as follows:

- First: An attempt has been made to altogether avoid the adverse impact through change in design, location or method of carrying out proposed activity.
- Second: If this is not possible, the significance of the impact is reduced through appropriate mitigation measures.
- Third: As a last resort, compensatory measures are taken to minimize the adverse impacts of the proposed activities.

The mitigation measures cannot eliminate the adverse impacts of the project activities; residual impacts remain even after the implementation of these measures. Therefore, impact assessment method includes determination of residual impacts. These residual impacts will be monitored during the project execution to ensure that these remain insignificant.

SECTION 4

4.0 BASE LINE ENVIRONMENTAL CONDITIONS

This section describes the environmental conditions of project area before the commencement of proposed activities including physical and biological aspects of project site. Prior to development of Solar farm, the site was found predominantly infertile land without having any agricultural activity. The development of proposed solar farm will have insignificant change in existing land use and would provide employment opportunities in the area.

In radius of 2.5 KM, most of the land is vacant or deserted chunk. A water reservoir is in south east direction of the site. Small shrubs and bushes are present on the site. 132 KV pylon is main existing features on the site. At present there is no other solar power installation in the area. The main use of the site is power generation; hence for Solar solution will be in compliance of the IFC standards. The proponent has the legal rights of the site through a lease of land which is in place for the power project. The proponent has already requested AEDB for approval of necessary amendments in Master Deed and Site Sub-Lease Deed to allow for installation and operation of proposed Solar PV Power Project for its proposed project life. Following are the features of baseline environmental conditions of proposed project site.

4.1 Transport and Access

The Solar Farm site is located on Makran Coastal Highway. The site can be directly accessible through Makran Coastal Highway. An old road bifurcates the site into two halves.

Road Types:

Primary = Makran Coastal Highway

Secondary = Access Road present in the site

Main roads such as Mehran Coastal Highway are in easy and close access of the proposed project site.

4.2 Surrounding Land use

The project site is an open land. The site doesn't have any distinctive land use and as site has a bit of sand cover, which make it unsuitable for any good quality crop. Only a small water

reservoir and one 132 KV grid is present within 2.5 Km radius. Gwadar industrial estate is also 2.5 Km radius of the site but still in the early stage of its development.

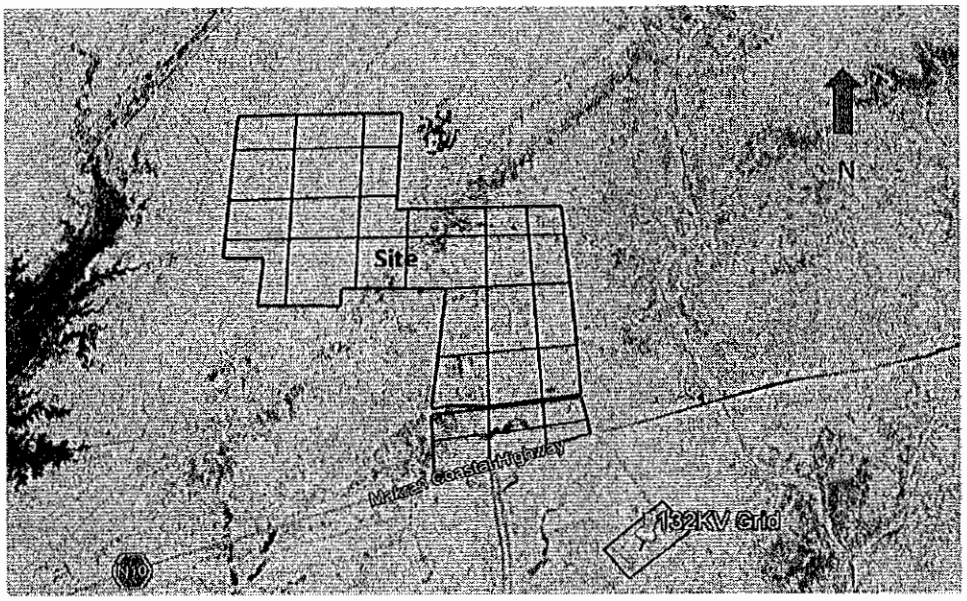


Fig No. Makran Coastal Highway is passing in front of Solar Farm Site

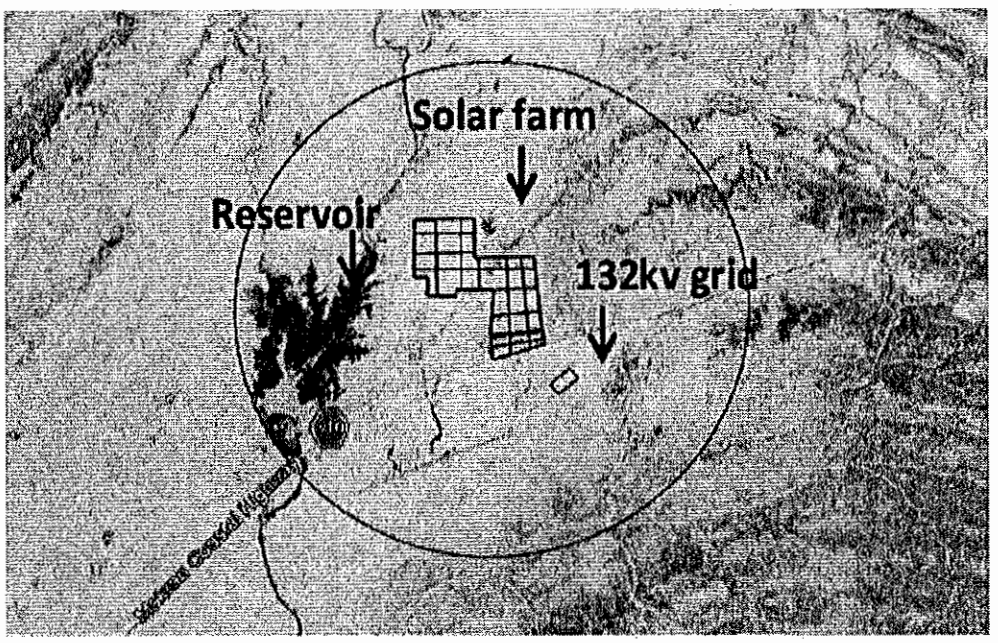


Fig No. Land use around the site

Existing use of the land is barren. Neither it has any crop on the top, nor is it in any public or commercial use.

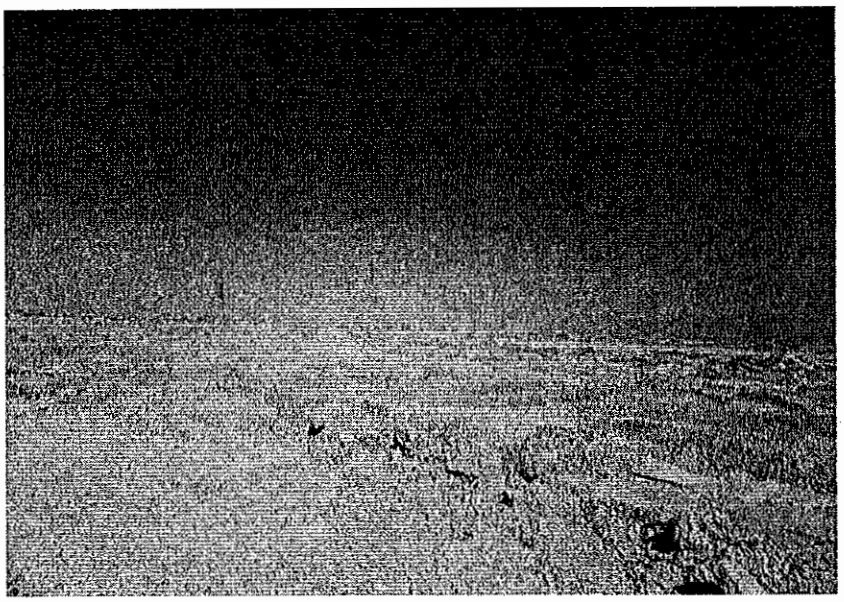


Fig No. Existing Land use of proposed project site is barren

4.3 Topography

The topography of the site is slightly undulating and slopes gradually from North to South which shows that the site does not have any reverse slope issues.

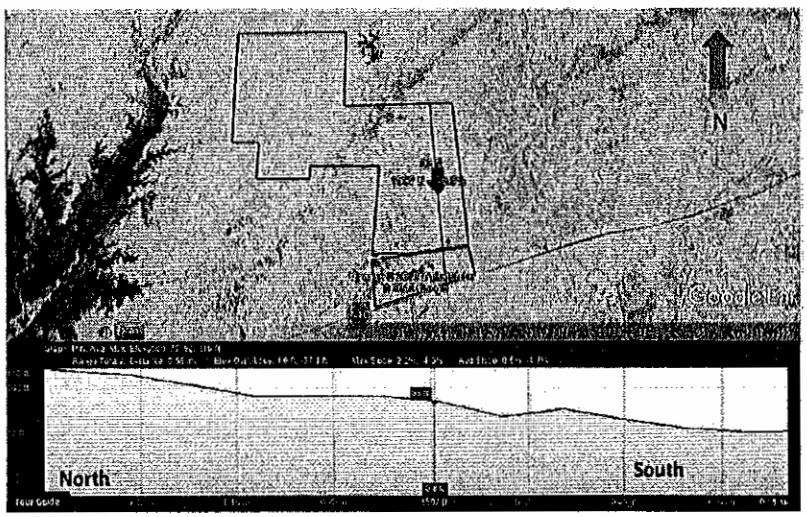


Fig No. Section through site and gradual fall of terrain towards south, average slope 0.5 %

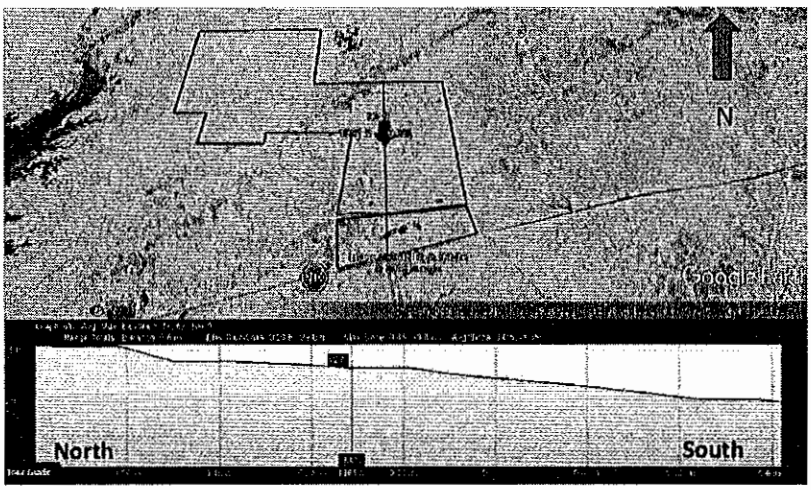


Fig No. Section through site and gradual fall of terrain towards south, average slope 0 %

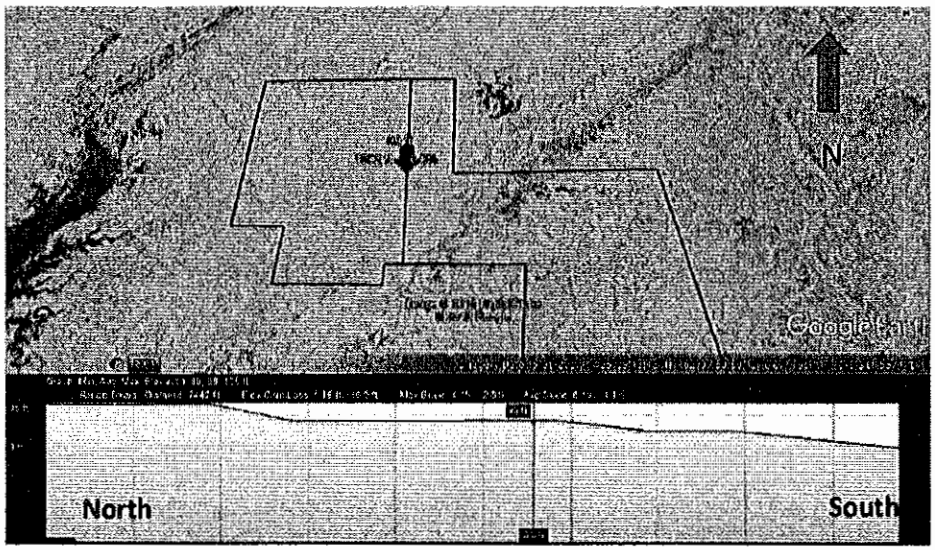


Fig No. Section through site and gradual fall of terrain towards south, average slope 0.1 %

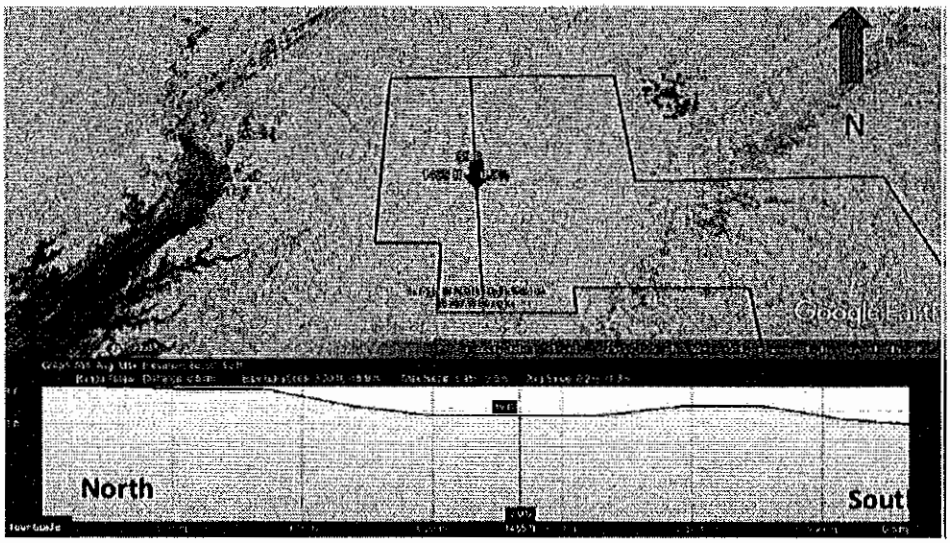


Fig No. Section through site and gradual fall of terrain towards south, average slope 0.2 %

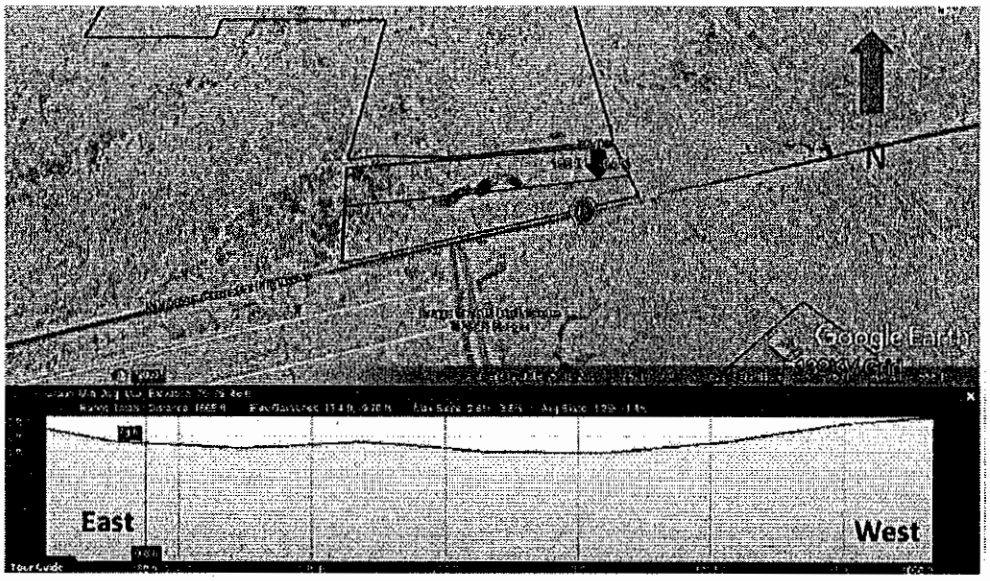


Fig No. Section through site and undulation in terrain with an average slope of 1.3 %

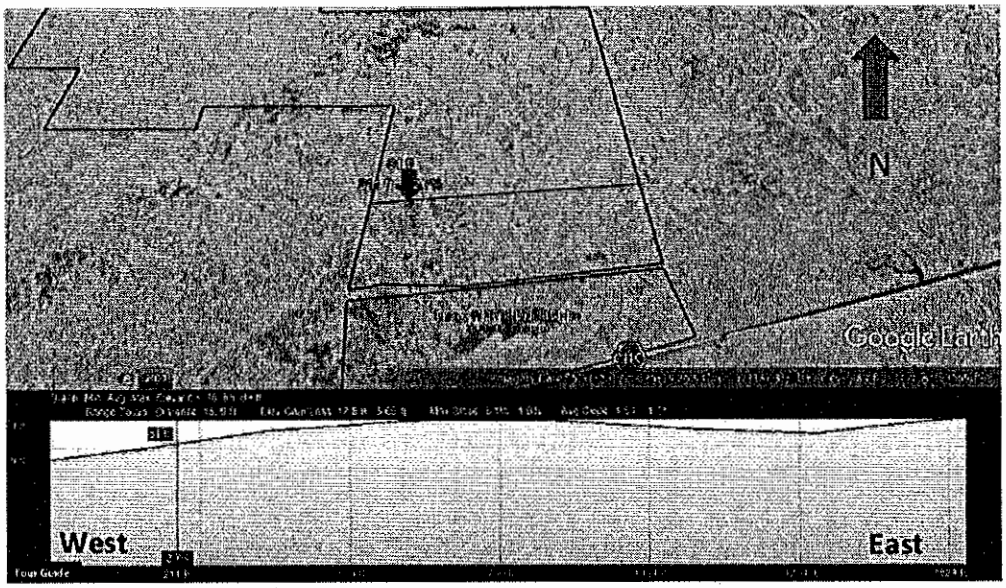


Fig No. Section through site and undulation in terrain with an average slope of 1.5 %

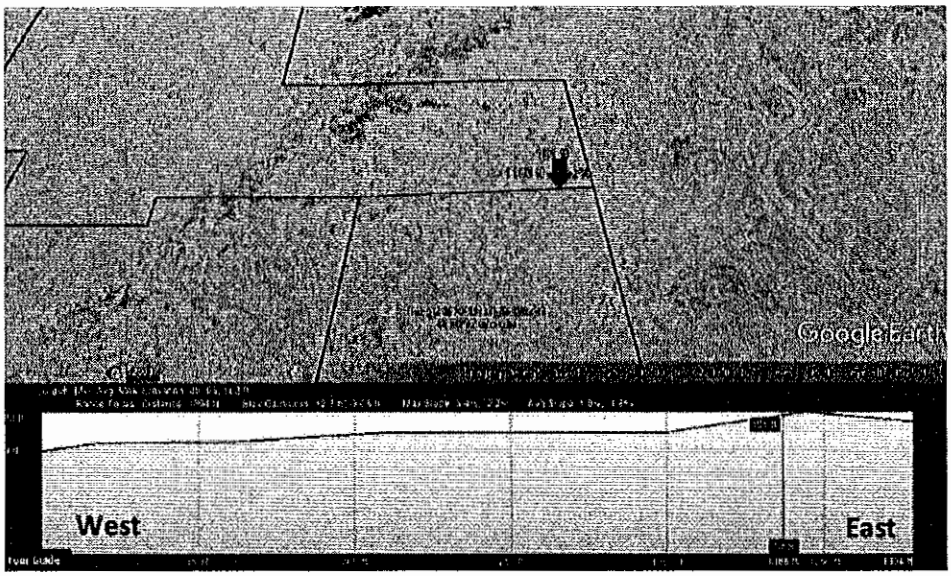


Fig No. Section through site predominantly flat and gradual drop in terrain from East to West, average slope of 1 %

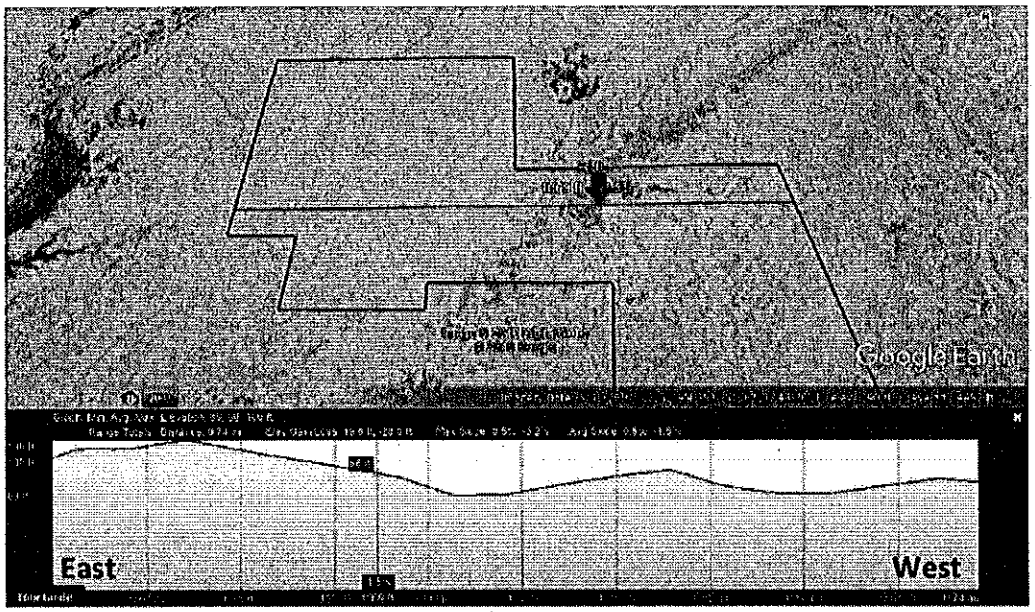


Fig No. Section through site, gradual drop in slope from East to West, average slope of 1.1 %

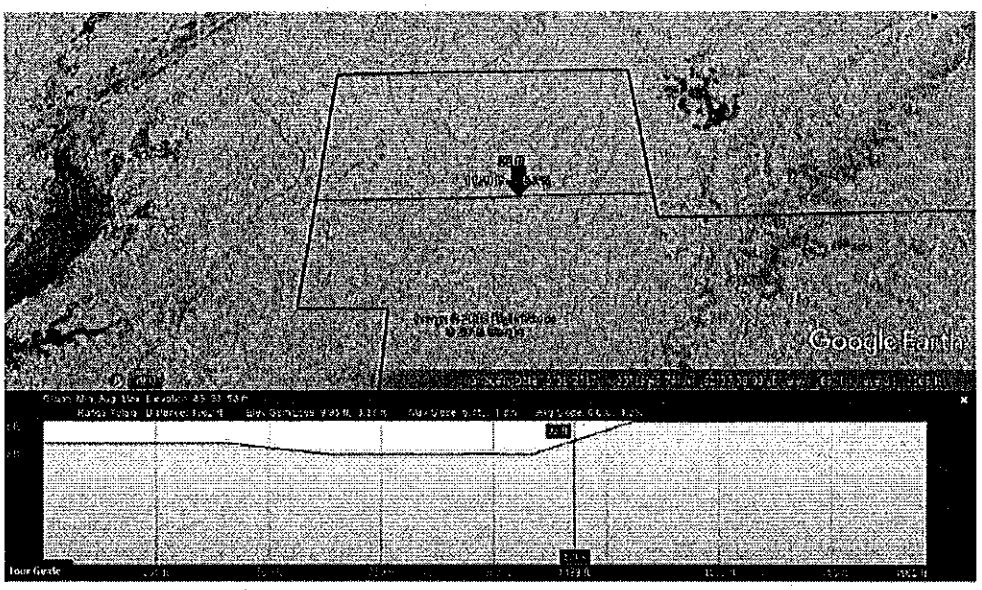


Fig No. Section through site, very gradual drop in terrain from East to West, average slope of 0.6 %

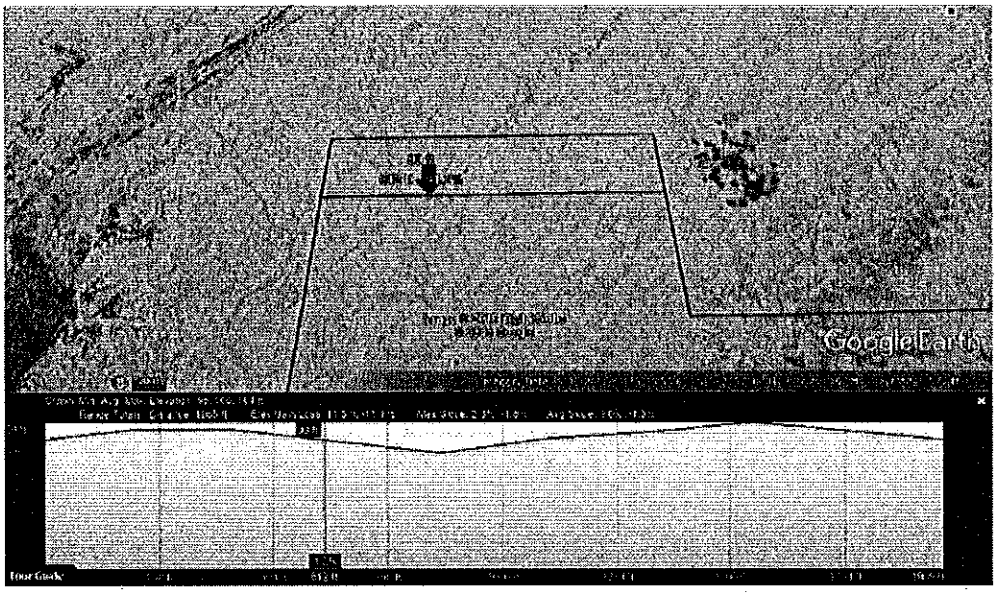


Fig No. Section through site, very gradual undulation, average slope of 1.2 %

4.4 Vegetation Features of the Site

As the land is covered with sand, there is no many existing plants and vegetation which will be affected by the project. However, various local plants are grown in the open area of the project site.

4.5 Geo Tech Features

The site is not suitable for any agricultural activity and have a bit of sand cover on the top, but generally suitable for ramming of mounting structure. The soil formation is generally a mixture of sand, silt and clay. No hard rock noticed/encountered.

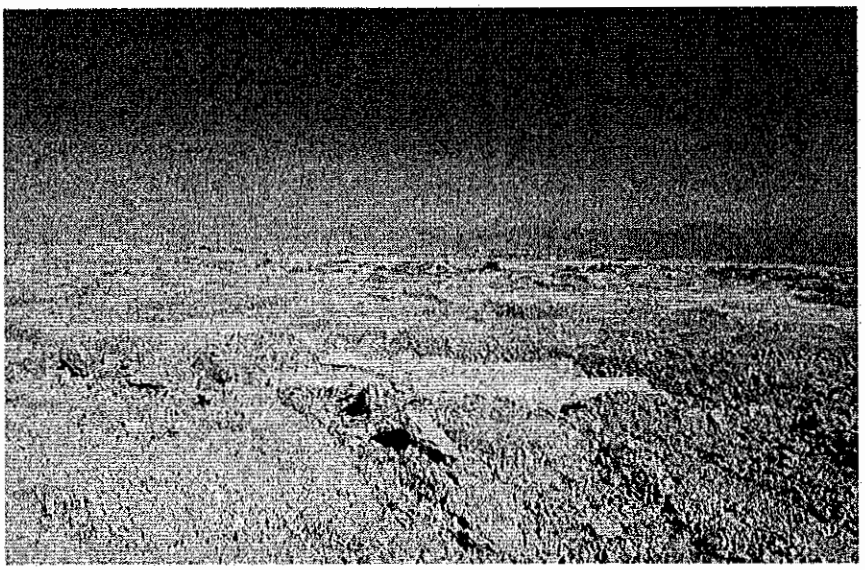


Fig No. Showing excavated strata on the site and formation is of sand, silt and clay

4.6 Flood Risk

Although the site is laying close to a water reservoir but due difference of spot height between the reservoir bed and Solar Farm, the risk of flooding is almost negligible. The level difference between reservoir bed level and Solar Farm is almost 17 – 23 feet, making the site safe from flooding from the reservoir. The site has a natural drain passing through it. If natural drainage pattern is accommodated in layout plant design, then it will reduce the risk of flooding and ponding onto site.

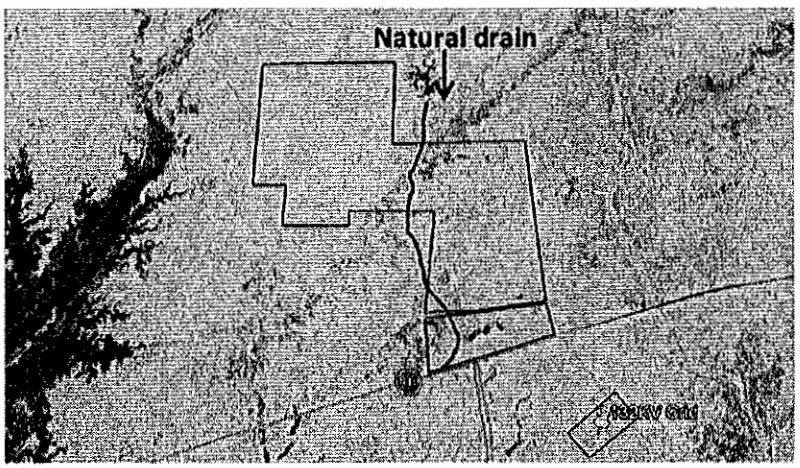


Fig No. Natural drain passing through the site

4.7 Shading

The site is free from any shading of trees or buildings. The only heighted feature on the site is 132 KV pylons passing through the site. The shading through pylons can be avoided by having proper buffers.

Fig No. Showing 132 KV pylon passing through the site

4.8 Utilities Connections

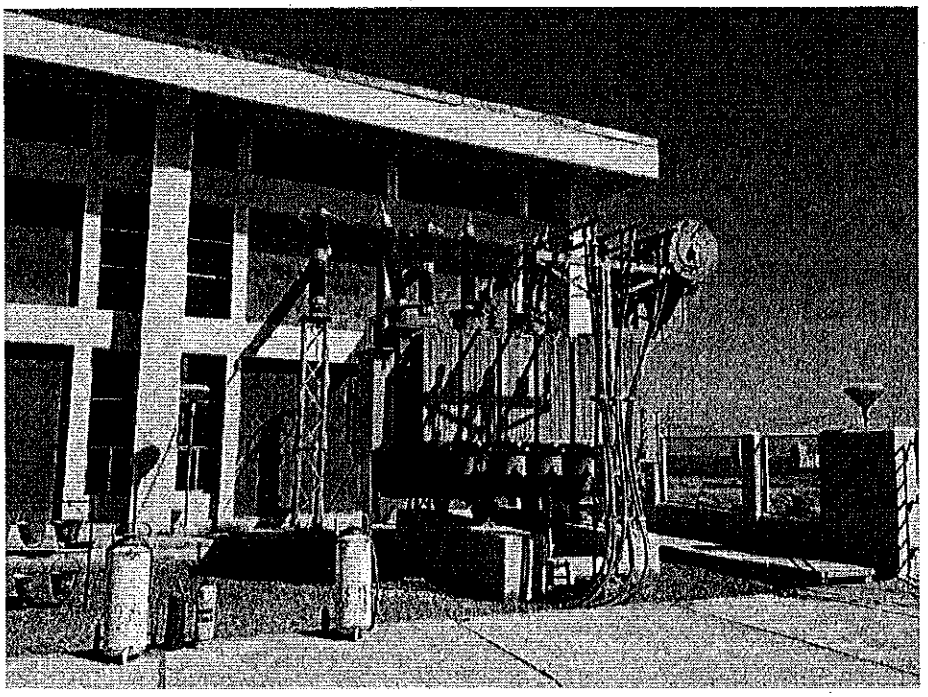
Being closer to the existing QESCO 132KV grid, the site will have electricity connection. For water during construction and maintenance, either a tube well would be required or treated sea water can be used.

4.9 DNO Connection

The proposed site location has been discussed and analysed with respect to power evacuation and grid Interconnectivity point of view. The Gwadar area lies in QUETTA Electric supply co. (QESCO), getting power directly from Iran. The proposed site location is Natural opposite to 132kV Gwadar industrial grid.

The Gwadar industrial grid is connected to 132kV Gwadar city grid and 132kV pasini grid but the T/L to pasini is not yet been energized. This line will be energized probably in one to two months' time. The 132kV line from Gwadar city and pasini grid is passing through 50MW proposed site that is very beneficial for grid Interconnectivity point of view. The 50MW solar

plant will be connected to existing line via looping IN/looping OUT arrangement with feed length not more than 100 meters.



From line capacity points of view, transmission lines have enough capacity to carry this power. In-fact the thermal stress on transmission line will be reduced because this 50MW plant which will give support to active and reactive power. Hence the frequency and voltage profile will be improved.

4.10 Meteorology and Climate

Pakistan lies in the temperate zone. The climate is generally arid, characterized by extreme south western part of the country where Gwadar is the main port city. The climate of Gwadar is mainly dry, arid and hot. The average annual rainfall is around 100 to 150 millimeters only. The mean temperature in the hottest month (June) remains between 31°C and 32°C. Summer months begins from March and remain until November (9 months). The mean temperature in the coolest month (January) varies from 18°C to 19°C. Winter stays from December to February (3 months). Despite of being situated outside the monsoon belt, Gwadar receives light monsoon showers in summers (June – August), however in winters, western disturbances does brings considerable rainfall.

Records of climatic parameters of past 30 years, obtained from Pakistan Meteorological Department shows annual precipitation which was recorded at 99.45 and 113.78 at Pasni and Jiwani stations respectively. Global irradiation of the area = 2430 KWhr/m.sq. (PVGIS Value).

The monthly 30 years mean maximum and minimum temperatures, precipitation and relative humidity recorded at Pasni and Jiwani stations are as follows:

Month	Mean Temperature (o C)		Precipitation (Millimeters)	Relative Humidity (%)
	Maximum	Minimum		
January	24.83	12.56	18.96	63.14
February	26.26	13.99	18.66	64.50
March	29.73	17.24	14.00	64.74
April	32.70	20.99	3.86	67.80
May	35.25	24.21	0.02	68.42
June	34.99	26.75	0.35	76.23
July	33.39	27.02	5.91	75.84
August	32.34	25.70	12.32	76.78
September	32.52	23.70	0.46	75.68
October	33.30	20.27	2.24	66.94
November	30.61	16.12	0.25	61.95
December	26.22	12.86	22.42	63.71
Annual	31.01	20.11	99.45	68.81

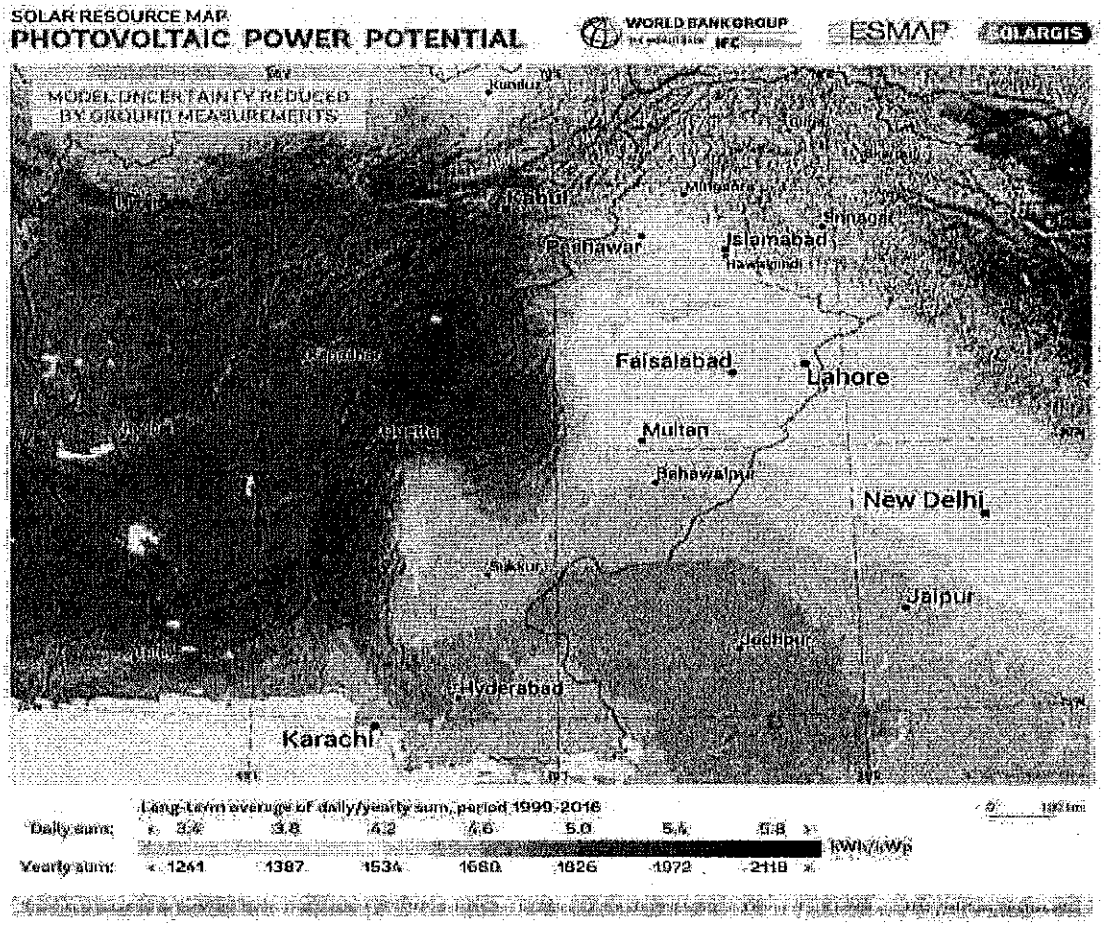
Source: Pakistan Meteorological Department

Month	Mean Temperature (o C)		Precipitation (Millimeters)	Relative Humidity (%)
	Maximum	Minimum		
January	23.93	14.06	27.27	56.65
February	24.84	15.21	33.38	61.76
March	28.43	18.78	9.89	65.15
April	31.57	22.09	5.95	65.16
May	33.97	25.15	0.18	68.48
June	34.09	27.39	0.60	73.38
July	32.51	27.41	7.73	74.60
August	31.05	26.14	3.56	75.41
September	31.41	24.52	0.25	74.05
October	23.38	21.99	0.17	67.25
November	29.39	18.27	4.49	58.38
December	25.52	15.24	20.31	57.71
Annual	29.17	21.35	113.78	66.50
Source: Pakistan Meteorological Department				

4.11 Irradiation Levels

Global Irradiation = 2430 KWhr / m.sq. (PVGIS value). More accurate weather data can be acquired from Solar GIS or Meteonorm etc.

Environmental considerations are extremely important for solar power plant siting. The project site is in high solar radiation zone and sun light is available for 8-9 months. Irradiation level of Pakistan is explained in Figure



4.12 Record of Tropical Cyclones in Balochistan

Pakistan has 1,046 kilometer coastline along the Arabian sea and the Gulf of Oman. Though cyclones are rare in the Arabian sea which is a part of North Indian Ocean, cyclones that form in the sea mostly move towards western India rather than Pakistan. Cyclones in the Arabian sea form mostly from May till June and then from September till October. Monsoon season plays a vital role for the formation of cyclone in this basin. Cyclones mostly hit Sindh coast instead of Balochistan coast in Pakistan. Recorded cyclones which impacted Gwadar and its adjacent coastal areas include following cyclones:

i) **Cyclone Gonu, June 2007**

It remained well in southwest of Pakistan, but it still produced heavy rainfall and strong winds in the city of Gwadar, where it cause damaged to dozens of boats and schools buildings.

ii) **Cyclone Yemyin, June 2007**

It was developed over the Bay of Bengal and intensified into a cyclone over the Arabian sea. It made rainfall near the towns of Ormara and Pasni in the Balochistan province on 26th June 2007 where it killed 300 people.

iii) **Cyclone Phet, June 2010**

It dropped heavy rainfall along the Makran coast. Gwadar recorded 370 mm (15 in) of rainfall which damaged 10,000 houses and disrupted portions of the Makran Coastal Highway.

4.13 Landscape and Visual

The site and surrounding area are characterized by an overall flat topography, with no elevated areas in the vicinity. The closest settlement to the proposed site is a residential area for management in the east and residential area for staff in west of power plant. The closest settlement near the solar site is located almost 5km away, in south east direction of the site. The residential area is located at lower elevation, because of distance from solar plant, it is high unlikely that proposed development will have any visual impact on the nearby residences.

The landscape character of the area is not outstanding and has not been designated as area of outstanding natural beauty or national park. Hence development of solar farm will not deteriorate the surrounding environment and landscape.

4.13.1 Ambient Air Quality

Since the primary source of air pollution at the above sites is the vehicular emissions and the emergency generators, dust is the key pollutant likely to be found at the locations the other

pollutants include carbon monoxide (CO), oxides of nitrogen (NOX), sulfur dioxide (SO_2), and particulate matter (PM). There does not exist any large industry or any other significant pollution source near these site.

4.14 Ecological Resources (Flora and Fauna)

The proposed site is not a prime agricultural land and does not have any record of threatened flora and fauna. Not a single endangered tree species has been found on site. Only native bushes are present on distant locations. The site strata is not suitable for a quality green cover. Usually, the flora of the area is governed by the type of soil and the amount of moisture available.

4.15 Hydrology and Water Use

The primary source of water provided at site is though tankers. Water is obtained from tube wells, canals and underground sources. For the proposed site, contract with local supplier is already in place. However for drinking purpose, filtrated water is used through filtration plant.

4.16 Archeology and Cultural Heritage

The site doesn't have any historic buildings in its surroundings. The history of land shows that site is free from any kind of archeological findings. The assessment clearly defines that site will not have any cultural or heritage impacts.

SECTION 5

5.0 POTENTIAL IMPACTS AND THEIR MITIGATION MEASURES

This section provides identification, characterization and assessment of potential impacts of proposed FFC Solar PV project on the physical, biological and social environment of project area. In addition, their significance and recommended mitigation measures to minimize impacts are also discussed. Those impacts that cannot be eliminated can be greatly reduced through mitigation measures such that residual impacts will be minimal.

5.1 Potential Impacts during Construction Phase

With respect to potential environmental impacts of project activities, the construction phase is a significant activity of proposed project life cycle. Construction activities will inevitably create environmental impacts on physical and biological factors including following:

i) Noise and Vibration
ii) Air Emissions
iii) Surface and Ground Water Contamination
iv) Landscape and Physical Disfiguration
v) Soil erosion, Degradation and Contamination
vi) Damage to Ecology/Wildlife Habitat

5.1.1 Noise and Vibration

Construction machinery and excavation at project site will generate noise and vibration which will lead to disturbance or noise pollution. As the size of project is small, so consequently machinery used for the construction would be in limited area and will cause mild effect within existing facility. Project site is away from communities, hence noise or vibration issues are expected to be negligible.

Unmitigated Impact Characterization

Nature:	Direct
Duration:	Short to Medium Term
Reversibility:	Reversible
Likelihood:	Likely
Consequence:	Minor
Significance:	Low

Mitigation Measures

Following mitigation measures will minimize noise impacts:

- Construction machinery, generators and vehicles will be kept properly maintained and tuned.
- Vehicles will have exhaust silencers to minimize noise generation.
- Movement of heavy machinery will be avoided at night as to prevent echo effect.
- Vehicle speeds will be kept slow and pressure horns will be avoided while passing through or near the communities.
- Ear protection for man-power will be provided.
- Noise Monitoring or Mapping may be considered for construction activity.
- Contractor(s) will submit plan for noise monitoring and obtain approval.
- Compliance of noise levels defined in SEQS will be ensured.

Residual Impact

- Mitigation measures will reduce the magnitude of impact of noise and vibration but will not eliminate it completely.
- Noise monitoring during project execution will ensure compliance to above mitigation measures and their adequacy, as well as verification of significance of residual impact.
- Significance of the residual impact is expected to be low.

5.1.2 Air Emissions

Construction machinery and vehicles will release exhaust air emissions comprising of Carbon Monoxide (CO), Sulfur Dioxide (SO2), Oxides of Nitrogen (NOx) and particulate matter (PM). Construction activities such as excavation, leveling, filling and vehicular movement will also generate fugitive dust emissions. These emissions will impact on ambient air quality in the immediate vicinity of project site. Since the project site is far away from communities, therefore no air quality issues are expected to be arising.

Unmitigated Impact Characterization

Nature:	Direct
Duration:	Short Term
Reversibility:	Irreversible
Likelihood:	Likely
Consequence:	Minor
Significance:	Medium

Mitigation Measures

Following mitigation measures will minimize air emissions impacts:

- Air quality analysis at the site will be conducted before start of construction, in order to establish baseline conditions of the ambient air quality.
- Construction machinery, generators and vehicles will be kept in good condition and properly tuned.
- Exhaust air emissions will comply with NEQS limits.
- Fugitive dust emissions will be minimized during construction activities by spraying water on soil.
- Project vehicles will avoid passing over loose soils to avoid fugitive dust emissions. If unavoidable, speed will be reduced to 15 km/h.

Residual Impact

- Mitigation measures will reduce the magnitude of impacts on ambient air quality but will not eliminate them completely.
- Environmental monitoring during the project execution will ensure compliance to the mitigation measures and their adequacy.
- Significance of the residual impacts on air quality is expected to be low.

5.1.3 Surface and Ground Water Contamination

The project activities that can contaminate surface or groundwater include following:

(i) Accidental spillage/leakage of fuels, oils and waste chemicals.

(ii) Solid waste disposal from construction activities.

(iii) Wastes from equipment/vehicle maintenance activities.

However, at the project location consequences of these impacts will be mild.

Unmitigated Impact Characterization

Nature:	Direct and Indirect
Duration:	Short to Medium Term
Reversibility:	Reversible
Likelihood:	Likely
Consequence:	Minor
Significance:	Medium

Mitigation Measures

- Groundwater quality analysis will be conducted before the start of construction activities, inorder to establish baseline characteristics of ground water.
- Continuous monitoring of ground water quality will be carried out at appropriate time intervals.
- Construction camp will be established considering area with least effect on surface and ground water.
- Contractor(s) will submit plan for waste disposal system and obtain approval.

Residual Impact

- By adopting mitigation measures, the project activities are unlikely to contaminate water resources of the area. The residual impacts of the project on the water quality will therefore be negligible.
- The environmental monitoring during the project execution will ensure compliance to the mitigation measures and significance of residual impacts.

5.1.4 Landscape and Physical Disfiguration

The existing land has vast space for construction and operations of the proposed project. The solar power facility will be constructed in the area which was unused so far, so there will be no landscaping, cutting of trees and disturbance of natural habitat or any ecological disturbance to the environment.

Unmitigated Impact Characterization

Nature:	Direct
Duration:	Short Term
Reversibility:	Irreversible
Likelihood:	Unlikely to possibly
Consequence:	Minor
Significance:	Medium

Mitigation Measures

- There will be no clearing of natural vegetation and cutting of trees; however if requirement arises, no herbicides will be used for the purpose.
- A complete record will be maintained for tree cutting/trimming or shrub removing. The record will include: the number, species, type, size, age, condition and photograph of the trees that would be cut/trimmed.
- Use of wood as fuel for cooking will not be allowed. Construction staff will be provided with fuel or cooked food would be bought from nearest hotel.
- No fires will be allowed in the open area or near the construction site.

Residual Impact

- The potential impacts of the proposed project on the natural vegetation are expected to be very low in nature.
- With mitigation measures, significance of residual impacts on vegetation of the area is expected to be 'very low to negligible'.
- The environmental monitoring during the project execution will ensure compliance to mitigation measures and their adequacy, as well as significance of residual impacts.

5.1.5 Soil Erosion, Degradation and Contamination

Soil erosion is likely to be caused during excavation and construction activities. Although, construction activities will be carried out in an already developed and operational site, where the roads are established and construction activity will be limited to a defined boundary. Insignificant bushes/shrubs may be removed for equipment installation purposes. There may be soil contamination because of fuel/oils spillage/leakage or inappropriate waste (solid as well as liquid) disposal.

Unmitigated Impact Characterization

Nature:	Direct
Duration:	Long Term
Reversibility:	Irreversible
Likelihood:	Likely
Consequence:	Minor
Significance:	Medium

Mitigation Measures

- To protect soil contamination on the project site, the contractors shall be bound to perform inspection of all its construction machinery.
- Fuel or Oil leakage from the vehicles or machines (Transformers) due to maintenance at work site will not be allowed. Maintenance will be done at workshops and maintenance area.
- Any debris or construction waste shall be collected at appropriate time and will not be left aside in open area.

Residual Impact

- The potential impacts of proposed project on soil erosion and contamination are expected to be low in nature due to the limited area and designated construction.
- Significance of the residual impacts on the soil erosion and contamination of the area is therefore expected to be 'low'.

5.1.6 Damage to Ecology/Wildlife habitat

The project area does not have any natural vegetation for grazing animals. There are no protected habitats areas at or near the project sites. The resilient animal species currently existing in the area have already adapted to human activities. Project activities will therefore have not any adverse effects on wildlife habitat.

Unmitigated Impact Characterization

Nature:	Direct
Duration:	Medium to Long Term
Reversibility:	Reversible
Likelihood:	Unlikely to possibly
Consequence:	Minor
Significance:	Low

Mitigation Measures

- Habitat destruction will be kept to minimal.
- Solid Wastes/Garbage will not be left in the open environment. Waste segregation, Reduce, Reuse, Recycle practices will be implemented.
- The project staff will not be allowed to indulge in any hunting or trapping activities.

Residual Impact

- The potential impacts of the proposed project on ecology and wildlife of the area are expected to be mild in nature.
- Significance of the residual impacts on flora and fauna is therefore expected to be 'low'.

5.2 Potential Impacts during Operation and Maintenance (O&M) Phase

The O&M activities will be performed in a controlled manner considering /safety measures and potential impacts. The potential impact during the operations phase includes contamination of soil and water as a result of inappropriate waste disposal (domestic solid waste, sewage, repair and maintenance waste such as waste oils, fuel and chemicals, etc.)

5.2.1 Soil and Ground water Contamination

The O&M activities at site will generate several types of wastes, which can cause soil or ground water contamination. These are listed below.

- Solid wastes from offices.
- Sewage from offices and facilities.
- Leakage and spillage of fuel and oil.

Unmitigated Impact Characterization

Nature:	Direct and Indirect
Duration:	Short to Medium Term
Reversibility:	Irreversible
Likelihood:	Likely
Consequence:	Minor
Significance:	Medium

Mitigation Measures

Following mitigation measures will greatly minimize; if not eliminate the impacts of the proposed project's O&M activities on soil and ground water of the area:

- The facility will implement appropriate solid waste collection and disposal practices based on waste minimization, reduction, re-use and recycling. Relevant contractor service will be obtained.
- Onsite sewage facility e.g Septic Tanks will be maintained such that treated wastewater will be directed to drain fields. Ground water table will be protected by maintaining depth of the installation and material of tanks.
- Sewage Sludge will be collected on defined intervals and disposed of through contractor.
- Waste oils, fuels and chemicals will be disposed of in accordance with their respective Material Safety Data Sheet (MSDS).
- Soil contaminated by oil/fuel spillage will be removed and disposed of appropriately in accordance with MSDS.

Residual Impact

- After the mitigation measures the residual impacts on soil or ground water contamination are expected to be low in nature.

5.2.2 Soil Erosion or Degradation

Most impacts of Solar PV project on soil are restricted to the construction phase, which will get stabilized during operation phase. The soil conditions of site would be allowed to stabilize during this period. The topsoil in areas would be restored and such portions of the site would be planted with appropriate plantation inside the boundary of the project. During operation of a project, no appreciable adverse changes in the soils are anticipated.

5.2.3 Air Quality

Plant operation would not significantly affect air quality, since solar project is green field project & there will be no gaseous emissions during operation phase from the proposed project.

5.2.4 Noise Pollution

During plant operations, there would be no significant noise generation. There might be use ofmachinery during maintenance of plant, but the activity will be restricted to day time. The noisegenerated will not exceed permissible limit as per SEQS for noise. Also the IFC EHS Guidelines for Noise will be implemented which is 55 db(A) at day time and 45 db (A) at night time. Noisemonitoring will be performed during construction and operation phases to keep in permissiblelimits.

5.2.5 Ecology

There is no sensitive ecological area / protected forest area such as national wildlife park, birdSanctuary near the project area. The area is vacant land and removal of small bushes duringinitial period of construction will be minimal and will be reversed through re-plantation. Therewill be no impact on the ecology of the area during operation phase.

5.2.6 Wastewater from cleaning of Solar PV modules

There shall be minimal discharge of wastewater from cleaning of Solar PV modules. Thewastewater emanating from cleaning operations shall be recycled for plantation around thePlant. The water for cleaning the module will not include any chemical agents. Modules shall be cleaned on defined time intervals i.e once or twice a month. Tanker water supply will bemade available and will be used by the cleaning staff.

5.2.7 Visual Impact/Reflection

The site, after completion of its development, would consist of built structures, landscaped togive a pleasing sight. The potential impacts could be visual and reflection. However, as theproject site and the surrounding areas provide no significant aesthetic value, the sights of a large area covered with solar PV panels will have no visual impact.

As the plant is near Bolari Air force airstrip so glare effects may be produced, but reflection problem will not occur in this Project as its surface of solar PV panels is designed to absorb sunlight and minimize sunlight reflections. The panels have more efficiency to absorb heat and there is very low chances of reflection. The panels which are being used have a negligible silicon inhalation.

5.2.8 Impact of Transmission Lines during Operation Phase

Electric Shock:

This may lead to death or injury to the workers in the area. This shall be minimized or avoided by:

- Security fences around substation
- Establishment of warning signs
- Careful design using appropriate technologies to minimize hazards.

Maintenance of Transmission Line and Substation:

Possible exposure to electromagnetic inter phase could occur during these activities. Design of transmission line shall comply with the limits of electromagnetic interference from overhead power lines.

Oil Spillage:

Contamination of water on land by the transformer oil can occur during operation due to leakage or accident. Substation transformers are normally located within secure and impervious areas with a storage capacity of 110% spare oil. Also proper drainage facilities will be constructedduring the construction stage to avoid overflow or contamination.

5.3 Potential Impacts during Decommissioning Phase

Dismantling operation will have impacts on environment. All activities shall be performed in a controlled way to keep the impacts minimum. Applicable laws and guidelines will be followed throughout all activities. Impacts during decommissioning of the project are described below:

5.3.1 Noise Pollution

Sources of noise during decommissioning will be similar to those of construction phase. Equipment will include rollers, bulldozers, diesel engines and vehicular traffic. However, it will be on intermittent basis and will occur for a limited period of time.

5.3.2 Air Pollution

Emissions from decommissioning activities include vehicular emissions, diesel emissions from large construction equipment, generators trucks and equipment traffic. These emissions will not likely exceed air quality standards defined in SEQS.

5.3.3 Ecological Impacts

Impacts to flora and fauna from decommissioning activities will be similar in nature to impacts from construction activities. It is expected that overall impact will be low.

5.3.4 Solid Wastes Impacts

Substantial amount and varied types of solid waste will be generated during the decommissioning and dismantling of the facility. Much of the solid material for e.g. Concrete and Masonry, Steel, Power Cables etc. could be recycled and sold as scrap, the remaining nonhazardous waste would be sent to permit disposal facilities. Disposal of solar PV panels shall be carried out at decommissioning at the end of PV Solar Panel lives that is probably 30 years. Following means of disposal shall be preferred for various types of solid wastes:

- Concrete waste will be disposed of in the landfill site within project premises.
- Steel will be reused and sold out as Scrap.
- Cables will be reused and sold out.
- PV for Solar plant will be dispose off as per standard industrial practice and the implementation of international protocols; Basel Convention and the Trans boundary movement of hazardous

wastes and their disposal May 5, 1992 would be preferred for the decommissioning of PV Plant.

- PV panels shall be segregated into reusable, recyclable and non-recyclable waste. Non-recyclable will be further separated into hazardous and non-hazardous waste. The categories for hazardous and non-hazardous waste shall be dealt accordingly as per EPA guidelines. A reputable 3rd party contractor shall be hired for handling such waste that would be having certification or approval from environmental protection agency as well as Basel convention act 1992.

5.4 Summary of Potential Impacts during Construction, O&M and Decommissioning

D	=	Direct		LT	=	Long Term		H	=	High
ID	=	Indirect		MT	=	Medium Term		M	=	Medium
MJ	=	Major		ST	=	Short Term		L	=	Low
MN	=	Minor		IR	=	Irreversible		R	=	Reversible
Li	=	Likely		LP	=	Likely Possible				

Table 7A: Potential Impacts during Construction Phase

Impact	Nature	Duration	Effect	Likelihood	Consequences	Severity
Noise & Vibration	D	ST	IR	Li	MN	M
Air Emissions	D	ST	IR	Li	MN	M
Surface & Ground Water Contamination	D & ID	ST-MT	R	Li	MN	M
Landscape and Physical Disfiguration	D	ST	IR	LP	MN	L
Soil Erosion & Contamination	D	LT	IR	Li	MN	L
Damage to Wildlife	D	MT	R	LP	MN	L

Table 7.1: Potential Impacts during O & M

Impact	Nature	Duration	Effect	Likelihood	Consequences	Severity
Soil and Ground Water Contamination	D & ID	ST	IR	Li	MN	M
Soil Erosion or Degradation	D	ST	R	Li	MN	L
Air Quality	ID	ST	R	LP	MN	L
Noise Pollution	ID	ST	R	LP	MN	L
Ecology	ID	ST	R	LP	MN	L
Wastewater from cleaning of Solar PV modules	D	ST	R	Li	MN	L
Visual Impact/Reflection	D	ST	R	Li	MN	L
Impact of Transmission Lines during Operation Phase	D & ID	LT	R	Li	MN	M

Table 8.1: Potential Impacts during Decommissioning

Impact	Nature	Duration	Effect	Likelihood	Consequences	Severity
Noise Pollution	D	ST	IR	Li	MN	M
Air Pollution	D	ST	IR	Li	MN	M
Ecological Impacts	D	MT	R	LP	MN	L
Solid Wastes Impacts	D	ST	R	Li	MN	M

5.5 Social and Economic Impacts

Most of the socio-economic concerns will arise during the construction phase of the proposed project. The key socioeconomic impacts are identified and assessed below:

5.5.1 Employment Generation

The project will generate employment opportunities for local population. Indirect job opportunities will also be created outside the project boundary. Local contractors and labors from nearby communities will be given priority for hiring skilled and unskilled labor. Overall, it is anticipated that the project will provide steady income source to local people during construction and O&M. Project activities employment impacts are thus positive.

5.5.2 Land Acquisition and Asset Loss

The project will not entail any physical or economic displacement. No Land will be acquired from any other third party; the new construction will be developed inside the area/premises of the existing Solar power facility.

5.5.3 Damage to infrastructure

The project is in the existing facility and no damage will occur on infrastructure.

5.5.4 Child Labor

Although the use of child labor is not prevalent in construction industry; however, the provisions of the Child Labor Act will still be made part of the construction contracts to ensure that no child labor will be employed at the project site.

5.5.5 Occupational Safety of Employees

Project construction activities will involve operation of construction machinery, vehicular traffic, excavation and filling. Solar power plant operation and maintenance activities will also expose workers to various occupational safety hazards. Following mitigation measures will be taken to protect workers from potential safety hazards.

(i) The construction sites will have protective fencing to avoid any unauthorized entry.

(ii) Drivers will be provided with Defensive Driving Training.

(iii) Vehicular speeds near/within premises will be kept slow.

(iv) Firefighting equipment will be made available at the camps and construction site.

(v) The camp staff will be provided with Firefighting Training.

(vi) All safety precautions as per MSDS will be taken to transport, handle and store hazardous Substances e.g. Flammable fuels etc.

5.5.6 Indigenous People

There are no indigenous peoples living on the project site, thus, no such community will be impacted by the project.

5.5.7 Renewable Power Sector Development

Solar energy holds the most potential of all renewable energy sources in Pakistan, possibly offering at a rate of 1000 watts per square meter. The project will demonstrate this potential for large-scale solar projects to meet power needs in the region. The project will establish the commercial viability of large-scale solar farms connected to the grid and set off the necessary growth in the sector by advancing a model that can be replicated by other private sector investors.

SECTION 6

6.0 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

This section provides the detail of implementation strategy for mitigation measures identified during the environmental assessment through an Environment Management Plan.

6.1 Purpose and Objectives of EMP

The purpose of EMP is to provide operational control details of implementation strategy for the environmental aspects of the respective area or the activity. The specific objectives of EMP are:

- Define the environmental control measure and their implementation mechanism.
- Define roles & responsibilities of project proponents, contractors, principal company, means of communication between them etc..
- Define monitoring and measurement of parameters and environmental performance criteria.
- Identify Training Need Assessment and training provision.

6.2 Scope of EMP

The EMP consists of the following components:

- Mitigation plan
- Monitoring plan
- Environmental Training Plan
- Institutional Arrangements
- Communication and documentation
- Budgetary estimates for EMP implementation.

6.3 Mitigation Plan

Mitigation measures are the key elements to implement environmental controls. The plan covers all the potential effects of each activity of project and their associated mitigation measures. For each activity of the project, the following information is presented in the plan:

- A listing of the potential impact associated with project activity

- A comprehensive listing of mitigation measures (actions)
- Responsibility of the concern for implementation action
- Responsibility of the concern for monitoring
- The timing of the action to ensure that the objectives of mitigation are fully met.

It is emphasized that the mitigation measures will have to be translated into environmental requirements and specifications to be made part of the contracts for the construction activities, with legal binding. Following mitigation plan will be implemented.

S.No.	Project Activities	Impact	Action	Timeline	Monitoring
1.	**Contractor Mobilization and Demobilization for Construction at site**	**Soil and Water Contamination**	• Construction machinery/vehicles must be kept slow on unpaved roads. • To prevent fuel/oil spill/leak, no machinery/vehicle shall be repaired or maintained at site. • Waste oils will be collected in drums and properly disposed of. • Construction camps will be established inside boundary of the existing premises. • Photographic record will be maintained of site conditions prior to establishment of camp. • Any land clearing, leveling and grading will be minimized to prevent soil erosion. • Contractors will submit a waste disposal plan to Proponent for approval and implementation. • Inert non-hazardous waste from such as card board, drums, broken/used parts, etc. will be disposed of through contractor. • Hazardous waste will be kept separate, handled and disposed of according to MSDS. • Domestic solid waste from construction camp will be disposed employing reduce, reuse and recycle strategy. • Camp sites will be built according to requirements of operation phase. All temporary structures will be removed. All debris and any other material will be removed from site. • Current source of water will be continued for water supply. • Planning will be employed to conserve water at the construction	Before, During and After Construction	Contractor & Proponent

			sites and camp. • Treated waste water/grey water from washing and kitchen may be used for greening the environment.		
2.		**Air Quality Deterioration**	• Construction machinery and vehicles, generators will be kept in good working condition and properly tuned, in order to minimize the exhaust emissions. • Vehicles exhaust will comply with the NEQS Limits. • Dust emissions will be minimized by appropriate methods, such as spraying water on soil, where required and appropriate.	During Construction	Contractor & Proponent
3.		**Noise**	• Vehicles will have exhaust mufflers (silencers) to minimize noise generation. • Vehicles noise will comply with NEQS. • Vehicle speeds will be kept slow, and horns will not be used while passing through or near the communities.	During Construction	Contractor & Proponent
4.		**Safety Hazards**	• Safety signage at the site, construction area will be affixed at appropriate locations to reduce safety hazard associated with project related vehicular traffic. • Project drivers will be trained on defensive driving. • Vehicle speeds near/within construction site, will be kept slow, to avoid safety hazards and dust emissions. • Protective fencing to be installed around the Camp to avoid any accidents. • Firefighting equipment will be made available at the camps. • Construction staff will be provided firefighting training. • All safety precautions will be taken to transport, handle and store hazardous substances, such as fuel.	During Construction	Contractor

5.		**Social and Gender Issues**	• Construction crew will avoid entering nearby settlement (if any) • No child labor will be employed. • Complaints (if any) from surroundings will be duly addressed.	During Construction	Contractor & Proponent
6.	**Operation and Maintenance Activities**	**Safety Hazards**	• Proponent or the Contractor will be provided essential protective gears and equipment. • Principal will be provided safety training. Refresher courses will be arranged on regular basis. • Firefighting equipment including Fire Extinguisher, buckets etc. will be made available at facility according to the probable fire types at Solar/Wind site and respective magnitude. • Emergency Response Plan (ERP), of Principal will also share and made available at facility. Its salient points will be displayed at prominent places within working and resting areas. • Emergency first aid treatment in case of snake/scorpion bites will be provided. Commute to nearest hospital will be made if required. • Appropriate signage on safety precautions will be installed at the key locations.	During Operation and Maintenance	Proponent

6.4 Monitoring Plan

Environmental monitoring will be undertaken during the project activities with an overall objective of management of environmental impacts. It will ensure effectiveness of mitigation measures in minimizing the project's impacts on environmental and social resources.

Monitoring activities will include performing systematically audit/observation of mitigation activities undertaken by proponent and contractors and verifying that these are in compliance with the legislative requirements and are within acceptable limits. Documentation and communication of monitoring observations to the concerned person(s) of the proponents and contractors will be done, for implementing appropriate and timely corrective actions.

Periodic monitoring reports of project's environmental performance will be documented, communicated to the stakeholders/BEPA and records will be maintained. Following monitoring plan will be implemented.

S.No.	Monitoring Parameter	Frequency	Locations to be monitored	Responsibility	Records
1.	**Soil Erosion**	Routine monitoring	Construction sites and campsites.	Contractor & Proponent	Photographs
2.	**Water Quality**	Quarterly	Local well / Boring/ Water Supply Line etc.	Contractor & Proponent	Test/Analysis Report
3.	**Water Consumption**	Monthly	Construction sites and campsites.	Contractor & Proponent	Applicable record/report
4.	**Waste water Quality**	Six Monthly	Samples after appropriate treatment.	Contractor & Proponent	Test/Analysis Report
5.	**Ambient Air Quality**	Annually	Campsites	Contractor & Proponent	Monitoring Report
6.	**Exhaust Air Emissions**	Quarterly	Generators, Construction Machinery, Vehicles etc.	Contractor & Proponent	Monitoring Report
7.	**Ambient Noise**	Annually	Generators, Construction Machinery, Vehicles etc.	Contractor & Proponent	Monitoring Report
8.	**Hazardous and Non-Hazardous Waste generation/Disposal**	Monthly	Construction sites and campsites.	Contractor & Proponent	Report
9.	**Environmental and Social complaints**	Monthly	Construction sites and campsites.	Contractor & Proponent	Report
10.	**Accidents and Incidents**	Monthly	Construction sites and campsites.	Contractor & Proponent	Report

6.5 Training Plan

Provision of Environmental and Safety Trainings will ensure that requirements of EMP are followed throughout the project period. The primary responsibility for providing training to all project personnel will be of proponent. Training plan will be finalized before the commencement of project.

Trainings will be provided to the proponent staff; the construction contractors and other staff engaged in project activities and will cover all staff levels, ranging from management and supervisory to the skilled and unskilled labor. The scope of the trainings will cover general environmental awareness and legislative requirements with special emphasis on sensitizing the project staff to the environmental and safety aspects of the area. During the O&M phase of the project, these trainings will continue to be provided by proponent for all relevant staff. Records will be maintained and contractors will be advised to submit training records accordingly.

Following Training Plan will be implemented.

S.No.	Topics	Participants	Schedule	Responsibility
1.	Environmental Impacts Mitigation, Occupational Safety and Social Awareness	All personnel	Prior to project kick off	Proponent
2.	Environment Management Plan & Occupational Safety Management Plan	Construction Staff	Before and during Construction	Contractors
3.	Road Safety and Defensive Driving	All drivers (Permanent and Contractual)	Before and during Construction	Proponent and Contractors
4.	Fire Fighting and First Aid	Construction Staff	Before and during Construction	Contractors
5.	Environmental and Occupational Safety Procedures e.g. Waste Disposal, Resource Conservation, Safety Hazards, Housekeeping etc.	Construction Staff	Before and during Construction	Contractors

6.6 Organizational Arrangement for EMP

6.6.1 Responsibilities

- Proponent will have an officer responsible for overseeing and monitoring implementation of EMP.
- EMP and relevant documents will be included in all contracts.
- During the O&M phase of the project, proponent will be responsible to ensure the implementation and reporting of environmental performance.

6.6.2 Communication and Documentation

- Recording/maintaining all information of monitoring will be in a predetermined format.
- Information will be compiled to produce periodic reports to be communicated accordingly.
- Communication channels will be well defined among proponent and contractors.
- Meetings will be held among proponent and contractors on defined intervals.
- Records will be retained according to the proponent or contractor records management policy/procedure (as applicable).

6.6.3 Estimated Budgetary requirements

Estimated cost of mitigation and monitoring shall be completely integrated with project cost and will not be separated. An officer overseeing environmental matters will be appointed. The table below mentions the cost estimates for the environmental management of the proposed project. It may be reduced or increased as per the conditions implies.

S.No.	Description	Frequency per year/Cost	Cost (PKR)
1.	Water Testing	4 X 25,000	100,000
2.	Waste Water Testing	2 X 25,000	50,000
3.	Ambient Air Quality Monitoring	1 X 45,000	45,000
4.	Equipment/Vehicles Exhaust Monitoring	4 X 45,000	180,000
5.	Ambient Noise Monitoring	1 X 45,000	45,000
6.	Environmental/Safety Trainings	6 X 45,000	270,000
7.	CSR Activities	Based on community needs and aspirations	200,000 per year
8.	Safety Signage, Posters, PPE's etc. during construction and O&M.	New and replacement of old Signage/PPEs etc.	150,000

SECTION 7

7.0 CONCLUSION & RECOMMENDATIONS

The scope of the proposed project is installation, commission and generation of power through solar panels connected with existing grid. The Project will be the replacement of conventional power generation with renewable energy. Solar energy will replace fossil fuel powered generation and therefore it would reduce greenhouse gas emissions into the atmosphere.

The PV technology to be utilized at the proposed Gwadar Solar Power Plant has several key benefits, when compared to the conventional energy sources, contributing to the sustainable development including:

- Safe for Construction and Operations of the photovoltaic facility have no heavy duty components to be installed during the construction phase of the development, preventing exposure of risks to workers such as fire, explosions and volatile organic emissions associated with thermal fluid-based solar thermal technologies;
- Low Environmental Impact. The Photovoltaic (PV) technology is land-efficient, waterless, with a lower direct project impact and a lowering the environmental risk throughout the project life cycle;
- Local manufacture, material and labor supply to comprise a high percentage of the project value;
- Promotes Solar Industry Growth. The Photovoltaic (PV) technology is uncomplicated, reliable, is sustainable and allows automated manufacture, thereby leveraging the strengths of the manufacturing sector.
- The surface layer of vegetation is not cleared underneath the facility, allowing for reduced ecological impact.
- Non-depletable source (the sun)
- Pollution free (no fuel, no emissions, recyclable)
- No noise No moving parts to wear out (if fixed panels are used). PV installations can operate for many years with little maintenance.
- PV systems are modular. You can start with a small system and expand as demand for power increases.

- PV systems have a long life & durability. Cells last 25-30 years.
- Systems installed and operated anywhere including areas of difficult access and remote locations.
- Do not require water
- Reduction of the CO2 emissions;
- Improvement of the quality of water supplies;
- Reclamation of degraded land;
- Reduction of the number of the required power transmission lines

From the socio-economic viewpoint, the benefits of the use of solar energy systems include:

- Reduction of the national dependency on fuel imports;
- Diversification and security of energy supply;
- Provision of significant job opportunities and working positions;
- Support of the energy market deregulation;
- Acceleration of the rural electrification in developing countries.

Initial Environmental Examination (IEE) has been conducted in line with legislative requirement of Pakistan Environmental Protection Act 1997, EIA / IEE Regulation and National Environmental Quality Standards. The results of initial examination comprises of site surveys and assessment of various environmental factors such as Topology, Air, Noise, Water resources, Ecology, Climate and Natural habitat, Community and employees health and safety etc., determination of legislative and other requirements and their compliance status, requirements from proponent.

Adverse Environmental impacts are not likely to result from the proposed project and those with some medium to low impacts are controllable through proposed mitigation measures or EMP. Overall, impacts are manageable, cost effectively. The proposed project will have number of positive impacts and negligible negative impacts to the existing environment. Some of the positive features of the project are as follows:

- Significant improvement in the economic activity of the surrounding areas due to generation of direct and indirect employment opportunities.
- The Project Area does not fall under any sensitive or protected ecosystem.
- No threatened / Near-Threatened species of wildlife are recorded in the Project Area.
- No trees will be removed from the project site.
- Environment pollution due to excavation and fill operation, transportation of materials, nuisance from dust, noise, vehicle fumes, smoke and vibration are short term impacts.
- Project will not entail physical or economic displacement of communities.
- Proper planning for transportation and material management will be implemented to overcome public inconvenience (if any) during the proposed project activities.
- The Project is not considered as highly sensitive or complex.

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

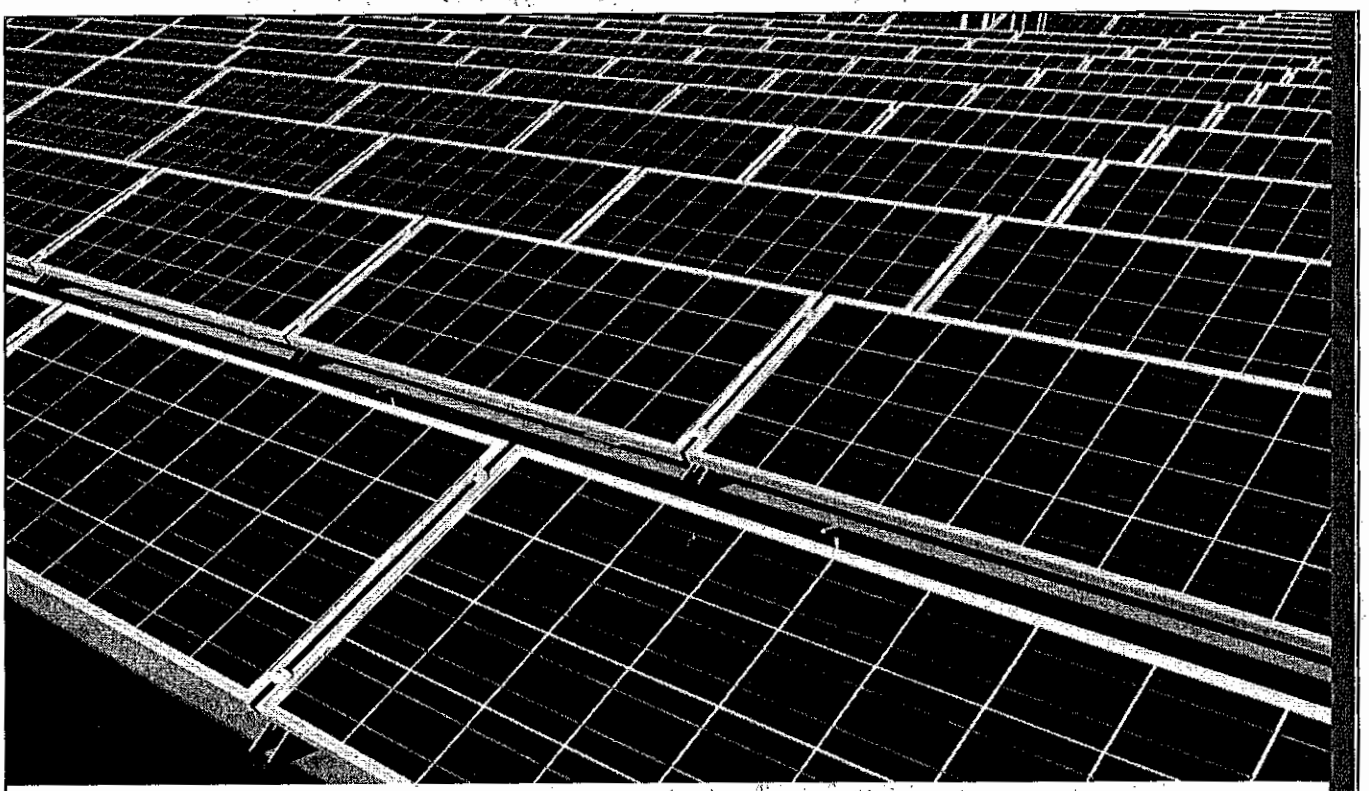
Most impacts are expected to occur during the construction phase and are considered to be of a temporary nature. The main construction impacts are associated with waste management and excavation and movement of soils. Mitigation measures related to construction activities will be incorporated into civil works contracts and their implementation will be primarily the responsibility of contractors. Hence, the proposed project has limited adverse environmental and social impacts.

On the basis of the environmental impact assessment and the conclusions, it is recommended that:

- EMP must be made a part of the contracts awarded for the proposed project.
- Training to contractors for environmental and social management must be made mandatory.

- Environmental and safety legislation to be made part of its awareness program for contractors.
- Contractors must demonstrate their commitment towards sound environmental and social management practices throughout operations.
- During the construction & operation local labor/human resources must be hired.
- All safety measures must be taken for the construction phase.
- Safety measures specific to liquid fueling operations shall be taken by the proponent and guided by the principal.
- Fencing of area/boundary wall must be ensured during construction phase. The land may be zoned for industrial use or be designated specifically for the purpose in a subdivision.
- Vehicular access/egress/crossover to be reasonably safe with adequate approach distances especially where main roads and intersections are involved.
- Wherever possible, sites to be erected on level rather than sloping site to prevent rolling over of discarded materials such as cans, drums, etc.
- All service areas to be paved to avoid dust nuisance.
- Signs must be in accordance with the regulations and should be located so as not to reflect the sun into the face of motorists and should be large enough so that they can be seen from a reasonable distance at a defined speed limit.
- Site must be equipped with fire-fighting and fire protection equipment installed in accordance with the requirements of the civil defense and applicable legislation.
- Fuel tanks are to be vented to the atmosphere.
- All volatile flammable liquid storage tanks shall be installed below ground in compliance with the applicable requirements.
- Proper facilities for storage and disposal of used and waste oil must be provided.
- Waste water from washing / cleaning purpose must be dispose of properly.
- Fuel should be stored in double walled container to minimize leakage and prevention of contamination of ground water.

In addition, the EMP parameters monitoring including environmental and social complaints (if any) will be carried out throughout the project activities.



GRID INTERCONNECTION ASSESSMENT OF 50MW(AC) IB VOGT SOLAR PV POWER PLANT

ARCO Energy

Draft Report
December, 2018

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CONTENTS

EXECUTIVE SUMMARY

This Grid Interconnection Assessment (GIA) report provides the documentation of an assessment that has been performed for the connection of a 50MW (AC) Solar PV Power Generation project by P&G Energy Pvt Ltd. (Ib Vogt) to the Quetta Electric Supply Company (QESCO) transmission system at 132kV. The '50MW (AC) Solar PV Power Generation project' located in Gwadar, Balochistan, Pakistan and has a commercial operation date of September 2021. The project will be connected by making an In/Out on 132kV Cairo Single circuit between Gwadar – Pasni grid station by a feed length of 0.5km of Cairo conductor.

Steady state power flow assessment has been performed using the already available network data of QESCO. Pre-project power flow study was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Post project power flow analysis has also been performed after the interconnection of the proposed project with the QESCO transmission system. The power flow results for the system intact and for the contingency conditions shows that the power flows on all the transmission line branches are within their normal thermal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

Dynamic stability analysis has been performed to access the dynamic impact of the Solar power plant on national grid system due to disturbances at the power plant and vice versa. The results of dynamic stability analysis indicate that the power system is stable for the interconnection proposal and it also fulfils all the criteria for generation connection with the power system.

Short circuit analysis has been performed to evaluate the contribution of the proposed project in fault current levels of substations in its electrical locality. Fault currents have been computed based on simulation of three-phase and single-line-to-ground faults by applying the criteria as mentioned in the IEC-60909 standard. Result of the analysis shows that the calculated fault currents are below the circuit-breaker interrupt ratings of existing grid stations located in locality of the project.

Based on the study results, it is concluded that proposed generation interconnection assessment for 50MW (AC) Solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This Grid Interconnection Assessment (GIA) report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by P&G Energy Pvt Ltd. (Ib Vogt) "Project Owner" or "PO" for the connection of a 50 MW (AC) Solar PV Power Generation project ("Project") to the Quetta Electric Supply Company (QESCO) transmission System at 132kV. The PO has proposed a commercial operation date of September 2021 for the Project.

The project is located in Gwadar, Balochistan. Figure 1.1 shows Google site map of the project. The pre-project and post-project geographical representation of power plant is shown in Figure 1.2 and Figure 1.3.

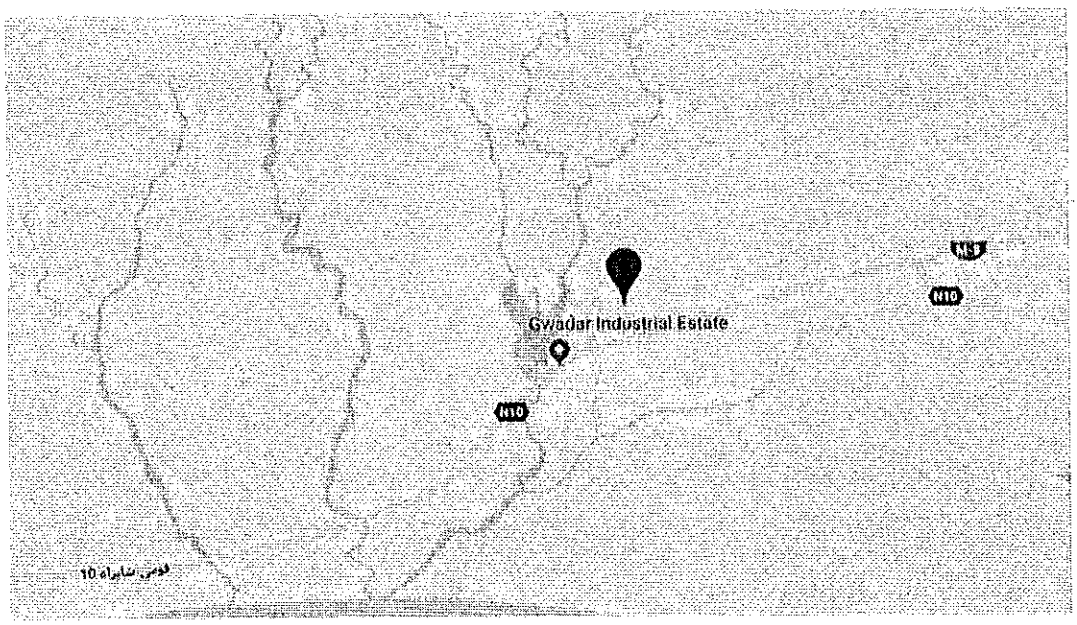

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

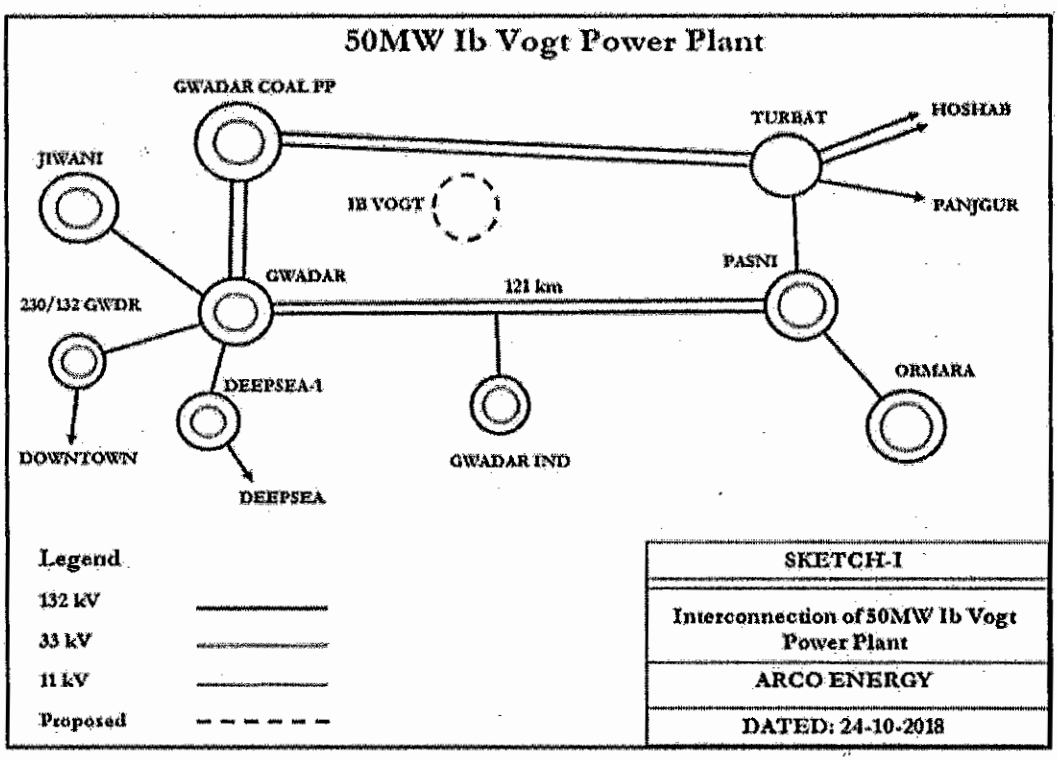

Figure 1.2: Existing Network around Ib Vogt Solar Park.

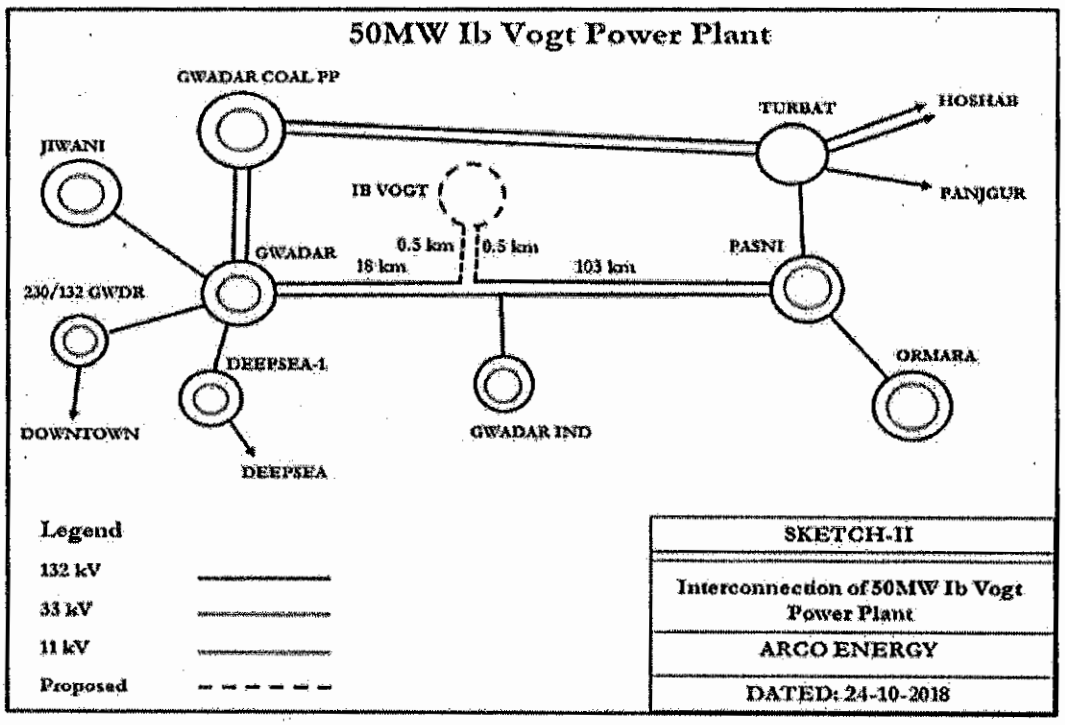

Figure 1.3: Interconnection Proposal of Ib Vogt Solar Park.

1.2 Grid Interconnection Arrangement

The project will be connected by making an In/Out on 132kV Cairo Single circuit between Gwadar – Pasni grid station by a feed length of 0.5km of Cairo conductor. The objective of the GIA is to evaluate the impact of the proposed solar power plant on the QESCO transmission system.

1.3 Study Components

GIA includes the following three types of analyses to evaluate the impact of interconnecting the proposed project:

i) Steady state analysis.

ii) Dynamic stability analysis.

iii) Short circuit analysis.

This report documents the results of the steady state, dynamic stability, short circuit and power quality analysis. The steady state analysis includes pre-project and post project power flow assessment. Dynamic stability analysis includes the post project dynamic stability assessment during occurrence of any fault. Short circuit analysis includes pre-project and post project short circuit current levels assessment at different buses in the vicinity of the project.

2 STUDY METHODOLOGY

2.1 Study Criteria

GIA has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kV and above
	Contingency	±10 % p.u
T/L Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Steady State Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on transmission system facilities under steady-state conditions. It involves two distinct analyses: thermal loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest which includes the following areas within QESCO:

- GWADAR
- TURBAT
- PASNI
- DEEPSEA-1
- GWADAR IND

2.2.1 System Intact Analysis

The incremental impact of the project on thermal loading of transmission facilities under system intact conditions was evaluated by comparing transmission system power flows without and with the proposed project. Loadings of the transmission facilities without and with the project were

tabulated and compared. The criteria to flag thermal overloads are 100% of continuous facility rating (Rate A in the power flow model).

2.2.2 Contingency Analysis

The contingency analysis for this study consists of single branch (N-1) outage in the study area.

2.2.3 Thermal Loading Analysis

132kV and 33kV rated transmission facilities in the study area have been monitored for thermal loadings.

2.2.4 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible pre and post project voltage violations in accordance with NEPRA Grid Code guidelines. In accordance with these guidelines, those buses that have a voltage change of more than ±5% p.u (System Intact condition) and ±10% p.u. (contingency condition) are considered affected.

2.3 Dynamic Stability Analysis

The purpose of dynamic stability analysis is to analyse the impact of the proposed solar power plant on transmission system facilities under transient conditions. The system is considered to be stable if the system recovers with good damping after the transients die out and the synchronism is retained.

Fault clearing time for different voltage levels in accordance with NEPRA Grid Code guidelines is presented in table below.

Voltage Level	Fault Type	Fault Clearing Time
132kV	3-Phase	5 Cycles (100msec)

2.4 Short Circuit Analysis

The purpose of short-circuit analysis is to investigate the fault current levels at nearby substations without and with the proposed project online. And to check whether the calculated pre-project and post-project fault currents are within the circuit breaker interrupt ratings. Short circuit analysis has been carried out by applying the criteria as mentioned in the IEC-60909 standard.

Key assumptions in IEC-60909 are given below.

- Tap ratios to unity
- Line charging to zero
- Shunts are set to zero in positive sequence
- Desired voltage magnitude at bus bars is set to 1.1p.u in maximum fault level.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in Annexure-A. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	20
Generation size of each collector (MVA)	2.5
Active Power of each collector Pgen. (MW)	2.375
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (MVAR)	-0.7806,0.7806
Rated Frequency	50 Hz
Generation Voltage	0.4kV
Xsource	∞
Switchyard Transformer	
No. of Transformer units	2
MVA Capacity of each GSU	55
Rating	33/132kV
% Reactance (X)	13%
(X+ve) = (Xzero) At 100MVA system base.	0.2 p.u
Generation Step Up (GSU) Transformer	
No. of Transformer units	20
MVA Capacity of each GSU	2.5
Rating	0.4/33kV
% Reactance (X)	6%
(X+ve) = (Xzero) At 100MVA system base.	2.4 p.u
Auxiliary Transformer	
No. of Transformer units	1
kVA Capacity of each GSU	50
Rating	0.4/33kV
% Reactance (X)	0.2%
(X+ve) = (Xzero) At 100MVA system base.	4 p.u

Steady state power flow assessment has been performed using the already available network data of QESCO.

3.2 Pre Project-Power Flow Assessment

A pre-project power flow study was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The results of the pre-project power flow analysis are in **Annexure-C.**

3.2.1 Base Year 2021: Peak Loading Summer

Power flow analysis has been performed on the peak loading summer (September) case of QESCO network. This base case included a detailed representation of the QESCO transmission system in the study area.

The power flow results for the system intact conditions show that the power flows on all the transmission line branches are within their normal thermal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area. The results of the pre-project power flow analysis are plotted in **Annexure-C.**

3.3 Post Project Power Flow Assessment

Post project power flow study was conducted to determine the reliability impact of the proposed 50MW Ib Vogt Solar Park project on the QESCO transmission system. This includes the performance of a contingency analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the post project power flow analysis are plotted in **Annexure-D.**

3.3.1 Base Year 2021: Peak Loading Summer

A base case has been developed for peak loading summer (September) 2021 that allow us to judge the maximum impact of Ib Vogt Solar Park project on the QESCO network, using the already available network data of QESCO.

Post-project power flow analysis has been performed after the interconnection of the proposed project with the QESCO transmission system. This includes the detailed representation of the power plant. A simulation of all possible contingencies within the NEPRA Grid Code planning criteria has also been carried out.

The steady state results for the system intact and contingency conditions depicts that the power flows on all the transmission line branches are within their normal thermal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Results from the power flow analysis are presented in table below.

Condition	Contingent Branch	Figure No.	Steady State Result
System Intact	-N.A-	Figure D-1	No overloading
Contingency	IB VOGT Solar PP to PASNI line out	Figure D-1.1	No overloading
Contingency	IB VOGT Solar PP to GWADAR line out	Figure D-1.2	No overloading
Contingency	DEEPSEA-1 to GWADAR line out	Figure D-1.3	No overloading
Contingency	PASNI to TURBAT line out	Figure D-1.4	No overloading
Contingency	TURBAT to GWDR COAL PP line out	Figure D-1.5	No overloading
Contingency	TURBAT to HOSHAB line out	Figure D-1.6	No overloading
Contingency	GWADAR to 230/132 GWADAR line out	Figure D-1.7	No overloading

3.3.2 Base Year 2022: Peak Loading Winter

A base case has been developed for peak loading winter (January) 2022 that allow us to judge the maximum impact of Ib Vogt Solar Park project on the QESCO network, using the already available network data of QESCO.

Post-project power flow analysis has been performed after the interconnection of the proposed project with the QESCO transmission system. This includes the detailed representation of the power plant. A simulation of all possible contingencies within the NEPRA Grid Code planning criteria has also been carried out.

The steady state results for the system intact and contingency conditions depicts that the power flows on all the transmission line branches are within their normal thermal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Results from the power flow analysis are presented in table below.

Condition	Contingent Branch	Figure No.	Steady State Result
System Intact	-N.A-	Figure D-2	No overloading
Contingency	IB VOGT Solar PP to PASNI line out	Figure D-2.1	No overloading
Contingency	IB VOGT Solar PP to GWADAR line out	Figure D-2.2	No overloading
Contingency	DEEPSEA-1 to GWADAR line out	Figure D-2.3	No overloading
Contingency	PASNI to TURBAT line out	Figure D-2.4	No overloading
Contingency	TURBAT to GWDR COAL PP line out	Figure D-2.5	No overloading

Contingency	TURBAT to HOSHAB line out	Figure D-2.6	No overloading
Contingency	GWADAR to 230/132 GWADAR line out	Figure D-2.7	No overloading

4 DYNAMIC STABILITY ANALYSIS

Dynamic stability analysis has been performed to access the dynamic impact of the solar power plant on national grid system due to disturbances at the power plant and vice versa.

4.1 Dynamic Model Development

Generic dynamic models, available in the PSSE model library, for the solar power plant have been used to develop the dynamic model of the power plant. Dynamic model of the power plant is presented in table below;

Component	Model
Generator	PVGU1
Electrical	PVEU1
Mechanical	PANELU1
Pitch	IRRADU1

4.2 Post-Project Dynamic Stability Assessment

4.2.1 Base Year 2021: Peak Loading Summer

Dynamic stability analysis has been carried out for the Base Year 2021 peak loading summer conditions. To access the dynamic behavior of power plant and system towards the disturbances, simulations have been carried out of 3 Phase fault at Ib Vogt Solar Park cleared in 5 cycles.

Each simulation has been performed for one second to depict steady state condition. Then fault is applied and system has been simulated for the fault clearance time. Post-fault condition has been simulated, from clearance of fault followed by a certain contingency, till 20 seconds.

4.2.2 3 Phase fault at 132kV Ib Vogt Solar Park cleared in 5 cycles

Three phase fault has been applied at Ib Vogt Solar Park, fault has been cleared in 100msec (5 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-1: 3 Phase fault at 132kV Ib Vogt Solar Park bus cleared in 5cycles (Stuck Breaker in 100msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-1.1	132kV line from Ib Vogt PP to Pasni	Bus Voltages of (i) 0.4kV Ib Vogt LV (ii) 33kV Ib Vogt MV (iii) 132kV Ib Vogt PP (iv) 132kV Pasni (v) 132kV Gwadar (vi) 132kV Gwadar Ind	E-1.1A	Stable
		Frequency of (i) 132Kv Ib Vogt Solar PP	E-1.1B	Stable
		MW and MVAR of Ib Vogt LV	E-1.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gwdr Coal PP (ii) Hubco PP	E-1.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) Ib Vogt PP to Pasni Bus (ii) Ib Vogt PP to Gwadar Bus	E-1.1E	Stable
E-1.2	132kV line from Ib Vogt PP to Gwadar	Bus Voltages of (i) 0.4kV Ib Vogt LV (ii) 33kV Ib Vogt MV (iii) 132kV Ib Vogt PP (iv) 132kV Pasni (v) 132kV Gwadar (vi) 132kV Gwadar Ind	E-1.2A	Stable

No.	Contingency	Monitored Element	Figure No.	System Response
		Frequency of (i) 132kV Ib Vogt Solar PP Bus	E-1.2B	Stable
		MW and MVAR of Ib Vogt LV	E-1.2C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gwdr Coal PP (ii) Hubco PP	E-1.2D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) Ib Vogt PP to Pasni Bus (ii) Ib Vogt PP to Gwadar Bus	E-1.2E	Stable

4.2.3 3 Phase fault at 132kV Pasni cleared in 5 cycles

Three phase fault has been applied at Pasni, fault has been cleared in 100msec (5 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-2: 3 Phase fault at 132kV Pasni bus cleared in 5cycles (Stuck Breaker in 100msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-2.1	132kV line from Pasni to Ib Vogt PP	Bus Voltages of (i) 0.4kV Ib Vogt LV (ii) 33kV Ib Vogt MV (iii) 132kV Ib Vogt PP (iv) 132kV Pasni (v) 132kV Gwadar (vi) 132kV Gwadar Ind	E-2.1A	Stable
		Frequency of (i) 132kV Ib Vogt Solar PP Bus	E-2.1B	Stable
		MW and MVAR of Ib Vogt LV	E-2.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gwdr Coal PP (ii) Hubco PP	E-2.1D	Stable

		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) Ib Vogt PP to Pasni Bus (ii) Ib Vogt PP to Gwadar Bus	E-2.1E	Stable

4.2.4 3 Phase fault at 132kV Gwadar bus cleared in 5 cycles

Three phase fault has been applied at Gwadar Grid, fault has been cleared in 100msec (5 cycles) with a particular N-1 contingency and dynamic stability response of the system is monitored, the same has been summarized in the table below.

Fault E-3: 3 Phase fault at 132kV Gwadar bus cleared in 5cycles (Stuck Breaker in 100msec)

No.	Contingency	Monitored Element	Figure No.	System Response
E-3.1	132kV line from Gwadar to Ib Vogt PP	Bus Voltages of (i) 0.4kV Ib Vogt LV (ii) 33kV Ib Vogt MV (iii) 132kV Ib Vogt PP (iv) 132kV Pasni (v) 132kV Gwadar (vi) 132kV Gwadar Ind	E-3.1A	Stable
		Frequency of (i) 132kV Ib Vogt Solar PP Bus	E-3.1B	Stable
		MW and MVAR of Ib Vogt LV	E-3.1C	Stable
		Rotor Angles w.r.t. Muzaffargarh Slack Bus: (i) Gwdr Coal PP (ii) Hubco PP	E-3.1D	Stable
		Active (P) and Reactive (Q) power flows on interconnecting 132kV lines from (i) Ib Vogt PP to Pasni Bus (ii) Ib Vogt PP to Gwadar Bus	E-3.1E	Stable

Dynamic Stability Analysis Results are attached in **Annexure-E.**

5 SHORT CIRCUIT ANALYSIS

Short circuit analysis has been performed to determine the need for any breaker replacements due to impacts of the solar power plant project. Single-line-to-ground and three-phase fault current values have been calculated for buses in the vicinity of the solar power plant project. The calculated fault currents observed at these buses were compared with the interrupting current capabilities of corresponding circuit breakers to determine need for upgrading existing circuit breakers.

5.1 Short Circuit Model Development

Short circuit database provided by QESCO has been used as a base case to perform short circuit assessment. The study project has been added to the base case to develop the post-project case. The short circuit model of the power plant is presented in table below.

Generator Data	
X (+ve)	∞
X (-ve)	∞
X (zero)	∞

5.2 Post-Project Short Circuit Assessment

With the addition of power plant, short circuit current at each bur bar is increased, so the circuit breaker capacity has analysed. Post-project short circuit assessment has been performed to evaluate the contribution of the proposed project in fault current levels of substations in its electrical locality and to compute the fault levels at Ib Vogt Solar Park.

5.2.1 Maximum Short Circuit: Base Year 2021

The maximum short circuit levels have been computed according to IEC-60909 standard. Pre and Post project maximum short circuit levels at the buses within the study area in the year 2021 have been presented in table below.

Bus Name	Bus kV	Pre-Project		Post Project	
		1-Φ Fault Level (kA)	3-Φ Fault Level (kA)	1-Φ Fault Level (kA)	3-Φ Fault Level (kA)
IB VOGT Solar MV Bus	33	-N.A-	-N.A-	0.0	8.2
IB VOGT Solar Bus	132	-N.A-	-N.A-	3.2	3.8
PASNI	132	2.2	2.8	1.9	2.5
GWADAR	132	6.2	5.9	5.9	5.7
GWADAR IND	132	2.1	2.7	1.9	2.5
TURBAT	132	4.0	3.6	3.5	3.2
DEEPSEA-1	132	3.0	4.1	3.1	3.9

Pre and Post project maximum short circuit analysis summary for the base year 2021 are attached in **Appendix F-1 and F-2** respectively.

Note:

In the attached short circuit study reports, both three phase and single-phase fault currents with polar coordinates and detailed output showing contribution from adjoining sources (i.e. lines and transformers connected to the bus bar) to the fault currents are included.

6 CONCLUSIONS

6.1 Steady State Assessment

Steady state power flow assessment has been performed using the already available network data of QESCO. Pre-project power flow study was conducted to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Post project power flow analysis has also been performed after the interconnection of the proposed project with the QESCO transmission system. The power flow results for the system intact and for the contingency conditions showed that the power flows on all the transmission line branches are within their normal thermal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges. Both options are further analysed and investigated under the influence of power & energy losses, cost of equipment installed, cost of augmentation required at substation.

6.2 Dynamic Stability Assessment

Dynamic stability analysis has been performed to access the dynamic impact of the solar power plant on national grid system due to disturbances at the power plant and vice versa. The results of dynamic stability analysis indicate that the power system is stable for the interconnection proposal and it also fulfils all the criteria for generation connection with the power system.

6.3 Short Circuit Assessment

Short circuit analysis has been performed to evaluate the contribution of the proposed project in fault current levels of substations in its electrical locality. Fault currents have been computed based on simulation of three-phase and single-line-to-ground faults by applying the criteria as mentioned in the IEC-60909 standard. Result of the analysis shows that the calculated fault currents are below the circuit-breaker interrupt ratings of existing grid stations located in locality of the project.

Hence, it is concluded that based on the study results the proposed generation interconnection assessment for 50MW (AC) IB VOGT Solar Park meets the NEPRA grid code planning criteria.