A D<u>CTGI-WK CHOLISTAN SOLAR POWER</u> WR <u>PROJECT (PVT) LTD</u>

No: CWCSPP/NEPRA/RGL/2015/03

Date: -13th April 2015

Iftikhar Ali Khan, Deputy Registrar, National Electric Power Regulatory Authority, Islamabad.

Subject: - APPLICATION OF CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LIMITED FOR GANT OF GENERATION LICENCE IN RESPECT OF 50.0 MW SOLAR POWER PLANT, DISTRICT BAHAWALPUR.

Dear Sir,

The subject application was submitted to the Authority under Section 15 of the NEPRA Act for the consideration of the grant of Generation Licence. We are in receipt of your Letter No. NEPRA/R/LAG-30/4249 dated: March 26, 2015, informing that the Authority has not admitted our application.

(2). Further, to the above, we have been directed to re-submit our application along with the specific comments of NTDC regarding Interconnection Arrangement for evacuation of power from our subject project. In this regard, we will like to clarify that the required Interconnection Study has already been carried out by the Planning Department of NTDC which was provided with the application. The review of the Interconnection Study will reveal that system of NTDC has the capacity to absorb the solar that will be injected into the system by our project. Further, the study also confirms that all system parameters will remain stable under steady state and transient conditions with the induction of our solar project.

(3). In view of the above, it is very clear that NTDC has already endorsed our project without any qualification. Accordingly, we are of the considered view that no further comments of NTDC will be required and the Authority must consider our application on merit. Accordingly, the application is being re-submitted with the request to process the same on priority without any further delay.

(4). Your kind support and cooperation in the earliest approval of the Generation Licence Application for further development of the project shall he highly appreciated.

Thanks & Regards,

the

Engr. Habil Ahmed Khan (Director Operations)





Application For Generation License Of 50 MW Solar PV Power Project at Lal Suhanara, Bahawalpur, Punjab, Pakistan

■ December, 2014



CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD

A PROJECT COMPANY ESTABLISHED BY WELT KONNECT (PVT) LTD JOINT VENTURE CHINA THREE GORGES SOUTH ASIAN INVESTMENT LIMITED (CSAIL)-A BROTHER COMPANY TO CHINA WATER & ELECTRIC CORPORATION (CWE), WHICH ARE BOTH WHOLLY-OWNED SUBSIDIARIES OF CHINA THREE GORGES CORPORATION (NOW THE DEVELOPER ON BEHALF OF CTG)



中水电国际投资有限公司 CHINA THREE GORGES SOUTH ASIAN INVESTMENT LTD







50 MW Solar Power Project in Cholistan
 Document No.
 02-0786-01

 Rev No. / Date
 02-0786-02

 Issue No. / Date
 15th December 2014

 Effective Date
 19th December 2014

Originally prepared by WK-JV-CSAIL

APPROVAL SHEET

TITLE : Application For Generation License

DOCUMENT NUMBER : 02-0786-02

CLASSIFICATION : Un-Classified

SYNOPSIS

This document is a application to the National Electric Power Regulatory Authority for the grant of a Generation Licence to the Project Company CTGI-WK Cholistan Solar Power Project (Pvt) Ltd pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

- Checklist: As per National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999 NOTIFICATION Islamabad, the 1999, S.R.O. 142 (I)/99Authorization 1st March, from Board Resolution/Power of Attorney, Application Fee (including indexation), Three Copies of Application, Certificate of Incorporation, Memorandum and Articles Of Association, Annual Returns Statements Or In lieu thereof, Profile of Experience of the Applicant, its management, its staff and its members in power sector, CV's of applicants senior management and technical professionals, Cash Balance and Bank Certificates, Expression Of Interest to provide credit or financing along with sources and details thereof, Latest Financial Statements, Employment record of Engineers and technical Staff, Profile of Sub Contractors, Verified References w.r.t Experience of the Applicant and its Sub Contractors, Encumbrances on Assets, Type of Technology, Feasibility Study Report, Prospectus.
- Schedule-I As per NATIONAL ELECTRIC POWER REGULATORY AUTHORITY Licensing (Generation) Rules EXTRAORDINARY PUBLISHED BY AUTHORITY ISLAMABAD, SATURDAY, APRIL 22, 2000 PART II, Statutory Notifications (S.R.O.) GOVERNMENT OF PAKISTAN NOTIFICATION *Islamabad the 17th April, 2000* S.R.O. 221(I)/2000. The Location, Size, Type of Technology, Interconnection

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Limits, Technical/Functional Specifications and other details specific to the Generation Facility/Solar Farm of the Licensee are described in this Schedule.

- Schedule-II: As per NATIONAL ELECTRIC POWER REGULATORY AUTHORITY Licensing (Generation) Rules EXTRAORDINARY PUBLISHED BY AUTHORITY ISLAMABAD, SATURDAY, APRIL 22, 2000 PART II Statutory Notifications (S.R.O.) GOVERNMENT OF PAKISTAN NOTIFICATION *Islamabad the 17th April, 2000* S.R.O. 221(I)/2000. The Total Installed Gross ISO Capacity of the Generation Facility / Solar Plant (MW), Total Annual Full Load (Hours), Average Sun Availability, Total Gross Generation of the Generation Facility/Solar Farm (in kWh), Annual Energy Generation (30 year equivalent Net AEP) kWh and Net Capacity Factor of the Generation Facility /Solar Farm of Licensee is given in this Schedule
- As per National Electric Power Regulatory Authority Licensing (Application and Schedule-III: Modification Procedure) Regulations, 1999 NOTIFICATION Islamabad, the 1st March, 1999 S.R.O. 142 (I)/99 Location Maps, Site Maps, Land, Technology, Size of Plant, Number of Units, Fuel: Type, imported/indigenous, supplier, logistics, pipelines, etc, Emission values, Cooling Water Source: Tube wells, sea/river/canal, distance from Source etc, Interconnection with National Grid Co. Distance and name of nearest grid, voltage level (single line diagram), Infrastructure: Roads, Rails, Staff Colony, Amenities, Project Cost, Information Regarding Sources and Amounts of Equity, Debt, Project Commencement and Completion Schedule with Milestones, ESSA (Environmental and Social Soundness Assessment), Safety Plans, Emergency Plans, System Studies, Load Flow, Short Circuit, Stability, Reliability, Plant Characteristics: Generation Voltage, Power Factor, Frequency, Automatic Generation Control, Ramping Rate, Control Metering and Instrumentation. Control, Metering, Instrumentation and Protection, Feasibility Study Report, **Training and Development**
- Approvals: As per Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 and Power Policy 2006-9 Government of Punjab. Approval of Feasibility Study by concerned agency. Approval of interconnection study by the concerned Agency. Approval of the Environmental Study of the Project by the concerned agency

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PREPARED BY:	Ms. Violet Rong Mr. Mohsin Iqbal Mr. Owais Chaudry
REVIEWED BY:	Mr. Fiaz Ahmad MAJ (Retd.) Riaz Ul Hassan

APPROVED BY:

Engr. Habil Ahmed Khan

Revisions

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DISTRIBUTION

1. National Electric Power Regulatory Authority (NEPRA)

2. China Three Gorges South Asia Investment Limited (CSAIL)

3. Welt Konnect (Pvt) Ltd

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National Electric Power Regulatory Authority	Licensing (Application and Modification Procedure)

Regulations, 1999 NOTIFICATION

Islamabad, the 1st March, 1999

S.R.O. 142 (I)/99

Check List For New Generation Facility

SECTION-A

S.No	Regulation	Information/Documents Required
1.	3(1)	Authorization from Board Resolution/Power of Attorney
2.	3(2)	Application Fee (including indexation)
3.	3(4)	Three Copies of Application
4.	3(5)(a)(i)	Certificate of Incorporation
5.	3(5)(a)(ii)	Memorandum and Articles Of Association
6.	3(5)(a)(iii)	Annual Returns Statements Or In lieu thereof
7.	3(5)b	Profile of Experience of the Applicant, its management, its staff and its members in
		power sector
8.	3(5)(c)	CV's of applicants senior management and technical professionals
9.	3(5)(d)(i)	Cash Balance and Bank Certificates
10.	3(5)(d)(ii)	Expression Of Interest to provide credit or financing along with sources and details
		thereof
11.	3(5)(d)(iii)	Latest Financial Statements
12.	3(5)(d)(iv)	Employment record of Engineers and technical Staff
13	3(5)(d)(v)	Profile of Sub Contractors
14	3(5)(d)(vi)	Verified References w.r.t Experience of the Applicant and its Sub Contractors
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Licensing (Generation) Rules				
	EXTRAORDINARY			
	PUBLISHED BY AUTHORITY			
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		PART II		
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		Facility/Solar Farm (Technical Limits) (Technical/Functional Specifications)		
6.	3(2)	Details specific to the Generation Facility/Solar Farm		
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		PUBLISHED BY AUTHORITY		
		ISLAMABAD, SATURDAY, APRIL 22, 2000		
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		GOVERNMENT OF PAKISTAN		
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		Schedule II		
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	r			
S.No	Regulation	Information/Documents Required		
1.	3(3)	The Total Installed Gross ISO Capacity of the Generation Facility / Solar Plant (MW)		
2.	3(3)	Total Annual Full Load (Hours)		
3.	3(3)	Average Sun Availability		
4.	3(3)	Total Gross Generation of the Generation Facility/Solar Farm (in kWh)		
5.	3(3)	Annual Energy Generation (30 year equivalent Net AEP) kWh		
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2.	3(6)(A)(a)(2)	Technology, Size of Plant, Number of Units	
3.	3(6)(A)(a)(3)	Fuel: Type, imported/indigenous, supplier, logistics, pipelines, etc	
4.	3(6)(A)(a)(4)	Emission values	
5.	3(6)(A)(a)(5)	Cooling Water Source: Tube wells, sea/river/canal, distance from Source etc	
6.	3(6)(A)(a)(6)	Interconnection with National Grid Co. Distance and name of nearest grid, voltage	
		level (single line diagram)	
7.	3(6)(A)(a)(7)	Infrastructure: Roads, Rails, Staff Colony, Amenities	
8.	3(6)(A)(a)(8)	Project Cost, Information Regarding Sources and Amounts of Equity, Debt	
9.	3(6)(A)(a)(9)	Project Commencement and Completion Schedule with Milestones	
10.	3(6)(A)(a)(10)	ESSA (Environmental and Social Soundness Assessment)	
11.	3(6)(A)(a)(11)	Safety Plans, Emergency Plans	
12.	3(6)(A)(a)(12)	System Studies, Load Flow, Short Circuit, Stability, Reliability	
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14.	3(6)(A)(a)(14)	Control, Metering, Instrumentation and Protection	
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ACKNOWLEDGMENTS

The management of the Project Company CTGI-WK Cholistan Solar Power Project (Pvt) Ltd would like to express their gratitude to the support and cooperation extended by the Government of Pakistan and the Government of Punjab in the development activities of the project.

We are also thankful to the dedicated teams of the National Electric Power Regulatory Authority (NEPRA) and of the Punjab Power Development Board (PPDB) for the generous guidance and support throughout all stages of project development.

We hope for and look forward to the continued cooperation of all relevant Government Organizations, Bodies and officials for further advancement in implementing the Project and pioneering the way for Solar Photo Voltaic in Pakistan.

DISCLAIMERS

This document is intended for use by the Stake Holders and relevant Government Authorities for understanding and effective decision making regarding this Project.

The Company and the sponsors are and will not be responsible for any decision made by the intended or unintended users for any other purpose except in relation to this project.

The Company and the Sponsors are and will also not be responsible for any decision made by any other person or party not being an intended user of this document whether related to this project or not without consent of the Company or Sponsors in this regard.

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DOCUMENT INFORMATION

Purpose and Scope:

The purpose of this Application Document is to provide information required for the relevant agency to make informed decision regarding the Grant of Generation License for the subject Power Project.

This document presents the requisite information for such project approval and development within Pakistan's economic and regulatory framework.

STRUCTURE OF THE DOCUMENT:

The Application For Generation License is composed of five (05) main parts/sections:

- Checklist
- Schedule I
- Schedule II
- Schedule III
- Requisite Approvals

Each Part is further sub-divided into sections and contains information as per the applicable Legislation, Guidelines, Rules and Regulation, for ease of reviewing and understanding the project.

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1 Executive Summary Of the Project

China Three Gorges (CTG) being a large international clean energy company, houses main businesses of including construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, initially starting with water conservancy & power projects, has now expanded its scope of business into Power Production through Wind, Solar and Nuclear Energy. Their vision is to be the World's largest clean energy group specializing in large-scale hydropower project development, management and operations; while also proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The Total assets of the Group stand around 41,316 million USD, with a revenue generation of 3,787 million USD, 99.47% from sales of electricity, and 1,418 million USD net profits.

Whereas China Three Gorges South Asian Investment Limited (CSAIL)-A Brother Company To China Water & Electric Corporation (CWE), which are both whollyowned subsidiaries of China Three Gorges Corporation (CTG) *is a new overseasinvestment subsidiary company of CTG*, which was established in Sep. 2013 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CSAIL has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CSAIL is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include the 1100 MW Kohala Hydropower Project, 720 MW Karot Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) is a Power Projects Developing company working in Pakistan. Its niche in the Energy Sector lies in the provision of Renewable Energy Engineering solutions particularly for Wind & Solar Power Projects as Independent Power Producers (IPP's) under the Clean Development Mechanism of the UNFCCC. These integrated solutions and systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in the ever growing and critical field of Renewable Energy.

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In Accordance with their development strategies respectively, in 2009 after consultation with the Esteemed Punjab Government Welt Konnect (Pvt) Ltd (WK) and China Three Gorges (CTG), planned to invest in the development & construction of Pakistan's first 50 MW Solar PV Power Farm in Cholistan in collaboration as a Joint Venture. For development of which consequently two MOU's were signed with the Punjab Government (Provided in Annexure 1 of FSR Vol 1: MOU between WK, CWE and The Punjab Government) in the presence of the Honorable Chief Minister Mr. Shahbaz Sharif, dated June 5th 2010 and later November 6th 2010 after having chalked out a way forward. An MOU was also signed with GTZ for support on developing the project under the Clean Development Mechanism of the UNFCCC (Provided in Annexure 2 of FSR Vol 1: MOU between WK and GTZ)

Teams were then immediately deployed to initiate work on the feasibility analysis of the project, and at the same time to search for a suitable site. With the help of the Punjab Government, 4 sites were short listed and identified in Cholistan, towards Southern Punjab with presence of the required minimum infrastructure, high irradiation levels and solar potential. After due scrutiny and deliberation by Experts over the sites; the 500 Acres strip of land located in (Chuk.No: 314 A Block No: 3, 4, 23, 24) approximately 3 to 4 Km away from the Marot Grid Station and about 50 km from Bahawalpur, the nearest urban city, was selected and finalized. The location was composed of a flat terrain with innocuous sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself a technically and logistically feasible location for the setup of a large solar power station.

However the process of selection & due allocation was delayed considerably due to the unfortunate flooding and ensuing humanitarian disaster in Pakistan during that period.

In parallel, a viable financial and economic model was developed for the project. Various financial institutions and carbon funding agencies were identified and engaged for the purpose. On the other hand search for suitable Solar PV equipment suppliers was initiated, with a special emphasis on quality of the products. Various technologies for Solar PV were considered, and the matter has been addressed in the feasibility study.

The project pre-feasibility study was completed by mid-2011. Subsequently after submission of the Pre-Qualification Documents, to the Punjab Power Development Board (PPDB) along with the Pre-Feasibility Report, Project Proposal, the required Bank Guarantees of 50'000.USD (fifty thousand) (FSR Vol 1 Annexure 4: Bank guarantee) and the requisite fees, the Joint Venture (JV) successfully obtained an LOI

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(Letter of Intent) (FSR Vol 1 Annexure 3: LOI) from the Board duly signed and accepted by both parties on 27-08-2011, along with Government Approvals and Support.

The JV also filed for and received confirmation/Allocation Letter (FSR Vol 1 Annexure 5: Allocation Letter issued by PPDB to the Joint Venture on 09th June 2011) from PPDB for the 500 Acres Project Site on 11-01-2012, after formulation of the requisite policy and procedure by PPDB for such sanctioning of land for Solar Power Projects. Under this framework a 5000 Acre piece of land was handed over by Cholistan Development Authority (CDA) to the Board of Revenue (BOR) which in turn placed it under the control of PPDB for allocation to deserving companies for development of such projects.

Immediately after the Selected Site with coordinates 29 10N (Latitude), 72 25 E (Longitude) which is approximately 4 KM away from the Grid Station was handed over to the JV, competent teams of Engineers & Specialists were deployed for conducting the Topographic Survey, Soil Testing and layout design activities, amongst other studies, which were successfully completed and compiled in the Feasibility Study Report, which was then submitted to PPDB with the stipulated time period for review by the Panel of Experts (POE).

Whereas the Complete Feasibility Study Report for the subject 50MW Solar PV Power Project was approved by the Panel of Experts (POE) of PPDB in its second meeting and notified vide Letter No. PPDB/05/2013, Dated 01/01/2013, Subject: Approval of 50MW Solar Power Project in Marot Cholistan Punjab (FSR Vol 1 Annexure 6: feasibility study report approval by the panel of experts (POE) of PPDB notified vide letter no. ppdb/05/2013, dated 01/01/2013).

However due to the change and relocation of the Project Site to the Quaid- E-Azam Solar Park (QASP) at Lal Suhanara, Bahwalpur, to facilitate and make viable the Grid Interconnection of the subject project, the Feasibility Study Report (FSR) including all studies which had been conducted for development of the 50MW Solar PV Power Project on the previous project site of Marot Cholistan Desert Punjab, were reconducted and updated to reflect such change and acquire all project related Approvals again.

Under the Vision of the Chief Minister of Punjab Mr. Shahbaz Sharif, the new location of the Quad-E-Azam Solar Park (QASP) at Lal Sohanra, Bahawalpur which in total comprises dedicated land of 6,500 acres will be used for the purposes of establishing Solar Power Generation Stations of approximately 1000 MW's.

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The New Project Site allocated to the Joint Venture comprising Welt Konnect Pvt Ltd & CWEI is composed of 250 Acres piece of land as allocated by the Energy Department of the Government of Punjab, through its Letter No.S.O(C)(ED)4-5 2014, Dated: 13th February 2014, Subject: Allocation/Earmarking of Land for 50MW Solar Project in QA Solar Park Bahawalpur (FSR Vol 1 Annexure 7: new project site allocation letter No.s.o(c)(ed)4-5 2014, dated: 13th February 2014). The Project is composed of Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354.

The updated studies revealed no environmental hazards related to the Project. The minor adjustments required during construction phase have been addressed and mitigation plan provided in Volume 5 Environmental Studies of the FSR. There are no settlements within 05-08 Km of the Project Site, which further supports the Project in this location.

Both the updated Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) were submitted to the competent authority of EPA Punjab for consideration, with all its concerns raised vide Letter No. DD (EIA)/EPA/F-362(IEE)/2013, dated 10/03/2014, answered in the documents which after its due diligence issued a No Objection Certificate (NOC)/Environmental Approval vide Letter No. DD(EIA)/EPA/F-362(IEE)/2012/0104/681, Dated 15/04/2014, Subject: Environmental Approval.

The Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) of the proposed project were conducted in accordance with the stipulations of Pakistan's environmental laws and the environmental guidelines of the International Finance Corporation (IFC).

Whereas NTDC which was hired in May 2012 to carry out the Grid Interconnection Study in order to propose the interconnection scheme for evacuation of power from the 50 MW Welt Konnect solar PV power plant to the system network, by the Joint Venture comprising Welt Konnect (Pvt) Ltd and CWE through their Letter dated 9th May 2012, Subject: Interconnection study for 50 MW photovoltaic solar PV project in Cholistan, containing the Bank Draft No. DD 1875227 dated 04th May 2012 amounting to Rs. 1,500,000/- payable to General Manager (Services Division) NTDC, WAPDA on account of Interconnection studies for dispersal of power from the 50 MW generation project to the national grid, (FSR Vol 1 Annexure 8: grid interconnection study correspondence with NTDC), after relocation of the Project to the QASP completed and submitted the draft final report of the grid interconnection study attached to its letter No. COO/GM/CPPA/CE-II/MT-IV/WKPL/2534-39, Dated 21st April 2014, Subject: Interconnection Study Report for Power Dispersal of 50MW PV Solar Project by M/s. Welt Konnect (Pvt) Ltd (FSR Vol 1 Annexure 8: grid interconnection study correspondence with NTDC).

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The results of extensive studies including load flow, short circuit, transient stability and power quality studies have been presented in the interconnection study of the subject 50 MW solar PV power plant. Whereas the adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect power plant and of the system network in its vicinity has been evaluated by NTDC in light of the Grid Code.

For the grid interconnection study, NTDC used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas M/s Welt Konnect(Pvt) Ltd provided the data of its power plant on data request from NTDC.

In addition the project has been developed under the Clean Development Mechanism (CDM) of the UNFCCC under the Kyoto Protocol. After successfully making and submitting the Project Idea Note (PINs) to the Designated National Authority (DNA), registration with the UNFCCC via Prior Consideration Form and issuance of a Letter Of Intent (LOI) from the DNA for further development of the Project Design Documents (PDD's), the PDD's were made and submitted to the DNA followed by the issuance of the final Host Country Approval (HCA) by the DNA, we are now in the phase of obtaining validation by the Designated Operational Entity (DOE) followed by the issuance of CER's by the Executive Board of UNFCCC.

The Joint Venture then submitted the final Updated Feasibility Study Report (FSR) of the subject project for approval by the Panel of Experts (POE) of the Punjab Power Development Board (PPDB), which it granted in the 4th Meeting of the Panel of Experts (POE) dated 06-30-2014, as communicated vide Letter No. 802/2014, Dated 07-04-2014 Subject: Minutes of 4th POE Meeting for M/S CWE & WK JV, For Development of 50MW Solar PV Power Project in Cholistan, Punjab.

The Joint Venture then decided to establish a Project Company to assume and undertake all previously completed, on-going and further development activities for the subject 50 MW Solar PV Power Project and subsequently *"CTGI-WK Cholistan Solar Power Project (Pvt) Ltd"* (hereinafter referred to as the *"Project Company"* or *"CTGI-WK-CSPP"*), was established, a company duly registered with the Securities Exchange Commission of Pakistan (SECP) under Section 40 of the Companies Ordinance 1984 (XLVII of 1984) with Corporate Universal Identification No. 00783664

The Project Company believes that keeping in view the recent improvement and trend in the viability of the technology, possibility of fast track implementation and current energy crises, this project is of paramount importance for Pakistan and will prove to be a pioneer in the Solar PV industry, paving the way for future progress in

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 15th December 2014

 Effective Date
 19th December 2014

Originally prepared by WK-JV-CSAIL

this ever growing field and at the same time provide a viable profitable investment opportunity to the business community.

We are now pleased to submit our application and apply to the National Electric Power Regulatory Authority (NEPRA) for the grant of a Generation Licence to the Project Company CTGI-WK Cholistan Solar Power Project (Pvt) Ltd pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

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National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999

NOTIFICATION

Islamabad, the 1st March, 1999

S.R.O. 142 (I)/99

<u>SECTION – A</u>

CHECKLIST FOR NEW GENERATION FACILITY

Authorization from Board Resolution/Power of Attorney, Application Fee (including indexation), Three Copies of Application, Certificate of Incorporation, Memorandum and Articles Of Association, Annual Returns Statements Or In lieu thereof, Profile of Experience of the Applicant, its management, its staff and its members in power sector, CV's of applicants senior management and technical professionals, Cash Balance and Bank Certificates, Expression Of Interest to provide credit or financing along with sources and details thereof, Latest Financial Statements, Employment record of Engineers and technical Staff, Profile of Sub Contractors, Verified References w.r.t Experience of the Applicant and its Sub Contractors, Encumbrances on Assets, Type of Technology, Feasibility Study Report, Prospectus

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 19th December 2014

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Authorization from Board Resolution/Power of Attorney

CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD Harressmerche Unerge of the Sun

BOARD RESOLUTION

(For Submission Of Application For Grant of Generation License)

Reference: CWCSPP-BR-GL/NEPRA-15-12-2014

Extracts from the Minutes of Board of Directors Meeting of CTGI-WK Cholistan Solar Power Project (Pvt) Ltd ("Company") on 15th December 2014 at its Head office, Suite. No: 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad. Pakistan

RESOLUTION

I, Fiaz Ahmad, the Chairman of Board of Directors, CTGI-WK Cholistan Solar Power Project (Pvt) Ltd hereby approve the following resolutions:

RESOLVED that the Project Company be and is hereby authorized to file an application for grant of Generation License (including any review petitions and any motion for review) to National Electric Power Regulatory Authority in respect of the 50 MW Solar power plant of the Project Company CTGI-WK Cholistan Solar Power Project (Pvt) Ltd at Lal Suhanara, Bahawalpur, Punjab, Quaid-E-Azam Solar Park ("Project") and in relation thereto, enter into and execute all required documents, make all filing and pay all applicable fees, of any nature what so ever".

FURTHER RESOLVED THAT in respect of filing the Generation License Application including any review petitions and any motion for review for submission to National Electric Power Regulatory Authority, Engr. Habil Ahmed Khan S/o Irshad Ahmed Khan,

Pakistan Office 8. Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info/@ctgiwkespp.com, www.etgiwkespp.com



A CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD Henry solution that the sum

having CNIC No: 61101-9543551-1, Director Operations, CTGI-WK Cholistan Solar Power Project (Pvt) Ltd be and is hereby authorized and empowered for and on behalf of the Project Company to:

> (i) review, execute, submit and deliver the Generation License Application (including any review petitions and any motions for leave for review) and any related documentation required by NATIONAL POWER REGULATORY AUTHORITY for the grant of the generation license, including any contracts, documents, power of attorney, affidavits, statements letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature what so ever;

> (ii) represent the Project Company in all negotiations, representations, presentations, hearings, conferences and meetings of any nature what so ever with any entity (including in no manner limited to NATIONAL POWER REGULATORY AUTHORITY and private parties, companies, partnerships, individuals governmental and/or semi-governmental authorities and / or any other entity of any nature whatsoever);



Pakistan Office 8, Ground Floor. Evacuee Trust Complex, F-5/1, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info@ctgiwkespp.com, www.ctgiwkespp.com



中国三峡南亚投资有限公司

China Three Gorges South Asia Investment Limited

地址: 北京市西城区金融大街 19 号 Add: No. 19 Financial St. Xicheng, Beijing 100032, China 电话 Tel: 86-10-58688709 传真 Fax: 86-10-586888588 网址 Web: www.ctgpc.com.cn

BOARD RESOLUTION

(For Submission Of Application For Grant of Generation License)

Reference: CSAIL/BR-GL/NEPRA-<u>0/</u>-12-2014

Extracts from the Minutes of Board of Directors Meeting of China Three Gorges South Asian
 Investment Limited (CSAIL) ("Company") a brother company to China Water & Electric
 Corporation (CWE) which are both wholly-owned subsidiaries of China Three Gorges
 Corporation held on <u>O1st</u> December 2014 at CSAIL Head office, No. 19 Financial St. Xicheng,
 Beijing 100032, China

RESOLUTION

I, Shaofeng Wang, <u>the Chairman of Board of Directors, China Three Gorges South Asian</u> <u>Investment Limited (CSAIL)-</u>a brother company to China Water & Electric Corporation (CWE), which are both wholly-owned subsidiaries of China Three Gorges Corporation (now is the developer of 50MW Solar PV Power Project on behalf of CTG), hereby approve the following resolutions:

RESOLVED that the Company be and is hereby authorized to file an application for grant of Generation License (including any review petitions and any motion for review) to National Electric Power Regulatory Authority in respect of the 50 MW solar power plant of the Company in joint venture with Welt Konnect (Pvt) Ltd at Lal Suhanara, Bahawalpur, Punjab, Quaid-E-Azam Solar Park ("Project") and in relation thereto, enter into and execute all required documents, make all filing and pay all applicable fees, of any nature what so ever".

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中国三峡南亚投资有限公司

China Three Gorges South Asia Investment Limited 地址:北京市西城区金融大街 19 号 Add: No. 19 Financial St. Xicheng, Beijing 100032, China 电话 Tel: 86-10-58688709 传真 Fax: 86-10-586888588 网址 Web: www.ctgpc.com.cn

FURTHER RESOLVED THAT in respect of filing the Generation License Application including any review petitions and any motion for review for submission to National Electric Power Regulatory Authority, Engr. Habil Ahmed Khan S/o Irshad Ahmed Khan, having CNIC No: 61101-9543551-1, Director Operations Welt Konnect (Pvt) Ltd be and is hereby authorized and empowered for and on behalf of the Company and Joint Venture to:

(i) review, execute, submit and deliver the Generation License Application (including any review petitions and any motions for leave for review) and any related documentation required by NATIONAL POWER REGULATORY AUTHORITY for the grant of the generation license, including any contracts, documents, power of attorney, affidavits, statements letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature what so ever;

(ii) represent the Company in all negotiations, representations, presentations, hearings, conferences and meetings of any nature what so ever with any entity (including in no manner limited to NATIONAL POWER REGULATORY AUTHORITY and private parties, companies, partnerships, individuals governmental and/or semi-governmental authorities and / or any other entity of any nature whatsoever);

For & on behalf of China Three Gorges South Asian Ipvestment Limited (CSAIL)

Shaofeng Wang (Chairman of Board of Directors)

WELT KONNECT (Pvt) Ltd



Driving You Into The Future

BOARD RESOLUTION

(For Submission Of Application For Grant of Generation License)

Reference: WK-BR-GL/NEPRA-15-12-2014

Extracts from the Minutes of Board of Directors Meeting of Welt Konnect (Pvt) Ltd (WK) ("Company") on 15th December 2014 at its Head office, Suit. No: 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad. Pakistan

RESOLUTION

I, Fiaz Ahmad, the Chairman of Board of Directors, Welt Konnect (Pvt) Ltd hereby approve the following resolutions:

RESOLVED that the Company be and is hereby authorized to file an application for grant of Generation License (including any review petitions and any motion for review) to National Electric Power Regulatory Authority in respect of the 50 MW Solar power plant of the Company in joint venture with China International Water & Electric Corporation (CWE) at Lal Suhanara, Bahawalpur, Punjab, Quaid-E-Azam Solar Park ("Project") and in relation thereto, enter into and execute all required documents, make all filing and pay all applicable fees, of any nature what so ever".

FURTHER RESOLVED THAT in respect of filing the Generation License Application including any review petitions and any motion for review for submission to National Electric Power Regulatory Authority, Engr. Habil Ahmed Khan S/o Irshad Ahmed Khan,

WELT KONNECT (Pvt) Ltd

Suit 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info@weltkonnect.com, www.weltkonnect.com

WELT KONNECT (Pvt) Ltd

Driving You Into The Future



having CNIC No: 61101-9543551-1, Director Operations Welt Konnect (Pvt) Ltd be and is hereby authorized and empowered for an on behalf of the Company and Joint Venture to:

> (i) review, execute, submit and deliver the Generation License Application (including any review petitions and any motions for leave for review) and any related documentation required by NATIONAL POWER REGULATORY AUTHORITY for the grant of the generation license, including any contracts, documents, power of attorney, affidavits, statements letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature what so ever;

> (ii) represent the Company in all negotiations, representations, presentations, hearings, conferences and meetings of any nature what so ever with any entity (including in no manner limited to NATIONAL POWER REGULATORY AUTHORITY and private parties, companies, partnerships, individuals governmental and/or semi-governmental authorities and / or any other entity of any nature whatsoever);

For & behalf of Welt Konnect (Pvt) Ltd Fiaz Abanad (Chairman)

WELT KONNECT (Pvt) Ltd Suit 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info@weltkonnect.com, www.weltkonnect.com

中国三峡南亚投资有限公司

China Three Gorges South Asia investment limited 地址: 北京市西城区金融大街 19 号 Add: No. 19 Financial St. Xicheng, Beijing 100032, China 电话 Tel: 86-10-58688709 传真 Fax: 86-10-586888588 网址 Web: www.ctgpc.com.cn

BOARD RESOLUTION

(For Creation of Specialized Project Company)

Reference: CSAIL/BR-SPC/<u>o1</u>-12-2014

Extracts from the Minutes of Board of Directors Meeting of China Three Gorges South Asian Investment Limited (CSAIL) ("Company") a brother company to China Water & Electric Corporation (CWE) which are both wholly-owned subsidiaries of China Three Gorges Corporation held on \underline{cl}^{st} December 2014 at CSAIL Head office, No. 19 Financial St. Xicheng, Beijing 100032, China

RESOLUTION

I, Shaofeng Wang, <u>the Chairman of Board of Directors, China Three Gorges South Asian</u> <u>Investment Limited (CSAIL)-</u>a brother company to China Water & Electric Corporation (CWE), which are both wholly-owned subsidiaries of China Three Gorges Corporation (now the developer of 50MW Solar PV Power Project on behalf of CTG), hereby approve the following resolution:

RESOLVED that the Company hereby authorizes and empowers the Specialized Project Company (SPC) with Name *"CTGI-WK Cholistan Solar Power Project (Pvt) Ltd"* (hereinafter referred to as "CTGI-WK-CSPP"), having been duly registered with the Securities Exchange Commission of Pakistan (SECP) under Section 40 of the Companies Ordinance 1984 (XLVII of 1984) with Corporate Universal Identification No. <u>0078366</u>, to assume and undertake all previously completed, on-going and further development activities for the subject 50 MW Solar

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中国三峡南亚投资有限公司

China Three Gorges South Asia Investment Limited 地址: 北京市西城区金融大街 19 号 Add: No. 19 Financial St. Xicheng, Beijing 100032, China 电话 Tel: 86-10-58688709 传真 Fax: 86-10-586888588 网址 Web: www.ctgpc.com.cn

PV Power Project being developed by Welt Konnect (Pvt) Ltd in Joint venture with <u>China Three</u> <u>Gorges South Asian Investment Limited (CSAIL)-</u>a brother company to China Water & Electric Corporation (CWE), which are both wholly-owned subsidiaries of China Three Gorges Corporation (now is the developer of 50MW Solar PV Power Project on behalf of CTG), under Letter of Intent (**LOI**) **No:** PPDB/1201/127/2011 **Dated:** 09-06-2011 issued by Punjab Power Development Board (PPDB)

For & on behalf of **China Three Gorges South Asian Investment Limited (CSAIL)**

Shaofeng Wang Chairman WELT KONNECT (Pvt) Ltd

Driving You Into The Future

BOARD RESOLUTION (For Creation of Specialized Project Company)

Reference: WK/BR-SPC/02 -12-2014

Extracts from the Minutes of Board of Directors Meeting of Welt Konnect (Pvt) Ltd ("Company") held on $\mathcal{O}\underline{2^{\prime\prime\prime}}$ December 2014 at Head office: Suite 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad.

RESOLUTION

I, Fiaz Ahmad, the Chairman of Board of Directors, Welt Konnect (Pvt) Ltd, hereby approve the following resolution:

RESOLVED that the Company hereby authorizes and empowers the Specialized Project Company (SPC) with Name *"CTGI-WK Cholistan Solar Power Project (Pvt) Ltd"* (hereinafter referred to as "CTGI-WK-CSPP"), having been duly registered with the Securities Exchange Commission of Pakistan (SECP) under Section 40 of the Companies Ordinance 1984 (XLVII of 1984) with Corporate Universal Identification No. 0078366, to assume and undertake all previously completed, on-going and further development activities for the subject 50 MW Solar PV Power Project being developed by Welt Konnect (Pvt) Ltd in Joint Venture with <u>China Three Gorges South Asian Investment Limited (CSAIL)</u>-a brother company to China Wáter & Electric Corporation (CWE), which are both wholly-owned subsidiaries of China Three Gorges Corporation (now is the developer of 50MW Solar PV Power Project on behalf of CTG), under Letter of Intent (LOI) No: PPDB/1201/127/2011 Dated: 09-06-2011 issued by Punjab Power Development Board (PPDB).

For & on behalf of Wél**t** Konnett (Pvt) Ltd

Fiaz Ahmad Chairman

WELT KONNECT (Pvt) Ltd Suit 8, Ground Floor, Evacuee Trust Complex, F-5/L, Islamabad 44000, Pakistan. Tel: +92-51-2870422-3, Fax: +92-51-2870424, Email: info@weltkonnect.com, www.weltkonnect.com



BEFORE THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

AFFIDAVIT

<u>AFFIDAVIT</u> of Engr. Habil Ahmed Khan, Authorized Representative of CTGI-WK Cholistan Solar Power Project (Pvt) Ltd.

I, the above named Deponent, do hereby solemnly affirm and declare that:-

- 1. I am the authorized representative of CTGI-WK Cholistan Solar Power Project (Pvt) Ltd.
- 2. The contents of the accompanying application for grant of Generation License of the 50 MW Solar Power Plant at Quaid-E-Azam Solar Park, Lal Suhanara, Bahawalpur, Punjab being developed under Letter of Intent (LOI) No: PPDB/1201/127/2011 Dated: 09-06-2011 issued by Punjab Power Development Board (PPDB) ,including all supporting documents are true and correct to the best of my knowledge and belief, and nothing material or relevant thereto has been concealed or withheld there form.
- 3. I also affirm that all further documentation and information to be provided by me in connection with the aforesaid Generation License Application shall be true and correct to the best of my knowledge and belief.

Deponent Engr. Habil Ahmed Khan

VERIFICATION

It is hereby verified on solemn affirmation at Islamabad, Pakistan on this <u>24th December 2014</u>, that the contents of the above Affidavit are true and correct to the best of my knowledge and belief, and that nothing material or relevant thereto has been concealed or withheld thereform.

Deponent Engri Habil Ahmed Khan

50 MW Solar Power Project in Cholistan
 Document No.
 02-0786-01

 Rev No. / Date
 02-0786-02

 Issue No. / Date
 15th December 2014

 Effective Date
 19th December 2014

Originally prepared by WK-JV-CSAIL

Certificate of Incorporation

(Including Respective Board Resolutions Authorizing Incorporation of Special Project Company)



SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

Company Registration Office 1st Floor SLIC Building No.7, Blue Area, Islamabad

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0078366

I hereby certify that <u>CTGI WK CHOLISTAN SOLAR POWER</u> <u>PROJECT (PRIVATE) LIMITED</u> is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is limited by shares





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Originally prepared by WK-JV-CWE

Memorandum and Articles of Association

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MEMORANDUM

THE COMPANIES ORDINACE, 1984 (COMPANIES ORDINACE, 1984

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LINGER

- I. The name of the Company is "CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LIMITED".
- **II.** The Registered Office of the Company will be situated in Islamabad Capital Territory.
- III. The objects for which the Company is established are all or any of the following:-
 - 1. To carry on all or any of the businesses of generating of solar power, steam turbine generating plant, gas turbine generating plant and 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 approval from concerned departments i.e. NEPRA, Ministry of Water and Power.
 - 2. To locate, establish, construct, equip, operate, use, manage and maintain thermal power plants and coal fired power plants, power grid station, transforming, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops, dispensing machines for pre-payment cards and other devices, showrooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities subject to approval from concerned departments i.e. NEPRA, Ministry of Water and Power.
 - 3. To locate, establish, construct, equip, operate, use, manage and maintain hydal power plants and all other acts required for establish, maintaining and running such plants, like building of dams and all the allied acts necessary for our objectives subject to approval from concerned departments i.e. NEPRA, Ministry of Water and Power.





Registration

- 4. To locate, establish, construct, equip, operate, use, manage and maintain hydal power plants run on alternate energy resources e.g. sunlight, wind, sugarcane and anyother new way of producing electricity and all acts necessary for achieving these ends, which include but are not limited to research, trainings, experiments, joint ventures etc subject to approval from concerned departments i.e. NEPRA, Ministry of Water and Power.
- 5. To carry on all or any of the businesses of wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturers, installer, filters, testers, repairers, maintainers, contractors, constructors, operators, users, inspectors, reconditioners, improvers, alterers, protectors, removers, hirers, replacers, importers and exporters of and dealers in, electrical appliances, systems, products and services used for energy conservation, equipments machinery, materials and installations, including but not limited to cables where a systems and things incidental to the efficient generation, products and things incidental to the efficient generation, products and things incidental to the efficient generation, products and the systems and things incidental to the efficient generation, products and the systems and things incidental to the efficient generation, products and the systems and the systems of electricity.
- 6. To ascertain the tariff for bulk supply that will secure recovery of operating structures interest charges and depreciation of assets, redemption at due time of loans of the than those covered by depreciation, expansion projects, payment of taxes, and reasonable return on investment, to quote the tariff to bulk purchasers of electrical power, and to prefer petition to the appropriate authority for approval of the schedule of tariff and of adjustments or increases in its bulk supply tariff, where desirable or necessary.
- 7. To carry on the business of general order suppliers including Government, Semi-Government Agencies, Armed Forces, Army, Military or Defense and commission, agents, indenters, traders and as general merchants, wholesalers, retailers, dealers, distributors, stockiest agents, sub-agents in any goods or products or within the scope of the object of the Company and subject to any permission required under the law.
- 8. To apply for, tender, offer and accept purchase or acquire any contracts and concessions for or in relation to the projection execution, carrying out improvements, management, administration or control of works and conveniences and undertake, execute, carry out, dispose of or otherwise turn to account the same.
- **9.** To carry on in or outside Pakistan the business of manufacturers, importers, exporters, indenters, transporters, dealers in all articles and commodities akin to or

connected with any of the business of the Company capable of being conveniently carried on or necessary for the promotion of the objects herein contained, as permissible, under law.

- **10.**To establish and manage branches, zonal, divisional and sub offices and to appoint representatives of the company or its allied associated concerns anywhere in Pakistan or in foreign countries.
- **11.** To go in for, buy or otherwise acquire and use any patent design, copyright, licenses, concession, convenience, innovation, invention, trade marks, or process, rights, or privileges, plants, tools or machinery and the like in Pakistan or elsewhere, which may for the time being appear to be useful or valuable for adding to the efficiency or productivity of the Company's work or business, as permissible under the law.
- **12.** To carry out joint venture agreements with other companies or countries within the scope of the objects of the Company.
- 13. To import, export, invent, design, develop, produce, manufacture, assemble, test, install, maintain, renovate, refurbish, recondition, utilize operate, manager and sell, hire out, supply and otherwise deal in plant, equipment and approximately business of the company.
- 14. To do the business of importing, exporting, simple & heavy machiness for the company's business and any other business.
- **15.** To provide for the benefit of other persons consultancy, advisory, training and management services , including but not limited to IT, Finance and Telecom Sectors; concerning or connected with anything that the company does in the exercise of its power or has power to do, or in which the company has gained or developed expertise in the course of its business, and to provide training and educational courses, documentation and material for employees of the company and for other persons in matters which in the opinion of the company and for other persons in matter are connected with, of concern or are of benefit to, the business and activates of the company or which utilize the company's communications systems or services.
- 16. To pay all costs, charges, and expenses preliminary or incidental incurred in formation or about the promotion and establishment of the Company and to remunerate any person, firm or company for services rendered or to be rendered in or about the formation or promotion of the Company or the conduct of its business.
- **17.**To grant pensions, allowances, gratuities and bonuses to employees of the Company or any of them or the dependants of all or any of the employees and to subscribe to any labor, industrial, charitable or other institutions, clubs, societies and funds.
- **18.** To create any Reserve fund, sinking fund, Insurance fund or any special or other funds whether for depreciation or for repairing, improving, extending or maintaining any of the property of the Company or for redemption of debentures/ventures or redeemable preference shares or for other purpose or purposes conducive to the interest of the Company.
- **19.** To apply for and obtain necessary consents, permissions and licences from any government, state, local and other authorities for enabling the Company to carry on any of its objects into effect as and when required by law.
- **20.** To distribute all or any of the property of the company among the members in specie or kind but so that no distribution amounting to a reduction in capital is made without sanction of the court where requisite.
- **21.**To do all or any of the above acts and all such acts as are incidental or may be thought conducive to the attainment of the above objects or any of them, and as agents, contractors, trustees or otherwise and either alone or in conjunction with others with the intention that the objects set forth in each of the several paragraphs of this memorandum shall be in no way limited or restricted by reference to or by inference in terms of any other paragraph of this memorandum.
- 22. It is undertaken that the Company shall not by advertisement, pamphlets or through other means, offer for sale or take advance money for the further second analyze plots, houses, flats etc., to the general public or individuals.
- 23. Notwithstanding anything stated in any object clause, the Company such other approval or license from the competent authority, as may be under any law for the time being in force, to undertake a particular busines



24. It is declared that notwithstanding anything contained in the foregoing object clauses of this Memorandum of Association nothing contained therein shall be construed as empowering the Company to undertake or to indulge in business of banking company, leasing, investment, managing agency, insurance business, any of the NBFC business, multi-level marketing (MLM), Pyramid and Ponzi Scheme, commodity, future contract or share trading business locally or internationally, directly or indirectly as restricted under the law or any unlawful operation





IV. The liability of the Member is Limited.

V. The Authorize Share Capital of the Company is Rs. 100,000/- (Rupees One Hundred Thousands only) divided into 1,000 ordinary shares of Rs.100/-(Rupees Hundred only) each each with powers to the company from time to time to increase and reduce its capital subject to any permission required under the law.







We the several persons, whose names and addresses are subscribed below are desirous of being formed into a Company in pursuance of the Memorandum of Association and we respectively agree to take the number of shares in the capital of the Company set opposite to 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 with any former Nationality	Occupatio n	Residential Address in full	Numb er of shares taken by each subscr iber	Signat ures
FIAZ AHMAD	61101- 1916032-5	Hakim Jan	Pakistani	Business	MARGALLA ROAD, HOUSE NO. 60, SECTOR F-8/2 ISLAMABAD	80 X	Xue
HABIL AHMAD KHAN	61101- 9543551-1	Irshad Ahmad Khan	Pakistani	Business	HOUSE NO. 324, STREET NO. 49, BLOCK G-10/3 ISLAMABAD	20	Hil
			Total nu	mber of sha	ares to be taken	100	

Dated: the 12th day of Jan 2012

Witness to above signatures.

National Institutional Facilitation Technologies Pvt. Ltd. 5th Floor, AWT Plaza I.I. Chundrigar Road, Karachi, Pakistan



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THE COMPANIES ORDINANCE, 1984 (COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF



CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LIMITED

- 1. CTGI WK CHOLISTAN SOLAR POWER PROJECT (PVT.) LIMITED is established as a private Company with limited liability in accordance with and subject to the provisions of the Companies Ordinance, 1984 and accordingly the following provisions shall have effect, namely:
 - (a) The numbers of the members for the time being of the Company (exclusive of persons who are for the time being in the employment of the Company), is not to exceed to fifty but when two or more persons hold one or more shares in the company jointly they shall, for the purpose of this paragraph, be treated as a single member;
 - (b) Any invitation to the public to subscribe for any shares or debentures or debenture stock of the Company is hereby prohibited.
 - (c) The right to transfer shares of the Company shall be restricted in manner hereinafter appearing,
- 2. The regulations contained in Table "A" in the First Schedule to The Companies Ordinance, 1984 shall apply to the Company, subject to the articles hereinafter provided.

INTERPRETATION

- 3. In these Articles unless there is something in the subject or context inconsistent therewith:
 - (i) "The Company" means the above named Company.
 - (ii) "The Ordinance" means the Companies Ordinance, 1984, or any statutory modification or re-enactment thereof for time being in force in Pakistan;
 - (iii) "The Directors" means the Directors for the time being of the Company or the Directors assembled at a Board;
 - (iv) "Month" means a calendar month;
 - (v) "The Office" means the Registered Office for the time being of the Company;
 - (vi) "The Seal" in relation to a Company means the common Seal of the Company.
 - (vii) "Writing" shall include printing and lithography and any other mode or modes representing or reproducing words in a visible form.



- (viii) Words importing the singular number only shall include the plural number and vice versa;
- (ix) Words importing the masculine gender only shall include the feminine gender;
- (x) Words importing persons shall include corporations.
- (xi) Subject as aforesaid any words or expressions defined in the Ordinance; shall except where the subject or context forbids bear the same meaning in these Articles.

CAPITAL

- **4.** The Authorized capital of the Company is Rs. 100,000/- (Rupees One Hundred Thousands Only) divided into 1,000 ordinary shares of Rs.100 each with powers to increase, consolidate, subdivide, reduce or otherwise reorganize the capital of the Company in accordance with the provisions of the Companies Ordinance, 1984.
- 5. The shares shall be under the control of the Directors who may allot or otherwise dispose off the same to such persons, firms or corporation on such terms and conditions and at such times, as they may deem fit.
- 6. Transfer of shares shall not be made or registered without the previous sanctions of the Directors if registration of shares is refused, the Directors shall within one month from the date when instrument of transfer was lodged send notice of refusal to the transferee and the transferor.
- 7. An instrument of share transfer must be accompanied by the certificate of shares sought to be transferred thereby.

GENERAL MEETINGS

- 8. An annual General meeting, of the Company shall be held within eighteen months from the date of it's incorporation and thereafter once at least in every calendar year within four months following the close of its financial year at such time and place as the Directors may determine, provided however, that no greater interval than fifteen months shall be allowed to elapse between two general meetings.
- **9.** The above mentioned meeting shall be called Annual General Meetings. All other general meetings shall be called extraordinary general meeting.

PROCEEDINGS AT GENERAL MEETING

- 10. At least Twenty-One days' notice of any General Meeting specifying the place, day and the hour of meeting and, in case of special business, the general nature of such business shall be given to members in manner hereinafter mentioned or in such other manner as may from time to time be prescribed by the Company in General Meeting. The accidental omission to give any such notice to or the non-receipt of any such notice by any member shall not invalidate the proceedings at any General Meeting or any resolution passed thereat.
- 11. The business of an Annual General Meeting shall be to receive and consider the profit and loss account, the balance sheet and the reports of the directors and auditors, to declare

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dividends, to elect the directors and to appoint and fix the remuneration of, the auditors, and to transact any other business which under these presents ought to be transacted at an Annual General Meeting and all business transacted at an Extraordinary General Meeting shall be deemed special.

- **12.** Two members present in person who represent not less than twenty five percent of the total voting power either of their own account or as proxies shall constitute quorum for a General Meeting.
- 13. No business shall be transacted at any General meeting unless the requisite guorum shall be present at the commencement of business.
- **14.** At every General Meeting the Chairman appointed by the Directors as the Chairman of the Meeting shall take the Chair, but if there be no such chairman or he be not presents within fifteen minutes after the time appointed for the meeting or is unwilling to act as Chairman, the members present shall choose a Director as Chairman and if none of the Directors be present, or willing to act as Chairman, the members present shall choose from one of their members, to be Chairman of the Meeting.
- 15. If within half an hour from the time appointed for the holding of a General Meeting the requisite quorum be not present, the meeting, if convened on the requisition of or by members, shall be dissolved and in every other case, it shall stand adjourned to the same day in the next week at the same hour and place, and, if at such adjourned meeting the requisite quorum be not present within half an hour from the time appointed for the meeting, two members present in person shall constitute a quorum and may transact the business for which the meeting was called.
- **16.** The Chairman with the consent of the meeting may adjourn any General Meeting from time to time and from place to place but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place and which might have been transacted at that meeting.
- 17. Every question submitted to any General Meeting shall be decided in the first instance by a show of hands and in the case of equality of votes the Chairman shall, both on a show of hands and at the poll have a casting vote in addition to the vote or votes to which he may be entitled as a member.

VOTES OF MEMBERS

- 18. Upon a show of hands every member holding ordinary shares present in person or by proxy or attorney or in case of corporation under section 162 of the Ordinance shall have one vote except for election of Directors in which case, the provisions of section 178 of the Ordinance shall apply and upon a poll every member present in person or by proxy or attorney or by representative under section 162 of the Ordinance shall have votes proportionate to the paid up value of the shares carrying voting rights held by such member.
- Votes may be given, either personally or by proxy or attorney or **19**. (a) representative subject to the provisions of the Ordinance
 - No person shall be appointed a proxy who is not a member of the Company and (b) gualified to vote save that a corporation or an organization being a member of

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the Company may appoint as its representative any person whether a member of the Company or not. An attorney of a member need not himself be a member.

20. The instrument appointing a proxy, and every power of attorney or other authority (if any) under which it assigned, or a notarially certified copy of that power of authority shall be deposited a the registered office of the Company, not less than 48 hours before the time for holding the meeting. Otherwise the instrument of proxy shall not be treated as valid.

DIRECTORS

- **21.** The number of directors shall not be less than two nor more than nine.
- **22.** The persons hereinafter named shall be the first directors and they shall hold the office upto the First Annual General Meeting.

(1) FIAZ AHMAD

(2) HABIL AHMAD KHAN

- 23. A Director may, with the approval of the directors, by notice in writing under his hand appoint any person to be an alternate director during his absence of not less than four months from Pakistan, and such appointment shall have effect and such appointee, whilst he holds office as an alternate director, shall be entitled to notice of meeting of directors, and to attend and vote thereat accordingly, but he shall ipso facto vacate office if and when the appointer returns to Pakistan or vacates office as Director, or removers the appointee from office by notice in writing under his hand.
- 24. The Directors shall subject to clause 21 hereof fix the number of Directors to comprise the Board of Directors at least 35 days before the convening of General Meeting at which election of directors is to take place.
- 25. The directors shall have power to fill a casual vacant but so that the total number of directors shall not at nay time exceed the maximum number fixed in clause 24 hereof. But any Director appointed in a casual vacancy shall hold office only for the remainder of the term of the director in whose place he is appointed and shall then be eligible for reelection.
- **26.** A Director must be a member of the Company except where the director is a nominee of a corporation or an organization, which is a member of the Company.
- **27.** The remuneration of every director shall be such sum not exceeding Rs 500/- for every meeting of the Board attended by him, as may from time to time be fixed by the Board.
- 28. If any Director being willing is called upon to perform extra services (which expression shall include work done by a Director as a member of any committee formed by the Directors), or to make any special exertion in going or residing abroad, or otherwise for any of the purposes of the Company, the directors may remunerate such director as may b determined by the Directors.
- 29. The continuing directors may act not withstanding any vacancy in their body, but so that if the number falls below the minimum fixed above, the Directors shall not except in emergencies or for the purposes of filling vacancies act so long as the number remains below the minimum.



ELECTION OF DIRECTORS

- **30.** At the first annual general meeting of the Company, the whole of the directors shall retire from office
- **31.** A director shall hold office for a period of three years, unless he earlier resigns, becomes disqualified from being a Director or otherwise ceases to hold office.
- 32. A retiring director shall be eligible for re-election

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33. The company at the annual general meeting at which a director retires in manner aforesaid may fill up the vacated office by electing a person thereto as provided in the Ordinance.

MANAGING DIRECTOR

- (a) The directors shall within fifteen days of the incorporation of the Company appoint any individual to be the Chief Executive, hereinafter called the Managing Director, of the company, to hold office till the holding of the first annual general meeting, unless the earlier resigns or otherwise ceases to hold office.
- (b) within fourteen days of election of Directors under the preceding Articles or the office of Chief Executive falling vacant, as the case may be as prescribed by section 199 of the Companies Ordinance, 1984, the directors shall appoint any individual, including an elected director, to be the Managing Director of the Company for a period not exceeding three years on such terms and conditions as the Directors deem fit.
- (c) On the expiry of the term of his office, the Managing Director shall be eligible for reappointment.
- **35.** The directors of a company by resolution passed by not less than three fourth of the total number of directors for the time being, or the company by a special resolution may remove the managing director before the expiry of his term of office notwithstanding anything contained in the articles or in any agreement between the company and the managing director.
- **36.** The remuneration of Managing Director shall from time to time be fixed by the Directors and may be by way of fixed salary or by any other mode.
- **37.** The directors may from time to time entrust to and confer upon the Managing Director for the time being such of powers as they may think fit and may confer such powers for such time and to be exercised for such objects and purposes and upon such terms and condition s and with such restrictions as they think expedient and may from time to time revoke, withdraw alter or vary all or any of such powers.

PROCEEDINGS OF DIRECTORS

38. The directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings and proceedings, as they think fit, and may determine the quorum necessary for the transactions of the business. Until otherwise determined two Directors shall be a quorum.



- **39.** A director may, at any time, convene a meeting of directors. A Director who is at any time not in Pakistan shall not during such time be entitled to notice of any such meeting.
- **40.** Questions arising at any meeting shall be decided by a majority of votes, and in case of an equality of votes, the Chairman shall have a second or casting vote.
- **41.** The directors may elect as chairman of their meetings and determine the period for which he is to hold office; and unless otherwise determined, the chairman shall be elected annually. If no such chairman is elected, or if at any meeting the chairman is not present within ten minutes after the time appointed for holding the same or is unwilling to act as chairman, the directors present shall choose one of their numbers to be chairman of the meeting.
- **42.** A meeting of directors for the time being at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretions by or under the Articles of the Company for the time being vested in or exercisable by the directors generally.
- **43.** The Directors may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or members of their body as they think fit and may from time to time revoke such delegation. Any committee so formed shall in the exercise of the powers delegated, conform to any restrictions that may from time to time be imposed upon it by the Directors.
- **44.** The meeting and proceedings of any such committee of two or more members shall be governed by the provisions herein contained for regulating the meetings and proceedings of the directors so far as the same are applicable thereto, and are not superseded by any regulations made by the directors under the last preceding clause.
- **45.** All acts done by any meeting of the Directors or by a committee of directors or by any person acting as a director shall notwithstanding that it shall afterwards be discovered that there was some defect in the appointment of such directors or persons acting as aforesaid or that they or any of them were disqualified be as valid as if every such persons had been duly appointed and was qualified to be a director.
- **46.** A resolution in writing signed by all the directors for the time being present in Pakistan, shall be valid and effectual as if it had been passed at a meeting of the directors duly called and constituted.

MINUTES

- 47. (a) The directors shall cause a fair and accurate summary of the minutes of all proceedings of general meetings and meetings of its directors and committee of directors, along with the names of those participating in such meetings, to be entered in properly maintained books.
 - (b) Any such minutes of any general meeting, or of any meeting of the directors or of any committee of the directors if purporting to be signed by the Chairman of such meeting, or by the chairman of the next succeeding meeting shall be receivable as prima facie evidence of the matter stated in such minutes.

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POWERS OF DIRECTORS

48. The management of the business of the company shall be vested in the directors, and the directors may exercise all such powers and do all such acts and things as the company is by its articles of association or otherwise authorized to exercise and do and are not hereby or by statute directed or required to be exercised or done by the Company in general meeting, but subject nevertheless to the provisions of the Companies Ordinance, 1984 or to any of these presents and regulations being not inconsistent with the aforesaid provisions, as may from time to time be prescribed by the company in general meeting shall invalidate any prior act of the directors which would have been valid if such regulation had not been made.

BORROWING POWERS

- **49.** The Directors may from time to time raise or borrow any sums of money for and on behalf the company from the members or other persons, Companies, firms or banks or they may themselves advance money to the company on such terms as may be approved by the directors.
- **50.** The directors may raise and secure payment of such sum or sums of money in such manner and upon such terms and conditions in all respects as they think fit, and in particular by the issue of debentures or bonds or by mortgage or charge of all or any part of the property of the company.

THE SEAL

51. The directors shall provide for the safe custody of the seal and the seal shall never be used except by the authority of the Directors or a committee of directors previously given and in the presence of two directors who shall sign every instrument to which the seal is affixed.

ACCOUNTS

- **52.** The directors shall cause true accounts to be kept in such form as they may decide for sums of money received and expended by the company and the mattes in respect of which such receipt and expenditure take place and of all sales and purchases of goods by the company and of the assets, credits and liabilities of the Company.
- **53.** The books of account shall be kept at the registered office of the company or at such other place or places as the directors think fit.
- 54. The directors shall, from time to time, determine whether and to what extent and at what times and places, under what conditions or regulations the accounts and books of the company or any of them shall be opened to the inspections of the members (not being a director) and no member not being a director shall have any right of inspecting any account or book or document of the company except as conferred bylaw or authorized by the directors or by a resolution of the company in a general meeting.

<u>AUDIT</u>

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- **55.** Once at least in every year the accounts of the Company shall be examined and the fairness of profit and loss account and balance sheet ascertained by one or more auditor or auditors.
- 56. The first auditor of the company shall be appointed by the directors.

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- **57.** (a) A notice may be given by the company upon any member either personally or by sending it by post to him to his registered address or (if he has no registered address in Pakistan) to the address, if any, within Pakistan supplied by him to the company for the giving of notices to him.
 - (b) Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, prepaying and posting a letter containing the notice unless the contrary is proved, to have been effected at the time at which the letters would be delivered in the ordinary course of post.
- **58.** Each holder of registered share whose registered place of address is not in Pakistan may from time to time notify in writing to the Company an address in Pakistan which shall be deemed his registered place or address within the meaning of the last preceding clause.

WINDING UP

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

INDEMNITY

60. Every director, manager, auditor, secretary, chief accountant and other officer or servant of the company shall be indemnified by the company against, and it shall be the duty of the directors out of the funds of the company to pay all costs, losses and expenses which any such officer or servant may incur or become liable to by reason of any contract entered into or thing done by him as such officer or servant or in any way in the discharge of his duties and the amount for which such indemnity is provided shall immediately attach as a lien on the property of the Company and have priority as between the members over all other claims.

No director, auditor or other officer of the company shall be liable for the acts, receipts, neglect or default of any other director or officer or for joining in any receipt or other act for conformity or for any loss or expenses happening to the company through the insufficiency or deficiency of title to any property acquired by order of the directors for or on behalf of the company or for the insufficiency or deficiency of any security in or upon which any of the money of the company shall be invested or for any loss or damage arising from bankruptcy, insolvency of any person with whom any moneys, securities or effects shall be deposited or for any loss occasioned by any error of judgment or oversight on his part or for any other damage or misfortune whatever which shall happen in the execution of the duties of his office or in relation thereto unless the same happens through his own dishonesty.



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

Name and	NIC No. (in case	Father's/	Nationality	Occupation	Residential Address	Numbe	Signatu
surname	of foreigner,	Husband's	with any		in full	r of	res
(present &	Passport No)	Name in full	former			shares	
former) in full			Nationality			taken	
(in Block						by	
Letters)						each	
						subscri	
						ber	
FIAZ AHMAD	61101-	Hakim Jan	Pakistani	Business	MARGALLA ROAD,	80	
	1916032-5				HOUSE NO. 60,		
					SECTOR F-8/2	'	m -
					ISLAMABAD		-
HABIL	61101-	Irshad	Pakistani	Business	HOUSE NO. 324,	20	
AHMAD KHAN	9543551-1	Ahmad			STREET NO. 49,		dely
		Khan			BLOCK G-10/3		91/
					ISLAMABAD		/
			Total n	umber of sha	res to be taken	100	

Dated: the 12th day of Jan 2012.

Witness to above signatures.

National Institutional Facilitation Technologies Pvt. Ltd. 5th Floor, AWT Plaza I.I. Chundrigar Road, Karachi, Pakistan

Registratio mabao 4 HCHANGE COM No. JRI Dated____ CALIFICATIONE INTERCOM 9 ante Corre

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PARTICULARS OF DIRECTORS AND OFFICERS, INCLUDING THE CHIEF EXECUTIVE, MANAGING AGENT,
SECRETARY, CHIEF ACCOUNTANT, AUDITORS AND LEGAL ADVISERS, OR OF ANY CHANGE THEREIN

THE COMPANIES ORDINANCE, 1984	тне	COMPANIES	ORDINANCE.	1984
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[SECTION 205]

FORM 29

1. Incorporation Number					
2. Name of Company	CTGI WK CHOLISTAN	SOLAR POW	ER PROJECT (PVT.) LIMITED		
3 Fee Paid (Rs.)	600 Name and Branch of Bank				
		ISLAMABA	D, MCB - Islamabad Stock Excl	hange (1390)	
4. Receipt No.	E-2012-090572			27/01/2012	
5. Mode of Payment (Indicate)	Bank Challan				

6. Particulars*:

6.1. New Appointment/Election

Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation*** (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)
FIAZ AHMAD	61 10 1- 1916032- 5	S/O HAKIM JAN	HOUSE NO. H-60 SECTOR F-8/2 MARGALLA ROAD ISLAMABAD ISLamabad Capital	Director	Pakistan	business	Since Incorporation.	
HABIL AHMAD KHAN	61101-6543551- 1	S/O IRSHAD AHMAD KHAN	HOUSE NO. 324, STREET NO. 49, BLOCK G- 10/3 ISLAMABAD Islamabad Capital	Director	Pakistan	business	Since Incorporation.	

6.2. Ceasing of Officer/Retirement/Resignation

F	Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation*** (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)

6.3. Any other change in particulars relating to columns (a) to (g) above

Present Name in Full (a)	NIC No. or Passport No. in case of Foreign National (b)	Father / Husband Name (c)	Usual Residential Address (d)	Designation (e)	Nationality** (f)	Business Occupation*** (if any) (g)	Date of Present Appointment or Change (h)	Mode of Appointement / change / any other remarks (i)
							Containy Regis	station Office

Name of Signatory

Signature of Chief Executive/Secretary

Designation FIAZ AH this ÷.

Date (DD/MM/YYYY)

Director

27/01/2012

20597 12-5-12 12/5/201 19 Martin

https://eservices.secp.gov.pk/eServices/EFormControllerServlet?mode=html&action=open... 5/12/2012

 Document No.
 02-0788-01

 Rev No. / Date
 02-0786-02

 Issue No. / Date
 15th December 2014

 Effective Date
 19th December 2014

Originally prepared by WK-JV-CWE

NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

Licensing (Generation) Rules

EXTRAORDINARY

PUBLISHED BY AUTHORITY

ISLAMABAD, SATURDAY, APRIL 22, 2000

PART II

Statutory Notifications (S.R.O.)

GOVERNMENT OF PAKISTAN

NOTIFICATION

Islamabad the 17th April, 2000

S.R.O. 221(I)/2000.

SECTION – B

SCHEDULE-I

The Location, Size, Type of Technology, Interconnection Arrangements, Technical Limits, Technical/Functional Specifications and other details specific to the Generation Facility/Solar Farm of the Licensee are described in this Schedule.

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Plant/Solar Farm Location

Image 1- Lal Suhanara Quaid-E-Azam Solar Park Location





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 December 2014

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 19th
 December 2014

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Satellite Map of Project Site

Plant/Solar Farm Location Coordinates

50 MW Project Coordinates						
Node	Longitude (East)	Latitude (North)				
1	71 49.196	29 17.650				
2	71 49.817	29 17.650				
3	71 49.196	29 16.998				
4	71 49.817	29 17.324				
5	71 49.608	29 17.324				
6	71 49.608	29 16.998				



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Process Flow Diagram













Transformer + switchgear



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 Issue No. / Date
 15th December 2014

 Effective Date
 19th December 2014

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Actual drawings pertaining to Solar Farm (SF)

1. Plant Layout

	i Mirin Kali		
7480 Strir	igs Connected to	o 2 Inverters an	d 1 Transformer
132 kV	(Outp	ut to Grid)	
Sand			



3. **Medium Voltage Transformer**: Two 1600-SC (SMA Solar Technology) Transformers are modeled. (7480 Modules / Transformer)

4. **Power Plant Controller**: Monitoring equipment and utilities will be kept in the same vicinity as the High Voltage Transformer

5. High Voltage Transformer: Customized transformer to feed high voltage in the grid

** Refer to **Annexure 18:** SMA Solar Power Plant Solution that has been used as reference for model. Blue Lines: DC Voltage at 640V (10 Connections represented)

Red Lines: AC Voltage at 360V

Green Lines: AC Voltage at 11 kV



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2. Wiring Layout Diagram



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INTERCONNECTION ARRANGEMENT FOR DISPERSAL OF POWER FROM THE GENERATION FACILITY/SOLAR FARM

1. The Government of Pakistan (GoP) plans to develop 1000 MW Quaid-e-Azam solar park at Lal Suhanra as a major step towards development of solar generation in Pakistan. M/s Welt Konnect intends contribute to this plan by setting up 50 MW solar PV power plant in Quaid-e-Azam solar park. M/s Welt Konnect JV CWE hired the services of Planning Power Department of NTDC to carry out grid interconnection study in order to propose interconnection scheme for evacuation of power from 50 MW Welt Konnect JV CWE solar PV power plant to the system network.

2. The draft final report of the grid interconnection study shows the results of extensive system studies including load flow, short circuit, transient stability and power quality studies have been presented pertaining to the interconnection of 50 MW Welt Konnect JV CWE solar PV power plant. The adequacy of the proposed

interconnection scheme regarding performance of 50 MW Welt Konnect JV CWE power plant and of the system network in its vicinity has been evaluated in the light of Grid Code.

3. For the grid interconnection study, NTDC has used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas, M/s Welt Konnect has provided the data of its power plant on data request from NTDC.

4. The load flow analysis has been carried out for operating scenarios of summer 2015 and 2016 with the induction of 50 MW Welt Konnect solar PV power plant and the results of load flow studies have been presented in this report. It has been found that the power



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 02-0786-02

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 15th
 December 2014

 Effective Date
 19th
 December 2014

Originally prepared by WK-JV-CWE

from 50 MW Welt Konnect solar power plant can reliably be evacuated to the system under normal and N-1 contingency conditions.

5. The proposed interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant is given as under:

"A 132 kV double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra single circuit line at the 132 kV switchyard of 50 MW Welt Konnect JV CWE Solar PV power plant."

6. Short circuit studies have been carried out with proposed Interconnection option to compute the maximum three phase and single phase short circuit levels after the induction of 50 MW Welt Konnect JV CWE solar PV power plant. It is found that the proposed solar generation has no adverse impact on the existing network in its vicinity and the short circuit currents remain within the installed switchgear ratings at the existing substations. On the other hand, the standard switchgear of the short circuit rating of 40 kA would be sufficient at 132kV switchyard of the 50MW Welt Konnect JV CWE solar PV power plant.

7. Transient stability analysis with the proposed interconnection scheme for 50 MW Welt Konnect solar PV power plant has been carried out using the NEPRA Grid Code Criteria. The stability of the solar PV plant and the power system has been checked with application of faults at the 132 kV switchyard of 50 MW Welt Konnect solar PV power plant and at the substations in the vicinity of the plant. It has been found that 50 MW Welt Konnect solar PV power plant and the surrounding power system network remain stable with no adverse effects after subjected to faults as per Grid Code requirement.

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The LVRT requirements for 50 MW Welt Konnect solar PV power plant are also met as mentioned in Grid Code Addendum for solar power plants (under approval by NEPRA).

8. The issues of power quality with the induction of the 50 MW Welt Konnect solar PV power plant have also been studied. The study results indicate that the power quality parameters including flicker and voltage unbalance, remain within the permissible limits as mentioned in relevant IEC standard.

9. On the basis of the results of the detailed system studies, it has been concluded that the proposed interconnection scheme has no technical constraints in evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.





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If there is any change in the final dispersal arrangement, the same will be communicated to NEPRA in due course.

Application For Generation License

50 MW Solar Power Project in Cholistan
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<u>Detail of</u> <u>Generation Facility/</u> <u>Solar Farm</u>

(A). General Information

(i)	Name of Licensee	CTGI-WK Cholistan Solar Power Project (Pvt)
		Ltd, duly registered with the SECP under
		Section 40 of the Companies Ordinance 1984
		(XLVII of 1984) with Corporate Universal
		Identification No. 0078366
(ii)	Registered /	Office 8, Ground Floor, Evacuee Trust
	Business Office	Complex, F-5/1, Islamabad 44000, Pakistan.
		Tel: +92-51-2870422-3, Fax: +92-51-2870424,
		Email: info@weltkonnect.com,
		www.weltkonnect.com
(iii)	Plants Location	Quaid-e-Azam, Solar Park, Lal Suhanara,
		Bahawalpur, Punjab
(iv)	Type of Generation	Solar Photovoltaic (PV)
	Facility	

(B). Solar Power Generation Technology & Capacity

(1)	Type of Technology	Mono Crystalline Photovoltaic (PV) Cell	
(2)	System Type	Grid Connected (Independent Power Producer)	
(3)	Installed Capacity of	50.2656 MWp DC	
	Solar Farm (MW)	(49.28 MW AC Inverter Output)	

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(C). <u>Technical Details of Equipment (At each site)</u>

(1)	Type of Module	240Wp
(2)	Type of Cell	Mono Crystalline
(3)	Dimension of each Module	Length 1675mm, Width 1001mm,
		Height 31mm
(4)	Module Surface Area	1,676,675mm ²
(5)	No of Panel/ Modules	209,440
(6)	Total Module Area	351,163 m ²
(7)	Total Land Area Used	250 Acres/ 1,011,715m ²
(8)	Panel's Frame	Alluminium
(9)	Weight of One Module	21.2 kg
(10)	Module Out put Warranty	240 Wp/ 25 years Warranty
		25 years Guarantee for depreciation
		not more than 0.7 %
(11)	Number of Solar Cells in each	60
	module	
(12)	Efficiency of Module	17 %
(13)	Environment Protection System	Details are provided in the FSR Vol
		5 with complete plan for
		Decommissioning.

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(14)	Maximum Power (Pmax)	240Wp		
(15)	Voltage @ (Pmax)	30.6V		
(16)	Current @ (Pmax)	7.87 A		
(17)	Open circuit Voltage (VOC)	37.6V		
(18)	Short circuit Current (VOC)	8.22 A		
(19)	Maximum system open circuit	640 V DC		
	voltage			
(20)	V-I Curve of Solar Cell at 25 C	See Below in Appendix 03		
(b)	PV Array	•		
(1)	Nos. of Sub-array	56		
(2)	Modules in a string	22		
(3)	Total Nos. of strings	9,520		
(4)	Modules in Sub-array	3,740		
(5)	Total No. of Modules	209,440		
(c)	PV Capacity			
(1)	Total	50.2656 MWp DC		
(d)	Inverters			
(1)	Capacity of Inverter (MW &	880 KVA@25°C / 800 kVA@50°C		
	MVA)			
(2)	Inverter Model	Sunny Central SC800CP XT		
(3)	Manufacturer	SMA Solar Technology, Germany		
(4)	Rated Input Voltage	620VDC		
(5)	Input operating Voltage Range	535V- 850V		



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Number of Inverters 56 (6)**Total Power** 9600 KW AC (7) 98.6% (Euro: 98.4%; CEC:98.5%) (8) Efficiency Max. Allowable Input voltage 1000 V DC (9) (10)Max. Current 1400 A Output electrical system 3 Phase, 3 Wire (11)Rated AC output Voltage 360V AC (+-10%) (12)(13) Rated Frequency 50 Hz/ 60 Hz (14) Power Control MPP Tracker (15) Modes of Operation of Inverter **On-Grid** Capacity of Inverter (MW & (16) 880 KVA@25°C / 800 kVA@50°C MVA) Reactive Capability Curve of see PQ-Diagram (Appendix 01) (17)Inverter Adjustable 0.9 Leading 0.9 (18)Power Factor of Inverter (Leading & Lagging) Lagging (0.9 Induction to 0.9 Capacitance) Operating -25 to 62°C temperature (19) Environmental range Enclosures Relative 15 to 95% Humidity Audible Noise <61 dB (A)



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		Operating	<2000m
		Elevation	
		Warranty	5 years
		Period	
		(a)	DC Circuit Breakers
		(b)	AC Circuit Breakers
(20)	Grid Operation	(c)	DC Over Voltage Protection
	Protection	(d)	Lightening Protection Level III
		(e)	Grid Monitoring
		(f)	Insulation Monitoring
		(g)	Anti Islanding
(e)	Medium Voltag	ge (Isolating)Tran	sformer
(1)	Rating		1.76 MVA (1760 KVA) * 28
	/Inverter Trans	former Capacity	(TRANSFORMER COMPACT
	(MVA)		STATION 1600SC by SMA
			Germany)
(2)	Type of Transfo	ormer	Low to Medium Voltage
(3)	Input Voltage		360 V
(4)	Output Voltage		11-33KV (Adjustable)
(5)	Purpose of Transformer		Step Up Voltage Transformer,
			Galvanic Isolation and Elimination
			of DC Current Injection.
(6)	Efficiency		98.8%

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(7)	No. of Taps of Inverter	0 ± 2.5 % ± 5 %
	Transformer	
(8)	Positive, Negative & Zero	1600kVA; Dy11y11; 15kV; 360V-
	Sequence impedances of inverter	Positive-, negative-sequence
	Transformer on its own MVA	impedance: 5,94%
	Vector Group	- Zero-sequence impedance: infinite
(9)	X/R Ratio of Inverter	6
	Transformer	
(10)	No. of Collecter Systems	7
(11)	Collector System Length	925 m
	(Section Wise)	
(12)	Collector System R, X, B in p.u	R: 0.0185
	on 100 MVA Base	X: 0.0453
		B: 0.0322
(13)	Plant Reactive Compensation	n/a
	Device Type	
(14)	Compensation Device Rating/	n/a
	Size	
(15)	Compensation Device MVAR	n/a
	Range (Leading and Lagging)	
(f)	Station Transformer	l
(1)	Station Transformer Capacity	60
	(MVA)	

		Application Fo 50 MW	o r Gen Solar F Cho	eration License Power Project in listan	Document No. 02-0786-01 Rev No. / Date 02-0786-02 Issue No. / Date 15 th December 2014 Effective Date 19 th December 2014 Originally prepared by WK-JV-CWE
(2)	Voltage L	oltage Level of Station		Voltage adjustme	ent
	Transform	sformer		range:±132KV×10%	
				8 step=8×1.25%	
(g).	Junction Boxes installed and fix Yard			ked on main steel	structure in Array
(1)	Number of J/Box Units		560		
(2)	Input circ	uits in each box		17	
(3)	Max. inp	Max. input current for each		10A	
	circuit	rcuit			
(4)	Max. inpu	Max. input Voltage		1000V	
(5)	Power of each box		85.7 kW		
(6)	Protection Level		IP 54		
	Over curr	ent Protection		Fuse	
	Out put S	Switch		125A, 1000V dise	connector
	Surge Pro	e Protection		1000V, Type II	
(7)	Purpose o	of Junction Box	(a)	To combine gro Sub-Arrays that the Inverter	ups of strings into will be wired into
			(b)	To provide Isola	tion of Sub Arrays

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	Application F 50 MV	or Ger V Solar I Cho	Decument No. 02-0786-01 Rev No. / Date 02-0786-02 Issue No. / Date 15 th December 2014 Power Project in plistan Originally prepared by WK-JV-CWE
		(c) (d) (e)	In case of fault provide arrangement for disconnection of each of the Sub-Arrays or Strings. To ensure safety of the electric works in the Solar Module Arrays Protection from back flow of short circuit current through use of semi- diodes.
(h).	Data Collecting System		
(1)	Weather Data	(i) (ii)	data collected for Direct Solar Radiation (W/sqm) using two Li- COR Pyranometers installed with the NRG Symphonies Plu3 Data Logger at the site data collected for Temperature (0C) using NRG 110s Sensor attached to the Solar Resource Assessment Equipment

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		(iii)	data collected for Rain in mm/Sqm
			using NRG Nova Lynx Rain Sensor
			attached to the Solar Resource
			Assessment Equipment
		(iv)	data collected for Wind Speed (ms ⁻
			¹) using NRG Wind Speed Sensor
			attached to the Solar Resource
			Assessment Fauinment
		(v)	date collected for Wind Direction
			(deg) using NDC 200D Wind Vore
			(deg) using NKG 200P wind vane
			Sensor attached to the Solar
			Resource Assessment Equipment
		(i)	DC input voltage (V), Current (A)
			of each module, string, sub array,
			Invertor
(2)	System Data	(ii)	Total Sub Array Power Generated
		:	and Inverter Power
		(iii)	AC output voltage (V) and current
			(A) of each inverter (Phase, total)
		(iv)	AC Output power (kW) and
			Energy (kwh) of each inverter
		(v)	Frequency (Hz)
		(vi)	Power Factor (PF)
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		(vii) Temperature inside inverter station
(i).	Out door Cubicle Control	Room
1.	Data record	Data Logging using softwares and
		hardware provided by SMA Germany as
		provided in FSR Vol 2, page 144
2.	Control Room System	Computerized Data Monitoring and
		communication systems using latest
		Satellite Technology
3.	Control Room System	Interfacing, Hardware and Software,
	Detail	suitable for such Multi-MW systems as
		shown in FSR Vol 2, Page 144.
(i).	Mounting Structure	
(1)	Structure	HDG Steel/Alluminium with concrete pile
		foundations as shown and further details
		provided in FSR Vol 2 pages 146-150.
(2)	Tilt of Array Frame	29 °C
(3)	Array Specification	Designed and Certified for Wind Speed
		and Seismic Requirements as provided in
		FSR Vol 2, page 146-150.
(j).	Foundation Pillars	I
(1)	No. of Foundations	104,720 as provided in FSR Vol 2 pages
		146-150
(2)	Foundation Structure	Reinforced Concrete

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(D). Other Details

(1)	Project Commissioning date	8 months after financial
	(Anticipated)	<u>close</u>
(2)	Expected Life of the project from	25 years
	commercial operation date (COD)	







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Appendix 03

Plant Layout

V-I Curve of Solar Cell at 25 C





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NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

Licensing (Generation) Rules

EXTRAORDINARY

PUBLISHED BY AUTHORITY

ISLAMABAD, SATURDAY, APRIL 22, 2000

PART II

Statutory Notifications (S.R.O.)

GOVERNMENT OF PAKISTAN

NOTIFICATION

Islamabad the 17th April, 2000

S.R.O. 221(I)/2000.

SECTION - C

SCHEDULE-II

The Total Installed Gross ISO Capacity of the Generation Facility / Solar Plant (MW), Total Annual Full Load (Hours), Average Sun Availability, Total Gross Generation of the Generation Facility/Solar Farm (in kWh), Annual Energy Generation (30 year equivalent Net AEP) kWh and Net Capacity Factor of the Generation Facility /Solar Farm of Licensee is given in this Schedule.

Application For Generation License

50 MW Solar Power Project in

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		Site Overall
1.	Total PV Installed Capacity of Generation Facility	50.2656 MWp DC (49.28 MW AC Inverter Output)
2.	Average sun hour availability /day (Irradiation on inclined surface)	5.23 Hrs
3.	Days per year	365
4.	PV Plant generating capacity annually (As Per Simulation)	76,054 MWh
5.	Expected total generation in 30 years life span	2,064,476 MWh
6.	Generation per year from plant keeping 24 hrs working	50.2656 x 24 x 365 = 440,326.656 MWh
7.	Net Capacity Factor (4/6)	17.27%

Note

All the above figures are indicative as provided by the Licensee. The Net energy available to the National Transmission Dispatch Company (NTDC) for dispatch will be determined through procedures contained in the Energy Purchase Agreement.

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National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, <u>1999</u>

NOTIFICATION

Islamabad, the 1st March, 1999

S.R.O. 142 (I)/99

<u>SECTION – D</u>

SCHEDULE-III

Location Maps, Site Maps, Land, Technology, Size of Plant, Number of Units, Fuel: Type, imported/indigenous, supplier, logistics, pipelines, etc, Emission values, Cooling Water Source: Tube wells, sea/river/canal, distance from Source etc, Interconnection with National Grid Co. Distance and name of nearest grid, voltage level (single line diagram), Infrastructure: Roads, Rails, Staff Colony,, Amenities, Project Cost, Information Regarding Sources and Amounts of Equity, Debt, Project Commencement and Completion Schedule with Milestones, ESSA (Environmental and Social Soundness Assessment), Safety Plans, Emergency Plans, System Studies, Load Flow, Short Circuit, Stability, Reliability, Plant Characteristics: Generation Voltage, Power Factor, Frequency, Automatic Generation, Control, Ramping Rate, Control Metering and Instrumentation. Control, Metering, Instrumentation and Protection, Feasibility Study Report, Training and Development

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Natior	al Electric Powe	r Regulatory Authority Licensing (Application and	d Modification Procedure) Regulations, 1999	
		NOTIFICATION		
	Islamabad, the 1st March, 1999			
		S.R.O. 142 (I)/99		
		Schedule III		
		ANNEX-D		
S.No	Regulation	Information/Documents Required	Status	
1.	3(6)(A)(a)(1)	Location Maps, Site Maps, Land	As provided above in Schedule 1 of the	
<u> </u>	2(6)(4)(2)(2)	Technology Size of Plant Number of Units	Generation License Application	
۷.	3(0)(A)(a)(2)	rechnology, size of Plant, Number of Units	As provided above in Schedule 1 of the	
2	3(6)(1)(2)(2)	Fuel: Type imported/indigenous supplier	Not Applicable	
3.	3(0)(A)(a)(3)	logistics, pipelines, etc		
4.	3(6)(A)(a)(4)	Emission values	Zero as Provided throughout FSR Volume	
			6, Clean Development Mechanism (CDM)	
5.	3(6)(A)(a)(5)	Cooling Water Source: Tube wells,	Provided in FSR Volume 2 Chapter 1,	
		sea/river/canal, distance from Source etc	section 1.11 t0 1.17 Page numbers 97 to	
			107	
6.	3(6)(A)(a)(6)	Interconnection with National Grid Co.	Provided in FSR Volume 7, Grid	
		Distance and name of nearest grid, voltage	Interconnection Study	
		level (single line diagram)		
7.	3(6)(A)(a)(7)	Infrastructure: Roads, Rails, Staff Colony,	Provided in FSR Volume 2 Chapter 1,	
		Amenities	section 1.12 to 1.15 Page numbers 97 to	
			107	
8.	3(6)(A)(a)(8)	Project Cost, Information Regarding Sources	Provided in FSR Volume 2 Chapter 6, Page	
		and Amounts of Equity, Debt	number 183	
9.	3(6)(A)(a)(9)	Project Commencement and Completion	Provided in FSR Volume 2, Chapter 8 Page	
		Schedule with Milestones	number 207.	
10.	3(6)(A)(a)(10)	ESSA (Environmental and Social Soundness	Provided in FSR Volume 5, Environmental	
		Assessment)	Study	
11.	3(6)(A)(a)(11)	Safety Plans, Emergency Plans	Provided in FSR Volume 2 Chapter 7	
			Section 7.7, 7.8 Page number 205	
12.	3(6)(A)(a)(12)	System Studies, Load Flow, Short Circuit,	Provided in FSR Volume 7 Interconnection	
		Stability, Reliability	Study by NTDC	
13.	3(6)(A)(a)(13)	Plant Characteristics: Generation Voltage,	Provided in FSR Volume 7 Interconnection	
		Power Factor, Frequency, Automatic	Study by NTDC	
		Generation Control, Ramping Rate, Control		
		Metering and Instrumentation.		
14.	3(6)(A)(a)(14)	Control, Metering, Instrumentation and	Provided in FSR Volume 7 Interconnection	
		Protection	Study by NTDC	
15.	3(6)(A)(a)(15)	Feasibility Study Report	Soft Copies Provided	



Application For Generation LicenseRev N50 MW Solar Power Project in
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16.	3(6)(A)(a)(16)	Training and Development	Provided in FSR Volume 2, Chapter 7,
			Page number 200

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SECTION - E

REQUISITE APPROVALS

Approval of Feasibility Study by concerned agency Approval of interconnection study by the concerned Agency Approval of the Environmental Study of the Project by the concerned agency





No. PPDB/	802	/201
PUNJAB POWER	DEVELOPM	IENT BOARD
ENERGY DEPARTMENT		
1 st Floor, Cer	ntral Design B	Building,

Irrigation Secretariat, Old Anarkali, Lahore (Ph: 042-99212794 Fax: 042-99212796)

Date 417 /2014

To,

- 1. Chief Executive Officer, NTDC, WAPDA House, Lahore.
- 2. Chief Executive Officer, AEDB, H # 3, Street # 8, Sector F-8/3, Islamabad.
- 3. Chief Executive Officer, MEPCO, Headquarter Khanewal Road, Multan.
- 4. Director General PCRET, PCRET, House No.25, H-9, Islamabad.

Subject: - MINUTES OF 4th PANEL OF EXPERTS (POEs) MEETING OF M/S. CWE & WK JV FOR DEVELOPMENT OF 50-MW SOLAR PV POWER PROJECT IN CHOLISTAN, PUNJAB

The subject meeting was convened on 30.06.2014 in the Committee Room of

Punjab Power Development Board, Irrigation Secretariat, Lahore. The approved minutes of said meeting are being enclosed for your kind information please.

MANAGING DIRECTOR Punjab Power Development Board (PPDB)

Encl. As stated above

<u>C.C:</u>

- i) P.S. to Addl. Chief Secretary (Energy), Govt. of the Punjah, 8th Floor, EFU Building, Jah Road, Lahore.
- ii) P.S. to Managing Director, Punjab Power Development Board (PPDB)
- iii) M/s. CWE & WK (Pvt.) Ltd. Suit 8, Ground Floor, Evacuee Trust Complex, Sector F-5/1, Islamabad. Fax: 051-2870424



PUNJAB POWER DEVELOPMENT BOARD ENERGY DEPARTMENT

MINUTES OF 4th PANEL OF EXPERTS (POES) MEETING OF M/S. CWE & WK JV FOR Subject: **DEVELOPMENT OF 50 MW SOLAR PV POWER PROJECT IN CHOLISTAN PUNJAB**

The meeting of Panel of Experts of PPDB for M/s. CWE & WK was arranged on 30.06.2014 at 11:00 hrs. under the Chairmanship of Managing Director, PPDB in the Committee Room of Energy Department. The following were the participants of the meeting:

PRESENT:

SR. # NAME

- Mrs. Saniya Awais 1.
- 2. Mr. Anwer Aziz Khan
- Mr. Shehzad Butt 3.
- Mr. Navid H. Bukhari 4.
- 5. Mr. Arshad Dharala
- Mr. S.Shahid Ali Bokhari 6.
- Mr. Jahangir Bhutta 7.

ON INVITATION:

- SR. # NAME
 - 8. Mr. Habil Ahmed Khan
 - Ch. Sajjad Ahmad 9.
 - Mr. Omer Iftikhar 10.

IN ATTENDANCE:

- SR. # NAME
- Mr. Salman Aizad 11.
- 12. Mr. Abdul Rauf

DESIGNATION

Managing Director **Deputy Director** Deputy Manager Director Additional Manager Deputy Director

Manager Finance

DESIGNATION **Director Operations** Project Manager Project Manager

DEPARTMENT / ORGANIZATION M/s. CWE & WK M/s. CWE & WK MR Consultant

DESIGNATION Manager Renewable Emergy Manager Finance

DEPARTMENT / ORGANIZATION Punjab Power Development Board Punjab Power Development Board

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DEPARTMENT / ORGANIZATION

Punjab Power Development Board

PCRET, Islamabad

AEDB, Islamabad

MEPCO, Multan

MEPCO, Multan

MEPCO, Multan

CPPA, NTDC

PROCEEDINGS:

The Meeting started with the welcome from the Chair. The Manager Project Renewable Energy gave briefing about the 3rd POE meeting of the project. The Managing Director PPDB requested the CWE & WK representative for presentation to the Panel of Experts (POE) on the revised Feasibility Study as required in article 4.2 para-51&52 of the Punjab Power Policy, 2006 (revised 2009).

Representing CWE & WK group Mr. Habil Ahmad Khan gave presentation about the revised feasibility study of the Project.

Item #	Description of Agenda Item	Recommendations of the Mecting
1.	Backdrop The revised Feasibility Study was reviewed by POE in the 3^{1d} meeting convened on 29.05.2014. In this meeting POE members suggested improvement / amendments in the volume 2 of the Feasibility Study Report. The MOM of the meeting issued on 10.06.2014. The amended volume of 2 of the Feasibility Study submitted to PPDB on 11.06.2014. The detail of each volume given as;	
	Volume 3 & 4 (revised Geo Tech study & Topography survey) Volume 5 (revised IEE from EPA Department & EIA Studies) Volume 6 (CDM 9.1.2012) Volume 7 (Interconnection study approved by NTDC)	
2.	In the light of MOM of 3 rd POE meeting, the POE members deliberated and reviewed the revised Feasibility Study. The financial expert from MEPCO observed that in economic calculation loan term is 12 years plus one year grace period at LIBOR plus margin of 5.25% and adjusted biannually. Responding this observation Mr. Habil informed that they expressed the terms of Chinese financial institution, however, it will be according to NEPRA guideline. It was also noted that M/s. CWE & WK JV has used "Meteonorm" for energy vield calculation of the Solar Power Project in the Feasibility. However no authentication/	 After detail discussion and deliberation all POE members appreciated the efforts made by M/s CWE&WK Joint Venture to carry out the detailed Feasibility study for the project having; Environmental Approval of the project given by EPA Punjab Interconnection Study Approved by N i DC

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Mr. Habil Khan on behalf of the Sponsor replied that they had a Memorandum of Sponsor shall pro-	he POE members that the ovide yield verification
Mr. Habil Khan on behalf of the Sponsor replied that they had a Memorandum of Sponsor shall pro	ovide yield verification
Understanding (MoU) with GIZ for conducting the Feasibility Study. M/s CWE&WK has	eteonorm and shall be
installed solar resource assessment equipment manufactured by NRG with data logger at	reasibility Study report.
site, since 2011 and two years actual solar site data is used for solar resource assessment in It was resolved unan	imously that based on the
this study report. It was further explained that they also used NASA data and PV Sys for Study of the 50 MW	fore the POE the Feasibility
energy yield calculation of the solar power plant. Furthermore, as per advice of GIZ stands approved	Solar Power Plant Project
Pakistan, M/s. CWE & WK paid to Meteonorm for use of data and their verification for	1
energy yield calculation.	

 \checkmark

The meeting ended with vote of thanks from and to the Chair.

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NATIONAL TRANSMISSION & DESPATCH CO. LTD

Chief Operating Officer / General Manager (CPPA) NTDCL

No.COO/GM/CPPA/CE-II/MT-IV/WKPL/2-534-39

M/s Welt Konnect (Pvt) Limited, Suit 8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad.

Subject: Interconnection Study Report for Power Dispersal of 50 MW PV Solar Project by M/s Welt Konnect (Pvt) Limited

Enclosed please find herewith a copy of the Grid Interconnection Study (draft final report) for power dispersal of 50 MW Solar PV Plant by M/s Welt Konnect in Quaide-Azam Solar Park prepared by General Manager Planning Power NTDCL for further necessary action at your end please.

The attached report contains scope of work, load flow studies, short circuit studies, transient stability studies and power quality studies of the proposed interconnection scheme for subject solar PV power plant.

DA/As above

(Engr. Javaid Naseeb Malik) General Manager (CPPA) NTDC

CC:

- i. Additional Secretary, Energy Department, Government of Punjab, Lahore.
- ii. Managing Director, Punjab Power Development Board, Irrigation and Power Department, 1st Floor Central Design Building, Irrigation Secretariat, Old Anarkali, Lahore.
- iii. Chief Executive Officer, Alternative Energy Development Board (AEDB), AEDB Head Officer, 2nd Floor, OPF Building G-5/2, Islamabad.
- iv. The General Manager Planning (Power) NTDC, 5th Floor, PIA Tower, Edgerton Road, Lahore.
- v. A to COO/GM (CPPA), 229-WAPDA House, Lahore. • Master File



ENVIRONMENT PROTECTION DEPARTMENT

Government of the Punjab

National Hockey Stadium, Ferozenur Road, Lahore.



NO. DD (EIA)/LPA/F-362(IEE) /2012/0104/6: Dated: 15/04/2014

To,

Mr. Faiz Ahmad, Managing Director, M/s Welt Knnect Pvt. Limited, Suit No. 08, Ground Floor, Evacuce Trust Complex, F-5/1, Islamabad.

Subject:

ENVIRONMENTAL APPROVAL

(Under Section 12 of the PEP Act, 1997 (amended in 2012) read with IEE/EIA Regulations, 2000)

Reference: Energy Department letter No. PPDB/1201/127/2011, dated: 09.06.2011 & letter No.SO(C)(ED)4-5/2012, dated: 13.02.2014

1. Description of Project: Development of 50-MW Solar Photovoltaic Power Project.

2. Location of Project:

The Project site is located in Sqr No. 1, 2, 3, 4, 5, 6, 7, 8, 9 & 10 of Main Block 354 of Quaid-e-Azam Solar Park in Lal Sohanra, Cholistan, District Bahawaipur.

3. Date of receiving of case 25.02.2014.

4. After review of the Initial Environmental Examination (IEE) Report, SIR by DOE and other relevant record, the Environmental Protection Agency, Punjab accord approval for construction phase of the above-mentioned project to safeguard the environmental issues subject to the following conditions:

- i. The proponent shall ensure compliance of National Environmental Quality Staudards (NEQS).
- ii. Mitigation measures suggested in the IEE Report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area.
- Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on monthly basis.
- iv. Hazard of soil crosion will be minimized with proper provision for resurfacing of exposed areas.
- v. Camping sites shall be located at suitable distance away from any sottlement to avoid disturbance to the local people. Sewage generated from camping sites shall be treated in septic tanks and snak pits.
- vi. The area around the project site shall be kept clean.
- vii. The proponent shall dispose of solid and electronic waste in a proper scientific way in consultation with TMA/District Government.

viii. The proponent shall ensure efficient health and first aid treatment facilities for protection of workers.

- ix. The proponent shall plant 5000 indigenous species of trees around the project area on available space within six months in the area and shall do proper landscaping after completion of the project.
- x. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.
- xi. The proponent shall care about noise issues during construction and operation stage of the project.
- xii. The objections/complaints of the locals/stakeholders (11 any) shall be redressed on priority basis.

The proponent shall provide compensation to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the relevant rates and that are agreed upon. There under all conflicting issues regarding compensation, etc. should be settled amicably by the competent authority before the start of the project activities.

xiv.

xiji.

The proponent shall obtain NOC / clearance from all other concerned departments bofore commencement of work.

xv. The proponent shall appoint Environmental Manager having qualification of M.Sc. Environmental Sciences or equivalent qualification recognized by the competent authority/ forum for the project and shall convey his name along with his complete Mailing Address and Phone Numbers.

5. The Proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.

6. The Proponent shall be liable for compliance of Regulations 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

7. This approval is accorded only for the construction phase of the project. The proponent will obtain approval for operational phase of the project in accordance with regulation 13(2)(b) and Regulation 18 of the IEE/EIA Regulations, 2000.

8. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.

9. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under regulation 16 of IEE / EIA Regulations, 2000.

10. This approval can be withdrawn at anytime without any prior notice if deem necessary in the public / national interest.

(AMEN HANIF) ASSISTANT DIRECTOR (EIA) for Director General, EPA, Punjab Ph: # 042-99232228.

NO. & DATE EVEN.

A copy is forwarded for information to:

1: The District Officers (Environment), Bahawalpur w.r.t. his letter No. 854/EIA/DO/EPA/BWP dated 29.03.2014. He is requested to ensure compliance of the above-mentioned conditions under intimation to this office.

(A MEN HANIF) ASSISTANT DIRECTOR (EIA) for Director General, EPA, Punjab





PROSPECTUS of 50 MW Solar PV Power Project at Lal Suhanara, Bahawalpur, Punjab, Pakistan

December, 2014



CTGI-WK CHOLISTAN SOLAR POWER PROJECT (PVT) LTD

A PROJECT COMPANY ESTABLISHED BY WELT KONNECT (PVT) LTD JOINT VENTURE CHINA THREE GORGES SOUTH ASIAN INVESTMENT LIMITED (CSAIL)-A BROTHER COMPANY TO CHINA WATER & ELECTRIC CORPORATION (CWE), WHICH ARE BOTH WHOLLY-OWNED SUBSIDIARIES OF CHINA THREE GORGES CORPORATION (NOW THE DEVELOPER ON BEHALF OF CTG)

中水电国际投资有限公司 CHINA THREE GORGES SOUTH ASIAN INVESTMENT LTD





Prospectus Of

03-0786-01 Document No. Rev No. / Date 03-0786-02 Issue No. / Date 31st December 2014 Effective Date 04th January 2015

50 Mw Solar Power Project In Cholistan

Originally prepared by CWCSPP

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PROJECT MAIN OFFICE IN ISLAMABAD

DOCUMENT INFORMATION

STRUCTURE OF THE DOCUMENT:

National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999 NOTIFICATION

Islamabad, the 1st March, 1999 S.R.O. 142 (I)/99

PART I	
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S.No	Section	Information/Documents Required
1.	2(i)(i)	A Brief Introduction Of The Applicant
2.	2(i)(ii)	The Salient Features Of The Facility Or The System In Respect Of Which The License Is
		Sought
3.	2(i)(iii)	The Purposed Investment
4.	2(i)(iv)	The Social And Environmental Impact Of The Purposed Facility Or System In A Non-
		Technical And Commonly Understood Language



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ACKNOWLEDGMENTS

The management of the Project Company CTGI-WK Cholistan Solar Power Project (Pvt) Ltd would like to express their gratitude to the support and cooperation extended by the Government of Pakistan and the Government of Punjab in the development activities of the project.

We are also thankful to the dedicated teams of the National Electric Power Regulatory Authority (NEPRA) and of the Punjab Power Development Board (PPDB) for the generous guidance and support throughout all stages of project development.

We hope for and look forward to the continued cooperation of all relevant Government Organizations, Bodies and officials for further advancement in implementing the Project and pioneering the way for Solar Photo Voltaic in Pakistan.

DISCLAIMERS

This document is intended for use by the Stake Holders and relevant Government Authorities for understanding and effective decision making regarding this Project.

The Company and the sponsors are and will not be responsible for any decision made by the intended or unintended users for any other purpose except in relation to this project.

The Company and the Sponsors are and will also not be responsible for any decision made by any other person or party not being an intended user of this document whether related to this project or not without consent of the Company or Sponsors in this regard.

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The materials in this document are the property of the CTGI-WK Cholistan Solar Power Project (Pvt) Ltd (A Project Company Established By Welt Konnect (Pvt) Ltd Joint Venture China Three Gorges South Asian Investment Limited (CSAIL)-A Brother Company To China Water & Electric Corporation (CWE), Which Are Both Wholly-Owned Subsidiaries Of China Three Gorges Corporation (Now The Developer On Behalf Of CTG)) and may be used for the purpose(s) mentioned in the National Electric Power Regulatory Authority Licensing (Application And Modification Procedure) Regulations, 1999 Read With The Provisions Of The Regulation Of The Generation, Transmission And Distribution Of Electric Power Act, 1997 And The Rules And Regulations Made Thereunder and the "Policy for Development of Power Generation" published in 2006 and revised in 2009 by Punjab Power Development Board. No part of this document may be reproduced or transmitted in any form or by any means, electronically or mechanically, for any purpose.

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HEAD OFFICE IN CHINA

Address	Room 191, Building B, Focus Plaza, No. 19 Financial Street, Xicheng District, Beijing 100033, P.R. China
Contact Person	Mr. Wang Feng
E-mail	wang_feng@ctg.com.cn

PROJECT MAIN OFFICE IN ISLAMABAD

Address	Suite.8, Ground Floor, Evacuee Trust Complex, F-5/1, Islamabad
Contact Person	Mr. Habil Ahmed Khan
E-mail	habil@weltkonnect.com

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DOCUMENT INFORMATION

Purpose and Scope:

The purpose of this Prospectus is to provide information required for the relevant agency to make informed decision regarding the Grant of Generation License for the subject Power Project.

This document presents the requisite information for such project approval and development within Pakistan's economic and regulatory framework.

STRUCTURE OF THE DOCUMENT:

The Prospectus is composed of four (04) main parts/sections:

- A Brief Introduction of the Applicant
- The Salient Features Of The Facility Or The System In Respect Of Which The License Is Sought
- The Purposed Investment
- The Social And Environmental Impact Of The Purposed Facility Or System In A Non-Technical And Commonly Understood Language.

Each Part is further sub-divided into sections and contains information as per the applicable Legislation, Guidelines, Rules and Regulation, for ease of reviewing and understanding the project.

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<u>PART I</u>

SECTION 2 (i) (i)

A BRIEF INTRODUCTION OF THE APPLICANT

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Brief Introduction of The Applicant

China Three Gorges (CTG) being a large international clean energy company, houses main businesses of including construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, initially starting with water conservancy & power projects, has now expanded its scope of business into Power Production through Wind, Solar and Nuclear Energy. Their vision is to be the World's largest clean energy group specializing in large-scale hydropower project development, management and operations; while also proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The Total assets of the Group stand around 41,316 million USD, with a revenue generation of 3,787 million USD, 99.47% from sales of electricity, and 1,418 million USD net profits.

Whereas China Three Gorges South Asian Investment Limited (CSAIL)-A Brother Company To China Water & Electric Corporation (CWE), which are both wholly-owned subsidiaries of China Three Gorges Corporation (CTG) *is a new overseas-investment subsidiary company of CTG*, which was established in Sep. 2013 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CSAIL has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CSAIL is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include the 1100 MW Kohala Hydropower Project, 720 MW Karot Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) is a Power Projects Developing company working in Pakistan. Its niche in the Energy Sector lies in the provision of Renewable Energy Engineering solutions particularly for Wind & Solar Power Projects as Independent Power Producers (IPP's) under the Clean Development Mechanism of the UNFCCC. These integrated solutions and systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in the ever growing and critical field of Renewable Energy.

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In Accordance with their development strategies respectively, in 2009 after consultation with the Esteemed Punjab Government Welt Konnect (Pvt) Ltd (WK) and China Three Gorges (CTG), planned to invest in the development & construction of Pakistan's first 50 MW Solar PV Power Farm in Cholistan in collaboration as a Joint Venture and later established the Project Company CTGI-WK Cholistan Solar Power Project (Pvt) Ltd, brief information of which is provided in the table below.

(A). <u>General Information</u>

(i)	Name of Project	CTGI-WK Cholistan Solar Power Project (Pvt)
	Company/Licensee	Ltd, duly registered with the SECP under
		Section 40 of the Companies Ordinance 1984
		(XLVII of 1984) with Corporate Universal
		Identification No. 0078366
(ii)	Registered /	Office 8, Ground Floor, Evacuee Trust
	Business Office	Complex, F-5/1, Islamabad 44000, Pakistan.
		Tel: +92-51-2870422-3, Fax: +92-51-2870424,
		Email:info@weltkonnect.com,
		www.weltkonnect.com
(iii)	Plants Location	Quaid-e-Azam, Solar Park, Lal Suhanara,
		Bahawalpur, Punjab
(iv)	Type of Generation	Solar Photovoltaic (PV)
	Facility	

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<u>PART I</u>

SECTION 2 (i) (ii)

THE SALIENT FEATURES OF THE FACILITY OR THE SYSTEM IN RESPECT OF WHICH THE LICENSE IS SOUGHT

General Information, Solar Power Generation Technology & Capacity, Technical Details of Equipment (at site), Project Details, Project Site, Process Flow Diagram, Plant Layout and 3D Layout Wiring Diagram, Interconnection Arrangement for the Project, Detail of Generation Facility, Interconnection Arrangement For Dispersal Of Power From The Generation Facility/Solar Farm

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<u>Detail of</u> <u>Generation Facility/</u> <u>Solar Farm</u>

(A). Solar Power Generation Technology & Capacity

(1)	Type of Technology	Mono Crystalline Photovoltaic (PV) Cell
(2)	System Type	Grid Connected (Independent Power Producer)
(3)	Installed Capacity of	49.28 MW AC Output (50.2656 MWp DC)
	Solar Farm (MW)	

(B). Technical Details of Equipment (at site)

(1)	Type of Module	240Wp
(2)	Type of Cell	Mono Crystalline
(3)	Dimension of each Module	Length 1675mm, Width 1001mm,
		Height 31mm
(4)	Module Surface Area	1,676,675mm ²
(5)	No of Panel/ Modules	209,440
(6)	Total Module Area	351,163 m ²
(7)	Total Land Area Used	250 Acres/ 1,011,715m ²
(8)	Panel's Frame	Alluminium
(9)	Weight of One Module	21.2 kg

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(10)	Module Out put Warranty	240 Wp/ 25 years Warranty
		25 years Guarantee for
		depreciation not more than 0.7 %
(11)	Number of Solar Cells in each	60
	module	
(12)	Efficiency of Module	17 %
(13)	Environment Protection System	Details are provided in the FSR
		Vol 5 with complete plan for
		Decommissioning.
(14)	Maximum Power (Pmax)	240Wp
(15)	Voltage @ (Pmax)	30.6V
(16)	Current @ (Pmax)	7.87 A
(17)	Open circuit Voltage (VOC)	37.6V
(18)	Short circuit Current (VOC)	8.22 A
(19)	Maximum system open circuit	640 V DC
	voltage	
(20)	V-I Curve of Solar Cell at 25 C	See Below in Diagram 03
(b)	PV Array	
(1)	Nos. of Sub-array	56
(2)	Modules in a string	22
(3)	Total Nos. of strings	9,520
(4)	Modules in Sub-array	3,740
(5)	Total No. of Modules	209,440
(c)	PV Capacity	J

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(1)	Total	50.2656 MWp DC
(d)	Inverters	
(1)	Capacity of Inverter (MW &	880 KVA@25°C / 800
	MVA)	kVA@50°C
(2)	Inverter Model	Sunny Central SC800CP XT
(3)	Manufacturer	SMA Solar Technology, Germany
(4)	Rated Input Voltage	620VDC
(5)	Input operating Voltage Range	535V- 850V
(6)	Number of Inverters	56
(7)	Total Power	9600 KW AC
(8)	Efficiency	98.6% (Euro: 98.4%; CEC:98.5%)
(9)	Max. Allowable Input voltage	1000 V DC
(10)	Max. Current	1400 A
(11)	Output electrical system	3 Phase, 3 Wire
(12)	Rated AC output Voltage	360V AC (+-10%)
(13)	Rated Frequency	50 Hz/ 60 Hz
(14)	Power Control	MPP Tracker
(15)	Modes of Operation of Inverter	On-Grid
(16)	Capacity of Inverter (MW &	880 KVA@25°C / 800
	MVA)	kVA@50°C
(17)	Reactive Capability Curve of	see PQ-Diagram (Diagram 01)
	Inverter	
(18)	Power Factor of Inverter	Adjustable 0.9 Leading 0.9
	(Leading & Lagging)	Lagging
		(0.9 Induction to 0.9 Capacitance)
		•

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		Operating	-25 to 62°C
		temperature	
(19)	Environmental	range	
	Enclosures	Relative	15 to 95%
		Humidity	
		Audible Noise	<61 dB (A)
		Operating	<2000m
		Elevation	
		Warranty	5 years
		Period	
		(a)	DC Circuit Breakers
		(b)	AC Circuit Breakers
(20)	Grid Operation	(c)	DC Over Voltage Protection
	Protection	(d)	Lightening Protection Level III
		(e)	Grid Monitoring
		(f)	Insulation Monitoring
		(g)	Anti Islanding
(e)	Medium Voltag	ge (Isolating)Trai	nsformer
(1)	Rating		1.76 MVA (1760 KVA) * 28
	/Inverter Trans	former Capacity	(TRANSFORMER COMPACT
	(MVA)		STATION 1600SC by SMA
			Germany)
(2)	Type of Transfo	ormer	Low to Medium Voltage
(3)	Input Voltage		360 V
(4)	Output Voltage		11-33KV (Adjustable)

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(5)	Purpose of Transformer	Step Up Voltage Transformer,		
		Galvanic Isolation and Elimination		
		of DC Current Injection.		
(6)	Efficiency	98.8%		
(7)	No. of Taps of Inverter	$0 \pm 2.5 \% \pm 5 \%$		
	Transformer			
(8)	Positive, Negative & Zero	1600kVA; Dy11y11; 15kV; 360V-		
	Sequence impedances of inverter	Positive-, negative-sequence		
	Transformer on its own MVA	impedance: 5,94%		
	Vector Group	- Zero-sequence impedance:		
		infinite		
(9)	X/R Ratio of Inverter	6		
	Transformer			
(10)	No. of Collecter Systems	7		
(11)	Collector System Length	925 m		
	(Section Wise)			
(12)	Collector System R, X, B in p.u	R: 0.0185		
	on 100 MVA Base	X: 0.0453		
		B: 0.0322		
(13)	Plant Reactive Compensation	n/a		
	Device Type			
(14)	Compensation Device Rating/	n/a		
	Size			
(15)	Compensation Device MVAR	n/a		
	Range (Leading and Lagging)			

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Prospectus Of 50 Mw Solar Power Project In Cholistan

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(f)	Station Transformer		
(1)	Station Transformer Capacity		60
	(MVA)		
(2)	Voltage Level of Station		Voltage adjustment
	Transformer		range:±132KV×10%
			8 step=8×1.25%
(g).	Junction Boxes installed a Yard	and fix	ed on main steel structure in Array
(1)	Number of J/Box Units		560
(2)	Input circuits in each box		17
(3)	Max. input current for	each	10A
	circuit		
(4)	Max. input Voltage		1000V
(5)	Power of each box		85.7 kW
(6)	Protection Level		IP 54
	Over current Protection		Fuse
	Out put Switch		125A, 1000V disconnector
	Surge Protection	_	1000V, Type II
		(a)	To combine groups of strings into
			Sub-Arrays that will be wired into
(7)	Purpose of Junction Box		the Inverter
		(b)	To provide Isolation of Sub
			Arrays

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50 Mw So		Prospectus Of Iar Power Project In Cholistan		Document No. 03-0788-01 Rev No. / Date 03-0788-02 issue No. / Date 31 st December 2014 Effective Date 04 th January 2015 Originally prepared by CWCSPP	
			(c) (d) (e)	In case of arrangement for each of the Sub- To ensure safe works in the Sol Protection from short circuit cur of semi-diodes.	fault provide or disconnection of Arrays or Strings ety of the electric lar Module Arrays m back flow of arrent through use
(h).	Data Co	ollecting S	ystem		<u></u>
(1)	Weather	r Data	(i)	data collected for Radiation (W/sCOR Pyranomothe NRGSymphonies Playthe site	or Direct Solar qm) using two Li- eters installed with u3 Data Logger at
(1)	Weather	r Data	(i) (ii)	data collected for Radiation (W/sCOR Pyranomothe NRGSymphonies Playthe sitedata collected(0C)using NRG 110to the Solar ResEquipment	or Direct Solar qm) using two Li- eters installed with u3 Data Logger at for Temperature os Sensor attached source Assessment

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			Rain Sensor attached to the Solar
			Resource Assessment Equipment
		(iv)	data collected for Wind Speed
			(ms ⁻¹) using NRG Wind Speed
			Sensor attached to the Solar
			Resource Assessment Equipment
		(v)	data collected for Wind Direction
			(deg) using NRG 200P Wind Vane
			Sensor attached to the Solar
			Resource Assessment Equipment
		(i)	DC input voltage (V), Current (A)
			of each module, string, sub array,
			Invertor
(2)	System Data	(ii)	Total Sub Array Power
			Generated and Inverter Power
		(iii)	AC output voltage (V) and
			current (A) of each inverter
			(Phase, total)
		(iv)	AC Output power (kW) and
			Energy (kwh) of each inverter
		(v)	Frequency (Hz)
		(vi)	Power Factor (PF)
		(vii)	Temperature inside inverter station
	Out door Cubicle Contro	l ol Rooi	n
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r		
1.	Data record	Data Logging using softwares and
		hardware provided by SMA Germany
		as provided in FSR Vol 2, page 144
2.	Control Room System	Computerized Data Monitoring and
		communication systems using latest
		Satellite Technology
3.	Control Room System	Interfacing, Hardware and Software,
	Detail	suitable for such Multi-MW systems as
		shown in FSR Vol 2, Page 144.
(i).	Mounting Structure	
(1)	Structure	HDG Steel/Alluminium with concrete
		pile foundations as shown and further
		details provided in FSR Vol 2 pages 146-
		150.
(2)	Tilt of Array Frame	29 °C
(3)	Array Specification	Designed and Certified for Wind Speed
		and Seismic Requirements as provided
		in FSR Vol 2, page 146-150.
(j).	Foundation Pillars	
(1)	No. of Foundations	104,720 as provided in FSR Vol 2 pages
		146-150
(2)	Foundation Structure	Reinforced Concrete

(D). Other Details

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(1)	Project Commissioning date	8 months after
	(Anticipated)	<u>financial close</u>
(2)	Expected Life of the project from	<u>25 years</u>
	commercial operation date (COD)	



Figure D01.1 showing PQ Diagram











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Satellite Map of Project Site

Plant/Solar Farm Location Coordinates

50 MW Project Coordinates

Node	Longitude (East)	Latitude (North)	
	······		
1	71 49.196	29 17.650	
2	71 49.817	29 17.650	
3	71 49.196	29 16.998	
4	71 49.817	29 17.324	
5	71 49.608	29 17.324	
6	71 49.608	29 16.998	

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Process Flow Diagram







Inverter



Transformer + switchgear

PV module

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Actual drawings pertaining to Solar Farm (SF)

1. Plant Layout

	Bid. 2010 Constant		· 书名》本 19月1日前19月1日前19月1日前19月1日
7480 Str	rings Connecter	d to 2 inverters a	and 1 Transformer
132 kV	(Ou	utput to Grid)	-
Sand			

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1. **PV Array**: The model consisted of 14960 modules (SW240 Mono) with a power output of 3.59 MWp

2. Inverters: Four SC 800 CP Inverters (SMA Solar Technology) are modeled. Rated output power is 3.52 MWp (3740 Modules / Inverter)

3. **Medium Voltage Transformer**: Two 1600-SC (SMA Solar Technology) Transformers are modeled. (7480 Modules / Transformer)

4. **Power Plant Controller**: Monitoring equipment and utilities will be kept in the same vicinity as the High Voltage Transformer

5. High Voltage Transformer: Customized transformer to feed high voltage in the grid

** Refer to Annexure 18: SMA Solar Power Plant Solution that has been used as reference for model.

Blue Lines: DC Voltage at 640V (10 Connections represented) Red Lines: AC Voltage at 360V Green Lines: AC Voltage at 11 kV

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2. Wiring Layout Diagram



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INTERCONNECTION ARRANGEMENT FOR DISPERSAL OF POWER FROM THE GENERATION FACILITY/SOLAR FARM

1. The Government of Pakistan (GoP) plans to develop 1000 MW Quaid-e-Azam solar park at Lal Suhanra as a major step towards development of solar generation in Pakistan. M/s Welt Konnect intends contribute to this plan by setting up 50 MW solar PV power plant in Quaid-e-Azam solar park. M/s Welt Konnect JV CWE hired the services of Planning Power Department of NTDC to carry out grid interconnection study in order to propose interconnection scheme for evacuation of power from 50 MW Welt Konnect JV CWE solar PV power plant to the system network.

2. The draft final report of the grid interconnection study shows the results of extensive system studies including load flow, short circuit, transient stability and power quality studies have been presented pertaining to the interconnection of 50 MW Welt Konnect JV CWE solar PV power plant. The adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect JV CWE power plant and of the system network in its vicinity has been evaluated in the light of Grid Code.

3. For the grid interconnection study, NTDC has used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas, M/s Welt Konnect has provided the data of its power plant on data request from NTDC.

4. The load flow analysis has been carried out for operating scenarios of summer 2015 and 2016 with the induction of 50 MW Welt Konnect solar PV power plant and the results of load flow studies have been presented in this report. It has been found that the power from 50 MW Welt Konnect solar power plant can reliably be evacuated to the system under normal and N-1 contingency conditions.

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5. The proposed interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant is given as under:

"A 132 kV double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra single circuit line at the 132 kV switchyard of 50 MW Welt Konnect JV CWE Solar PV power plant."

6. Short circuit studies have been carried out with proposed Interconnection option to compute the maximum three phase and single phase short circuit levels after the induction of 50 MW Welt Konnect JV CWE solar PV power plant. It is found that the proposed solar generation has no adverse impact on the existing network in its vicinity and the short circuit currents remain within the installed switchgear ratings at the existing substations. On the other hand, the standard switchgear of the short circuit rating of 40 kA would be sufficient at 132kV switchyard of the 50MW Welt Konnect JV CWE solar PV power plant.

7. Transient stability analysis with the proposed interconnection scheme for 50 MW Welt Konnect solar PV power plant has been carried out using the NEPRA Grid Code Criteria. The stability of the solar PV plant and the power system has been checked with application of faults at the 132 kV switchyard of 50 MW Welt Konnect solar PV power plant and at the substations in the vicinity of the plant. It has been found that 50 MW Welt Konnect solar PV power plant and the surrounding power system network remain stable with no adverse effects after subjected to faults as per Grid Code requirement.

The LVRT requirements for 50 MW Welt Konnect solar PV power plant are also met as mentioned in Grid Code Addendum for solar power plants (under approval by NEPRA).

8. The issues of power quality with the induction of the 50 MW Welt Konnect solar

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PV power plant have also been studied. The study results indicate that the power quality parameters including flicker and voltage unbalance, remain within the permissible limits as mentioned in relevant IEC standard.

9. On the basis of the results of the detailed system studies, it has been concluded that the proposed interconnection scheme has no technical constraints in evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.





If there is any change in the final dispersal arrangement, the same will be communicated to NEPRA in due course.

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National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, <u>1999</u>

NOTIFICATION

Islamabad, the 1st March, 1999

<u>S.R.O. 142 (I)/99</u>

PART I

SECTION 2 (i) (iii)

THE PROPOSED INVESTMENT

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PROPOSED INVESTMENT AND PROJECT COST

Economic calculations have been based on the method of internal rate of return and the levelized cost of energy. The important considerations for the 50 MW Solar PV Power project and others in the vicinity is the interest rate obtained for the project. The contributing factors in this region are the risk ratings of the countries in the financial market. The analysis have been based on an interest rate of 5.25% plus LIBOR. The project has been analyzed on the basis of 17% internal rate of return as per requirements set by the authorities. The project has been evaluated with consideration to the 0.8% annual deprecation in energy generation for the life of the project.

The cost of the project is further divided in to the EPC and Non-EPC Cost. The EPC cost of the project is USD **\$89.63** Million and Non EPC component of the total cost is USD **\$ 8.71** Million approximately. **The project will be funded through 30% equity investment by the Sponsors and 70% loan for a period of 12 years**.

Calculations have accounted for Insurance during construction and the Sinosure Premium required for investments in this project. The project cost also has a component of financial charges which includes the arrangement fee, banks advisors charges and charges for arrangement of insurance.

The entire debt is coming from foreign banks in US Dollars. The term of the loan discussed with the banks at this time is 12 years plus one year grace period based on LIBOR plus a margin of 5.25 percent. LIBOR is going to be adjusted on a bi-annual basis i.e. 6 months LIBOR.

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Financial Baseline

Below is the basic information of the project based on the feasibility study report.

Description	USD
EPC Cost	
EPC Cost	89,630,000
Sub-Total	
	89,630,000
Project Land and Development	902,978
Standby Generator including ancillaries	204,734
Administrative Onice and Stan Accommodation	1,173,873
Dowsers and Project venicles	116,785
Access Koad, Jand, construction and other intrastructure	2 000 000
Deviant Devia company Cost	3,000,000
All Project Development Costs including studies regulatory for and	7 500 000
administrative	2,500,000
Sub-Total	2,500,000
Insurance During Construction	an shekarar kara shekar kara kara kara shekara shekara ta shekara kara kara kara kara kara shekara shekara kar
1.35% of the EPC Cost for two years reduced to 8 months	672,225
Sub-Total	672,225
Financing Fees and Charges	
Financing Fees and Charges	2,514,808
Sub-Total	2,514,808
Interest During Construction	
Interest During Construction	899,029
Sub-Total	899,029
	an a
TOTAL PROJECT COST	99,216,062

Table: Project Cost

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National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999

NOTIFICATION

Islamabad, the 1st March, 1999

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<u>PART I</u>

SECTION 2 (i) (iv)

THE SOCIAL AND ENVIRONMENTAL IMPACT OF THE PROPOSED FACILITY OR SYSTEM IN A NON TECHNICAL AND COMMONLY UNDERSTOOD LANGUAGE

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INTRODUCTION

The subject Solar Farm is a 50 MW electricity generation plant designed to produce electricity by solar energy in Cholistan Desert in the province of Punjab, Pakistan. It employs solar photovoltaic (PV) technology that converts solar energy directly into electricity, while emitting zero greenhouse gases (GHG) into the atmosphere. The project is planned to be implemented in phases of 5 MW each and would become operational and start generating CERs right after the completion of the first phase of the project, with work on the other phases continuing. The generated electricity will be supplied to the national grid.

The project conforms to the government policy that promotes development of renewable energy technology and contributes to lowering dependence on electricity generation by fossil fuels which is over 66% of total generation in Pakistan. It is expected to help alleviate the huge energy deficit in Pakistan. It is the first Solar PV project of its size in Pakistan and will be a good source of clean energy.

The area of this project will be about $1011714.105m^2$ (250Acres) and annual amount of electricity going to the grid will be about 76,037 MWh/yr. As a result over 30,000 tons of CO₂ emissions will be abated per year approximately.

The Environmental Studies cover the assessment of the solar power plants' social and environmental impacts and identification of the most appropriate mitigation measures based on the review of the environmental aspect in the plants' feasibility study report. The environmental studies include a review of Welt Konnect and CWEI corporate policies and operational framework for environmental and social management. The studies conclude that the proposed project will have insignificant environmental and negligible social impacts. The Sponsors and Project Company is fully committed to its environmental and social responsibility and discharges this responsibility in adherence to principles of good corporate governance.

One of the most important feature of solar PV systems is that there are no emissions of carbon dioxide - the main gas responsible for global climate change - during their operation. Although indirect emissions of CO2 occur at other stages of the lifecycle, these are significantly lower than the avoided emissions. PV does not involve any other polluting emissions or the type of environmental safety concerns associated with conventional generation technologies. There is no pollution in the form of exhaust fumes or noise.

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Decommissioning a system is unproblematic. Although there are no CO2 emissions during operation, a small amount does result from the production stage. PV only emits 21.65 grams CO2/kWh, however, depending on the PV technology. The average emissions for thermal power, on the other hand, are 900g CO2/kWh. By substituting PV for thermal power, a saving of 835879 g/kWh is achieved.

The benefit to be obtained from carbon dioxide reductions in a country's energy mix is dependent on which other generation method, or energy use, solar power is replacing. Where off-grid systems replace diesel generators, they will achieve CO2 savings of about 1 kg per kilowatt-hour. Due to their tremendous inefficiency, the replacement of a kerosene lamp will lead to even larger savings, of up to 350 kg per year from a single 40 Wp module, equal to 25kg CO2/kWh. For consumer applications and remote industrial markets, on the other hand, it is very difficult to identify exact CO2 savings per kilowatt-hour.

Recycling of PV modules is possible and raw materials can be reused. As a result, the energy input associated with PV will be further reduced. If governments adopt a wider use of PV in their national energy generation, solar power can therefore make a substantial contribution towards international commitments to reduce emissions of greenhouse gases and their contribution to climate change. Natural gas is the most environmentally sound of the fossil fuels, because it produces roughly half as much carbon dioxide as coal, and less of other polluting gases. Nuclear power produces very little CO2, but has other major safety, security, proliferation and pollution problems associated with its operation and waste products.

Policy Legal and Administrative Framework

As per the general criteria the project is consistent with the national laws and sustainable development policies, strategies and plans including:

Pakistan Environmental Protection Act- 1997

The project is in compliance with the PEPA 1997, and as mentioned in Para 12 of the said act, this project being a solar PV project in a desert with almost no population or wildlife or plantation, does not have any adverse effect on the environment whatsoever. However an Environment studies have been submitted to and approved by the relevant authorities after their evaluation.

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• National Energy Conservation Strategy

The project complies with the three explicit objectives of the NECS: conservation of natural resources, promotion of sustainable development, and improvement of efficiency in the use and management of resources; and would also abide by policies outlined for pollution control as in S.No 4, 8, 10, 12 and 13 of the 14 core programme areas.

• National Environment Policy

The project is in unison and support of the NEP, particularly contents of 3.4, 3.4(h), 3.6, 3.7, 3.9, 4.1, 4.3, 4.4, 5.4, 5.5 and 5.6.

National Forestry Policy

The project is in harmony with the National Forestry Policy and although being situated in a desert namely Cholistan it will contribute to the national grid and hence meet the objectives of Para 1.2 by generating power from solar energy which will indirectly hinder cutting of mountain trees for firewood. It also supports Para 7, 10.2, and 10.3.

National Renewable Energy Policy

The project complies with NREP, articles 4 (4.4), 8.1, and 8.3 (8.3.3)

Medium-term Development Framework

The project supports Medium term Development Framework objectives such as poverty reduction, upgrading of physical infrastructure, energy security, accelerated development of lesser developed areas, and environment.

Pakistan Environmental Protection Agency Regulations 2000

Environmental impact assessment or Initial Environment Examination is not required for solar power projects in Pakistan as per section 3 and 4 of the Pakistan Environmental Protection Agency's Regulations 2000. However a complete IEE Document has been prepared for the project.

Other Relevant Policies and Plans of the Government

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The project complies and is in harmony with all relevant concerned policies of the government of Pakistan. The project will not result in any obligation towards the investor country other than CER authorization.

Description of Environment

Site Condition

The land acquired by the Joint Venture consists primarily of flat ground and scarce sand dunes at the peripheral of the site. Construction of the solar farm will be focused on the flat areas.

Cholistan has very low propensity towards natural disasters or similar risks. Till date the nearest area to Cholistan which has faced the effects of a flood is Bahawalpur and that too only once in history. Cholistan and nearby areas for a significant radius are not prone to earth quakes (as per past records). The Project is strategically positioned between the Farm Lands being irrigated by man-made canals taken out from the Indus River passing through Punjab on its way to Sindh which cover it on 3 sides and on the other hand a national park on the fourth side giving a natural cover. **Extract 4** represents the topographic survey of the project site.



Extract 1: Topographic Survey of the Site

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Micro Climate Effects

The Pakistan Meteorological Department is both a scientific and a service department, and functions under the Ministry of Defense. It is responsible for providing meteorological service throughout Pakistan to wide variety of interest and for numerous public activities and projects which require weather information.

In its services to aviation the department's responsibility goes to some extent beyond national boundaries in fulfillment of accepted international agreements and obligations which include, among other things, the collection and rebroadcast of meteorological data.

Apart from meteorology, the department is also concerned with Agro meteorology, Hydrology, Astronomy and Astrophysics (including solar physics), Seismology, Geomagnetism, Atmospheric Electricity and studies of the lonosphere and Cosmic Rays. Pakistan Meteorological Department shoulders the responsibility to investigate the factors responsible for global warming, climate change its impact assessment and adaptation strategies in various sectors of human activities.

Microclimate effects of Cholistan and nearby area are characterized by low and rare sporadic rain. The mean annual rainfall varies from less than 100 mm in the west to 200 mm in the east and as per collected Synthetic Data, installed SRA equipment on site and information gathered from Locals, it rains only 1 to 3 times a years.

Rain usually falls during monsoon (July through September), winter and spring (January through March). Aridity is the most striking feature of the Cholistan desert with wet and dry years occurring in clusters. Cholistan is one of the hottest regions of Pakistan. Temperatures are high in summer and mild in winter. The mean summer temperature (May, June) is 34 °C with the highest reaching above 51 °C. Extract 2 gives us the meteorological details of the site.

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	Average Temperature ⁰ C		Average	Precipitation		
		e La constanta da cons		National at a star and		
Months	Min	Max		Mean		
Jan	6.95	19.9	45.3	0.30		
Feb	9.19	22.9	38.2	0.61		
Mar	15.1	29.3	29.3	0.66		
Apr	20.8	34.2	27.4	0.52		
May	25.3	37.9	30.3	0.54		
Jun	28.2	38.2	43.4	1.22		
Jul	28.0	35.1	61.8	3.63		
Aug	26.9	33.4	67.7	2.95		
Sep	24.8	33.8	55.4	1.22		
Oct	19.3	32.6	33.5	0.40		
Nov	13.8	27.8	31.6	0.09		
Dec	8.99	22.2	39.1	0.23		

Extract 2 The meteorological details of the site

Soil, Water and Vegetation Condition

The investigated site is located at Lal Suhanara, Quaid E Azam Solar Park (QASP) District Bahawalpur. The area is mainly underlain by Sandy Silty Clay up to the maximum explored depth.

Soil

The onsite material is generally classified as SANDY SILTY CLAY (CL-ML) group of Unified Soil Classification System. Prior to any construction activity, the site must be cleared of all debris and surface vegetation. The leveling and grading can be carried

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out by normal earth moving machine. It is recommended that immediately after excavation for construction of foundation or other substructures, the excavation bottoms and slopes are cleared of all debris, proof rolled and covered by a 5 cm thick blinding concrete layer.

Water

The site is facilitated with a very favorable level of water table, less than 40m below ground level. The project team would drill bores to gain access to this water table and its supply.

Vegetation

Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading. The panels would be mounted on racks, facing due south, at an angle of 30 degrees above horizontal to maximize the system for annual energy production.

Anticipated Impacts and Mitigation Measures

Impacts during Construction

The civil, mechanical and electrical works will be minor and will spread over the large project site. Considering the nature and magnitude of construction works and the ecological insensitivity of the project site, it is certain that the construction would create only minor and manageable environmental disturbances such as noise from trucks and excavation equipment, which are insignificant impacts due to the absence of communities in the area. No toxic and hazardous materials will be used in the construction apart from diesel oils for vehicles, which will be properly stored. The construction contracts will require the EPC contractors to be responsible for undertaking effective measures for environmental impact mitigation. Environmental performance of the EPC contractors will be monitored by the joint on site project management team, specifically the personnel of HSE Department.

Impacts during Operation

The solar power plant does not create noise and gaseous emissions during operation. A small volume of wastewater would be daily generated from washing dust from surface of the solar panels. This wastewater contains only suspended solids and will be drained into the storm drainage basin. Not more than 10 staff for operation and

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for maintenance such as PV surface cleaning; Domestic wastes generated by this small number of people could be readily handled by a septic tank system.

The potential impacts could be visual and reflection. However, as the project 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. With the old design of solar PV arrays, reflected sunlight may cause problems if the system is close to a road and is facing in a direction which the reflected sunlight may cause problems. This problem will not occur in this Project as its surface of solar PV panels is designed to absorb sunlight and minimize sunlight reflections. Though the reflection problem will not occur because the panels are designed to absorb sunlight, the project team will plant trees along the road as green belt.

Decommissioning

The Project Company will ensure that the entire Project Location is restored back to its pre-construction condition (successional vegetation land use or as may be appropriate at that time) and that the decommissioning is conducted in accordance with the applicable local (Bahawalpur and Cholistan bodies), provincial (Punjab Government) and federal requirements. In addition, potential effects and mitigation pertaining to significant natural features on and/or in proximity to the Project Location will documented. Overall, no significant adverse impacts to the environment are expected as a result of decommissioning the Project. **The Flow Chart below (Extract 3: From Feasibility Report)** shows the flow chart of the decommissioning procedure.

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Social Impacts

There will be reduction of poverty in an economically depressed region with very little industry and high unemployment as jobs are created during installation as well as operation for both unskilled and skilled workers. The skill sets of locals will be improved through training and capacity building for employment in the project contributing to technical advancement.

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Grievance Redress Mechanism

At least 2 channels for environmental complaints will be created. These would comprise of complaints using emails, and telephone. The details of both these channels would be mentioned on all direction and site boards for the project. The most effective channel for response is by telephone because the contact can be made anytime and is two-way communication. No matter which channel is used, the responders from the HSE (Health, Safety and Environment) team will firstly obtain the information from the complainer as much as possible to identify source of the problem and inform the operations or maintenance departments. When the operations or maintenance department receives the information from HSE, they will find out if the complaint is caused from their operation. In case "yes", they will fix the problem or stop their operation.

A follow up will be carried out when the operation will call back HSE staff for the situation so that HSE staff can communicate to the complainer as soon as possible. Moreover, HSE staff will also meet the complainer, if required and possible, at site for better understanding and curing his/their feelings and inform them the progress of mitigation measures from time to time until the problem has been solved.

Environmental Management Plan

Management System

After the completion of this 50MW Solar PV Project, a joint management organization will be established with the principle of requiring "few on-duty staff". After the electrical equipment and machinery have entered their stable operation mode, the PV plant shall be managed with "no on-call staff and few on-guard staff".

The WK & CTGI 50 MW PV Plant is divided into the production area and the utility area. The production area includes facilities such as Solar PV panels, etc. The complex will have multiple functions of administration, living, and production. The offices of the building will consist of relay protection room (including the DC panel room), central control room, communication room, and general purpose offices. The control room, the room for distributing high and low voltage electricity, and power distribution will be arranged conveniently so as to reduce the total length of cable laying and save construction cost. The other section is for daily lives including dormitories, dining room, and kitchen.

Housekeeping of Facility

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OEMs for Solar panels are responsible for providing the generic maintenance plans for solar panels which include cleaning. The joint management between Welt Konnect, CTGI and EPC Contractor will be required to further determine the suitable cleaning requirements for the panel. This would be done by sharing complete site information (dust, dirt, pollen and/or pollution in the site environment; the frequency of rain or snow) with the OEMs for Solar panel, and ask them for site specific cleaning plans and details for the solar panels. Innovative methods for different maintenance and operation aspects are being employed all over the globe.

Safety and Security Concerns

Responsibility for security concerns before the construction of the project will lie with the EPC Contractor with monitoring authority of Welt Konnect and CTGI. Postconstruction the responsibility will lie with the joint management to develop a team and an SOP mentioning the number of personnel required for the security purpose of the facility.

Responsibility for security concerns before the construction of the project will lie with the EPC Contractor with monitoring authority of Welt Konnect and CTGI. Postconstruction the responsibility will lie with the joint management to develop a team and an SOP mentioning the number of personnel required for the security purpose of the facility.

Risk Management

The risk management plan, documents the procedures that will be used to manage risk throughout the project. In addition to documenting the results of the risk identification, it also covers who will be responsible for managing various areas of risk, how risks will be tracked throughout the project, and how plans of action will be implemented.

Risk management plan is an assessment tool that may is used in the project oversight process. For the 50 MW Solar PV Power Project in Cholistan, the RMP includes at least the following information:

- Purpose and scope
- Risk management methodology
- Overview or summary of risk
- Risk identification

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- Risk analysis
- Risk response planning
- Risk monitoring and controls

Emergency Response Processes

During the construction and operation of the project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personnel safety of the workers. The safety and health supervision department will provide appropriate inspection equipment, as well as necessary public education service for production safety.

HSE personnel will be required to draft emergency shutdown procedures for the plant in collaboration with the maintenance and project department during the detailed design phase of the Project. These would include all procedures in case of fire, lightning, flood, other natural disasters, etc. The procedures would be based on the guidelines from OSHA Standards (29 CFR 1910).

Social Development

For the purpose of measuring Social Development the "JEDI - Jobs and Economic Development Impact" model of evaluating socio economic factors has been employed. The (JEDI) models are user-friendly tools that estimate the economic impacts of constructing and operating power generation and biofuel plants at the local level. Based on project-specific and default inputs (derived from industry norms), JEDI estimates the number of jobs and economic impacts to a local area (usually a state) that could reasonably be supported by a power generation project.

For example, JEDI estimates the number of in-state construction jobs from a new solar project. JEDI models are input-output models designed to provide reasonable estimates, not exact numbers. JEDI also provides estimates on land lease and property tax revenues, when appropriate.

Various ownership and financing structures can be incorporated by the user as well. Results obtained for the impact of this project on the local employment can be represented by empirical changes on employer payroll. This can be seen in **Extract 4**: Empirical results of Using JEDI with Cost estimates on employer payroll.

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	Cost	Local Share	Locally (Y or N)
Labor	cost	Local Share	
Technicians	\$136.667	100%	
Subtotal	\$136.667		
Materials and Services	¥ = - = ,		
Materials & Equipment	\$113,333	100%	N
Services	\$0	100%	
Subtotal	\$113,333		
Sales Tax (Materials & Equipment Purchases)	\$9,350	100%	
Average Annual Payment (Interest and Principal)	\$1,508,000	0%	
Property Taxes	\$0	100%	
Total	\$1,767,350		
Other Parameters			
Financial Parameters			
Debt Financing			
Percentage financed	80%	0%	
Years financed (term)	10		
Interest rate	10%		
Tax Parameters			
Local Property Tax (percent of taxable value)	0%		
Assessed Value (percent of construction cost)	0%		
Taxable Value (percent of assessed value)	0%		
Taxable Value	\$0		
Property Tax Exemption (percent of local taxes)	100%		
Local Property Taxes	\$0	100%	
Local Sales Tax Rate	8.25%	100%	
Sales Tax Exemption (percent of local taxes)	0%		
Payroll Parameters	Wage per hour	Employer Payroli	Overhead -
Construction and Installation Labor	Contract of Party of State		
Construction Workers / Installers	\$21,39	45.6%	
O&M Labor	17.2 July 1		

Extract 4: Empirical results of Using JEDI with Cost estimates on employer payroll

The current recession being faced by the globe has shifted the attention towards major socio-economic disasters such as inflation, industries crashing, unemployment rise, and standards of living reducing dramatically. Pakistan and the nearby region has been a victim of these conditions prior to recessions and is expected to keep facing similar situations in the aftermath of recess.

Projects like these provide us with the two major solutions to problems which form the foundation of social and economic disasters; Employment and cheap power for
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comfort. Through projects of this scale and nature, direct benefits to the community and economy are that of:

- Immediate employment
- Cheap energy and comfort

Some indirect and important benefits are:

- A Creation of a local market and/or of a local industry for PV products and services
- Security of energy supply
- Poverty alleviation, Creation of education facilities (need of skilled personnel)
- Recovery of vegetation due to improved irrigation / improved access to safe drinking water due to solar water purification

All methods employed during the engineering, procurement and construction phase have not only been screened to develop opportunities in Pakistan but also to cater to important requirements such as providing a healthy environment to the community. This project will also play a crucial role in improving awareness on renewable energy and in turn on the right consumption pattern of power for consumers.

The project holds complete compliance to every law and rule set down by the Government of Pakistan, Provincial government of Punjab, regulatory bodies for power, and regulatory bodies for Economics such as SECP and regulatory requirements of Environment.

At an early stage of PV power development it is not likely that PV modules or cells for large power plants will be produced in Pakistan, so the creation of local industry should not be overestimated in beginning of the development of a the national PV market.

Environmental Impacts Mitigation

The requirements set by the Government of Pakistan and the Provincial Government of Punjab on different aspects of environment have been reviewed in detail, apart from the primary requirements of IEE, EIA and NEQS there are multiple legislations and laws that need to be considered for any power generation projects in Pakistan.

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For renewable energy projects, these laws and legislations belong to 14 various sectors.

Solar projects are out of the scope of noise sector, as opposed to those of wind power projects.

Renewable Energy Projects do not have relevance to the sectors or concerns of Toxic or hazardous substances, Air Quality, Marine and Fisheries (except for any wind power projects undertaken which is off-shore), mineral Development and Public health and safety.

PV Power and Biogas projects do need to consider all laws set by sectors of livestock and solid wastes.

Important issues with the Solar PV Project and other similar projects in the region have to pay serious attention to the selection site for power generation to cater to the environmental standards as set by sectors like forest conservation, Parks and Wildlife conservation, cultural environment, Environmental protection, Land use and water quality and resources.

Considering the size of this project, primary focus was kept on the laws and legislations of land use set by the Provincial Government of Punjab, meaning the Land acquisition Act 1984, Soil Reclamation Act 1964 and The Punjab Development of Damaged Areas Act 1952. Damaged areas have been defined as any area that is declared damaged by the government through notification.

The Project Site is not used for agriculture farming due to very arid climate and undulating topography. Neither is livestock grazing an option due to the limiting weather conditions of the Land There is scarcity of drinking water both for humans and scarce livestock. As a result livestock production is less than its potential.

Groundwater is never the less available less than 40 meters below the surface however in some locations it is too saline to drink. The main method of keeping animals in areas further away from this hyper-arid region is a free availability of forage and monsoon rains which leave water stored in the pools dug in past by their owners.

Main soil types of Cholistan desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%).

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Conclusions And Recommendations

The project site is not used for agriculture, is not located in a sensitive ecosystem, and has no historical and cultural value. This nature of the project site coupled with the clean nature of solar power generation ensures that the Project will not cause any significant, lasting environmental and social impacts during construction, operation and decommissioning. Only minor and transient environmental disturbances would be experienced at the project site during construction and operation, and they will be minimized through implementation of the Environment Management Procedures. It is then recommended that the Project be considered environmentally and socially feasible, and that this IEE is adequate to justify environmental and social feasibility of the Project. There is no need for further analysis and the environmental and social assessment of the Project is considered complete.

The Project Company is fully committed to its environmental and social responsibility and discharge this responsibility in adherence to principles of good corporate governance. In their daily business operations, the Project Company shall fully meet the environmental, occupational health, and safety requirements and risk management within the basic framework of globally recognized environmental management system standard. Its staff and contractors are fully committed to their environmental responsibility and discharge their responsibility within the HSE policy and operational framework.

The Project Company discharge their social responsibility through: (i) fair treatment of its employees in full compliance with all applicable laws and regulations; and (ii) supporting community participation and development activities through its CSR program. Involuntary resettlement and indigenous peoples are not relevant issues in the operations of the project and are unlikely to become relevant issues in its future operations.





Feasibility Study Report First 50 MW Solar PV Power Project In Cholistan, Punjab, Pakistan

April, 2014



Volume 1 (Updated) Main Report - Part 1

JOINT VENTURE

CHINA WATER AND ELECTRIC INVESTMENT CORPORATION

&

WELT KONNECT (PVT) LTD



中水电间际投资有限公司 CWE INVESTMENT CORPORATION



50 MW Solar Power Project in Cholistan

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APPROVAL SHEET

TITLE: Feasibility Report50 MW Solar Power Project in Cholistan

DOCUMENT NUMBER : 01-0786-02

CLASSIFICATION : Un-Classified

SYNOPSIS

This document is a feasibility study report of 50 MW Solar PV Power Project sponsored by China Three Gorges International Corp. and Welt Konnect (Pvt) Ltd. It is divided into 7 Volumes volumes for ease of review and approvals.

- Volume 1: Main Report Part 1 (Updated): of this report contains detailed information regarding the geographic features of Pakistan, along with the insight to Pakistan's Energy and Electricity market. After discussing the solar energy industry and carbon credit details for information purposes, the volume focuses on mentioning the regulatory regime of the country that is applicable to the project and all legal requirements. The volume also summarizes the salient features of the project.
- Volume 2: Main Report Part 2 (Updated): of the report focuses entirely on the specific details of the project. It provides information on the selected site, the description of the technical equipment and the layout of plant. The report further includes the basis for calculations and designing, by giving details of the grid connections available and yield of power. Prior to conclusion, the report also gives details of the policies and procedures for O&M, Project Management, and tariff calculation. The report concludes with details of the ecological and socio-economic benefits of the project.
- Volume 3: Geo-Technical Study Topographic Survey (Updated): of the Project Site, with detailed analysis.
- Volume 4: Geo-Technical Investigation Report (Updated): for the Project Site, including Soil Testing

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Feasibility Report – Volume 1 50 MW Solar Power Project in

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Volume 5: Environmental Study (Updated): contains the Initial Environmental Examination Report (IEE), the Environmental Impact Assessment Report (EIA), and the No Objection Certificate (NOC) for the project issued by the Environmental Protection Agency (EPA) of Punjab.

- Volume 6: Clean Development Mechanism: is composed of the Project Idea Note (PIN's), the Letter of Intent (LOI) issued by the Designated National Authority (DNA) the Clean Development Mechanism Cell of Pakistan, Ministry of Climate Change, followed by the Prior Consideration form, the Project Design Document (PDD's) and the Host Country Approval (HCA) by the DNA.
- Volume 7: Grid Interconnection Study has been conducted and approved by National Transmission Dispatch Company (NTDC).

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TABLE OF PROFESSIONALS

Sr. No.	Work Scope	Reviewed By	Designation	Approved By
1	Project Management, Economic Evaluation and FSR Compilation	Ms. Violet Rong	Projects and Investment Expert	Jia Yangang
2	Financial Evaluation	Mr Lu Tinghua	Finance Advisor	Jia Yangang
3	FSR Compilation	Awan Arshad	Project Manager	Jia Yangang
4	Project Management	Steven Chen	Project Manager	Jia Yangang
5	Project Management and FSR Compilation	Mohsin Iqbal	Project Manager	MAJ (Retd.) Riaz Ul Hassan
6	Socio-Economic Benefits, Ecological Impacts and Comprehensive Explanations	Zeeshan Ahmed	Project Section Head	MAJ (Retd.) Riaz Ul Hassan
7	Technical and Design Evaluation	Mr Sun Yuming	Senior Design Engineer	Jia Yangang
8	O&M Methodology, Working Management	Adnan Aurengzeb	Senior Elect. Engineer	MAJ (Retd.) Riaz Ul Hassan
9	Engineering Electrical Power Systems	Riaz Ahmed	Electronics Engineer	MAJ (Retd.) Riaz Ul Hassan
10	Engineering Electrical and Instrument Controls	Noman Naseer	Electronics Engineer	MAJ (Retd.) Riaz Ul Hassan
11	Solar Resource Assessment Monitoring and Recording	Sarosh Tahir	Electronics Engineer	Kashif Riaz
12	Health, Safety and Environment Procedures	Umer Yar	Electronics Engineer	Kashif Riaz
13	Fire-Fighting and Emergency Procedures for Project	Fasi Ul Islam	Electronics Engineer	Kashif Riaz
14	Engineering and Vendor Selection for Solar panels, Inverters and Equipment	Naveed Ahmed	Electronics Engineer	Kashif Riaz
15	Engineering Geology	Daniyal Haider	Electronics Engineer	Kashif Riaz
16	Engineering task force analysis	Adil Mustafa	Electronics Engineer	Kashif Riaz
17	Civil Works and Construction Management	Sajjad Akhtar Choudhary	Civil Engineer	Kashif Riaz
18	Simulation and Solar Resource Modeling	Abdullah Usman	Design Engineer	Kashif Riaz

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LIST OF ABBREVIATIONS

AC	Alternate Current
AEDB	Alternative Energy Development Board
Approx.	Approximately
ASL	Associated Surveyors (Pvt)Ltd
ВМ	Build Margin
BOO	Build Own and Operate
BOR	Board of Revenue
Bwp	Bahawalpur
САА	Civil Aviation Authority
CCGT	Combined Cycle Gas Turbine
CDA	Cholistan Development Authority
CDM	Clean Development Mechanism
CDMA	Code division multiple access
CERs	Certified Emission Reductions
CEEG	China Electric Equipment Group
CEEG SI	CEEG Solar Energy Research Institute Co, Ltd
СМ	Combined Margin

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- CMA Certified Management Accountant
- CNG Compressed natural Gas
- CO2 Carbon dioxide
- COD Commercial Operational Date
- CoP Conference of the Parties
- CPPA Central Power Purchasing Agency
 - CPV Concentrator photovoltaic
 - CTG China Three Gorges
- CTGC China Three Gorges Corporation
 - CTGI China Three Gorges International Corp.
 - CTGPC China Three Gorges Project Company
 - CWE China Water and Electric Corporation
- CWEIC China Water and Electric Investment Corporation
- CYP China Yangtze Power Co. Ltd
- DC Direct Current
- deg Degree
- DG Diesel Generator
- DGPs Dual Global Positioning System

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- DISCOs Distribution Companies
- DNA Designated National Authority
- DOE Designated Operational Entity
- DSSC Dye-Sensitized Solar Cells
- EE Energy Efficiency
- EF_y Baseline Emission Factor
- EIA Environmental Impact Analysis
- EMC Electromagnetic Compatibility
- EMP Environment Plan
- EPA Energy Purchase Agreement
- EPC Engineering Procurement Construction
- EPIA European Photovoltaic Industry Association
- EU European Union
- FDI Foreign Direct Investment
- FSR Feasibility Study Report
- GDP Gross Domestic Product
- GENCOs Generation Companies

GHG Green Gas

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- GIS Geographic Information System
- GoP Government of Pakistan
- GPS Global Positioning System
- GSM Global System for Mobile Communications
- GTZ/GIZ Deutsche Gesellschaft für Technische Zusammenarbeit
 - HCA Host Country Approval
 - HFCs Hydro Fluorocarbons
- HOMER Hybrid Optimization Model for Electric Renewables
 - HSE Health Safety and Environment
 - HSHD Hard Surface High Duty
 - Hz Hertz
 - IA Implementation Agreement
 - IDC Interest During Construction
 - IEA International Energy Agency
 - IEE Initial Environmental Examination
 - IEEE Institute of Electrical and Electronic Engineers
 - IFC International Finance Cooperation
 - IPPs Independent Power Producers

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- IRR Internal Rate of Return
- JEDI Jobs and Economic Development Impact
 - JI Joint Implementation
- JRC European Joint Research Centre
- Km Kilometer
- KV Kilovolt
- KW Kilowatt
- LIBOR London Interbank Offered Rate
- LNG Liquefied Natural Gas
- LNG Liquefied Natural Gas
- LOI Letter of Intent
- LOS Letter of Support
- LPG Liquefied Petroleum Gas
- LUC Local Control Unit
- m² Meter Square
- m³/h Meter cube per hour
- MEPCO Multan Electric Power Company

mm Millimeters

11.

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mmcft	Million Cubic Feet	
MoU	Memorandum of Understanding	
MTDF	Medium Term Development Framework	
MVA	Million Volt-Ampere	
MW	Megawatt	
N₂O	Nitrous Oxide	. e Arrendan
NAPWD	Northern Area Public Works Department	
NASA	National Aeronautics and Space Administration	
NCS	National Conservation Strategy	• •
NEC	National Energy Conservation	
NEPRA	National Electricity Power Regulatory Authority	
NEQs	National Environmental Quality Standards	
NGOs	Non-Government Organizations	
NOCs	No Objection Certificate	
NOCT	Nominal Operating Cell Temperature	
NREL	National Renewable Energy Laboratories	
NTDC	National Transmission and Dispatch Company	
0 & M	Operation & Management	

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- OECD Organization for Economic Cooperation and Development
- OEMs Original Equipment Manufacturer
- OHL Overhead Lines
- OLTC On-Load Tap Changer
- OM Operating Margin
- OPV Organic photovoltaic
- OSHA Occupational Safety and Health Administration
- PAEC Pakistan Atomic Energy Commission
- PAEC Pakistan Atomic Energy Commission
- PCM Pulse Code Modulation
- PCRET Pakistan Council of Renewable Energy and technology
- PDD Project Design Document
- PEPA Pakistan Environment Protection Act
- PINs Project Idea Note
- PLC Programmable Logic Control
- PMD Pakistan Meteorological Department
- POE Panel of Experts
- PPDB Punjab Power Development Board

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- PPIB Private Power Infrastructure Board
- PV Photo Voltaic
- PVC Poly Vinyl Carbonate
- QC Quality Control
- R & D Research and Development
- RE Renewable Energy
- RE2 Renewable Resources (Pvt) Ltd
- RFP Request for Proposal
- RFQ Request for Quotation
- **RMP** Risk Management of Project
- ROC Return on Capital
- ROE Return on Equity
- RQD Rock Quality Designation
- SECP Security Exchange of Pakistan
- SHYDO Sarhad Hydro Development Organization
 - SOP Standard Operating Procedure
 - SPT Standard Penetration Test
 - SRA Solar Resource Assessment

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;

- SRO Statutory Regulatory Order
- TGP Three Gorges Project
- TOE Tons Oil Equivalent
- tsf Tones/square foot
- TTG Trans Tech Group
- TTP Trans Tech Pakistan
- UNFCCC United Nations Framework Convention on Climate Change
 - UPS Uninterruptible Power Supply
 - USA United States of America
- WAPDA Water & Power Development Authority
 - WK Welt Konnect (Pvt) Ltd
- WMO World Metrological Organization

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The management of CWE Investment Corporation a fully owned subsidiary of China Three Gorges International Corporation & Welt Konnect (Pvt) Ltd comprising the Joint Venture would like to express their gratitude to the support and cooperation extended by the Government of Punjab in the development activities of the project.

We are also thankful to the dedicated team of the Punjab Power Development Board (PPDB) for the generous support throughout all stages of project development.

We hope for and look forward to the continued cooperation of all relevant Government Organizations, Bodies and officials for further advancement in implementing the Project and pioneering the way for Solar Photo Voltaic in Pakistan.

DISCLAIMERS

This document is intended for use by the Stake Holders and relevant Government Authorities for understanding and effective decision making regarding this Project.

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DOCUMENT INFORMATION

Purpose and Scope:

The purpose of this report is to provide information required for the relevant agencies to make informed decision regarding the implementation and execution of this project.

This document presents the technical, financial and commercial viability of this project within Pakistan's economic and regulatory framework.

STRUCTURE OF THE DOCUMENT:

The Feasibility Study has been divided into 2 main parts/volumes followed by supporting Volumes 3 to 7 composed of essential studies:

- Volume 1: is composed of the Executive Summary, Introduction and Overview of the Project along with the relevant regulatory framework and policies. Where as
- Volume 2: contains the Technical and Financial Studies: including Engineering Drawings and Plant 3D layout.
- Volume 3: is composed of the Geo-Technical Study Topographic Survey.
- Volume 4: is the Geo-Technical Investigation Report.
- Volume 5: is a compiled Environmental Study.
- Volume 6: contains all documents relevant to the Clean Development Mechanism of the UNFCCC.
- Volume 7: Grid Interconnection Study has been conducted and approved by National Transmission Dispatch Company (NTDC).

Each Volume is further sub-divided into chapters for ease of reviewing and understanding the project. Information in the document is supplemented by Annexures attached at the end of each volume.

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1 Executive Summary Of the Project

China Three Gorges (CTG) being a large international clean energy company, houses main businesses of including construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, initially starting with water conservancy & power projects, has now expanded its scope of business into Power Production through Wind, Solar and Nuclear Energy. Their vision is to be the World's largest clean energy group specializing in large-scale hydropower project development, management and operations; while also proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The Total assets of the Group stand around 41,316 million USD, with a revenue generation of 3,787 million USD, 99.47% from sales of electricity, and 1,418 million USD net profits.

Whereas China Water and Electric Investment Corp. (CTGI) is a new overseasinvestment subsidiary company of CTG, which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CWE Investment Corporation (CWEIC) has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CWEIC is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include Sonda Jehrruk Coal Mine & Power Generation, 1100 MW Kohala Hydropower Project, 720 MW Karot Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) is a Power Projects Developing company working in Pakistan. Its niche in the Energy Sector lies in the provision of Renewable Energy Engineering solutions particularly for Wind & Solar Power Projects as Independent Power Producers (IPP's) under the Clean Development Mechanism of the UNFCCC. These integrated solutions and systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in the ever growing and critical field of Renewable Energy.

In Accordance with their development strategies respectively, in 2009 after consultation with the Esteemed Punjab Government Welt Konnect (Pvt) Ltd (WK)

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and China Three Gorges (CTG), planned to invest in the development & construction of Pakistan's first 50 MW Solar PV Power Farm in Cholistan in collaboration as a Joint Venture. For development of which consequently two MOU's were signed with the Punjab Government (**Annexure 1**: MoU between WK, CWE and The Punjab Government) in the presence of the Honorable Chief Minister Mr. Shahbaz Sharif, dated June 5th 2010 and later November 6th 2010 after having chalked out a way forward. An MOU was also signed with GTZ for support on developing the project under the Clean Development Mechanism of the UNFCCC (**Annexure 2**: MoU between WK and GTZ)

Teams were then immediately deployed to initiate work on the feasibility analysis of the project, and at the same time to search for a suitable site. With the help of the Punjab Government, 4 sites- were short listed and identified in Cholistan, towards Southern Punjab with presence of the required minimum infrastructure, high irradiation levels and solar potential. After due scrutiny and deliberation by Experts over the sites; the 500 Acres strip of land located in (Chuk.No: 314 A Block No: 3, 4, 23, 24) approximately 3 to 4 Km away from the Marot Grid Station and about 50 km from Bahawalpur, the nearest urban city, was selected and finalized. The location enjoys a flat terrain with innocuous sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself a technically and logistically feasible location for the setup of a large solar power station.

However the process of selection & due allocation was delayed considerably due to the unfortunate flooding and ensuing humanitarian disaster in Pakistan during that period.

In parallel, a viable financial and economic model was developed for the project. Various financial institutions and carbon funding agencies were identified and engaged for the purpose. On the other hand search for suitable Solar PV equipment suppliers was initiated, with a special emphasis on quality of the products. Various technologies for Solar PV were considered, and the matter has been addressed in the feasibility study.

The project pre-feasibility study was completed by mid-2011. Subsequently after submission of the Pre-Qualification Documents, to the Punjab Power Development Board (PPDB) along with the Pre-Feasibility Report, Project Proposal, the required Bank Guarantees of 50'000.USD (fifty thousand) (**Annexure 4**: Bank guarantee) and the requisite fees, the Joint Venture (JV) successfully obtained an LOI (Letter of Intent) (**Annexure 3**: LOI) from the Board duly signed and accepted by both parties on 27-08-2011, along with Government Approvals and Support.

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The JV also filed for and received confirmation/Allocation Letter (Annexure 5: Allocation Letter issued by PPDB to the Joint Venture on 09th June 2011) from PPDB for the 500 Acres Project Site on 11-01-2012, after formulation of the requisite policy and procedure by PPDB for such sanctioning of land for Solar Power Projects. Under this framework a 5000 Acre piece of land was handed over by Cholistan Development Authority (CDA) to the Board of Revenue (BOR) which in turn placed it under the control of PPDB for allocation to deserving companies for development of such projects.

Immediately after the Selected Site with coordinates 29 10N (Latitude), 72 25 E (Longitude) which is approximately 4 KM away from the Grid Station was handed over to the JV, competent teams of Engineers & Specialists were deployed for conducting the Topographic Survey, Soil Testing and layout design activities, amongst other studies, which were successfully completed and compiled in the Feasibility Study Report, which was then submitted to PPDB with the stipulated time period for review by the Panel of Experts (POE).

Whereas the Complete Feasibility Study Report for the subject 50MW Solar PV Power Project was approved by the Panel of Experts (POE) of PPDB in its second meeting and notified vide Letter No. PPDB/05/2013, Dated 01/01/2013, Subject: Approval of 50MW Solar Power Project in Marot Cholistan Punjab (Annexure 6: feasibility study report approval by the panel of experts (POE) of PPDB notified vide letter no. ppdb/05/2013, dated 01/01/2013).

However due to the change and relocation of the Project Site to the Quaid- E-Azam Solar Park (QASP) at Lal Suhanara, Bahwalpur, to facilitate and make viable the Grid Interconnection of the subject project, the Feasibility Study Report (FSR) including all studies which had been conducted for development of the 50MW Solar PV Power Project on the previous project site of Marot Cholistan Desert Punjab, have now been re-conducted and updated to reflect such change and acquire all project related Approvals again.

The project site under the Vision of the Chief Minister of Punjab Mr. Shahbaz Sharif, has been shifted to the new location of the Quad-E-Azam Solar Park (QASP) near to Lal Sohanra, Cholistan, Bahawalpur which in total comprises dedicated land of 6,500 acres for the purposes of establishing Solar Power Generation Stations of approximately 1000 MW's.

The New Project Site allocated to the Joint Venture comprising Welt Konnect Pvt Ltd & CWEI is composed of 250 Acres piece of land as allocated by the Energy Department of the Government of Punjab, through its Letter No.S.O(C)(ED)4-5 2014, Dated: 13th February 2014, Subject: Allocation/Earmarking of Land for 50MW Solar Project in QA Solar Park Bahawalpur (**Annexure 7**: new project site allocation letter

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No.s.o(c)(ed)4-5 2014, dated: 13th February 2014). The Project is composed of Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354.

The updated studies reveal no environmental hazards related to the Project. The minor adjustments required during construction phase have been addressed and mitigation plan provided in Volume 5 Environmental Studies of the FSR. There are no settlements within 05-08 Km of the Project Site, which further supports the Project in this location.

Both the updated Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) were submitted to the competent authority of EPA Punjab for consideration, with all its concerns raised vide Letter No. DD (EIA)/EPA/F-362(IEE)/2013, dated 10/03/2014, answered in the documents which after its due diligence issued a No Objection Certificate (NOC)/Environmental Approval vide Letter No. DD(EIA)/EPA/F-362(IEE)/2012/0104/681, Dated 15/04/2014, Subject: Environmental Approval.

The Initial Environment Examination (IEE) & Environmental Impact Analysis (EIA) of the proposed project were conducted in accordance with the stipulations of Pakistan's environmental laws and the environmental guidelines of the International Finance Corporation (IFC).

Whereas NTDC which was hired in May 2012 to carry out the Grid Interconnection Study in order to propose the interconnection scheme for evacuation of power from the 50 MW Welt Konnect solar PV power plant to the system network, by the Joint Venture comprising Welt Konnect (Pvt) Ltd and CWEI through their Letter dated 9th May 2012, Subject: Interconnection study for 50 MW photovoltaic solar PV project in Cholistan, containing the Bank Draft No. DD 1875227 dated 04th May 2012 amounting to Rs. 1,500,000/- payable to General Manager (Services Division) NTDC, WAPDA on account of Interconnection studies for dispersal of power from the 50 MW generation project to the national grid, (Annexure 8: grid interconnection study correspondence with NTDC), after relocation of the Project to the QASP completed and submitted the draft final report of the grid interconnection study attached to its letter No. COO/GM/CPPA/CE-II/MT-IV/WKPL/2534-39, Dated 21st April 2014, Subject: Interconnection Study Report for Power Dispersal of 50MW PV Solar Project by M/s. Welt Konnect (Pvt) Ltd (Annexure 8: grid interconnection study correspondence with NTDC).

The results of extensive studies including load flow, short circuit, transient stability and power quality studies have been presented in the interconnection study of the subject 50 MW solar PV power plant. Whereas the adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect power

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plant and of the system network in its vicinity has been evaluated by NTDC in light of the Grid Code.

For the grid interconnection study, NTDC used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas M/s Welt Konnect provided the data of its power plant on data request from NTDC.

In addition the project has been developed under the Clean Development Mechanism (CDM) of the UNFCCC under the Kyoto Protocol. After successfully making and submitting the Project Idea Note (PINs) to the Designated National Authority (DNA), registration with the UNFCCC via Prior Consideration Form and issuance of a Letter Of Intent (LOI) from the DNA for further development of the Project Design Documents (PDD's), the PDD's were made and submitted to the DNA followed by the issuance of the final Host Country Approval (HCA) by the DNA, we are now in the phase of obtaining validation by the Designated Operational Entity (DOE) and issuance of CER's by the Executive Board of UNFCCC.

The Joint Venture is now submitting the final Updated Feasibility Study for approval by the Panel of Experts (POE) of the Punjab Power Development Board (PPDB). After sanctioning of which competent companies in the field of Solar Photovoltaic's will be selected through a Short Listing Criteria based on Experience, Financial And Technical Competencies of such firms in development & construction of Power Projects and Project Management, which shall be advertised in the News Papers & other relevant media. Consequently the Request for Proposal (RFP) shall be circulated and shared amongst the qualifying companies for finalization of the Engineering Procurement & Construction (EPC) Contract after which a petition for Generation License and a petition for tariff would simultaneously be filed with the National Electric Power Regulatory Authority (NEPRA) directly for the second stage tariff as per the directives of the Economic Coordination Committee (ECC) for Solar and Wind Power Projects and allowed under the NEPRA regulations, before issuance of the LOS (Letter Of support) by AEDB. This is intended to save time and cut through avoidable red tape in the development of Independent Power Producers in Pakistan.

The Joint Venture has also completed substantial work on the financial modeling for the project. The JV believes that keeping in view the recent improvement and trend in the viability of the technology, possibility of fast track implementation and current energy crises, this project is of paramount importance for Pakistan and will prove to be a pioneer in the Solar PV industry, paving the way for future progress in this ever growing field and at the same time provide a viable profitable investment opportunity to all stake holders of the country. Feasibility Report – Volume 1 50 MW Solar Power Project in Cholistan
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2 Introduction

As a large international clean energy company, China Three Gorges main businesses include: construction and management of water conservancy projects, electric power production and related relevant technological services. In the area of electric power production, CTG, starting with water conservancy projects, has now expanded the scope of its business into power generation through wind, solar and nuclear energy.

With the vision of being the World's largest clean energy group specializing in largescale hydropower development, project management and operations; proactively developing Wind Power, Solar Power and other forms of renewable energy; steadily expanding and exploring avenues of overseas business.

The company was founded in 1993 upon approval of the State Council with the mission of implementing the Three Gorges Project and developing hydropower resources in the upper Yangtze.

The China Three Gorges Project has a Total installed capacity amounting to 22,250MW, with Expected annual average power generation accounts up to 100 TWH. The Three Gorges Project (TGP) ranks the *biggest* one in terms of installed capacity. TGP electricity is unceasingly transmitted as far as 1,000 Km to Central China Grid, East China Grid, South China Grid, and Chongqing-Sichuan Grid

The Total assets of the Group are 41,316 million USD, with revenue of 3,787 million USD, 99.47% from sales of electricity, 1,418 million USD net profits.

Whereas China Water and Electric Investment Corp. (CWEIC) *is a new overseas-investment subsidiary company of CTG*, which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power. CWEIC has now officially taken over as main sponsor from China Water and Electric Corporation (CWE) in all projects previously being developed by CWE. CTGI is tracing on more than a dozen projects located in Asia, Africa, Europe, North America and South America. Some of the projects located in Pakistan include Sonda Jehrruk Coal Mine & Power Generation, 1100 MW Kohala Hydropower Project, 720 MW Karot

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Hydropower Project, 120MW Taunsa Hydro Power Project, 50MW Wind Energy and First 50 MW Solar PV Power Project in Pakistan.

Whereas the Trans Tech Group of Companies is a multipurpose engineering concern and actively engaged in various Civil Engineering, Railway, Telecommunication and Renewable Energy Projects in Pakistan since 1991. TTP is committed to professional excellence and is playing its due role in the national progress and development of Pakistan.

Trans Tech Group incorporates technical, ecological and economical optimization in its solutions and ensures an efficient and effective implementation of its projects. The man power resource pool of TTP consists of managers, engineers, planners, computer professionals, economists, support staff and skilled technicians.

The Group has been working in Pakistan for the past 25 years and has targeted a number of projects including but not limited to the Infrastructure Sector: namely Construction of Roads, Bridges and Motorways, and The Power Sector; including Hydro Projects, Coal Power Projects, and Wind Energy Projects, and is currently working with its valuable foreign partners in implementing large scale projects.

Whereas Welt Konnect Pvt. Ltd ("WK" or the "client") a subsidiary of the Transtech Group is a duly established company under the laws of Pakistan specializing in Power Project Development. Its niche in the Alternative Energy sector lies in the provision of Renewable Energy Engineering particularly Wind & Solar Projects as Independent Power Producers (IPP's), various commercial applications & CDM projects. These integrated systems are designed, simulated and tested by its team of experts and engineers' using the most advanced software's and tools the industry has to offer at this time. WK believes in doing top quality engineering works and takes immense pride in being one of the few companies in Pakistan to have achieved this level of competence in this ever growing field of Renewable Energy.

Jointly both valuable partners are developing the strategic 120MW Taunsa Hydro Power Project, the First 50MW Solar PV Power Project and Coal Mining & Power generation projects amongst other projects of national importance.

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Whereas MR Consultants ("MR" or "the Consultant") is an international consulting company that offers engineering consultancy services in the fields of energy, hydropower and transport since 1990.

Whereas CEEG SI (CEEG Solar Energy Research Institute Co., Ltd.) is comprehensive new energy system supplier with international advanced level which is founded by CEEG Group for wide application of worldwide solar & other new energy technology and great advancement for worldwide energy revolution. CEEG SI has a research team with abundant technical strength and work experience leaded by Zhizhang Liu who is the chief scientist on new energy application and Doctor Jianhua Zhao who keeps the world record (25%) in laboratory photoelectric conversion efficiency of P type silicon solar cell.

CEEG SI provides a complete set of system solutions of 9 new energy application areas, and gives the service about system research, design, consultation and construction which mainly focuses on photovoltaic system and also contains new energy relevant products (incl. photo-thermal, wind power generation, water conservancy, ground source heat pumps, biomass energy, and tidal energy). As earlier domestic system supplier who has paid great efforts to R&D and market promotion, CEEG SI undertakes and finish multiple project both national key technologies research and development program of china and international collaboration programs one after another.

CEEG SI has undertaken the first BIPV on-grid project in 4 provinces in China successfully, and it is the international training centre for solar application in developing country assigned by ministry of science and technology (MOST), the new energy workstation for Post doctor student in Jiangsu province, the managing unit for engineering center of module preparation and control system in Jiangsu province. CEEG SI has better popularity and influence both at home and abroad, and especially it gains more achievements in research and application of solar energy photovoltaic generating system.

After due diligence the Joint Venture awarded CEEG SI & MR Consultants the task to provide technical consultancy Services for conducting the Feasibility Study Report (FSR) in accordance with the requirements of the Letter of Intent (LOI) issued by Punjab Power Development Board (PPDB) under the 2006-2009 Punjab Power Policy

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coupled with an energy yield assessment for the PV Plant of 50MW, located in the region of Bahawalpur in the province of Punjab Pakistan. This report describes the results of the Feasibility Study performed for the 50MW PV Plant on the site (29° 17.650' N, 71° 49.196' E). The study also investigated solar power technology options that were appropriate for a large scale solar power facility in the Quaid-E-Azam Solar Park, Punjab and the economic viability of such a solar power facility

The plant consists of a rammed fixed mounted system with an installed module capacity of **50266 kWp** using Multi and Mono-crystalline Q-Cells module QC-C05 and 56 SMA Sunny Central inverters SMA SC 800 CP with a total AC capacity of 49,280 kVA.

The Project Layout has been designed to utilize 28 of "1.6 MW Inverter" combined units of two SMA 800 CP Series Inverters (Actual power output at test conditions is 1.76 MW for each unit) which are further connected to 28 SMA Low to Medium range voltage transformers at approximately 360V AC, one for each 1.6 MW unit respectively giving an output between 11 to 20KV range, leading finally to the switch gear or transformer from medium to high voltage range for connection to the Grid Station at 132KV. Each unit of 1.6 MW will consist of 7480 panels, 2 inverters and 1 transformer.

A string concept is being used with 22 modules connected to a string, and 17 strings connected on a Bus leading to the SMA Inverters connection in parallel with a total of 10 such connections. The total number of PV modules used in this arrangement would be 3470 units per 1.6 MW with a total of approximately 28 such units for the complete 50 MW setup.

The FSR also includes an introduction to the Country's Power Sector followed by an Analysis of the legal framework for ease of understanding the procedures and development steps to be taken ahead.

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climatic conditions, shading situation, inverter failures, used PV technology and inverter type, external cabling and grid connection losses.

- Determination of expected losses, performance ratio (PR) and long-term performance taking into account module degradation;
- Uncertainty analysis of the simulation and the PV plant energy production assessment;
- Probability analysis of variances above the determined uncertainties concerning the amount of energy produced;
- If necessary, suggestions for improvement of the layout in order to improve the yield, the accuracy or mitigate the risks;
- Statement on the durability of the main equipment (modules, inverters and mounting structure)
- Description of technical equipment and Plant layout studies.
- Economic & Financial Analysis in concurrence with the prevailing industry regulations, standards and the National Electric Power Regulatory Authorities (NEPRA) policy regarding tariff determination
- Efficient Operation & maintenance studies with efficient Project management throughout
- Ecological lifecycle calculations & Ecological footprint, Environment Studies including IEE and EIA
- Socio-economic effects
- Geo-Technical Studies including Topographic Survey and Soil Testing
- Complete Clean Development Mechanism activities including development of PIN's, PDD's, Prior Consideration Form, and Evalutation Matrix

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2.2 Background of Study

In view of the accelerated development of new markets for large scale solar power generation around the World and specifically in the so called "Sun-Belt" countries, of which Pakistan happens to be a very prominent member with veny high irradiation levels; the JV aims at the identification and development of such large scale Solar PV Power Projects through collaboration with the concerned relevant boards and bodies through a structured approach and vision.

The "sunbelt" region is described as the region between 35N to 35S, encompassing 148 countries globally including Pakistan, as can be seen in Figure 2.2.1:



Source, Wind Pack, MP, & T. Kearney analysis

Figure 2.2.1: Sun Belt Countries Analysis

With Photovoltaic (PV) development booming globally the time seems just right for investment in the sector. More than 7,000 MW was added to the global generation base in 2009 alone; expanding the cumulated installed base well over 22 GW. Since then, there have been years of vigorous growth of the world-wide PV market, even during times of financial and economic crisis. Revisiting 2011 and now the early part of 2012 we see further growth and emphasis on the sector in emerging markets by Governments and the Private Sector alike. The volume of new grid-connected PV capacities world-wide rose from 16.6 GW in 2010 to 27.7 GW in 2011. Almost 21 GW of this growth can be accounted in Europe.

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This somewhat paradoxically shows that the growth so far has mainly been driven by countries outside the world's Sunbelt; whereas by taking the initiative and focusing on the Sunbelt Countries, the growth of PV could be exponentially accelerated by tapping in to this huge natural resource. This phenomenon of unbalanced growth is further explained by the figure below:





It can clearly been seen that out of the top 10 PV markets of the world most are not as favorable in terms of PV potential but still have shown tremendous growth even through an era where skepticism over the affordability of the Solar Resource was high and financial crises had plagued several major global economies. It is further shown in Figure 2.2.2 that out of the total worldwide electricity demand of 17'900 TWh, 39% lies in the Sunbelt region whereas Cumulative Installed PV Capacity of the Sunbelt region is only 9% compared to 91% in non-Sunbelt countries. This shows the colossal latent opportunity for growth and investments in the PV sector in these areas.

Investing and tapping this huge naturally abundant resource would bring enormous benefits to the Sunbelt countries as summarized in Figure 2.2.3. The electricity grid may be decentralized, line losses reduced, and generation may be where it is needed rather than where it is available as is the case with other technologies and resources. PV can further contribute significantly to cover the dynamically increasing electricity demand of these growing economies in the shortest possible time, by

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harnessing low-carbon, free energy solar resource therefore decreasing dependencies on (imported) fossil fuels (one of the major reasons for trade deficits of most of these economies), reducing pressures on water use and improving the carbon balance.

ENERGY CHALLENGES FOR SUNBELT COUNTRIES

Electricity consumption forecast to grow by 150% within the next 20 years in Sunbelt countries

Electricity infrastructure is often poor and 1.5 billion people have no access to electricity which nampers economic and spois: development

Many countries have a high dependency on moonted fuels for electricity generation

Large investments in generation and system infrastructure are needed to meet surging aloctricity demand

Proside on Sunber countries to increase cover generation while keeping CO, chrospons and other environmental impacts to a migratimum.

en finde en de service de la cleater de array array.

KEY BENEFITS OF PV ADDRESSING THESE CHALLENGES

PV taos into unlimited indigenous energy supply and can make a sizeable contribution to meet rising power demand.

FV generales power cicae to consumption, thus supporting strained grids or enabling local miningrids. It can be combined well with other renewable or conventions, technologies. PV can thus appelerate electrification and stimulate economic activity, while reducing import reliance.

High madiation evels make FV stready competitive compared to desctilgenerators, in the future, FV will be highly competitive to all strengtives. Directing investment into FV new provides a long term source of energy with low operations post and enables correction industry build up

PV is a low carbon technology and has an renergy packback" (melof 10-20 months). It doesn't need water to operate and has no adverse impacts on toosi ar quelity.

Figure 2.2.3: Benefits of PV for Sunbelt Countries

Amongst the Sunbelt countries we see Pakistan as a member with one of the highest PV Resource Potential with high average irradiation levels of almost 5.8 KWh/m² across the country but rather low installed capacity so far for a number of reasons effecting the region in the recent past; which include socio-political, financial and technical reasons coupled with the humanitarian disasters ensuing the country every couple of years.

However the opportunity for progress is immense, courtesy of the correct & appropriate environment which has now been developed through Government Support and Policy Emphasis on renewable energy, in face of the acute power shortage of almost 5000 to 6000 MW annually. The capacity for understanding the sector has also been on a constant rise which has further contributed to the sectors growth in Pakistan. Figure 2.2.4 shows how the country has been positioned in the past amongst other Sunbelt members.



Located on the western stretch of the South Asian Continent, Islamic Republic of Pakistan is largely under the influence of tropical desert climate with high global irradiation levels. Solar energy has excellent potential in most areas of Pakistan that receive high levels of solar radiation throughout the year. Every day, the country receives an average of about 19 Mega Joules per square meter of solar energy



Map 2.2.1: Pakistan Global Solar Irradiation Map

Pakistan covers 796,095 square kilometers of land between latitudes 24° and 36° north and longitudes 61° and 76° east. At present, it faces serious energy problems: majority of its electricity generation comes from hydropower, which becomes less productive during the driest, hottest months of the year and cannot keep pace with the sharp rise in energy demand.

The relative shortage of conventional energy resources in Pakistan, when coupled with the hiking energy prices worldwide, leads to a tension in the power supply of the country, it has become a top agenda of Pakistan government to find alternative energies, including solar power.

Also, about 70 per cent of the population lives in some 50,000 villages dispersed around the country. Many of these villages are far from the main transmission lines of the national grid and, because of their relatively small populations; it is usually not economically viable to connect these villages to the grid, however decentralized or networks could be developed on Solar Energy to power these areas, which provides an opportunity for micro-grid applications as well.

Government of Pakistan has formulated a policy to standardize and encourage the participation of private sector in the development and application of renewable energies. A Federal Government organization called Alternative Energy

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Development Board (AEDB) and respective Provincial Power Boards including the competent and highly esteemed Punjab Power Development Board (PPDB) have been established to facilitate the implementation of renewable energy projects. PPDB has been given a mandate, requisite resources and target to facilitate development of a number of Solar PV Power projects in Cholistan Desert, Bahawalpur District, Punjab Province.

Since the 18th Amendment to the Constitution of Pakistan, and the Powers vested to Provinces under article 157 Point 2(a) to 2(d), the Provincial bodies such as PPDB are now working actively and aggressively to ensure fast track development of Power Projects in their particular domains.

Keeping the above in view the Joint Venture comprising China Three Gorges International Corp. (CTGI) a new overseas-investment subsidiary company of CTG, which was established in Sep. 2011 with the core business and focus on OVERSEAS INVESTMENT in the Power Sector including but not limited to hydropower, wind power and solar power and Welt Konnect (Pvt) Ltd (a subsidiary of the Transtech Group) which is a Power Projects Developing company working in Pakistan jointly therefore have now opted to invest in the Solar PV Power Project of 50 MW installed capacity. The current Project Site is located within the Quaid-E-Azam Solar Park, at Lal Suhanara, Bahawalpur, Punjab and is composed of 250 Acres of land comprising Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354, about 18 km from Bahawalpur City Center, the nearest urban center. The locality enjoys a flat terrain, scarce plant cover, rich solar radiation, and availability of large area suitable for project expansion, accessibility and proximity to medium voltage transmission network, thus rendering itself an appropriate location for large Solar PV power stations.



Both CTGI and Welt Konnect (Pvt) Ltd have been following closely the Solar Power sector of Pakistan since 2005, and in 2009 registered as a member of PPDB and in the same year obtained a preliminary qualification for solar power development. Consequently CTGI and Welt Konnect (Pvt) Ltd jointly began development of the 50 MW Solar PV project in Cholistan Desert, with an intention to further enhance and

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develop a total of 200MW with support of the Punjab Government, in light and spirit of the MOU signed in the presence of the Honorable Chief Minister Mr. Shahbaz Sharif, dated June 5th 2010 and later November 6th 2010, provided in **Annexure 1:** MoU between WK, CWE and the Punjab Government on 06th Nov 2010".

The project was conceived in 2009 and by April 2010, the pre-feasibility study for the project was completed.

A MoU between Welt Konnect and the Punjab Government was signed on the 5th of June, 2010. At the same time a MoU was signed with GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit) for facilitation in incorporation of the Carbon Development Mechanism for the project, and to provide assistance in other technical aspects of the project provided in **Appendix 2**: MoU between WK and GIZ on 16th June 2010"

PPDB also issued a letter of interest for said 50 MW Solar PV Power developments (LOI) to the consortium in 2011 (given in **Annexure 3**: LOI issues by PPDB to CTGI and WK on 09th June 2011); and in January 2012, PPDB allocated the project site of 500 Acres.

To stimulate this development, the government has passed a number of Fiscal Incentives for the Promotion of Renewable Energy which provides tax and customs duties exemptions for projects based on renewable energies.

The 50 MW Solar PV Power project benefits include avoided fossil fuel costs and emissions reductions from the displaced conventional power generation, and the economic analysis based on the guaranteed 17% Internal Rate of Return demonstrates that the project is beneficial to the investors and project developers. The Levelized cost of Energy comes out to be about **18.4568** cents per KWh.

PV Mono Crystalline Cells have been selected as the preferred technology as the prices of various cell types have been converging and the use of slightly cheaper thin film technologies such as amorphous Silicon (a-Si) or Cadmium Telluride with a-Si would be requiring about 80% more land and at lower efficiency and hence off setting whatever cost benefit which was to be gained in the past. The Summary of the design layout is provided below in Figure 2.2.5.

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	Grid-Connected S	ystem: Main results	
Project :	Cholistan 19-sep		
Simulation variant :	19-Sep Nasa		
Main system parameters PV Field Orientation PV modules PV Array Inverter Inverter pack User's needs	System type tilt Model Nb. of modules Model Nb. of units Unlimited load (grid)	Grid-Connected 29° azimuth SW 240 Mono Pnom 209440 Pnom total Sunny Central 800CP Pnom 56.0 Pnom total	0° 240 Wp 50266 kWp 880 kW ac 49280 kW ac

Figure 2.2.5: Plant Design Summary

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2.3 Project overview

The Project Site is located near the Cholistan Desert, District Bhawalnagar, with nearest city of Bahawalpur; with is one of the oldest cities of the region with a very rich historical heritage. The direct distance between the Project Site and Main Bahawalpur City is about 17.5km. Detailed information on the Cholistan Desert and Bahawalpur City can be found in **Annexure 9**: General Site information, however relevant and concise information is provided below.

You will also find in **Annexure 10:** Report on Cholistan visit for Solar Power Project Site Selection; the Executive Summary Report on the Site Selection in Cholistan with a list of short listed sites with a few pictures.

Whereas in **Annexure 11** you will find the survey report for selection of land in the Quaid-E-Azam Solar Park.

Cholistan Desert sprawls thirty kilometers from Bahawalpur, Punjab, Pakistan and covers an area of 26,300 km². It adjoins the Thar Desert extending over to Sindh and into India.

The word Cholistan is derived from the Turkish word Chol, which means Desert. Cholistan thus means Land of the Desert. The people of Cholistan lead a seminomadic life, moving from one place to another in search of water and fodder for their animals. The dry bed of the Hakra River runs through the area, along which many settlements of the Indus Valley Civilization have been found.

The Desert also has an Annual Jeep Rally, known as Cholistan Desert Jeep Rally. It is the biggest motor sports event in Pakistan

Bahawalpur located in Punjab, is the twelfth largest city in Pakistan. The city was once the capital of the former princely state of Bahawalpur. The city was home to various Nawabs (rulers) and counted as part of the Rajputana states (now Rajasthan, India). The city is known for its famous palaces such as the Noor Mahal, Sadiq Ghar Palace, and Darbar Mahal, as well as the ancient fort of Derawar in the Cholistan Desert bordering India. The city is located near the historical and ancient cities of Uch and Harappa, which were once a stronghold of the Delhi Sultanate and Indus Valley Civilization. The city is home to one of the few natural safari parks in Pakistan, Lal Suhanra National Park.

In 2007, the city's population was recorded to have risen to 798,509 from 403,408 in 1998. Punjabi and Saraiki are the major languages of local people, while Urdu is well

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understood and English is the official languages used in various educational and government institutions. Bahawalpur is located south of the Sutlej River and lies in the Cholistan region near the Thar Desert. It is situated 90 km from Multan, 420 km from Lahore, and 270 km from Faisalabad.

The main crops for which Bahawalpur is recognized are cotton, sugarcane, wheat, sunflower seeds, rape/mustard seed and rice. Bahawalpur mangoes, citrus, dates and guavas are some of the fruits exported out of the country. Vegetables include onions, tomatoes, cauliflower, potatoes and carrots. Being an expanding industrial city, the government has revolutionized and liberalized various markets, allowing the caustic soda, cotton ginning and pressing, flour mills, fruit juices, general engineering, iron and steel re-rolling mills, looms, oil mills, poultry feed, sugar, textile spinning, textile weaving, vegetable ghee and cooking oil industries to flourish.

Geography and climate: The city, which lies just south of the Sutlej River, is the site of the Adamwahan Empress Bridge, the only railway bridge over the Sutlej in Pakistan. It is situated 90 km from Multan, 420 km from Lahore, 122 km from Burewala, 90 km from Vehari, 270 km from Faisalabad and about 700 km from the national capital, Islamabad. The west region of the city is called the Sindh. It is a fertile alluvial tract in the Sutlej River valley that is irrigated by floodwaters, planted with groves of date palm trees, and thickly populated forests. The chief crops are wheat, gram, cotton, sugarcane, and dates. Mango Sheep and cattle are raised for export of wool and hides. East of Bahawalpur is the Pat, or Bar, a tract of land considerably higher than the adjoining valley. It is chiefly desert irrigated by the Sutlej inundation canals and yields crops of wheat, cotton, and sugarcane. Farther east, the Cholistan, is a barren desert tract, bounded on the north and west by the Hakra depression with mound ruins of old settlements along its high banks; it is still inhabited by nomads.

The climate is mainly hot and dry. In the summer the temperature reaches the high forties (Celsius) during the day and the nights are slightly cooler. Since the city is located in a desert environment there is little rainfall. Weather conditions reach extremes in both summer and winter. The average temperature in summer is 33 °C (91 °F) and 18 °C (64 °F) in winter. The average rainfall is 20 to 25 mm annually. (Kindly note all readings mentioned above are averages)

Demographics: Bahawalpur is one of the largest districts of Pakistan covering an area of 24,830 km². It has peculiar demographic, topographic and geographical characteristics. The district is situated almost in the center of the country at an elevation of 152 meters from the sea levels. The population of Bahawalpur district increased from 1.453 million in 1981 to 2.411 million in 1998, showing a growth rate of 3.88% per year and population density has increased from 59 in 1981 to 97 in

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1998. The majority of Bahawalpur's residents speak Punjabi and Saraiki, while Urdu, and English are common languages used in various educational and government institutions

Transport: Bahawalpur is well connected with various cities in Pakistan. The city has its own airport built by the Dubai Civil Aviation Department and the CAA. Bahawalpur Airport links the city with various Pakistani cities such as Dera Ghazi Khan, Islamabad, Karachi and Lahore with the national flag carrier, Pakistan International Airlines. The airline has launched international flights to Dubai, and plans to introduce more international destinations. There are daily trains and bus services from Multan, Lahore, Sukkur and Karachi to Bahawalpur, taxicabs and rickshaws are plentiful in the city. Cars are also available for hire in the city.

The distance between Project Site and the border between Pakistan and India is between 100 to 150Km. The Project covers an area of **250 Acres which is equivalent to 1.01171 Square Kilometers**. The latitudes and longitudes are provided in a table below. The altitude is 150m above sea level. The monsoon from the Indian Ocean, which is stable in its direction and high in its quality, brings rich wind energy resource to the Site.

The installed capacity of the Project is planned to be 50 MW. The geographical location of the project is shown in Map 2.3.1





Map 2.3.1: Regional Map showing Project Site in District Bhawalpur, Punjab

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Table 2.3.1: Geographical Coordinates of Project Site

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The electric grid selected for connection with the PV power plant is the Marot Grid Station due to a number of factors. Connection to this grid station is most feasible as per initial surveys and research. The grid station has the required capacity (and is going up-gradation) for receiving and distributing maximum load from the PV Power station. Operators at grid station have also demonstrated their confidence in being able to forecast required information.

The grid station falls under the Multan Electric Power Company's (MEPCO) authority with which an initial round of meetings has already been conducted. The geographical details of the grid station are mentioned below:

Latitude:	N029 17.650
Longitude:	E071 4 <u>9.1</u> 96
Distance (from site):	3.2 to 4.5 Km



Map 2.3.3: Satellite Map of Project Site showing Grid Station

The Project shall have an installed capacity of 50.26 MW. There shall be a substation of 132KV, which shall dispatch electricity to MEPCO Grid through their station at Marot, which is to the North of the Site which would be between 3.2 to 4.5 Km's from the Power Station depending on where the switch gear is finally positioned on the project site.

The Project Site is connected to Bahawalpur through good quality metal road capable of handling high loads and Bahawalpur is connected to all major cities of the country via network of Roads and Highways, providing a good facility for transportation of equipment.



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2.3.1 Project Size

The Project will install 209,440 Solar PV Modules of 240 Wp each, totaling 50.26MWp approx., covering an area of almost 1000 Meters square (250 acres), as shown below in Figure 2.3.1.1

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	Grid-Connected S	ystem: Main results	
Project :	Cholistan 19-sep		
Simulation variant :	19-Sep Nasa		
Main system parameters	System type	Grid-Connected	
PV Field Orientation	tilt	29° azir	nuth 0°
PV modules	Model	SW 240 Mono P	nom 240 Wp
PV Array	Nb. of modules	209440 Pnom	total 50266 kWp
Inverter	Model	Sunny Central 800CP P	nom 880 kW ac
Inverter pack	Nb. of units	56.0 Prom	lotal 49280 kW ac
User's needs	Unlimited loads(orid)		

Figure 2.3.1.1: Plant Design Summary

2.3.2 Project Status and Calendar

The project has successfully achieved a number of milestones as outlined in the Executive Summary and Background of the Study provided above, and now the Comprehensive Feasibility Study Report is being submitted from here onwards for approval of feasibility and all its parts from the concerned stakeholders / Panel of Experts of the Punjab Power Development Board (PPDB). In parallel, the Project shall also pursue and continue work on determination of tariff and signing of EPA/ IA.

All factors have been taken into account during the preparation of this Feasibility Study including the Project Site Location, natural resources, environment and construction of this Solar Power farm along with the local government's plans for social and economic development as well as requirements for the exploitation and use of Solar Power by the Federal and Provincial Governments of Pakistan.

The following time line in Fig. 2.3.2.1 has been estimated till the Commercial Operation Date (COD) of the project which includes all major milestones and activities which need to be undertaken.

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			APPROVAL COMMENTS ON EPA & IA 🦻	OF FSR BY PPOB
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Table 2.3.2.1 Project Planned Milestones

2.3.3 Geological Conditions

The site selected lies in the vicinity of the Cholistan desert and has been selected due to favorable conditions for a Solar PV Power plant in regards to the available infrastructure, microclimate effects, risks of natural hazards, geographical advantages, presence of distribution network for power and Geological conditions. The site map and coordinates of the site have been shown in **Figure 2.3.3.1** and **Figure 2.3.32** respectively.



The Project Site encompasses an area of 250 Acres (Square No: 1,2,3,4,5,6,7,8,9 & 10 of the Main Block 354 in the Quad-E-Azam Solar Park at Lal Suhanra, Bahawalpur, Punjab) which is approximately 2 to 3 Km away from the nearest Grid Station and

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about 17.5 km from Bahawalpur (the nearest urban city). The location enjoys a flat terrain with sand dunes in the peripheral, scarce plant cover, rich solar irradiation, availability of water, nearby Government Guest houses and immediate access to the power grid at about 4km, thus rendering itself an appropriate location for the setup of a large solar power station

The subsurface stratum at the site consists of sandy silty clay and similar results were found to the maximum explored depth of 5m (16.4ft). Geological (Solid Earth) characteristics of the site are also affected by the microclimate factors of the area. Bahawalpur and nearby area are characterized by low and sporadic rain. Therefore aridity is the most striking feature of the Bahawalpur with wet and dry years occurring in clusters. Bahawalpur is one of the hottest regions of Pakistan.

Bahawalpur has very low propensity towards natural disasters or similar risks. Till date the nearest area to Bahawalpur which has faced the effects of a flood is Bahawalpur and only once in our history. Cholistan and nearby areas for a significant radius are not prone to earth quakes (as per past records). Similar studies support the selection of the site as a safe geographical location for operations of a solar power project. Figure 2.3.3.3 and Figure 2.3.3.4 show hazard maps of Pakistan.



Figure 2.3.3.3: Shows the Flood hazard map of Pakistan

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Figure 2.3.3.4: Shows the Natural Hazard map of Pakistan

The site is facilitated with a very favorable level of water table, less tan 20m below ground level. The project team would drill bores to gain access to this water table and its supply. Simultaneously for initial work scope, there are existing wells within approachable distance which are being used by local habitants for their livestock.

The land acquired by the Joint Venture consists primarily of flat ground and sand dunes. Construction of the solar farm will be focused on the flat areas. Scant vegetation (shrubs and bushes) is found in these areas causing no troubles regarding shading.

2.3.4 Solar Resource Assessment

The SRA equipment installed at site has been manufactured by NRG, Vermont with Data Logger Model # 4941 (Fig. 10.3.5 NRG Data Logger Installed and Connected). The Solar Resource Assessment System; NRG Systems SymphoniePLUS3[™] data logger, iPackGPS communications modules (GSM, CDMA, and Satellite), SDR software, meteorological tower components, and reliable sensors from NRG Systems is designed for the professional solar PV developer looking for quick and repeatable deployment, easy and autonomous off grid operation, and bankable data. The system is comprised of proven products including the NRG Systems SymphoniePLUS3[™] data logger, iPackGPS communications modules (GSM, CDMA,

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and Satellite), SDR software, meteorological tower components, and reliable sensors. NRG Systems resource assessment equipment is currently used on all continents and across 145 countries.

The complete region of Pakistan falls in the "sunbelt" region of the globe. The rise in interest of international PV industry in the region is due to its geographical location on the whole and the natural advantages as compared to other regions. As per NREL solar resource maps (Fig 10.1.1 Solar resource map for Pakistan), average solar irradiation in Pakistan varies from 3.5 - 7 kWh/m2 per day while Germany witnesses a variation of 2.5 - 3.2 kWh/m2.



Figure 2.3.4.1: Solar Radiation Map of Pakistan

As can be clearly seen from Fig 2.3.4.1, the greatest amount of solar radiation after parts of Balochistan is in the southern part of Punjab. The daily radiation levels at the project site vary between $4.6 - 7.00 \text{ kWh/m}^2/\text{day}$ and average at 5.53 kWh/m²/day.

2.3.5 Solar Power Plant Equipment and Energy Yield Estimate

PV Modules

The modules used in the Feasibility Study have been selected after stringent analysis of technologies in the market. The product to be used is SW 240 Mono which is a

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240 W solar panel manufactured by Solar World. The technology used in these panels is Mono-Crystalline silicone. It has the following specifications:

	STC*	NOTC**
P _{max}	240Wp	175.4
		Wp
V _{mpp}	30.6 V	27.9 V
Impp	7.87 A	6.30 A

Table 2.3.5.1: Specifications of PV Modules

- Test conditions according to UL1703
- ** Performance at 800 W/m², NOCT (Nominal Operating Cell Temperature)

The total number of modules used is 209,440 units creating nominal power of 50.26 MW.

Inverters

The basic function of inverters is to convert DC electricity generated by the PV array into AC electricity. The inverter selected is the SC 800-CP model manufactured at SMA Solar Technology. The power rating of these inverters is at 800W at 50 °C and 880W at 25 °C. The specification of the inverter is as follows:

	Input (DC)	Output (AC)
P _{max}	89 8 kW	898 kW
Voltage Range	583 V - 820 V	324 V – 396 V
@ 50 °C	(620V Rated)	(360V Rated)
I _{max}	1400 A	1411 A

Table 2.3.5.2: Specifications of Inverter

The modules are to be connected to the inverters in a sub-array concept. A string consists of 22 panels. 17 of these strings constitute a single connection. 10 such connections are connected to a single inverter. Therefore the total number of strings connected to an inverter is 170. The total number of inverters utilized is 56 units. The inverters are planted in close vicinity of the PV array

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Transformers

A medium voltage transformer is used to step-up the voltage from 360V to 11 kV. The transformer used is the TSC 1000SC model also manufactured by SMA Solar Technology. The specifications are as follows:

	Medium-Voltage	Low-Voltage
Prated	1760 kVA	_
Voltage Range	10 kV – 33 kV	360 V
@ 50 °C	(20 kV Rated)	
Imax	46.2 A	2 x 1283 A

Table 2.3.5.3: Specifications of Transformer

2 inverters could be connected to a single transformer. A total of 28 such transformers would be planted in close vicinity to the inverters. The transformers used in this layout are supplied by the manufacturers of the inverters thus allowing for optimum performance.

The output lines carry medium voltage electricity to specially constructed switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline. It has an input range from 10 kV to 33kV. The specifications are as follows:

Model:	SFZ9-60000/11/132 STEP UP TRANSFORMER
Input Voltage:	11 kV ~~~
Output Voltage:	132 kV
Capacity:	60000 kVA

Computer generated simulations of the layout showed that the annual system production is 76,037 MWh/yr at an average of 208.8 MWh/day.

All the equipment complies with international standards set by the IEC. The equipment also comes with certificates that guarantee performance at temperature extremes varying from -10 °C to 50 °C and under sand dust conditions.

2.3.6 Design of Electrical Engineering

The Project has an Installed capacity of 50.26 MW, with 209,440 solar modules installed. The module to be used for power generation is the "SW240 Mono Model" which is a 240 W solar panel manufactured by Solar World, using Mono-crystalline silicon. The output lines carry medium voltage electricity to specially constructed

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switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline.

Electrical designing of the plant has been done in view of recommendations and best practices of running Solar Power PV plants in the world. To prevent the design and installation issues discussed in research reports, system engineers have ensured that all components such as over current devices, fuses, and disconnect switches are dc rated. Metallic enclosures, junction boxes, disconnect switches, and equipment used in the entire solar power system, which could be accidentally energized are required to be grounded. NEC Articles 690, 250, and 720 describe specific grounding requirements. Equipment grounding conductors similar to regular wires are required to provide 25 percent extra ground current-carrying capacity and are sized by multiplying the calculated ground_current value by 125 percent. The conductors must also be oversized for voltage drops as defined in NEC Article 250.122(B).

The modules are to be connected to the inverters in a sub-array concept. A string consists of 22 panels. 17 of these strings constitute a single connection. 10 such connections are connected to a single inverter. Therefore the total number of strings connected to an inverter is 170. The total number of inverters utilized is 56 units. The inverters are planted in close vicinity of the PV array.

A medium voltage transformer is used to step-up the voltage from 360V to 11 kV. 2 inverters could be connected to a single transformer. A total of 28 such transformers would be planted in close vicinity to the inverters. The transformers used in this layout are supplied by the manufacturers of the inverters thus allowing for optimum performance. The output lines carry medium voltage electricity to specially constructed switchgear which steps up the voltage from 11 kV to 132 kV and feeds the electricity to the gridline. Computer generated simulations of the layout showed that the annual system production is 76,037 MWh/yr at an average of 208 MWh/day.

2.3.7 Design of Civil Works

Prior to any construction activity, the site must be cleared of all debris and surface vegetation if any. The leveling and grading can be carried out by normal earth moving machine. It is recommended that immediately after excavation for construction of foundation or other substructures, the excavation bottoms and slopes are cleared of all debris, proof rolled and covered by a 5 cm thick blinding concrete layer. The onsite material is generally classified as SANDY SILTY CLAY (CL-ML) group of Unified Soil Classification System. Select fill material should consist only of inorganic material and shall have 5-20% passing the No. 200 sieve. Fill material should pass 100% the 50 mm sieve. Besides, that portion of material

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passing sieve No. 40 should not have liquid limit more than 35 and plasticity index of not more than 12. Atterberg limits are not required for select fill material with less than 15% passing sieve No. 200. Select fill material shall have a carbonate content of less than 25% by weight.

The main construction activities of the Project are the foundations of the 132kV substation and the mountings for the PV modules. Detailed topographic analyses of the project site were conducted after which a structural design of the mountings was developed. Details of these designs have been provided in **Section 12**. The units have been designed to ensure easy site installations.

The inverters and medium voltage transformers provided by SMA are housed in compact and weatherproof enclosures ready for immediate outdoor set-up in close vicinity to the PV arrays.

In order to be safe, the load carrying strata must be competent to sustain the imposed loading without undergoing shear failure, and at the same time settlements of the foundations must not exceed the tolerable limits. Therefore, the load carrying characteristics of the strata must be evaluated keeping in view these two considerations. As per the information provided by the consultant, a foundation for solar panel is to be constructed at the site. Based on the type of structure, envisaged loading, type of subsurface strata and engineering analysis carried out, shallow foundation could be adopted for the intended structure. For the intended structure we recommend adopting isolated/strip footings with an allo wable bearing pressure of 150 kN/m² (1.50tsf). Depth of foundations have been taken as 1.0m (3.28ft) below the existing investigated level which was already excavated up to 5ft from existing ground level.

2.3.8 Fire Fighting Management

In general, small-size solar power system wiring projects, such as residential installations commonly undertaken by licensed electricians and contractors who are not trained in life safety installation procedures; do not represent a major concern. However, large installations where solar power produced by photovoltaic arrays generates several hundred volts of dc power require exceptional design and installation measures.

A complete SOP for the firefighting management will be prepared duping the Procurement and construction phases, in light of the guidelines given by OEMs and the structuring of the Power Plant. The decision is based on a brief introduction to "Fire Fighting Management in Solar Power Systems, by The Fire Protection Research Foundation"

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Certain basic safety precautions should be taken into account by all fire fighters on the fire ground. Determining the presence of a PV system is the key to preventing fire ground injuries. The following six points of safe operation are offered for fire fighters:

- Daytime = Danger;
- Nighttime = No Hazard
- Inform the IC that a PV system is present
- Securing the main electrical does not shut down the PV modules
- At night apparatus-mounted scene lighting does not produce enough light to generate an electrical hazard in the PV system
- Cover all PV modules with 100 percent light-blocking materials to stop electrical generation
- Do not break, remove, or walk on PV modules, and stay away from modules, components, and conduit

A photovoltaic array will always generate electricity when the sun shines. These units do not turn "off" like conventional electrical equipment. Fire fighters on the fire ground should always treat all wiring and components as energized. Breaking or compromising a photovoltaic module is extremely dangerous and could immediately release all the electrical energy in the system.

Without light, photovoltaic panels do not generate electricity, and thus nighttime operations provide an inherent level of safety. Emergency scene lighting during a nighttime fire ground operation, such as from a mobile lighting plant unit, are not bright enough for the photovoltaic system to generate a dangerous level of electricity. Light from a full moon, which is reflected light, also will not energize the photovoltaic cells. However, lightning is bright enough to create a temporary surge of electrical current.

In summary, there are several fundamental points of consideration for fire fighters and incident commanders when handling any building fire equipped with a solar power system:

- Identify the existence of a solar power system
- locate rooftop panels
- clarify electrical disconnects
- obtain system information
- Identify the type of solar power system
- Solar Thermal System
- Photovoltaic System
- Isolate and shutdown as much of the system as possible

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- Lock-out and tag-out all electrical disconnects
- Isolate the photovoltaic system at the inverter using reliable methods
- Work around all solar power system components

2.3.9 Construction Management

Installation and construction of Solar PV Power Stations require many specific considerations:

- Orientation and setting of the modules to take full advantage of sun as generators of energy
- Selection, delivery and handling of fragile, state-of-the-art components
- Expertise and qualifications of system installers such as roofers, electricians and glaziers.

Prior to and during construction activities, all contractors will be required to follow . three main principles:

- Conduct systematic site inspections and prepare site plans with clients
- Project managers should be skilled at specifying, receiving and safely installing valuable materials
- Ensure that all personnel engaged in construction and installation are well qualified and trained

Civil works team is required to follow certain site specific guidelines. To avoid possible attack of deleterious salts on cement, we recommend the use of Type-I cement in underground structures including foundations. To minimize corrosion potential the concrete mix should be designed using a water cement ratio not greater than 0.45. Admixtures may be required to provide workability. Concrete shall be densified using vibrators and a cover of 75mm should be provided over all reinforcing steel embedded in foundations concrete. A layer of bitumen coating should be applied to the exterior of all the foundation and other concrete coming in contact with soil.

For construction activities of the project, during the planning phase primary focus is kept on the laws and legislations of land use set by the Provincial Government of Punjab, meaning the Land acquisition Act 1984, Soil Reclamation Act 1964 and The Punjab Development of Damaged Areas Act 1952; so that all activities are carried out in a manner which do not hinder the decommissioning procedures of the project or repairing the damaged areas.

Main soil types of Bahawalpur desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%). The 50 MW Solar PV Power project is

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exempted from all requirements of IEE and EIA as it falls under schedule II classified by the Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. However both studies were conducted and submitted to EPA Punjab which after its due diligence has issued a No Objection Certificate (NOC) to the Project. The site will be restored to the original landscape in the later phase of construction.

2.3.10 O & M Management

After the completion of its construction, the Project shall be jointly managed with the 132 kV Substation. A joint management organization will be established with the principle of requiring "few on-duty staff". After the electrical equipment and machinery have entered their stable operation mode; the solar farm and substation shall be managed with "no on-call staff and few on-guard staff".

OEMs for Solar panels are responsible for providing the generic maintenance plans for solar panels which include cleaning. The maintenance manuals would be prepared for the utility plant. The joint management between Welt Konnect, CTGI and EPC Contractor will be required to further determine the suitable cleaning requirements for the panel. This would be done by sharing complete site information (dust, dirt, pollen and/or pollution in the site environment; the frequency of rain or snow) with the OEMs for Solar panel, and ask them for site specific cleaning plans and details for the solar panels.

Operation and maintenance team members and their qualification requirements will be dependent on the requirements presented by OEMs for equipment and components, requirements identified by EPC Contractors, Welt Konnect and China Three Gorges International Cooperation. Team structure would be dependent on the nature of approach taken towards the responsibility of O&M.

Welt Konnect, CWEIC & the EPC Contractor will jointly draft procedure and decision protocols regarding the presence of skilled engineers and technicians on site to operate the plan or control through utility from remote location. The systems of Patrol Inspection, operation guardianship, maintenance and overhaul will be established for the daily maintenance of production equipment, instruments and apparatus. These SOPs would be in-line with all requirements of International Standards of Safety, Management, Quality and Human resource management.

2.3.11 Environmental Management

A separate environment study has been carried out. Please refer to Volume 5. There are no significant hazards. The minor adjustments required during construction

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phase have been addressed and mitigation plan provided. There are no settlements within 05-08 Km of the Project Site, which further supports the Project in this location. As mentioned above, the 50 MW Cholistan Solar PV Power project is exempted from all requirements of IEE and EIA as it falls under the schedule II classified by Pakistan Environmental Protection Agency regulations 2000, S.R.O 339(1)/2001. However both studies were conducted and submitted to EPA Punjab which after its due diligence has issued a No Objection Certificate (NOC) to the Project.

2.3.12 Health and Safety

During the construction and operation of the Project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personal safety of workers.

HSE personnel will be required to draft emergency shutdown procedures for the plant in collaboration with the maintenance and project department during the detailed design phase of the Project. These would include all procedures in case of fire, lightning, flood, other natural disasters, etc. The procedures would be based on the guidelines from OSHA Standards (29 CFR 1910). Further standards and guidelines will be reviewed and adopted based on the recommendations of different stake holders.

A safety and health supervision department will be established on the site, which is to be in charge of the education, training and management of safety and health related issues after the project is put into operation. There will be safety personnel in the production section, and a part-time worker for the routine safety and health work.

The systems of patrol inspection, operation guardianship, maintenance and overhaul will be established for the daily maintenance of production equipment, instruments and apparatus. The safety and health supervision department will provide appropriate inspection equipment, as well as necessary public education service for production safety.

A comprehensive safety system will be established during the preparation phase, and carefully implemented during the construction process. The systems of work sheet, operation sheet shift relief, patrol inspection, operation guardianship, maintenance and over-haul will be strictly implemented, The Safety Regulation of the wind farm will also be seriously observed to preclude accidents such as fall, fire, or electric shock.

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2.3.13 CDM Aspect

Thorough work has been done to develop the Project under the Clean Development Mechanism of the UNFCCC. The Project is a power generation project with renewable resource and zero emission. When put into operation, the project can provide power supply to the southern Pakistan power grid, which currently is mainly relying on fossil fuel. Therefore, it can help to reduce the greenhouse gas emission from coal or oil-fired power generation. It can deliver good environmental and social benefits. It is also consistent with the spirit of the Kyoto Protocol and qualifies for the application of CDM projects', NEPRA is allowing almost the same return on equity (RoE) to the thermal and the renewable energy projects. The Sponsors of the Project require CERs to bring the RoE at a level where they can invest in renewable energy projects in Pakistan in future as well. If the project is approved and registered as a CDM project, CERs can provide slightly extra financial resource for the project it encouraging project sponsors and lenders. Besides providing minutely more favorable conditions for the project financing, it will improve competitiveness of the project, and reduce investment risk during the project implementation process.

Refer to Volume 6 for detailed studies for the Project under the Clean Development Mechanism – Project Idea Note (PIN's), Letter of Intent (LOI) by the Designated National Authority (DNA) Project Design Document (PDD's), PDD Evaluation Matrix, the Prior Consideration Form and the Host Country Approval (HCA) by the DNA of Pakistan.

1	Location of the Solar Farm		
1.1	Elevation	m	135
1.2	Longitude (East)		71" 49" 19.6"
1.3	Latitude (North)		29" 17" 65.0"
2	Solar resource		
2.1	Annual Average Horizontal Radiation	kWh/m2/day	5.53
3	Major Equipment		
3.1	PV Modules		
(1)	Quantity	Ea	209,440
(2)	Technology		Mono Silicone
(3)	No. of cells	Ea/panel	60
(4)	Impp	A	30.6
(5)	Vmpp	v	7.87

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 Originelly Prepared by MR Consultants & CEEG

(6)	Detect Device	14/2	240	
32	Rated Power	toro	240	
(1)	Quantitu	5	56	
(2)	Quantity		890	
(2)		vvp	672	
(3)		V	1338	
(5)		A	1556	
(5)		V	1400	
101	Output Imax		1400	
(1)	Medium In	ansionners Es	28	
(2)			1760	
(2)	Pmax	vvp	262	
(3)		V	303	
(4)		A	2 × 1400	
(5)	Output Voltage	kV	11	
(0)	Output Imax	A	46.2	
3.4	High Voltage		1	
(1)	Quantity	ta	1	
(2)	Capacity	KVA	11	
(3)	Input Voltage	KV	11	
(4)	Output Voltage	kV	132	
(5)	Frequency	Hz	50	
(6)	Phase	Ea	3	
4		gineering	- immediate installation	
4.1	PV Module Mountings	at s	ite	
4.2	Foundation for High Voltage Substation			
		· ·		
5	Const	ruction	L	
5.1	Construction Period	month ,	9	
6	Production Analysis			
	Annual Benchmark Energy Yield	GWh/yr	76.03	
7	Budgetary Estimates			
7.1	EPC Cost	Min US\$	89.63	
7.2	Total Project Cost	Min US \$	99.216062	
7.3	0&M Cost for Year 01 – 02	Min US \$	2.044	
7.4	O&M Cost for Year 03 – 05	Min US S	2.044	
7.5	O&M Cost for Year 06 – 20	Min US \$	2.044	
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50 MW Solar Power Project in Cholistan

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	sectors at the barrent of

8	Referenced Levelized Tariff		-
8.1	Levelized Tariff	US Cents / KWh	18.4568

Figure 2.3.13.1: Project Technical and Financial Summary

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National Transmission and Despatch Company Limited (NTDCL)



Grid Interconnection Study for Evacuation of Power from 50 MW Welt Konnect Solar PV Plant in Quaid-e-Azam Solar Park at Cholistan

(Draft Final Report)



Prepared by

Planning (Power) Department 5th Floor, PIA Tower, Egerton Road, Lahore.

April 2014
Executive Summary

- The Government of Pakistan (GoP) plans to develop 1000 MW Quaid-e-Azam solar park at Lal Suhanra as a major step towards development of solar generation in Pakistan. M/s Welt Konnect intends contribute to this plan by setting up 50 MW solar PV power plant in Quaid-e-Azam solar park. M/s Welt Konnect has hired the services of Planning Power Department of NTDC to carry out grid interconnection study in order to propose interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.
- 2. This is draft final report of the grid interconnection study in which the results of extensive system studies including load flow, short circuit, transient stability and power quality studies have been presented pertaining to the interconnection of 50 MW Welt Konnect solar PV power plant. The adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect power plant and of the system network in its vicinity has been evaluated in the light of Grid Code.
- 3. For the grid interconnection study, NTDC has used the latest system network model data & transmission expansion plans of NTDC and MEPCO, whereas, M/s Welt Konnect has provided the data of its power plant on data request from NTDC. Most of the data was provided by M/s Welt Konnect but some assumptions for the missing data pertaining to dynamic model parameters of 50MW Welt Konnect solar PV power plant have been made to conduct the studies.
- 4. The load flow analysis has been carried out for operating scenarios of summer 2015 and 2016 with the induction of 50 MW Welt Konnect solar PV power plant and the results of load flow studies have been presented in this report. It has been found that the power from 50 MW Welt Konnect solar power plant can reliably be evacuated to the system under normal and N-1 contingency conditions.
- 5. The proposed interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant is given as under:

"A 132 kV double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra single circuit line at the 132 kV switchyard of 50 MW Konnect solar PV power plant."

6. The project sponsor initially proposed 1x60 MVA power transformer at 132/15 kV voltage level but it is recommended in this report that 2x60 MVA power transformers at 132/15 kV voltage level should be installed at Welt Konnect

power plant to ensure supply of power under N-1 contingency condition as mentioned the Grid Code.

- 7. Short circuit studies have been carried out with proposed Interconnection option to compute the maximum three phase and single phase short circuit levels after the induction of 50 MW Welt Konnect solar PV power plant. It is found that the proposed solar generation has no adverse impact on the existing network in its vicinity and the short circuit currents remain within the installed switchgear ratings at the existing substations. On the other hand, the standard switchgear of the short circuit rating of 40 kA would be sufficient at 132kV switchyard of the 50MW Welt Konnect solar PV power plant.
- 8. Transient stability analysis with the proposed interconnection scheme for 50 MW Welt Konnect solar PV power plant has been carried out using the NEPRA Grid Code Criteria. The stability of the solar PV plant and the power system has been checked with application of faults at the 132 kV switchyard of 50 MW Welt Konnect solar PV power plant and at the substations in the vicinity of the plant. It has been found that 50 MW Welt Konnect solar PV power plant and the surrounding power system network remain stable with no adverse effects after subjected to faults as per Grid Code requirement.
 - The LVRT requirements for 50 MW Welt Konnect solar PV power plant are also met as mentioned in Grid Code Addendum for solar power plants (under approval by NEPRA).
- 9. The issues of power quality with the induction of the 50 MW Welt Konnect solar P∀ power plant have also been studied. The study results indicate that the power quality parameters including flicker and voltage unbalance, remain within the permissible limits as mentioned in relevant IEC standard. However, this is the responsibility of developer of the 50 MW Welt Konnect solar PV power plant to install necessary monitoring and compensating equipment at its switchyard to meet the power quality standards as per requirements of Grid Code Addendum for solar power plants (under approval by NEPRA).
- 10. On the basis of the results of the detailed system studies, it is concluded that the proposed interconnection scheme has no technical constraints in evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.



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1. Introduction

The Government of Pakistan plans to establish 1000 MW Quaid-e-Azam solar park at Lal Suhanra, Cholistan as a major step towards development of solar generation in Pakistan. M/s Welt Konnect intends to contribute to this plan by adding a 50 MW solar PV power plant in Quaid-e-Azam solar park.

M/s Welt Konnect has hired the services of Planning Power department of NTDC to carry out grid interconnection study in order to propose interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network.

This is draft final report of the grid interconnection study in which the results of extensive system studies including load flow, short circuit, transient stability and power quality studies, pertaining to the interconnection of 50 MW Welt Konnect solar PV power plant, have been presented. The adequacy of the proposed interconnection scheme regarding performance of 50 MW Welt Konnect power plant and of the system network in its vicinity has been evaluated in the light of Grid Code.

2. Proposed Interconnection Scheme

The interconnection scheme for evacuation of power from 50 MW Welt Konnect solar PV power plant to the system network is proposed as below:

"A 132 kV double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra single circuit line at the 132 kV switchyard of 50 MW Konnect solar PV power plant."

The geographical diagram showing the above scope of work for the proposed solar generation is shown in Figure #1. The geographical diagram showing all the proposed solar power plants (with total gross capacity of 1000 MW) in Quaide-Azam solar park is shown in Figure #2.

It is important to highlight that the existing 132 kV single circuit, Bahawalpur – Lal Suhanra, will become Yazman – Lal Suhanra, after the expected commissioning of Yazman 132 kV grid station in year 2015.

3. Study Assumptions and Criteria

3.1 Study Assumptions

The system studies are based on the following assumptions:

- Latest load forecast.
- Latest generation expansion plan.
- Latest transmission expansion plans of NTDC and DISCOs especially, the expansion plans of MEPCO.
- The 132 kV and 11 kV capacitors particularly proposed by MEPCO have also been incorporated in the studies.
- The system has been assumed to be operating in an interconnected manner, however, 132 kV bus bar at the existing Bahawalpur 220/132 kV substation have been assumed as split bus; and 132 kV line openings have been assumed at some parts in the surrounding MEPCO network in order to keep power flows within line capacities wherever necessary, as per system requirements.
- In the studies, the following reinforcements have been assumed in MEPCO network, a requirement for evacuation of power from all the solar power projects to be connected at 132 kV network of MEPCO:
 - i. By-passing of existing 132 kV S/C from Bahawalpur old to Lodhran at the following substations;
 - a. Baghdad-ul-Jaded substation
 - b. Lodhran substation.
 - ii. 132 kV shunt capacitors (36 MVAR) proposed at Hasilpur 132 kV substation when 1000 MW (total gross capacity) of solar generation at Quaid-e-Azam Solar Park, will be inducted in the system.
- As per information provided by project sponsor, the total gross & net capacity of Welt Konnect solar PV power plant have been assumed as 50 MW & 44.8MW respectively and the modeling of Welt Konnect solar power plant has been made as under:

- Power generation of Welt Konnect Solar PV would generate power at low voltage of 0.4 kV (after DC/AC conversion) which would be stepped up to a medium voltage of 15 kV through 15/0.3 kV transformers.
- Seven collector groups of 6.4 MW each to be connected to a 15 kV collector station bus bar which would be stepped up to high voltage of 132kV through 132/15 kV transformers.

In the report, 2x60 MVA transformers have been used instead of originally proposed 1x60 MVA transformer by the project sponsor in order to meet N-1 contingency requirement of NEPRA.

The detailed plant layout showing PV collector systems of 50 MW Welt Konnect solar power plant has been attached as Figure #3.

 Other solar power plants (with 50 MW gross capacity each) planned to be inducted in Solar Power Park in three phases (Phase-I, II & III) have also been assumed in the system studies. In general, the net capacities of the solar power plants have been used in the system studies.

3.2 System Study Criteria

The system studies have been carried out keeping in view of the following system operating criteria/limits in accordance with NTDC's Grid Code:

Voltage Limits:	$\pm 5\%$ under normal and $\pm 10\%$ under contingency conditions. However, voltages at generation and/or substations may be kept upto +8% under normal operating conditions as per network configuration and/or system requirements.
Transmission Line and Transformer Loading Limits:	100% of rating under normal and N-1 contingency conditions.
Frequency Limits:	49.8 – 50.2 Hz (Frequency Band during Gen ramping up & load pickup) under normal condition
	49.4 – 50.5 Hz (Max. Acceptable Frequency Band) under N-1 condition.

The short circuit studies have been carried out to compute maximum three phase and single phase fault levels by using the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to Zero
- Set shunt to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.1 p.u.

The transient stability studies have been carried out to assess the dynamic performance of the solar power plant and grid after being subjected to the following disturbances as given in NEPRA's Grid Code:

- Permanent three-phase fault on any transmission line, cleared in 5 cycles and the outage of the associated line.
- Failure of a circuit breaker to clear a fault (Stuck Breaker Condition) in 5 cycles, with backup clearing in 9-cycles after fault initiation.

In addition to the above stability criteria for a conventional power plant, the following Low Voltage Ride Through (LVRT) requirements are also to be met by a solar power plant as mentioned in the Grid Code Addendum for solar power projects which is under approval by NEPRA:

- The PV Solar Power Project must withstand a voltage dip down to 30% Retained Voltage for a duration of at least 100 msec for a normal clearing case and at least for 180 msec in case of Stuck Breaker condition.
- The PV Solar Power Project will manage active power restoration, after voltage recovery, at a rate of at least 20% of nominal output power per second.

4. Load Flow Analysis

The load flow analysis has been carried out for operating scenarios of summer 2015 & 2016 in order to evaluate adequacy of the proposed interconnection scheme for 50 MW Welt Konnect solar power plant on the system network under normal and single line (N-1) contingency conditions. The description of the simulated scenarios is given as under:

4.1 Peak Load June 2015

Load flow study for peak load of June 2015 under normal operating condition has been carried out and is attached as Exhibit #1. In this scenario, Welt Konnect solar power plant and three other solar power plants of 50 MW gross capacity each, have been assumed in operation. As per load flow study, it is found that power from Welt Konnect solar power project can be evacuated to the 132 kV system of MEPCO under normal condition without any transmission constraint, i.e., the loading of the transmission lines and transformers in the system as well as system voltage profile would remain within limits.

The load flow studies have also been carried out with critical single line contingency (N-1) analysis in the vicinity of Welt Konnect solar power project and are attached as Exhibit #2-8 in Appendix-1. The results of the contingency studies are summarized as under;

Exhibit #	Contingency Conditions	Remarks	
2	Welt Konnect solar power plant – Solar PP-2 S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.	
3	Welt Konnect solar power plant – Solar PP-4 S/C out	-do-	
4	Solar PP-1 – Lal Suhanra 132kV S/C out	-do-	
5	Bahawalpur Cantt. – Lal Suhanra 132 kV S/C out	-do-	
6	Solar PP-4 – Yazman 132kV S/C out	-do-	

Exhibit #	Contingency Conditions	Remarks
7	Bahawalpur – Yazman 132kV S/C out	-do-
8	Bahawalpur Cantt. – Bahawalpur 132 kV S/C out	-do-

4.2 Peak Load June 2016

Load flow study for peak load of June 20165 under normal operating condition has been carried out and is attached as Exhibit #9. In this scenario, 50 MW Welt Konnect solar power plant and additional solar power plants with a total gross solar generation as 950 MW have been assumed. As per load flow study, it is found that the power from 50 MW Welt Konnect solar power plant in the presence of all of other the solar power projects can be evacuated to the National Grid under normal without any transmission constraint, i.e., the loading of the transmission lines and transformers in the system as well as system voltage profile would remain within limits.

The load flow studies also cover critical single line contingency (N-1) analysis in the vicinity of these solar projects and are attached as Exhibit #10-16 in Appendix-1. The results of the contingency studies are summarized as under;

Exhibit #	Contingency Conditions	Remarks
10	Welt Konnect solar power plant – Solar PP-2 S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
11	Welt Konnect solar power plant – Solar PP-4 S/C out	-do-
12	Solar PP-1 – Lal Suhanra 132kV S/C out	-do-
13	Solar PP-5 – Lal Suhanra 132kV S/C out	-do-
14	Solar PP-4 – Yazman 132kV S/C out	-do-

Exhibit #	Contingency Conditions	Remarks
15 Bahawalpur – Yazman 132kV S/C out		-do-
16 Bahawalpur Cantt. – Bahawalpur 132kV S/C out		-do-

4.3 Conclusion of Load Flow Analysis

The power from the 50 MW Welt Konnect solar power project can reliably be evacuated to the system through the proposed interconnection scheme under normal and N-1 contingency conditions.

5. Short Circuit Analysis

The short circuit studies have been carried out with proposed interconnection scope of work for 50 MW Welt Konnect solar power plant to compute the maximum three phase and single phase short circuit levels for the system scenario of Aug/Sept 2016. The studies have been carried out with all the existing and planned generation including all the planned 1000 MW solar generation at Quaid-e-Azam Solar Park, Lal Suhara and with interconnected transmission system. The results of the short circuit studies are summarized as under:

Name of Faulted Bus Bar	Voltage	Maximum Short Circuit Levels	
Hame of Funced Dus Dar	Level	Three Phase	Single Phase
Welt Konnect Solar PV Plant	132 kV	6.31 kA	4.09 kA
Lal Suhanra-New	220 kV	8.23 kA	4.86 kA
Bahawalpur	220 kV	11.18 kA	6.94 kA
Lal Shuanra-New	132 kV	9.63 kA	6.52 kA
Bahawalpur-New Bus Bar-1	132 kV	12.69 kA	8.97 kA
Bahawalpur-New Bus Bar-2	132 kV	6.84 kA	5.25 kA
Lal Suhanra (Old)	132 kV	6.73 kA	4.35 kA
Yazman	132 kV	6.14 kA	3.94 kA
Bahawalpur Cantt	132 kV	11.33 kA	7.82 kA
Solar PP-1	132 kV	6.43 kA	4.14 kA
Solar PP-2	132 kV	6.36 kA	4.11 kA
Solar PP-4	132 kV	6.25 kA	4.07 kA

5.1 Conclusions of Short Circuit Analysis

It is evident from the above table that the induction of 50 MW Welt Konnect solar power plant has no adverse impact on the existing 220 kV and 132 kV substations in the vicinity and the short circuit currents remain within the installed switchgear ratings. Moreover, the standard switchgear of the short circuit rating of 40 kA would be sufficient at 132kV switchyard of the solar plant and 220/132 kV substation at Lal Suhanra. The detailed results of short circuit studies are attached in Appendix-2.

6 Transient Stability Analysis

Transient stability studies have been carried out to evaluate the time domain response of bus voltage, frequency, active/reactive power flows on transmission lines, and active/ reactive power flows from Welt Konnect solar PV power plant after occurrences of faults. The transient stability simulations are used to check whether the solar power plant and power system remain stable or not after subjected to severe disturbances in the light of Grid Code.

6.1 Simulation Time Frame

The time domain stability simulations have been run as follows:

- Run simulation for initial one second for pre-fault steady state condition.
- Apply fault at one second and run the simulation for 1.1-second duration.
- At 1.1 second clear the fault and trip the required circuit.
- Run the simulation up to 10 seconds after clearing fault.

6.2 Modelling of Solar Power Plant

Transient stability studies have been carried out using following dynamic models available in the PSS/E model library for a solar power plant;

Generator Model	PVGU1
Electrical Model	PVEU1
Solar Panel Model	PANELU1
Solar Radiation Model	IRRADU1

The parameters for the above dynamic models have been provided by M/s Welt Konnect solar power plant, however, for the missing parameters, assumption as mentioned in Appendix-3, have been made in order to complete the transient stability analysis. The assumed data/parameters are required to be validated from the EPC contractor/equipment manufacturer of Welt Konnect solar power plant.

6.3 Transient Stability Study Results

The solar plant and system network variables monitored and recorded in the simulations are provided below:

- i. Bus Frequency plot
- ii. Bus Voltage plot
- iii. Line Power Flows, i.e., P (MW) & Q (MVAR) plots
- iv. P (MW) & Q (MVAR) of Solar power plant

In order to interpret the stability plots, the bus numbers assigned to bus bars on various voltage levels at the switchyard of 50 MW Welt Konnect solar PV power plant are given as under:

Bus Number	Bus Name
7653	132 kV (HV) Bus at Welt Konnect solar plant
76531	15 kV (MV) Bus at Welt Konnect solar plant
765311	O.4 kV (LV) Collector Station-1 (CS-1) Bus at Welt Konnect solar plant

The response of Welt Konnect solar PV power plant to meet LVRT requirements can be observed from the results of transient stability simulations carried out in this section.

The transient stability studies for 5 cycles fault during peak load condition of September 2016 (summer season) for the 50 MW Welt Konnect solar PV power plant have been carried out. The plotted results of the dynamic simulations are attached as Appendix-4. The details of the faults and the outages with description of respective plots depicting their stability behaviour are provided in the Table-1 given below:

Tab	e-1:	
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Transient Stability Results for 5 Cycles Faults

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	3-phase fault at Welt Konnect 132 kV bus	1	Frequency	Welt Konnect solar
1 cleared in 5 cycles and the outage of Welt Konnect to	2	Voltage	NTDC/MEPCO	
	Welt Konnect to	3	P & Q Line Flows	systems remain stable. No LVRT

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	Solar PP-4 132 kV single circuit.	4	P & Q of Solar power plant	problem at Welt Konnect solar power plant.
	3-phase fault at Welt	5	Frequency	
	cleared in 5 cycles	6	Voltage	
2	and the outage of Welt Konnect to	7	P & Q Line Flows	-00-
	Solar PP-2 132 kV single circuit.	8	P & Q of Solar power plant	
	3-phase fault at Welt	9	Frequency	
	cleared in 5 cycles	10	Voltage	
3	and the outage of 132/15kV	11	P & Q Line Flows	-do-
	transformer.	12	P & Q of Solar power plant	
4	3-phase fault Welt Konnect 15 kV bus cleared in 5 cycles and the outage of Welt Konnect collector station (6.4MW).	13	Frequency	
		14	Voltage	
		15	P & Q Line Flows	-do-
		16	P & Q of Solar power plant	
5	3-phase fault at Lal	17	Frequency	
	bus cleared in 5	18	Voltage	
	outage of Lal Suhnara (old) to Solar PP-1 132 kV single circuit.	19	P & Q Line Flows	-do-
		20	P & Q of Solar power plant	
6	3-phase fault at Lal Suhanra (old) 132 kV bus cleared in 5 cycles and the outage of Lal Suhnara (old) to Solar PP-5 132 kV single circuit.	21	Frequency	
		22	Voltage	
		23	P & Q Line Flows	-do-
		24	P & Q of Solar power plant	
7	3-phase fault at	25	Frequency	-do-
	Bahawalpur-Cantt 132kV bus cleared in	26	Voltage	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response	
	5 cycles and the	27	P & Q Line Flows		
	Bahawalpur-Cantt to Lalsohanra 132 kV single circuit.	28	P & Q of Solar power plant		
	3-phase fault at	29	Frequency		
	132kV bus cleared in	30	Voltage		
8	5 cycles and the outage of	31	P & Q Line Flows	-do-	
	Bahawalpur-Cantt to Bahawalpur 132 kV single circuit.	32	P & Q of Solar power plant		
	3-phase fault at	33	Frequency		
	Bahawalpur 132 kV bus cleared in 5	34	Voltage		
9	cycles and the outage of	35	P & Q Line Flows	-do-	
	Bahawalpur to Yazman 132 kV single circuit.	36	P & Q of Solar power plant		
10	3-phase fault at Bahawalpur 132 kV	37	Frequency		
	bus cleared in 5	38	Voltage		
	outage of	39	P & Q Line Flows	-00-	
	Bahawalpur to Bahawalpur-Cantt. 132kV single circuit.	40	P & Q of Solar power plant		
11	3-phase fault at Yazman 132 kV bus cleared in 5 cycles and the outage Yazman to Solar PP-4 132 kV single circuit.	41	Frequency		
		42	Voltage		
		43	P & Q Line Flows	-do-	
		44	P & Q of Solar power plant		
12	3-phase fault at Yazman 132 kV bus cleared in 5 cycles and the outage Yazman to Bahawalpur 132 kV single circuit.	45	Frequency		
		46	Voltage		
		47	P & Q Line Flows	-do-	
		48	P & Q of Solar power plant		

The transient stability studies for 9 cycles fault (stuck breaker) during peak load conditions of September 2016 (summer season) for 50 MW Welt Konnect solar power plant have been carried out. The plotted results of the simulations are attached as Appendix-4. The details of the faults and the outages with description of respective plots depicting their stability behaviour are provided in the Table-2 given below:

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response	
	3-phase fault at Welt Konnect 132 kV bus cleared in 9 cycles	49	Frequency	Welt Konnect	
		50	Voltage	solar power plant	
1	Welt Konnect to Solar	51	P & Q Line Flows	systems remain	
	PP-4 132 kV single circuit.	52	P & Q of Solar power plant	stable. No LVRT problem at Welt Konnect solar power plant.	
	3-phase fault at Welt	53	Frequency		
	cleared in 9 cycles	54	Voltage		
2	and the outage of Welt Konnect to Solar PP-2 132 kV single circuit.	55	P & Q Line Flows	-do-	
		56	P & Q of Solar power plant		
2	3-phase fault at Welt Konnect 132 kV bus cleared in 9 cycles and the outage of 132/15kV transformer.	57	Frequency	-do-	
		58	Voltage		
5		59	P & Q Line Flows		
		60	P & Q of Solar power plant		
4	3-phase fault Welt Konnect 15 kV bus cleared in 9 cycles and the outage of Welt Konnect collector station (6.4 MW).	61	Frequency		
		62	Voltage		
		63	P & Q Line Flows	-do-	
		64	P & Q of Solar power plant		
	3-phase fault at Lal Suhanra(old) 132 kV bus cleared in 9	65	Frequency		
5		66	Voltage	-do-	
		67	P & Q Line Flows		

	Table-2: ⁻	Transient	Stability	Results	for 9	Cycles	Faults
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Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	cycles and the outage of Lal Suhnara (old) to Solar PP-1 132 kV single circuit.	68	P & Q of Solar power plant	
	3-phase fault at Lal	69	Frequency	
6	Suhanra (old) 132 kV bus cleared in 9	70	Voltage	
	cycles and the outage of Lal Subnara (old) to	71	P & Q Line Flows	-00-
	Solar PP-5 132 kV single circuit.	72	P & Q of Solar power plant	
	3-phase fault at	73	Frequency	
	132kV bus cleared in	74	Voltage	
7	9 cycles and the	75	P & Q Line Flows	-do-
	outage of Bahawalpur-Cantt to Lalsohanra 132 kV single circuit	76	P & Q of Solar power plant	
8	3-phase fault at Bahawalpur-Cantt 132kV bus cleared in 9 cycles and the outage of Bahawalpur-Cantt to Bahawalpur 132 kV single circuit.	77	Frequency	
		78	Voltage	
		79	P & Q Line Flows	-do-
		80	P & Q of Solar power plant	
9	3-phase fault at	81	Frequency	
	Banawaipur 132 kV bus cleared in 9 cycles and the outage of Bahawalpur to Yazman 132 kV single circuit.	82	Voltage	
		83	P & Q Line Flows	-do-
		84	P & Q of Solar power plant	
10	3-phase fault at Bahawalpur 132 kV bus cleared in 9 cycles and the outage of Bahawalpur to Bahawalpur-Cantt. 132 kV single circuit.	85	Frequency	
		86	Voltage	
		87	P & Q Line Flows	-00-
		88	P & Q of Solar power plant	
	3-phase fault at Yazman 132 kV bus cleared in 9 cycles and the outage	89	Frequency	
11		90	Voltage	-do-
		91	P & Q Line Flows	

Sr. #	Type of Faults	Exhibit #	Plotted Quantity	Response
	Yazman to Solar PP-4 132 kV single circuit.	92	P & Q of Solar power plant	
	3-phase fault at	93	Frequency	
12	Yazman 132 kV bus cleared in 9 cycles and the outage Yazman to Bahawalpur 132 kV single circuit.	94	Voltage	
		95	P & Q Line Flows	-do-
		96	P & Q of Solar power plant	

6.4 Conclusions of Transient Stability Analysis

The results of transient stability analysis indicate that 50 MW Welt Konnect solar power plant connected with the system network through the proposed interconnection scheme and the system networks of MEPCO & NTDC are strong enough to absorb the worst disturbances on either side, i.e., on solar power plant side or the Grid side. It can also be seen from the above stability plots that Welt Konnect solar power plant also fulfills the requirements of LVRT and the rate of power restoration after voltage dip is faster than 20% per second as required in Grid Code under approval.

In general, there is no problem of transient stability and LVRT pertaining to the Welt Konnect solar power plant with the proposed interconnection; and both Welt Konnect solar power plant and the power system remain stable when subjected to severe disturbances.

(A)

7. Power Quality Analysis

The power quality analysis is very important for a solar PV power plant that may cause flicker and distortions in the power supply due to inverter action. These issues become more significant for weak power systems having low short circuit strength. Therefore, power quality analysis including flicker and voltage unbalance, has been carried out with the proposed interconnection scheme of 50 MW Welt Konnect solar PV power plant for the worst case scenario of minimum system short circuit levels in Aug/Sept 2016.

7.1 Flicker

IEC61400-21 standard have been used for the calculation of flicker levels for steady-state continuous operation. The probability of 99th percentile flicker emission from a single inverter during continuous operation for short time $Pst\Sigma$ and long time flicker level $P1t\Sigma$ are assumed same and calculated by the following formula:

$$P_{st\Sigma} = P_{lt\Sigma} = \frac{1}{S_k} \cdot \sqrt{\sum_{i=1}^{N_{wt}} (c_i(\psi_k, \upsilon_a) \cdot S_{n,i})^2}$$

Where

 S_n is the rated apparent power of the one inverter S_k is the short-circuit apparent power at PCC

 \mathbf{N}_{wt} is the number of inverters connected to the PCC

The value of c (φ_k) may not be greater than 1, therefore for the present analysis, the value of 1 for the worst case has been assumed. PCC is the point of common coupling which is 132 kV bus of the switchyard of 50 MW Welt Konnect solar power plant.

For the minimum short circuit case, the system network in the vicinity of Welt Konnect solar power plant has been modeled with minimum generation in operation, especially, in Muzaffargarh, Kot Addu & Multan areas and the generation in Quaed-e-Azam solar park has been reduced to 50%. The short circuit calculations have been done at 0.9 p.u. voltage. All the invertors of 50 MW Welt Konnect solar power plant have been assumed in operation for the

calculation of extreme value of flicker level at 132 kV bus of solar power plant. The values used in the calculation of flicker are as below:

> S_n = 0.8 MVA N_{WT} = 56 S_k for 132 kV bus = 1377.24 MVA

Using the above data in Equation (A), we get

 $P_{St\Sigma} = P_{It\Sigma} = 0.004347 = 0.43\%$

Whereas, the acceptable value in IEC Standard is less than 4%. Therefore, the flicker level is far less than the maximum permissible limit which implies that the inverters at 50 MW solar power plant would not cause any flicker problem during steady state operation even in the weakest system conditions.

7.2 Voltage Unbalance

i. Voltage Step-Change

The rise of the voltage with solar PV units at the point of PCC should be less than 3%. With only one collector group at PCC of a solar plant under study and 50% generation in solar park in operation, this condition is evaluated by using the following formula;

$$K_{k1} = \frac{S_{kV}}{\sum S_{Amax}} \tag{B}$$

The value of K_{kl} > 33 represents less than 3% (1/33) step-change in voltage.

In the simulated case for Welt Konnect solar PV power plant, the short circuit power and apparent power come out as under:

- S_{kV} = Short circuit power at the PCC = 1347.31 MVA
- S_{max} = Maximum apparent power of one collector group connected to the PCC = 6.4 MVA

Using above values in Equation (B), we get

 K_{kl} = Voltage Step-change factor = 210.51

It corresponds to 0.48% (1/210.51) step-change in voltage which is quite less than the permissible limit of 3%.

ii. Voltage Variation

The voltage variation with only one collector group at PCC of the solar plant under study can be estimated by the following formula:

$$\Delta u_a = k_{imax} \cdot \frac{S_{rE}}{S_{kV}} \tag{C}$$

kimax = Maximum inrush current in relation to the nominal current

 S_{kv} = Short-circuit power at the PCC

 S_{rE} = Nominal apparent power of the Solar PV unit that is to be connected

The above calculation gives an upper assessment for a safe margin basically. For a solar power plant, $K_{i,max}$ can be assumed to be 1. In the simulated case for Welt Konnect solar PV power plant, the values of short circuit power and apparent power come out as under:

$$S_{kV} = 1347.31 \text{ MVA}$$

 $S_{rE} = 0.8 \text{ MVA}$

Using above values in Equation (C), we get

$$U_a = 0.000594 = 0.0594\%$$

The above voltage variation is far less the acceptable limit of 2.34% in IEC Standard.

7.3 Conclusion of Power Quality Analysis

The important power quality parameters like flicker and voltage unbalance, have been computed for Welt Konnect solar PV power plant with the worst case scenario and compared with limits given in IEC standards. The study results indicate that the levels of flicker and voltage unbalance are within permissible limits of IEC standards, with the interconnection of 50 MW Welt Konnect solar PV power plant.

5. Conclusions and Recommendations

On the basis of detailed grid interconnection studies including load flow, short circuit, transient stability and power quality studies carried out for evacuation of power from 50 MW Welt Konnect solar PV power plant, the conclusions and recommendations are given as below::

i. The following proposed interconnection scheme has no technical constraints or problems in evacuation of power from 50 MW Welt Konnect solar PV power plant to the system networks of NTDC and MEPCO:

"A 132 kV Double circuit line, approx. 4 km long on Rail conductor for looping In/Out of the existing Bahawalpur (Yazman) – Lal Suhanra 132kV single circuit line at the 132 kV switchyard of 50 MW Konnect solar power plant."

- ii. The project sponsor has proposed 1x60 MVA power transformer at 132/15kV voltage level in the switchyard of Welt Konnect solar power plant but it is recommended to install 2x60 MVA power transformers at 132/15kV voltage level to ensure supply of power under N-1 contingency condition. In addition, it is recommended to design the 132 kV switchyard of the 50MW Welt Konnect solar PV power plant with double bus bar arrangement.
- iii. As per load flow analysis carried out for operating scenarios of summer 2015 and 2016, it has been found that the power from 50 MW Welt Konnect solar power plant can be dispersed to the system under normal and N-1 contingency conditions.
- iv. As per short circuit analysis, the 50 MW Welt Konnect solar power plant has no adverse impact on the surrounding 132 kV and 220 kV substations and the short circuit currents remain within installed switchgear ratings. On the other hand, the standard switchgear with short circuit rating of 40 kA would be sufficient for the 132 kV switchyard of 50 MW Welt Konnect solar power plant.
- v. As per transient stability analysis, 50 MW Welt Konnect solar power plant and the power system have been found to remain stable with no adverse effects after application of faults at the 132 kV switchyard of 50 MW Welt Konnect solar power plant and at the grid stations & other power plants in its vicinity. However, it is important to intimate that in order to carry out

transient stability analysis, some of the missing data for Welt Konnect solar PV plant regarding dynamic model has been assumed. The assumed data is required to be validated from the EPC contractor/equipment manufacturer of Welt Konnect solar power plant.

The LVRT requirements for 50 MW Welt Konnect solar PV power plant are also met as mentioned in Grid Code Addendum for solar power plants (under approval by NEPRA).

- vi. The power quality related parameters computed in the studies have also been found well within permissible limits as mentioned in the relevant IEC standards. However, this is the responsibility of developer of 50 MW Welt Konnect solar PV power plant to install necessary monitoring and compensating equipment at its switchyard to meet the power quality standards as per requirements of Grid Code Addendum for solar power plants (under approval by NEPRA).
- vii. The comments of project sponsor on draft grid interconnection study of 50MW Welt Konnect solar PV power plant are welcome for incorporation in the final report.

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- vii. The comments of project sponsor on draft grid interconnection study of 50MW Welt Konnect solar PV power plant are welcome for incorporation in the final report.