NRTC Energies

NRTC ENERGIES PRIVATE LIMITED
72 Block, PECO Road, Lahore, Pakistan
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www.nrtcenergies.com

To

The Registrar
National Electric Power Regulatory Authority (NEPRA)
NEPRA Tower Attaturk Avenue (East)
Sector G-5/1, Islamabad
Pakistan.

Subject: **APPLICATION FOR GENERATION LICENCE / CONCURRENCE**

I, Jawad Anjum, Director NRTC Energies, being the duly authorized representative of NRTC Energies (Private) Limited by virtue of Board Resolution dated 16.12.2024 hereby apply to the National Electric Power Regulatory Authority for the grant of a generation licence / concurrence to NRTC Energies (Private) Limited pursuant to Section 14-B of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I hereby certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application, Modification, Extension and Cancellation) Procedure Regulations, 2021, and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and no material omission has been made.

A Pay Order in the sum of Rupees 549,787 (Rupees Five Hundred and Forty-Nine Thousand, Seven Hundred and Eighty-Seven only), being the non-refundable licence application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 2021, is also attached herewith.

Date: 17/3/2025

Jawad Anjum, Director
NRTC Energies (Pvt.) Ltd.

NRTC ENERGIES (PVT) LTD
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Sr. No.	Information / Documents required under NEPRA Licensing (Application, Modification, Extension and Cancellation) Procedure Regulations, 2021	Information/Documents Submitted
1	Application for Generation Licence along with Affidavit, Extract of Minutes Book, Board Resolution & Power of Attorney pursuant to Regulation 3 (1)	**Annexure- I**
2	Application Fee pursuant to Regulation 3(l)	**Annexure- II**
3	Certificate of Incorporation pursuant to Regulation 3(4)(c)(i) (A)	**Annexure- III**
4	Memorandum and Articles of Association pursuant to Regulation *3(4)* (c)(i) (BJ)	**Annexure- IV**
5	Evidence of cash balance held in Reserves and bank certificates pursuant to Regulation 3(4)(d)(i)	**Annexure- V**
6	Latest Audited Financial Statements of the Application pursuant to Regulation 3(4)(d)(iii)	**Annexure- VI**
7	Annual Reports of the Company pursuant to Regulation 3(4)(c)(i)(C)	**Annexure- VII**
8	Last filed Annual Return pursuant to Regulation 3(4)(c)(ii)	**Annexure- VIII**
9	The authorized, issued, subscribed and paid-up share capital of the Applicant pursuant to Regulation 3(4)(c)(ii i)	The Authorized capital of the company is Rs. 10,000,000 (Ten Million Rupees Only) divided into 100,000 (One Hundred Thousand) Ordinary shares of Rs. 100 (One Hundred Only) each.
10	The shareholding pattern of the Applicant including list of shareholders pursuant to Regulation 3(4)(c)(iv)	**Annexure- IX**
11	Details of charges and encumbrances Attached to Applicant's assets pursuant to Regulation 3(4)(d)(ii)	The Applicant Company does not have any charges or encumbrances attached to Applicant's assets.
12	A prospectus pursuant to Regulation 3(4)(b)	**Annexure- X**
13	Expression of interest to provide credit or financing along with sources and details thereof as required pursuant to Regulation 3(4)(d)(iv)	Since the Applicant does not intend to sell electricity to the grid or seek a tariff from the Regulator, it is

NRTC ENERGIES (PVT) LTD. NRTC

		requested that this condition may please be waived.
14	Documents describing net worth and equity and debt ratios of the Applicant pursuant to Regulation 3(4)(d)(y)	**Annexure V & VI**
15	Detailed profile and CVs of senior management pursuant to Regulation 3(4)(d)(vi)	**Annexure- XI**
16	Employment records of engineering and technical staff of the Applicant pursuant to Regulation 3(4)(d)(vii)	
17	Profile of Sub-contractors, if any, along with expression of interest of such sub-contractors as required pursuant to Regulation *3* (4)(d)(viii)	**Annexure- XII**
18	Verifiable references with reference to experience of the Applicant and its sub-contractors as required pursuant to Regulation 3(4)(d)(ix)	**Annexure- X & XII**
`19	Environmental Impact Assessment Study pursuant to Regulation *3(4)(a)* Schedule-Ill clause A(e)(2)	**Annexure- XIII**
20	Information relating to water source at site for maintenance pursuant to Regulation 3(4)(a), Schedule-Ill Clause A(a) (4.) (iii))	Unlike conventional thermal power generation plants, solar power plants do not require extensive use of water since cooling and auxiliary consumption is not required. The only water requirement would be the fortnightly cleaning of panels which is done through modern equipment that conserves water. For this purpose, the normal utility water available at the site would be used.
21	Information relating to infrastructure(Roads, rail, staff colony, amenities) pursuant to Regulation 3(4)(a) Schedule-Ill clause A(e)(3)(iv)	The Ground & rooftop mounted PV facilities will be constructed at MES sites. No new infrastructural development is part of the scope of this project.

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22	Information relating to Project commencement and completion schedule (with milestones) pursuant to Regulation 3(4)(a), Schedule-Ill Clause A(e)(3.)(v))	**Annexure- XIV**
23	Information relating to Safety and Emergency plans pursuant to Regulation 3(4)(a) Schedule-Ill clause A(c)(3)(vii)	**Annexure- XV**
24	Information relating to plant characteristics (generation voltage, frequency etc.) pursuant to Regulation *3(4)(a)* clause A(e)(3)(vii)	**Annexure- XVI**
25	Feasibility study of the project as required pursuant to Regulation 3(4)f	
26	Affidavit stating whether the Applicant has been granted any other license under the Act pursuant to Regulation 3(4)(g)	**Annexure- XVII**
27	A duly authorized statement stating whether the applicant has been refused grant of license under the Act and if so, the particulars of the refused application including date of making the application and the decision on the application Pursuant to Regulation *3* (4)(h)	
28	Bank Guarantee Equivalent to Applicable Annual License Fee for two years pursuant to Regulation 3(8)	The Applicant is ready to furnish Bank Guarantee pursuant to the said regulation. However, the Authority has not yet provided any format of this guarantee. The Applicant pledges to provide the Authority with the Bank Guarantee as soon as a format is provided by the Regulator.
29	Technical and financial proposals in reasonable details pursuant to Regulation 3(4)(e)	
30	Information relating to control, metering instrumentation and protections pursuant to Regulation *3(4)(a)* Schedule-Ill clause A(e)(3/(viii)	**Annexure- XVI**
31	Information relating to technology size of the plant number of units etc. pursuant to Regulation 3(4)(a) Schedule-Ill clause A(e)(3)(ii)	

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32	Interconnection study pursuant to Regulation 3(4)(a) Schedule-III clause A(e)(I).	**Annexure- XVIII**
33	Information relating to location (location maps, site maps, land etc.) pursuant to Regulation 3(4)(a), Schedule-III clause A(e)(3)(i)	**Annexure- XVI**
34	Information relating to Degradation Factors. (Regulation 3(4)(a), Schedule-III Clause A(e)(3.)(x))	**Annexure- XVI**
35	Information relating to Estimated Capacity Factor at site. (Regulation 3(4)(a), Schedule-III Clause *A(e)(3.)(ix))*	

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Annexure-I

Application for Generation Licence / Concurrence along with Affidavit, Extract of Minutes Book, Board Resolution & Power of Attorney

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BEFORE THE NATIONAL ELECTRIC POWER REGULATORY AUTHORITY

"Application for seeking Generation License"

ON BEHALF OF

NRTC ENERGIES (PRIVATE) LIMITED

AUTHORIZED STATEMENT

I, Mr. Jawad Anjum, holding CNIC No. (42301-7799857-1), Chief Executive Officer, NRTC Energies (Private) Limited hereby solemnly affirm and declare that the contents of the accompanying Application for Generation License (the "License") is true and correct to the best of my knowledge and belief and nothing material has been concealed there from.

I also affirm that all further documentation and information to be provided by me in connection with the accompanying application for Generation License will also be true to the best of my knowledge and belief.

Date: 20-02-2025

Chief Executive Officer

NRTC Energies (Private) Limited

NRTC ENERGIES (PVT) LTD NRTC

Application for the Grant of Generation License / Concurrence

1. Background

NRTC Energies Private Limited was incorporated on 17.11.2021 under Section- 16 of the Companies Act, 2017 with Corporate Unique Identification No. 0184244. The business office of the company is at 72 Block, PECO Road, Lahore, Pakistan

The Company has completed various Solar projects nationally in a very short span of time. Up till now, the company has over 05 megawatts of solar projects in Pakistan.

NRTC Energies aims to alleviate Pakistan's energy problems by introducing innovative distributed solar and energy management solutions. The Pakistan and the NRTC Energies teams are committed to achieve excellence in every aspect of solar design, construction, and operation & maintenance.

2. Project Rationale

The Military Engineering Services (MES) in Pakistan has a rich history dating back to the British colonial era. After the independence of Pakistan in 1947, the MES was reconstituted to serve the Pakistan Army. The MES is responsible for providing engineering support to the Pakistan Armed Forces, including construction, maintenance, and repair of military infrastructure.

Apart from the strategic importance of activities carried out by MES and their requirement of reliable electric power, MES is committed to play a notable role in reducing carbon footprints of Pakistan. To achieve the endeavor, MES is determined to meet their electric power demand through Solar energy. For aforementioned purpose, MES engaged NRTC Energies and their team conducted surveys to the sites of Military Engineering Services (MES) Pakistan and keeping in view their annual energy consumption, a 3.5 MWp Solar PV Solution at five site in Lahore is proposed. It is anticipated that the project will serve a projected annual production of 5,110,000 kWh/year.

3. Environment Benefits

Almost all conventional methods of energy generation have varying degrees of adverse environmental impact. These methods have far reached detrimental effects on the climate, air, water, land and wildlife of the adjacent vicinities. However, Solar PV energy technology provides significant environmental advantages in comparison to the conventional energy sources while contributing to the sustainable development of human activities. Besides slowing down the depletion of natural resources, the main environmental advantage is zero air emissions, waste production and eventual reduction in emissions of greenhouse gases (COx, NOx) and toxic gases (SOx).

Solar power plants have zero fuel requirement and hence limit the depletion of natural resources, fossil fuels. Unlike conventional thermal power plants, no water consumption is required for cooling purposes. A very optimized quantity of water is occasionally used for plant maintenance / cleaning.

4. Prayer

NRTC Energies has performed an in-depth technical and financial analysis for proposed 3.5 MWp Solar PV solution at stated five sites of MES. Findings from these analyses suggest that the proposed sites are suitable for installation of Solar PV power plants with substantial benefits for the environment and promotion of distributed grid in Pakistan. Technical details of the sites and system designs (PVSyst simulations) have been attached with this application.

Keeping in view the considerable amount of effort and attention to the minute details put into the Solar PV system designing and diverse experience of solar sector, NRTC Energies is confident that if allowed by the honorable Authority to construct this plant, it will be able to achieve the required results without any problem.

In view of above it is requested that the application of NRTC Energies (Private) Limited may very kindly be processed and placed before the Authority for admission.

NRTC Energies (Private) Limited further requests the honorable Authority to kindly grant the Generation Licence / Concurrence for 3.5 MWp Solar PV plants at sated sites of Military Engineering Services (MES) Pakistan. In case, any further document or information is required then it is requested that same may kindly be communicated.

Sincerely,

Jawad Anjum, Director
NRTC Energies (Pvt.) Ltd.

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RESOLUTION BY CIRCULAR

Date: December 16, 2024

RESOLVED that an application for the Generation License (**"The GL Application"**) be filed by and on behalf of NRTC Energies (Pvt.) Ltd., (**"The Company"**) with the National Electric Power Regulatory Authority (**"NEPRA"**), in connection with the GL Application for the company in respect of the Military Engineering Services (**"MES"**) (**"The Company"**) for 3.5 MWp Solar Power Project at four zones spanning over different cities of Pakistan. (**"The Project"**).

Further Resolved that Mr. Jawad Anjum, holding CNIC No.42301-7799857-1, Director of the company, be and is hereby authorized to sign the GL Application, and any documentation ancillary thereto, pay all the filing fees, and provide any information required by NEPRA in respect of the project, and do all acts and things necessary for the processing, completion and finalization of the GL application.

CLARIFICATION

CERTIFIED that, the above resolution by circulation was duly passed by the Board of Directors of NRTC Energies (Pvt.) Ltd on 16th Dec 2024 for which the quorum of directors was present.

FURTHER CERTIFIED, that the said resolution has not been rescinded and is in operation and that this is the true copy thereof.

Jawad Anjum
CEO/Director

NRTC ENERGIES (PVT) LTD NRTC

Zahid Mehmood Maitla
Director

NRTC ENERGIES (PVT) LTD NRTC

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

Company Registration Office

CERTIFICATE OF INCORPORATION

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

Corporate Unique Identification No. 0184244

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

Given at **Islamabad** this **Seventeenth** day of **September,** Two **Thousand** and **Twenty One**

M. [signature]

Moeen Rajput
Deputy Registrar

SEAL OF REGISTRAR OF COMPANIES
SECP

https://eservices.secp.gov.pk/eServices/ControllerServlet?request_id=VERIFY_ONLINE_INCORP_CERT&id=0184244

NRTC ENERGIES (PVT) LTD

THE COMPANIES ACT, 2017 (XIX of 2017)

(COMPANY LIMITED BY SHARES)
MEMORANDUM OF ASSOCIATION
OF

NRTC ENERGIES (PRIVATE) LIMITED

1. The name of the Company is NRTC ENERGIES (PRIVATE) LIMITED
2. The Registered Office of the Company will be situated in the Province of Punjab
3. (i) The principal line of business of the company shall be to carry on businesses of solar energy system, its manufacturing through poly silicon and chemical technology, processing, casting, cell manufacturing, module manufacturing and installation thereof and also to install, run, own and manage biomass/waste-to-energy power plant, waste heat power plant, combined cycle power plant and to produce wind, biomass, wave and tidal energy and to deal in all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of energy and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply, subject to permission of relevant authorities.

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

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

(iv) It is hereby undertaken that the company shall not:
(a) engage in any of the business mentioned in sub-clause (iii) above or any unlawful operation;
(b) launch multi-level marketing (MLM), Pyramid and Ponzi Schemes, or other related activities/businesses or any lottery business;
(c) engage in any of the permissible business unless the requisite approval, permission, consent or licence is obtained from competent authority as may be required under any law for the time being in force.

4. The liability of the members is limited.
5. The authorized capital of the company is Rs. 10,000,000 (Ten Million Rupees Only) divided into 100,000 (One Hundred Thousand) Ordinary shares of Rs.100 (One Hundred Rupees Only) each.

NRTC ENERGIES (PVT) LTD NRTC

THE COMPANIES ACT, 2017 (XIX of 2017)
(PRIVATE COMPANY LIMITED BY SHARES)
ARTICLE OF ASSOCIATION
OF

NRTC ENERGIES (PRIVATE) LIMITED

1. The Regulations contained in Table 'A' to the First Schedule to the Companies Act, 2017 shall be the regulations of NRTC ENERGIES (PRIVATE) LIMITED so far as these are applicable to a private company.

PRIVATE COMPANY

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

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

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

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

TRANSFER OF SHARES

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

DIRECTORS

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

1 Tofique Ahmed

2 Imran Gul

3 Jawad Anjum

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

Name and surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No)	Father / Husband Name in full	Nationality (ies) with any former Nationality	Occupation	Usual residential address in full or the registered/principal office address for a subscriber other than natural person	Number of shares taken by each subscriber (in figures and words)	Signatures
Tofique Ahmed	342023874002[illegible]	Muhammad Munir	Pakistan	Director NRTC, Director NRTC Itech (Pvt) Ltd	Mohalla Cantt Railway station, Kharian GUJRAT Punjab Pakistan 50070	1	
Imran Gul	3420207444589	Muhammad Gul	Pakistan	CEO NRTC Itech (Pvt) Ltd	House No. B-1, Ghaznawi Street, Garrison Adiala Road RAWALPINDI Punjab Pakistan [illegible]	1	
Jawad Anjum	4230177998571	Anjum Parvez	Pakistan	Director M/s OnSun (Pvt) Ltd	Flat No.43-G, Askari 3, School Road KARACHI SOUTH Sindh Pakistan 75530	1	
The National Radio Telecommunication Corporation (Pvt) Ltd through Imran Gul	3420207444589	Muhammad Gul	Pakistan	CEO NRTC Itech (Pvt) Ltd	T and T Complex, Haripur HARIPUR Khyber Pakhtunkhwa Pakistan 22620	74,998	
OnSun (Pvt) Ltd through Jawad Anjum	4230177998571	Anjum Parvez	Pakistan	Director M/s OnSun (Pvt) Ltd	Flat No.43-G, Askari 3, School Road KARACHI SOUTH Sindh Pakistan 75530	24,999	

Total number of shares taken (in figures and words)	100,000 (One Hundred Thousand)

Dated: the 15 day of Sep 20 21

Witness to above signatures: witness not required since the documents submitted electronically

Signature:

Address

NRTC ENERGIES (PVT) LTD NRTC

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February 7, 2024
749

The Board of Directors
NRTC Energies (Private) Limited (the Company)
Lahore

Dear Sirs

FINANCIAL STATEMENTS FOR THE YEAR ENDED JUNE 30, 2023

We enclose three copies of the above referred financial statements with our draft audit report thereon initialed by us for identification purposes. We shall be pleased to sign our report in present or amended form after:

i) the financial statements have been approved by the Board of Directors (the Board) and signed by the Chief Executive and a director authorized by the Board in this behalf;

ii) we have seen board's specific approval for items listed in Annexure to this letter, restatement of prior year financial statements as disclosed in note 29 and reclassification of corresponding figures as disclosed in note 30 to the financial statements;

iii) we have reviewed the Directors report presented to the Board along with the audited financial statements;

iv) we have reviewed the Company's statement of compliance with the code of public sector entities; and

v) we have received a representation letter on the lines of the enclosed draft, duly signed by the Chief Executive and the Chief Financial Officer of the Company.

2. Responsibilities of the auditors and the management in relation to the financial statements

The responsibilities of the independent auditors, in a usual examination of financial statements, are explained in the International Standard on Auditing – 200 "Overall Objectives of the Independent Auditor and Conduct of an Audit in Accordance with International Standards on Auditing". While the auditors are responsible for forming and expressing their opinion on the financial statements, the responsibility for preparation of the financial statements is primarily that of the Company's management. The management's responsibilities include the maintenance of adequate accounting records and internal controls, the selection and application of accounting policies, safeguarding the assets of the Company and prevention and detection of frauds and irregularities. The audit of financial statements does not relieve the management of its responsibilities. Accordingly, our examination of the books of accounts and records should not be relied upon to disclose all the errors or irregularities in relation to the financial statements.

A. F. FERGUSON & CO., Chartered Accountants, a member firm of the PwC network
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▪KARACHI ▪LAHORE ▪ISLAMABAD

NRTC ENERGIES (PVT) LTD

3. Liabilities and Equity status

We noted that the Company has current liabilities in excess of current assets and also has a negative equity of Rs 17,624,731 as at June 30, 2023. We have been apprised by the management that the entity is in its initial years of operations and foresees a positive outlook in future year. Further the Company has already achieved positive cashflows from operations and the management is confident that the Company will be able to settle its liabilities in normal course of business. We trust that the Board is aware of the aforesaid facts and is in agreement with the management's views in this regard.

4. Public Sector Companies (Corporate Governance) Rules, 2013 (the Code)

The Company is required to report on compliance with requirements of the Code. Whilst the non-compliances are to be reported in the statement of compliance with the Code, yet we feel appropriate in outlining that steps be taken and concerned authorities and officials be pursued for attaining full compliance of the Code. We may caution that besides other penal consequences, same also attract negative implications for group taxation, where opted for, under the requirements of Income Tax Ordinance, 2001 which can have an entity level impact for the Company as well.

5. Records and documents

5.1 We noted certain instances where contracts with customers were not completed within the prescribed timelines. The delay may attract any penalties or damages. We recommend that a dashboard of timelines for customer contracts be maintained and periodically reviewed for deviations and necessary actions are taken to avoid any penalties or damages.

5.2 We noted that purchase requisitions, purchase orders and goods receipt notes are not sequentially numbered. We recommend that the supporting documents are sequentially numbered to ensure completeness and better control over procurement process.

5.3 We noted instances where related supporting documents for vouchers were not attached with the vouchers. Further, in some cases, supporting documents were in the form of pictures captured through a cellular phone and in various instances were not legible as well. Notwithstanding the legible nature of the pictures, we may draw attention to the fact that same does not suffice for the original records as are required to be kept by the Company under the law. We recommend that books of account and underlying records be appropriately maintained and retained per the various statutory requirements attracted towards the Company.

6. Compliance with Human Resource Policy

We noted certain instances where certain documents, such as Human Resource (HR) form, technical interview evaluation form, offer letter, offer acceptance letter, joining letter annual performance review, latest increment letters etc., as required by the HR policy were not available for our review in the personnel files. We recommend that the practices be aligned with the HR policy.

7. Information system

7.1 We observed that the financial management system of the Company is neither computerized / automated nor integrated and the Company is maintaining manual accounting records. Further, the journal entries are posted manually which may pose possibility of revisions.

NRTC ENERGIES (PVT) LTD

We recommend that the use of a secure and automated information system be evaluated as to have better control over financial reporting process. Further, access to general ledgers and other records should be restricted to authorized users only.

7.2 We have been apprised that certain steps have been taken by the Company for protection of records, but the Company is yet to formulate a data protection plan and back up policy for protection and back up of data. We recommend that appropriate contingency plan be drawn for safeguarding of data and robust controls and procedures should be placed for retrieval of data in different mode and forms including assessment of the need for any off site backup. Further, steps may also be taken to guard the data, information, and related records from any possible loss.

8. End of service benefits to employees

We noted that the Company does not offer any service terminal benefits to employees. We recommend that the Company may seek guidance from its legal counsel and take steps to ensure any compliance due, with local laws and regulations. Further, adjustments, if required, are incorporated in books of account.

9. Mechanism for calculation of Expected Credit Losses (ECL) on financial assets

IFRS 9 "Financial Instruments" requires that an entity shall assess and recognise a loss allowance for ECL on all financial assets that are carried at amortised cost model. In this respect, we noted that a formal mechanism for calculation of ECL on financial assets was not in place. We recommend that ECL be evaluated on periodic basis for all financial assets and adjustment, if any required, be adequately incorporated in books of account of the Company to remain in compliance with the statutory reporting framework requirements. Further, key inputs of the ECL model are sourced carefully keeping in view suitability, source data limitations, recent economic trends and their long-term impacts on financial assets of the Company.

10. Fixed assets

10.1 IAS 16 Property, Plant and Equipment requires the items of property and equipment be capitalized when it is probable that the future economic benefits associated with the item will flow to the entity and the cost of item can be measured reliably. However, we noted that the Company does not have a written capitalization policy in place for property and equipment. Given the foregoing, we recommend that the related policy be formulated and assessed for appropriateness by the Company.

10.2 We also observed that the fixed assets are neither coded and tagged nor captured per the fixed assets register requirements outline vide TR 6 prescribed by Institute of Chartered Accountants of Pakistan. In addition, the Company does not have any practice of periodic physical verification of fixed assets. We recommend that fixed assets should be physically verified, properly tagged / coded and captured in the fixed assets register for proper control over assets along appropriate record keeping thereof.

11. Cost allocation

We noted that costs pertaining to employees have been allocated by the Company to direct cost based on a predetermined ratio. Further we also noted that time sheets are not prepared by employees of the Foundation as to determine their accurate effort level allocable

ENERGIES (PVT) LTD

for each activity. We recommend that the activity cost drivers are duly identified, and the basis of allocation thereof be periodically evaluated to arrive at precise margins/operational results of each activity.

12. Facility availed without consideration

We noted that the Company is using various resources and facilities of the parent Company. In this respect, we have been confirmed that the related amounts are insignificant for the Company and neither any amount in this respect is charged by the Company nor would be charged to the Parent Company thus no such amount is recognized as expense by the management of the Company.

We recommend that the related matter be appropriately assessed in light of respective requirements including taxation and accounting covenants. Further, terms of business and support by the Company be formally documented and approved by the concerned.

13. Restatement and reclassification

We feel appropriate in drawing attention to the contents of note 29 and 30 of the enclosed financial statements which outline certain prior period reclassifications/restatements. In this respect, we have been apprised that certain of the related matters pertain to error in the prior periods and have now been appropriately addressed by the management. We recommend that related matters be internally deliberated, and steps taken for robust responsiveness to avoid reoccurrence of any such error in the future accounting/reporting matters.

14. Please note that, in due course of time, we shall also issue a management letter which shall be including our observations on certain internal controls and accounting matters which came to our notice during the course of the audit, together with our recommendations, as considered appropriate in these respect. We may however, add that our audit procedures were designed with a view to expressing an opinion on the financial statements taken as a whole and not to provide an independent assurance on the internal control structure which may be the objective of any related focused examination

15. We wish to place on record our appreciation of the co-operation and courtesy extended to us by the management and staff of the Company during audit.

Yours truly

A.F.Ferguson & Co.

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Annexure

NRTC ENERGIES (PRIVATE) LIMITED
FINANCIAL STATEMENTS FOR THE YEAR ENDED JUNE 30, 2023

List of items requiring the Board's specific approval as referred to in our letter 749 dated February 7, 2024:

		Rupees
(i)	Property and equipment	
	Operating assets	
	- Additions at cost during the year	3,416,283
(ii)	Capital work in progress	
	- Additions during the year	3,235,725
(iii)	Transactions with related parties as disclosed in note 28 to the financial statements.	
(iv)	Remuneration of Chief Executive, Directors and Executives as disclosed in note 26 to the financial statements.	

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INDEPENDENT AUDITOR'S REPORT

To the Members of NRTC Energies (Private) Limited

Report on the Audit of the Financial Statements

Opinion

We have audited the annexed financial statements of NRTC Energies (Private) Limited (the Company), which comprise the statement of financial position as at June 30, 2023, and the statement of profit or loss, the statement of comprehensive income, the statement of changes in equity, the statement of cash flows for the year then ended, and notes to the financial statements, including a summary of significant accounting policies and other explanatory information, and we state that we have obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purposes of the audit.

In our opinion and to the best of our information and according to the explanations given to us, the statement of financial position, the statement of profit or loss, the statement of comprehensive income, the statement of changes in equity and the statement of cash flows together with the notes forming part thereof conform with the accounting and reporting standards as applicable in Pakistan and give the information required by the Companies Act, 2017 (XIX of 2017), in the manner so required and respectively give a true and fair view of the state of the Company's affairs as at June 30, 2023 and of the loss and other comprehensive loss, the changes in equity and its cash flows for the year then ended.

Basis for Opinion

We conducted our audit in accordance with International Standards on Auditing (ISAs) as applicable in Pakistan. Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Company in accordance with the International Ethics Standards Board for Accountants' Code of Ethics for Professional Accountants as adopted by the Institute of Chartered Accountants of Pakistan (the Code) and we have fulfilled our other ethical responsibilities in accordance with the Code. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Information Other than the Financial Statements and Auditor's Report Thereon

Management is responsible for the other information. The other information comprises the information included in the director's report but does not include the financial statements and our auditor's report thereon.

Our opinion on the financial statements does not cover the other information and we do not express any form of assurance conclusion thereon.

In connection with our audit of the financial statements, our responsibility is to read the other information and, in doing so, consider whether the other information is materially inconsistent with the financial statements or our knowledge obtained in the audit, or otherwise appears to be materially misstated. If, based on the work we have performed, we conclude that there is a material misstatement of this other information, we are required to report that fact. We have nothing to report in this regard.

Responsibilities of Management and Board of Directors for the Financial Statements

Management is responsible for the preparation and fair presentation of the financial statements in accordance with the accounting and reporting standards as applicable in Pakistan and the requirements of Companies Act, 2017(XIX of 2017) and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the Company's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Company or to cease operations, or has no realistic alternative but to do so.

Board of directors are responsible for overseeing the Company's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with ISAs as applicable in Pakistan will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with ISAs as applicable in Pakistan, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Company's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.
- Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Company's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Company to cease to continue as a going concern.

NRTC ENERGIES (PVT) LTD

- Evaluate the overall presentation, structure and content of the financial statements, including the disclosures, and whether the financial statements represent the underlying transactions and events in a manner that achieves fair presentation.

We communicate with the board of directors regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.

Report on Other Legal and Regulatory Requirements

Based on our audit, we further report that in our opinion:

a) proper books of account have been kept by the Company as required by the Companies Act, 2017 (XIX of 2017);

b) the statement of financial position, the statement of profit or loss, the statement of comprehensive income, the statement of changes in equity and the statement of cash flows together with the notes thereon have been drawn up in conformity with the Companies Act, 2017 (XIX of 2017) and are in agreement with the books of account and returns;

c) investments made, expenditure incurred and guarantees extended during the year were for the purpose of the Company's business; and

d) no zakat was deductible at source under the Zakat and Ushr Ordinance, 1980 (XVIII of 1980).

Other Matter

The financial statements of the Company for the year ended June 30, 2022 were audited by another auditor who expressed an unmodified opinion on those financial statements on January 17, 2024.

The engagement partner on the audit resulting in this independent auditor's report is JehanZeb Amin.

A.F.Ferguson & Co.

Chartered Accountants
Islamabad
Date: October 9, 2024
UDIN: AR202310083nlP7sz2XI

NRTC ENERGIES (PVT) LTD

NRTC ENERGIES (PRIVATE) LIMITED
STATEMENT OF FINANCIAL POSITION
AS AT JUNE 30, 2023

	Note	2023 Rupees	2022 Rupees (Restated)
ASSETS			
NON-CURRENT ASSETS			
Property and equipment	5	6,652,467	327,175
Long term deposits		922,000	215,300
		7,574,467	542,475
CURRENT ASSETS			
Stock in trade	7	80,642,763	201,481
Trade and other receivable	8	40,242,894	11,676,881
Advances	9	2,287,912	8,732,650
Sales tax refundable-net	10	14,366,237	1,952,187
Prepayments	11	400,473	-
Cash and bank balances	12	100,353,093	273,459
		238,293,372	22,836,659
TOTAL ASSETS		245,867,839	23,379,134
EQUITY & LIABILITIES			
EQUITY AND RESERVES			
Share capital	13	10,000,000	10,000,000
Accumulated (losses) / profit		(27,624,731)	662,134
		(17,624,731)	10,662,134
NON-CURRENT LIABILITIES			
Deferred tax liabilities	14	164,842	13,442
CURRENT LIABILITIES			
Loan from Onsun Pvt Ltd - unsecured	15	10,650,654	650,654
Trade and other payables	16	147,414,383	11,671,337
Contract liabilities	17	99,530,132	-
Provision for taxation	18	5,732,559	381,567
		263,327,728	12,703,558
TOTAL EQUITY AND LIABILITIES		245,867,839	23,379,134
CONTINGENCIES AND COMMITMENTS			

The annexed notes 1 to 32 form an integral part of these financial statements.

~~CHIEF EXECUTIVE OFFICER~~ Director

~~DIRECTOR~~ Cheif Executive officer

ENERGIES (PVT) LTD

NRTC ENERGIES (PRIVATE) LIMITED
STATEMENT OF PROFIT OR LOSS
FOR THE YEAR ENDED JUNE 30, 2023

	Note	2023 Rupees	2022 Rupees
Revenue - net	19	458,670,733	37,335,328
Cost of sales	20	(423,089,685)	(27,336,071)
Gross profit		35,581,048	9,999,257
Selling and distribution expenses	21	(7,748,200)	(1,290,148)
Administrative expenses	22	(50,228,422)	(7,564,608)
Operating (loss) / profit		(22,395,574)	1,144,501
Finance cost	23	(6,508)	(2,233)
(Loss) / Profit before taxation		(22,402,082)	1,142,268
Income tax expense	24	(5,884,784)	(480,134)
(Loss) / Profit for the year		(28,286,866)	662,134

The annexed notes 1 to 32 form an integral part of these financial statements.

~~CHIEF EXECUTIVE OFFICER~~

Director

~~DIRECTOR~~

Cheif Executive officer

NRTC ENERGIES (PVT) LTD NRTC

NRTC ENERGIES (PRIVATE) LIMITED
STATEMENT OF COMPREHENSIVE INCOME
FOR THE YEAR ENDED JUNE 30, 2023

	2023 Rupees	2022 Rupees
(Loss) / Profit for the year	(28,286,866)	662,134
Other comprehensive (loss) / income for the year - net of tax	-	-
Total comprehensive (loss) / income for the year	(28,286,866)	662,134

The annexed notes 1 to 32 form an integral part of these financial statements.

~~CHIEF EXECUTIVE~~ OFFICER
Director

~~DIRECTOR~~
Cheif Executive officer

NRTC ENERGIES (PVT) LTD

NRTC ENERGIES (PRIVATE) LIMITED
STATEMENT OF CASH FLOWS
FOR THE YEAR ENDED JUNE 30, 2023

	Note	2023 Rupees	2022 Rupees
Cash flows from operating activities			
(Loss) / Profit before tax		(22,402,082)	1,142,268
Adjustments for:			
Depreciation	5	326,716	15,045
Operating cash flows before working capital changes		(22,075,366)	1,157,313
Changes in operating activities			
Stock in trade	7	(80,441,282)	(201,481)
Trade and other receivable	8	(36,066,013)	(4,176,881)
Advances	9	6,444,738	(8,732,650)
Sales tax refundable-net	10	(12,414,050)	(1,952,187)
Prepayments	11	(400,473)	-
Long term deposits		(706,700)	(215,300)
Trade and other payables	16	135,743,046	11,671,337
Contract liabilities	17	99,530,132	-
		111,689,399	(3,607,163)
Cash generated from operating activities		89,614,034	(2,449,850)
Taxes paid		(382,392)	(85,125)
Net cash generated / (used) from operating activities		89,231,642	(2,534,975)
Cash flows from investing activities			
Additions in property and equipment	5	(6,652,008)	(342,220)
Net cash used in investing activities		(6,652,008)	(342,220)
Cash flows from financing activities			
Proceeds from issue of share	13	7,500,000	2,500,000
Loan from Onsun (Private) Limited - unsecured	15	10,000,000	650,654
Net cash generated from financing activities		17,500,000	3,150,654
Net increase in cash and cash equivalents		100,079,634	273,459
Cash and cash equivalents at beginning of the year		273,459	-
Cash and cash equivalents at end of the year		100,353,093	273,459

The annexed notes 1 to 32 form an integral part of these financial statements.

~~CHIEF EXECUTIVE OFFICER~~

Director

~~DIRECTOR~~

Chief Executive officer

NRTC ENERGIES (PVT) LTD NRTC

NRTC ENERGIES (PRIVATE) LIMITED
STATEMENT OF CHANGES IN EQUITY
FOR THE YEAR ENDED JUNE 30, 2023

	Share capital Ordinary shares	Accumulated (losses) / profit	Total
	Rupees		
Balance at September 17, 2021	-	-	-
Total comprehensive income for the period			
Profit for the period	-	662,134	662,134
Other comprehensive income for the period	-	-	-
Total comprehensive income for the period	-	662,134	662,134
Transactions with owners			
Issue of share	10,000,000	-	10,000,000
Balance at June 30, 2022	10,000,000	662,134	10,662,134
Balance at July 1, 2022	10,000,000	662,134	10,662,134
Total comprehensive income for the year			
Loss for the year	-	(28,286,866)	(28,286,866)
Other comprehensive income for the year	-	-	-
Total comprehensive income for the year	-	(28,286,866)	(28,286,866)
Balance at June 30, 2023	10,000,000	(27,624,731)	(17,624,731)

The annexed notes 1 to 32 form an integral part of these financial statements.

~~CHIEF EXECUTIVE OFFICER~~

Director

~~DIRECTOR~~

Cheif Executive officer

NRTC ENERGIES (PVT) LTD NRTC

NRTC ENERGIES (PRIVATE) LIMITED
NOTES TO THE FINANCIAL STATEMENTS
FOR THE YEAR ENDED JUNE 30, 2023

1. LEGAL STATUS AND OPERATIONS

NRTC Energies (Private) Limited is a Company registered under the Companies Act, 2017. The Company was incorporated in Pakistan on September 17, 2021 under the Companies Ordinance, 1984 (repealed by the Companies Act, 2017). The Company's registered office is located at Nasralla Link Road, Mumtaz City, Islamabad, Pakistan. The principal activity of the Company is to carry on business of import and trading of solar energy system and promotion of green energy. The Company is the subsidiary of National Radio Telecommunication Corporation (Private) Limited (NRTC).

The prior period financial statements cover the period from September 17, 2021 to June 30, 2022 for comparative information and therefore, are not entirely comparable in respect of statement of profit or loss, statement of comprehensive income, statement of cashflow, statement of changes in equity, and notes to and forming part of the financial statements.

2. BASIS OF PREPARATION

2.1 Statement of compliance

These financial statements have been prepared in accordance with the accounting and reporting standards as applicable in Pakistan. The accounting and reporting standards applicable in Pakistan comprise of:

- International Financial Reporting Standards (IFRS Standards) issued by the International Accounting Standards Board (IASB) as notified under the Companies Act, 2017; and
- Provisions of and directives issued under the Companies Act, 2017.

Where provisions of and directives issued under the Companies Act, 2017 differ from the IFRS Standards, the provisions of and directives issued under the Companies Act, 2017 have been followed.

2.2 Accounting Convention

These financial statements have been prepared on the basis of 'historical cost convention' using accrual basis of accounting except as otherwise stated in the respective accounting policies notes.

2.3 Critical accounting estimates and judgements

The preparation of financial statements in conformity with approved accounting standards requires the use of certain critical accounting estimates. It also requires management to exercise its judgment in the process of applying the Company's accounting policies. Estimates and judgments are continually evaluated and are based on historic experience, including expectations of future events that are believed to be reasonable under the circumstances. The areas involving a higher degree of judgment or complexity, or areas where assumptions and estimates are significant to the financial statements, are as follows:

i) Estimated useful life of property and equipment (note - 4.5)
ii) Impariment of non financial assets (note - 4.6)

NRTC ENERGIES (PVT) LTD
NRTC

iii) Provision for stock in trade (note - 4.7)
iv) Expected credit losses (note - 28)
v) Provision for current and deferred tax (note - 4.1)
vi) Contingencies (note - 4.4)

3 Adoption of new and amended standards and interpretations

3.1 Standards, interpretations and amendments to published approved accounting standards that are effective but not relevant

Standards, amendments and interpretations to existing standards that are not yet effective and have not been adopted early by the Company.

		Effective date (annual periods beginning on or after)
IAS 1	Presentation of financial statements (Amendments)	January 1, 2023 & January 1, 2024
IAS 7	Statement of Cash Flows (Amendments)	January 1, 2024
IAS 8	Accounting policies, changes in accounting estimates and errors (Amendments)	January 1, 2023
IAS 12	Income Taxes (Amendments)	January 1, 2023
IFRS 4	Insurance contracts (Amendments)	January 1, 2023
IFRS 7	Financial Instrument Disclosures (Amendments)	January 1, 2024
IFRS 16	Leases (Amendments)	January 1, 2024

The management anticipates that the adoption of the above standards, amendments and interpretations in future periods, will have no material impact on the financial statements other than in presentation / disclosures.

Further, the following new standards and interpretations have been issued by the International Accounting Standards Board (IASB), which are yet to be notified by the Securities and Exchange Commission of Pakistan, for the purpose of their applicability in Pakistan:

IFRS 1	First-time Adoption of International Financial Reporting Standards
IFRS 17	Insurance Contracts
IFRIC 12	Service concession arrangements

4 SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

4.1 Income tax

The tax expense for the year comprises current and deferred income tax, and is recognized in the statement of profit or loss, except to the extent that it relates to items recognized in other comprehensive income or directly in the equity. In this case, the tax is also recognized in other comprehensive income or directly in equity, respectively.

NRTC ENERGIES (PVT) LTD

Current

The current income tax charge is calculated on the basis of the tax laws enacted or substantively enacted at the statement of financial position date. Management periodically evaluates positions taken in tax returns with respect to situations in which applicable tax regulation is subject to interpretation and establishes provisions where appropriate on the basis of amounts expected to be paid to the tax authorities.

Deferred

Deferred income tax is recognized, using the balance sheet liability method, on temporary differences arising between the tax bases of assets and liabilities and their carrying amounts in the financial statements.

Deferred income tax liabilities are recognized for all taxable temporary differences and deferred tax assets are recognized to the extent that it is probable that taxable profits will be available against which the deductible temporary differences, unused tax losses and tax credits can be utilized.

Deferred income tax is calculated at the rates that are expected to apply to the period when the differences reverse, based on tax rates that have been enacted or substantively enacted by the statement of financial position date.

Deferred income tax assets and liabilities are offset when there is a legally enforceable right to offset current income tax assets against current tax liabilities and when the deferred income tax assets and liabilities relate to income tax levied by the same taxation authority on either the same taxable entity or different taxable entities where there is an intention to settle the balance on a net basis.

4.2 Trade and other payables

Liabilities for trade and other amounts payable are carried at cost, which is the fair value of the consideration to be paid in future for goods and services received, whether or not billed to the Company.

4.3 Provisions

A provision is recognized in the financial statements when the Company has a legal or constructive obligation as a result of past events and it is probable that an outflow of resources embodying economic benefits will be required to settle the obligation and a reliable estimate can be made of the amount of obligation.

4.4 Contingent liabilities

A contingent liability is disclosed when the Company has a possible obligation as a result of past events, the existence of which will be confirmed only by the occurrence or non-occurrence, of one or more uncertain future events, not wholly within the control of the Company; or when the Company has a present legal or constructive obligation, that arises from past events, but it is not probable that an outflow of resources embodying economic benefits will be required to settle the obligation, or the amount of the obligation cannot be measured with sufficient reliability.

NRTC ENERGIES (PVT) LTD

4.5 Property and equipment

All operating fixed assets are stated at cost less accumulated depreciation and impairment loss, if any except for capital work in progress which is stated at cost less impairment loss, if any. The cost of operating fixed assets includes its purchase price and non-refundable purchase taxes and any directly attributable costs of bringing the asset to its working condition and location for its intended use.

Depreciation on additions to property and equipment is charged, using reducing balance method, on pro rata basis from the month in which the relevant asset is acquired or capitalized, upto the month in which the asset is disposed off. Impairment loss, if any, or its reversal, is also charged to income for the year. Where an impairment loss is recognized, the depreciation charge is adjusted in future periods to allocate the asset's revised carrying amount, less its residual value, over its estimated useful life.

Maintenance and normal repair costs are expensed out as and when incurred. Major renewals and improvements are capitalized and assets so replaced, if any are retired.

Gains and losses on disposal of fixed assets, if any, are recognized in statement of profit or loss.

4.6 Impairment of non-financial assets

Assets that are subject to depreciation are reviewed for impairment on the date of the statement of financial position, or whenever events or changes in circumstances indicate that the carrying amount may not be recoverable. An impairment loss is recognized, equal to the amount by which the asset's carrying amount exceeds its recoverable amount. An asset's recoverable amount is the higher of its fair value less costs to sell and value in use. For the purposes of assessing impairment, assets are grouped at the lowest levels for which there are separately identifiable cash flows. Non financial assets that suffered an impairment, are reviewed for possible reversal of the impairment at each statement of financial position date. Reversals of the impairment loss are restricted to the extent that asset's carrying amount does not exceed the carrying amount that would have been determined, net of depreciation, if no impairment loss has been recognized. An impairment loss, or the reversal of an impairment loss, are both recognized in the statement of profit or loss.

4.7 Stock-in-trade

Inventories are stated at the lower of cost and net realizable value. Cost is calculated using the weighted average method. Cost comprises invoice value and other cost incurred for bringing the stock at their present location and condition for intended use. Net realizable value is the estimated selling price in the ordinary course of business, less cost of completion and costs necessary to be incurred to make the sale.

4.8 Trade debts and other receivables

Trade debts and other receivables are recognised initially at the amount of consideration that is unconditional, unless they contain significant financing component in which case such are recognised at fair value. The Company holds the trade debts with the objective of collecting the contractual cash flows and therefore measures the trade debts subsequently at amortised cost using the effective interest method.

NRTC ENERGIES (PVT) LTD

4.9 Cash and cash equivalents

Cash and cash equivalents include cash in hand and cash at banks. For the purpose of the statement of cash flows, cash and cash equivalents are bank balances and cash in hand.

4.10 Revenue from contracts with customers

The Company measures progress of satisfaction of performance obligation for its revenue from Contracts with customers under IFRS 15 'Revenue from Contracts with Customers'. The Company measures its revenue by determining stage of completion when the customer obtains control over the relevant products or services. Costs incurred are recognised as cost of sales in the statement of profit or loss when the related revenue is recognised in the statement of profit or loss.

Variations in contract work, claims/damages and incentive payments are included to the extent that they have been agreed with the customer. When it is probable that total contract costs will exceed total contract revenue, the expected loss is recognized as an expense immediately.

Revenue from sale of goods is recognized on transfer of goods to customers. Revenue from maintainance services and other contracts is recognized when services are rendered to the

No element of financing is deemed present as the sales are made with a credit term of up to 120 days, which is consistent with the market practice.

4.11 Contract liabilities

Contract liability relates to amounts that are paid by or due to customers for which performance obligations are unsatisfied or partially satisfied.

4.12 Functional and presentation currency

Items included in the financial statements are measured using the currency of the primary economic environment in which the Company operates. The financial statements are presented in Pakistan (Rupees) which is the Company's functional and presentation currency. All financial information presented in Pakistan Rupees has been rounded to the nearest rupee unless otherwise stated.

4.13 Foreign currency transactions

Foreign currency transactions are translated into the functional currency using the exchange rate prevailing on the date of the transaction. Monetary assets and liabilities denominated in foreign currencies are translated into functional currency using the exchange rate prevailing at the statement of financial position date. Foreign exchange gains and losses resulting from the settlement of such transactions and from the translation at year-end exchange rates are recognised in the statement of profit or loss.

NRTC ENERGIES (PVT) LTD

4.14 Financial instruments

Initial recognition

All financial assets and liabilities are initially measured at cost which is the fair value of the consideration given or received. These are subsequently measured at fair value, amortised cost or cost as the case may be.

Classification of financial assets

The Company classifies its financial assets in the following categories:

- at fair value through profit or loss ("FVTPL"),
- at fair value through other comprehensive income ("FVTOCI"), or
- at amortised cost.

The Company determines the classification of financial assets at initial recognition. The classification of instruments (other than equity instruments) is driven by the Company's business model for managing the financial assets and their contractual cash flow characteristics.

Financial assets that meet the following conditions are subsequently measured at amortised cost:

- the financial asset is held within a business model whose objective is to hold financial assets in order to collect contractual cash flows; and

- the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

Financial assets that meet the following conditions are subsequently measured at FVTOCI:

- the financial asset is held within a business model whose objective is achieved by both collecting contractual cash flows and selling the financial assets; and

- the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

By default, all other financial assets are subsequently measured at FVTPL.

Classification of financial liabilities

The Company classifies its financial liabilities in the following categories:

- at fair value through profit or loss ("FVTPL"), or
- at amortised cost.

Financial liabilities are measured at amortised cost, unless they are required to be measured at FVTPL (such as instruments held for trading or derivatives) or the Company has opted to measure them at FVTPL.

NRTC ENERGIES (PVT) LTD

Subsequent measurement

i) **Financial assets at FVTOCI**

Investments elected to be as equity instruments at FVTOCI are initially recognised at fair value plus transaction costs. Subsequently, they are measured at fair value, with gains or losses arising from changes in fair value recognised in other comprehensive income / (loss).

ii) **Financial assets and liabilities at amortised cost**

Financial assets and liabilities at amortised cost are initially recognised at fair value, and subsequently carried at amortised cost, and in the case of financial assets, less any impairment.

iii) **Financial assets and liabilities at FVTPL**

Financial assets and liabilities carried at FVTPL are initially recorded at fair value and transaction costs are expensed in the statement of profit or loss. Realised and unrealised gains and losses arising from changes in the fair value of the financial assets and liabilities held at FVTPL are included in the statement of profit or loss in the period in which they arise.

Impairment of financial assets

The Company recognises loss allowance for Expected Credit Loss (ECL) on financial assets measured at amortised cost, at an amount equal to life time ECLs except for the following, which are measured at 12 months ECLs:

- Cash and bank balances for whom credit risk (the risk of default occurring over the expected life of the financial instrument) has not increased since the inception

- Other receivables that have not demonstrated any increase in credit risk since inception

Life time ECLs are the ECLs that results from all possible default events over the expected life of a financial instrument. 12 months' ECL are portion of ECL that result from default events that are possible within 12 months after the reporting date.

ECLs are a probability weighted estimate of credit losses. Credit losses are measured as the present value of all cash shortfalls (i.e. the difference between cash flows due to the entity in accordance with the contract and cash flows that the Company expects to receive).

The gross carrying amount of a financial asset is written off when the Company has no reasonable expectation of recovering a financial asset in its entirety or a portion thereof.

NRTC ENERGIES (PVT) LTD

Derecognition

The Company derecognises financial liabilities when, and only when, the Company's obligations are discharged, cancelled or they expire.

i) **Financial assets**

The Company derecognises financial assets only when the contractual rights to cash flows from the financial assets expire or when it transfers the financial assets and substantially all the associated risks and rewards of ownership to another entity. On derecognition of a financial asset measured at amortised cost, the difference between the asset's carrying value and the sum of the consideration received and receivable is recognised in profit or loss. In addition, on derecognition of an investment in a debt instrument classified as FVTOCI, the cumulative gain or loss previously accumulated in the investments revaluation reserve is reclassified to profit or loss. In contrast, on derecognition of an investment in equity instrument which the Company has elected on initial recognition to measure at FVTOCI, the cumulative gain or loss previously accumulated in the investments revaluation reserve is not reclassified to profit or loss, but is transferred to statement of changes in equity.

ii) **Financial liabilities**

The Company derecognises financial liabilities only when its obligations under the financial liabilities are discharged, cancelled or expired. The difference between the carrying amount of the financial liability derecognised and the consideration paid and payable, including any non-cash assets transferred or liabilities assumed, is recognised in the statement of profit or loss.

Offsetting of financial assets and financial liabilities

Financial assets and liabilities are offset and the net amount is reported in the statement of financial position if the Company has legally enforceable right to set-off the recognised amounts and the Company intends to settle on a net basis or realise the asset and settle the liability simultaneously.

Write-off

The gross carrying amount of a financial asset is written off when the Company has no reasonable expectations of recovering a financial asset in its entirety or a portion thereof. The Company individually makes an assessment with respect to the timing and amount of write-off based on whether there is a reasonable expectation of recovery. The Company expects no significant recovery from the amount written off. However, financial assets that are written off could still be subject to enforcement activities in order to comply with the Company's procedures for recovery of amounts due.

NRTC ENERGIES (PVT) LTD

4.15 Fair value measurement

Fair value is the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date. The fair value measurement is based on the presumption that the transaction to sell the asset or transfer the liability takes place either:

- In the principal market for the asset or liability; or

- In the absence of a principal market, in the most advantageous market for the asset or liability

The principal or the most advantageous market is accessible by the Company. The fair value of an asset or a liability is measured using the assumptions that market participants would use when pricing the asset or liability, assuming that market participants act in their economic best interest.

A fair value measurement of a non-financial asset takes into account a market participant's ability to generate economic benefits by using the asset in its highest and best use or by selling it to another market participant that would use the asset in its highest and best use.

The Company uses valuation techniques that are appropriate in the circumstances and for which sufficient data are available to measure fair value, maximizing the use of relevant observable inputs and minimizing the use of unobservable inputs.

All assets and liabilities for which fair value is measured or disclosed in the financial statements are categorized within the fair value hierarchy, described as follows, based on the lowest level input that is significant to the fair value measurement as a whole:

- Level 1 — Quoted (unadjusted) market prices in active markets for identical assets or liabilities;

- Level 2 — Valuation techniques for which the lowest level input that is significant to the fair value measurement is directly or indirectly observable; and

- Level 3 — Valuation techniques for which the lowest level input that is significant to the fair value measurement is unobservable

For assets and liabilities that are recognized in the financial statements at fair value on a recurring basis, the Company determines whether transfers have occurred between levels in the hierarchy by re-assessing categorization (based on the lowest level input that is significant to the fair value measurement as a whole) at the end of each reporting period.

The Company determines the policies and procedures for both recurring fair value measurement and for non-recurring measurement. For the purpose of fair value disclosures, the Company determines classes of assets and liabilities on the basis of the nature, characteristics and risks of the asset or liability and the level of the fair value hierarchy, as explained above.

NRTC ENERGIES (PVT) LTD

		Note	2023 Rupees	2022 Rupees
5	**PROPERTY AND EQUIPMENT**			
	Operating fixed assets	5.1	3,416,742	327,175
	Capital work in progress	5.2	3,235,725	-
			6,652,467	327,175

5.1 Operating fixed assets

	Furniture and fixture	Computer equipment	Electrical equipment	Motor vehicles	General equipment	Total
			Rupees			
As at September 17, 2021						
Cost	-	-	-	-	-	-
Accumulated depreciation	-	-	-	-	-	-
Net book value	-	-	-	-	-	-
Year ended June 30, 2022						
Opening net book value	-	-	-	-	-	-
Additions	48,500	136,120	38,700	108,900	10,000	342,220
Disposals						
- Cost	-	-	-	-	-	-
- Accumulated depreciation	-	-	-	-	-	-
	-	-	-	-	-	-
Disposals						
- Cost	-	-	-	-	-	-
- Accumulated depreciation	-	-	-	-	-	-
	-	-	-	-	-	-
Depreciation charge	(1,213)	(9,459)	(1,401)	(2,723)	(250)	(15,045)
Net book value	47,288	126,661	37,299	106,178	9,750	327,175
As at July 1, 2022						
Cost	48,500	136,120	38,700	108,900	10,000	342,220
Accumulated depreciation	(1,213)	(9,459)	(1,401)	(2,723)	(250)	(15,045)
Net book value	47,288	126,661	37,299	106,178	9,750	327,175
Year ended June 30, 2023						
Opening net book value	47,288	126,661	37,299	106,178	9,750	327,175
Additions	816,013	1,766,100	-	-	834,170	3,416,283
Disposals						
- Cost	-	-	-	-	-	-
- Accumulated depreciation	-	-	-	-	-	-
- Net book value	-	-	-	-	-	-
Depreciation charge	(21,506)	(241,744)	(11,290)	(16,127)	(36,049)	(326,716)
Net book value	841,795	1,651,017	26,009	90,051	807,871	3,416,742
Cost	864,513	1,902,220	38,700	108,900	844,170	3,758,503
Accumulated depreciation	(22,719)	(251,203)	(12,691)	(18,850)	(36,299)	(341,761)
Closing net book amount	841,795	1,651,017	26,009	90,051	807,871	3,416,742
Annual rate of depreciation %	15%	30%	30%	15%	30%	

NRTC ENERGIES (PVT) LTD

NRTC

5.2 CAPITAL WORK-IN-PROGRESS

	2023 Rupees	2022 Rupees (Restated)
Balance at beginning of the year	-	-
Additions during the year	3,235,725	-
	3,235,725	-

6 Long term deposits

This represent security deposit paid to vendor in respect of fuel purchases.

7 STOCK IN TRADE

	2023 Rupees	2022 Rupees
Solar panel	42,217,630	-
Inverter	31,439,322	201,481
Wire	6,985,811	-
	80,642,763	201,481

8 TRADE AND OTHER RECEIVABLE

	2023 Rupees	2022 Rupees
Trade receivable - unsecured	26,737,021	4,176,881
Retention money - unsecured	13,505,874	-
Capital subscribed by the National Radio Telecommunication Corporation	-	7,500,000
Less: Impairment loss on trade debts	-	-
	40,242,894	11,676,881

9 ADVANCES

	2023 Rupees	2022 Rupees
Advances - considered good		
- against business expenses	569,474	71,912
- to suppliers	190,000	8,602,738
- to employees - secured	1,120,139	58,000
Others	408,299	-
	2,287,912	8,732,650

10 SALES TAX REFUNDABLE-NET

This mainly includes the sales tax paid for the purchase of batteries and inverter etc.

11 PREPAYMENTS

	2023 Rupees	2022 Rupees
Insurance premium	400,473	-

NRTC ENERGIES (PVT) LTD

		2023 Rupees	2022 Rupees
12	**CASH AND BANK BALANCES**		
	With Bank		
	Current account - local currency	**100,136,060**	1,006
	Cash in hand	**217,033**	272,453
		100,353,093	273,459

13 SHARE CAPITAL

13.1 Authorized share capital

	2023	2022
100,000 (2022: 100,000) ordinary shares of Rs. 100 each	**10,000,000**	10,000,000

13.2 Issued and subscribed capital

2023 Number	2022 Number	Ordinary shares	2023 Rupees	(Restated) 2022 Rupees
100,000	100,000	Ordinary shares of Rs. 100 each paid / payable in cash	**10,000,000**	10,000,000
100,000	100,000		**10,000,000**	10,000,000

13.3 Paid up capital

	2023	2022
100,000 (2022: 25,000) ordinary shares of Rs. 100 each paid in cash	**10,000,000**	2,500,000

13.3.1 National RadioTelecommunication Corporation (NRTC), holds 75,000 (2022: 75,000) and Onsun (Private) Limited, holds 25,000 (2022: 25,000) ordinary shares of the Company at the year end.

13.3.2 All ordinary shares rank equally with regard to the Company's residual assets. Holders of these shares are entitled to dividends as declared from time to time and are entitled to one vote per share at general meetings of the Company.

NRTC ENERGIES (PVT) LTD

		2023 Rupees	2022 Rupees
14	**DEFERRED TAX LIABILITIES**	164,842	13,442

14.1 The movement in deferred tax is as follows:

	Opening Balance as on July 1	Recognized in profit or loss	Closing balance as on June 30
2023		Rupees	
Taxable temporary difference			
Property and equipment	13,442	151,400	164,842
	13,442	151,400	164,842
2022			
Taxable temporary difference			
Property and equipment	-	13,442	13,442
	-	13,442	13,442

14.2 Deffered tax assest, the potential tax benefit of which amounts Rs 12,376,266 has not been recognized on balance representing tax credits as at June 30, 2023 as utilization of these tax credit is not certain. The tax losses and tax credits expire on follows:

	Tax year	Amount
Tax credit related to minimum tax	2026	5,733,384
Business losses	2028	6,491,482
		12,224,866

15 **LOAN FROM ONSUN PVT LTD - UNSECURED**

This represents the amount received from Onsun (Pvt) Ltd, the associate, in order to meet the working capital requirements of the Company. The loan is unsecured, interest free and payable on demand.

		2023 Rupees	2022 Rupees (Restated)
16	**TRADE AND OTHER PAYABLES**		
	Creditors	142,293,827	11,084,445
	Salaries and wages payable	166,000	-
	Withholding tax payable	4,017,945	189,412
	Other liabilities	936,611	397,480
		147,414,383	11,671,337

17 **CONTRACT LIABILITIES**

This represents advances received from customers in the ordinary course of business.

		2023 Rupees	2022 Rupees
18	**PROVISION FOR TAXATION**		
	Opening balance	381,567	-
	Provision for taxation	5,733,384	466,692
	Tax deducted at source	(382,392)	(85,125)
		5,732,559	381,567

NRTC ENERGIES (PVT) LTD

		Note	2023 Rupees	2022 Rupees
19	**REVENUE - NET**			
	Revenue from contract with customers		**460,736,789**	37,335,328
	Less: Sales tax		**(2,066,056)**	-
			458,670,733	37,335,328

19.1 As at June 30, 2022, no contract liabilities were carried, ,no revenue has been recognised during the year which would have been carried from amongst the contract liabilities at the beginning of the year.

			Note	2023 Rupees	2022 Rupees
20	**COST OF SALES**				
	Cost of goods sold		20.1	**403,667,830**	24,611,505
	Civil work and other related expenses			**13,844,255**	1,844,611
	Salaries, wages and other benefits			**5,577,600**	879,955
				423,089,685	27,336,071
20.1	**Cost of goods sold**				
	Add:	Opening stock in trade		**201,481**	-
		Purchased		**484,109,112**	24,812,986
	Less:	Closing stock in trade	7	**(80,642,763)**	(201,481)
	Cost of goods sold			**403,667,830**	24,611,505
21	**SELLING AND DISTRIBUTION EXPENSES**				
	Salaries, wages and other benefits			**7,168,600**	1,130,961
	Advertisement and promotional expenses			**579,600**	159,187
				7,748,200	1,290,148
22	**ADMINISTRATIVE EXPENSES**				
	Salaries, wages and other benefits			**18,427,502**	2,907,232
	Utilities			**56,872**	29,153
	Consultancy fee			**1,355,825**	600,000
	Rent, rate and taxes			**802,553**	-
	Printing, postage and stationery			**541,351**	105,239
	Travelling and Conveyance			**5,456,589**	947,412
	Legal and professional fees			**42,140**	-
	Health Insurance fee			**110,457**	-
	Entertainment expenses			**2,927,598**	251,350
	Commissions and fees			**113,174**	1,300,000
	Repair and maintenance charges			**12,192,703**	288,702
	Auditor's remuneration		22.1	**700,000**	225,000
	Freight charges			**2,288,560**	14,320
	IT Expenses			**656,313**	57,631
	Insurance expenses			**170,979**	-
	Depreciation expense			**326,716**	15,045
	Miscelleneous expenses			**4,059,090**	823,524
				50,228,422	7,564,608

NRTC ENERGIES (PVT) LTD NRTC

		Note	2023 Rupees	2022 Rupees
22.1	**Auditor's remuneration**			
	Annual audit of standalone financial statements		550,000	225,000
	Reporting on compliance of Public Sector Companies (Corporate Governance Rules), 2013		100,000	-
	Out of pocket expenses		50,000	-
			700,000	225,000
23	**FINANCE COST**			
	Bank charges		6,508	2,233
24	**INCOME TAX EXPENSE**			
	Current			
	For the year		5,733,384	466,692
	Prior year		-	-
			5,733,384	466,692
	Deferred tax expense	14.1	151,400	13,442
			5,884,784	480,134
	Accounting (loss) / profit for the year		(22,402,082)	1,142,268
	Applicable tax rate for companies (%)		29%	21%
	Income tax at applicable rate		(6,496,604)	239,876
	Income taxed at lower rate		5,733,384	240,258
	Deferred tax not recognized		6,642,882	-
	Change of rate of tax		5,121	-
			5,884,784	480,134

25 CASH AND CASH EQUIVALENTS

Cash, cash equivalents (used for cash management purposes) include the following for the purposes of statement of cash flows.

	Note	2023 Rupees	2022 Rupees
Cash and bank balances	12	100,353,093	2,306,633

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NRTC ENERGIES (PVT) LTD NRTC

26 REMUNERATION OF CHIEF EXECUTIVE, DIRECTORS AND EXECUTIVES

The aggregate amounts recognized during the year on account of remuneration, including benefits and perquisites, are as follows:

	Chief Executive		Executive	
	2023	2022	2023	2022
	Rupees			
Managerial remuneration	5,302,964	-	5,846,734	-
Bonus	949,908	-	888,595	-
	6,252,872	-	6,735,329	-
Number of persons	1	-	1	-

26.1 Chief Executive and Executive are provided with Company rented cars.

26.2 No remuneration were paid to Chief Executive and directors in previous period.

27 FINANCIAL INSTRUMENTS - FAIR VALUES AND RISK MANAGEMENT

Fair value is the amount that would be received on sale of an asset or paid on transfer of a liability in an orderly transaction between market participants at the measurement date. Consequently, differences can arise between carrying values and fair value estimates. Underlying the definition of fair value is the presumption that the Company is a going concern without any intention or requirement to curtail materially the scale of its operations or to undertake a transaction on adverse terms.

The fair value of financial assets and liabilities traded in active markets i.e. listed equity shares are based on the quoted market prices at the close of trading on the period end date. The quoted market prices used for financial assets held by the Company is current bid price. A financial instrument is regarded as quoted in an active market if quoted prices are readily and regularly available from an exchange, dealer, broker, industry group, pricing service or regulatory agency, and those prices represent actual and regularly occurring market transactions on an arm's length basis.

IFRS 13 'Fair Value Measurements' requires the Company to classify fair value measurements using a fair value hierarchy that reflects the significance of the inputs used in making the measurements. The fair value hierarchy has the following levels:

- Quoted prices (unadjusted) in active markets for identical assets or liabilities (level 1).
- Inputs other than quoted prices included within level 1 that are observable for the asset or liability, either directly (that is, as prices) or indirectly (that is, derived from prices) (level 2).
- Inputs for the asset or liability that are not based on observable market data (that is, unobservable inputs) (level 3).

NRTC ENERGIES (PVT) LTD

27.1 The following table shows the carrying amounts and fair values of financial assets and financial liabilities, including their levels in the fair value hierarchy.

On-balance sheet financial instruments	Note	Carrying amount			Fair value			
		Amortized Cost	FVTPL	Total	Level 1	Level 2	Level 3	Total
		Rupees						
As at June 30, 2023								
Financial assets not measured at fair value								
Long term deposits		-	922,000	922,000	-	-	922,000	922,000
Trade and other receivable	8	40,242,894	-	40,242,894	-	40,242,894	-	40,242,894
Cash and bank balances	12	100,353,093	-	100,353,093	-	100,353,093	-	100,353,093
		140,595,987	922,000	141,517,987	-	140,595,987	922,000	141,517,987
Financial liabilities not measured at fair value								
Loan from Onsun Pvt Ltd - unsecured	15	10,650,654	-	10,650,654	-	10,650,654	-	10,650,654
Trade and other payables	16	147,414,383	-	147,414,383	-	147,414,383	-	147,414,383
Provision for taxation	18	5,732,559	-	5,732,559	-	5,732,559	-	5,732,559
		163,797,596	-	163,797,596	-	163,797,596	-	163,797,596
As at June 30, 2022								
Financial assets not measured at fair value								
Long term deposits		-	215,300	215,300	-	-	215,300	215,300
Trade and other receivable	8	11,676,881	-	11,676,881	-	11,676,881	-	11,676,881
Cash and bank balances	12	273,459	-	273,459	-	273,459	-	273,459
		11,950,340	215,300	12,165,640	-	11,950,340	215,300	12,165,640
Financial liabilities not measured at fair value								
Loan from Onsun Pvt Ltd - unsecured	15	650,654	-	650,654	-	650,654	-	650,654
Trade and other payables	16	11,671,337	-	11,671,337	-	11,671,337	-	11,671,337
Provision for taxation	18	381,567	-	381,567	-	381,567	-	381,567
		12,703,558	-	12,703,558	-	12,703,558	-	12,703,558

NRTC ENERGIES (PVT) LTD

rating of counterparties determined by the VIS Credit Rating Company Limited (formerly JCR - VIS Credit

27.2 The Company has not disclosed the fair value for these financial assets and financial liabilities, as these are either short term in nature or repriced periodically. Therefore, their carrying amounts are a reasonable approximation of their fair values.

27.3 The Company has exposure to the credit risk, market risk and liquidity risk from its use of financial

The Board of Directors has overall responsibility for the establishment and oversight of the Company's risk management framework. The Board is also responsible for developing and monitoring the Company's risk management policies.

27.4 Credit risk

Credit risk is the risk of financial loss to the Company if a customer or counterparty to a financial instrument fails to meet its contractual obligations, and arises principally from trade debts, advances, deposits, other receivables, margin on letter of guarantee, short tern investments and bank balances. The carrying amount of financial assets represents the maximum credit exposure.

The Company's credit risk exposure is categorized under the following headings:

Trade debts and other receivables

The Company's exposure to credit risk is influenced mainly by the individual characteristics of each customers. The Company has established a credit policy under which each new customer is analyzed individually for creditworthiness before the Company's standard payment terms and conditions are offered. Credit limits are established for each customer, which are regularly reviewed and approved by the management. Customers that fail to meet the Company's benchmark creditworthiness may transact with the Company only on a prepayment basis.

Concentration of credit risk

Geographically there is no concentration of credit risk. The maximum exposure to credit risk for financial assets at the reporting date by type of counter party is as follows:

	2023 Rupees	2022 Rupees
Banks and financial institutions	100,136,060	1,006
Others	217,033	272,453
	100,353,093	273,459

Credit quality of financial assets

The credit quality of the Company's financial assets have been assessed below by reference to external credit rating of counterparties determined by the VIS Credit Rating Company Limited (formerly JCR - VIS Credit Rating Company Limited). The counterparties for which external credit ratings were not available have been assessed by reference to internal credit ratings determined based on their historical information for any default in meeting their obligations.

Trade receivables	2023 Rupees	2022 Rupees
Counterparties without external credit ratings with no default in the past	26,737,021	11,676,881

NRIC ENERGIES (PVT) LTD

Impairment loss

The aging of trade debts at the reporting date was:

	2023		2022	
	Gross	Impairment	Gross	Impairment
	Rupees		Rupees	
Past due 1-30 days	8,011,000	-	1,726,881	-
Past due 31-60 days	-	-	900,000	-
Past due 61-90 days	15,712,821	-	1,550,000	-
Past due 91-120 days	-	-	-	-
Over 120 days	3,013,200	-	-	-
	26,737,021	-	4,176,881	-

Based on past experience, the management believes that no impairment allowance is necessary in respect of carrying amount of trade debts. The Company expects no material expected credit loss under IFRS 9 'Financial Instruments' on trade debts at the year end.

The allowance account in respect of trade debts is used to record impairment losses unless the Company is satisfied that no recovery of the amount owing is possible at which point the amount considered irrecoverable is written off against the financial asset directly.

Exposure to credit risk

The carrying amount of financial assets represents the maximum credit exposure. The maximum exposure to credit risk at the reporting date was:

	Note	2023 Rupees	2022 Rupees
Long term deposits		922,000	215,300
Trade and other receivable	8	40,242,894	11,676,881
Bank balances	12	100,136,060	1,006
		141,300,954	11,893,187

Geographically there is no concentration of credit risk.

The maximum exposure to credit risk for trade debts at the reporting date is with end - user customers and represents debtors within the country.

The Company's most significant customer is an end user from whom Rs. 11,943,440 (2022: Rs. 1,400,000) was outstanding and which is included in total carrying amount of trade debtors as at June 30, 2023.

The Company limits its exposure to credit risk by placing funds with banks that have high credit rating. Management actively monitors credit ratings and given that the Company only has placed funds in the banks and financial institutions with high credit ratings, management does not expect any counter party to fail to meet its obligations.

				2023 Rupees	2022 Rupees
Long term deposits					
Counterparties without external credit ratings				922,000	215,300
Trade and other receivables					
Counterparties without external credit ratings				40,242,894	11,676,881
Bank balances	**Credit rating agency**	**Long term rating**	**Short term rating**		
Meezan Bank Limited	VIS	AAA	A-1+	100,136,060	1,006

NRTC ENERGIES (PVT) LTD

		%
National Radio Telecommunication Corporation (Private) Limited (NRTC)	Parent Company	75.00

27.5 Liquidity risk

Liquidity risk is the risk that the Company will not be able to meet its financial obligations as they fall due. The Company's approach to managing liquidity is to ensure, as far as possible, that it will always have sufficient liquidity to meet its liabilities when due, under both normal and stressed conditions, without incurring unacceptable losses or risking damage to the Company's reputation. The Company uses different methods which assists it in monitoring cash flow requirements and optimizing its cash return on investments. Typically the Company ensures that it has sufficient cash on demand to meet expected operational expenses for a reasonable period, including the servicing of financial obligations; this excludes the potential impact of extreme circumstances that cannot reasonably be predicted, such as natural disasters.

The following are the contractual maturities of financial liabilities, including expected interest payments and excluding the impact of netting agreements:

	Carrying amount	Contractual cash flows	Up to one year	One to two years	Two to five years	Five years onwards
2023			Rupees			
Loan from Onsun Pvt Ltd - unsecured	10,650,654	10,650,654	10,650,654		-	-
Trade and other payables	147,414,383	147,414,383	147,414,383	-	-	-
	158,065,037	158,065,037	158,065,037	-		
2022						
Loan from Onsun Pvt Ltd - unsecured	650,654	650,654	650,654			
Trade and other payables	11,671,337	11,671,337	11,671,337	-	-	-
	12,321,991	12,321,991	12,321,991	-	-	-

It is not expected that the cash flows included in the maturity analysis could occur significantly earlier or at significantly different amounts.

27.6 Market risk

Market risk is the risk that the value of the financial instrument may fluctuate as a result of changes in market interest rates or the market price due to change in credit rating of the issuer or the instruments' supply and demand of securities and liquidity in the market. The Company is not exposed to any market risk.

NRTC ENERGIES (PVT) LTD

28 RELATED PARTY TRANSACTIONS AND BALANCES

Related parties comprise of directors, entities over which the directors are able to exercise significant influence, entities with common directors, major shareholders and key management personnel which include Chief Executive Officer (CEO),Chief Operating officer (COO) and Chief Financial Officer (CFO).

Related party	Basis of relationship	Percentage of shareholding %
National Radio Telecommunication Corporation (Private) Limited (NRTC)	Parent Company	75.00
Onsun (Private) Limited	Associated Company	25.00

Balances and transactions with related parties are disclosed in notes to the financial statements. Transactions and balances with related parties other than those disclosed elsewhere in these financial statements are as follows:

Transactions and balances with related parties	2023 Rupees	2022 Rupees
National Radio Telecommunication Corporation (Private) Limited (NRTC)		
- Investment	**7,500,000**	-
- Sale	**89,295,960**	-
Onsun (Private) Limited		
- Loan received	**10,530,000**	2,435,654
- Loan repayment	**530,000**	1,785,000
Others		
- Remuneration to key management personnel (other than Chief Executive)	**6,735,329**	-

29 RESTATEMENT OF PRIOR YEAR FINANCIAL STATEMENTS

In accordance with the requirements of IFRS 9 "Financial Instruments" "advances" and "Trade and other payables" were understated by Rs 8,602,738 respectively. These have been adjusted retrospectively and prior period financial have been restated. The effects of the restatement are summarized below:

Statement of financial position	2022 Rupees
Assets and liabilities	
Increase / (decrease) in:	
Advances	8,602,738
Trade and other payables	(8,602,738)
	-

NRTC ENERGIES (PVT) LTD

30 CORRESPONDING FIGURES

Corresponding figures have been reclassified as per the details given below to reflect more appropriate presentation of the related transactions in the financial statements. These reclassifications have no effect on previously reported net income or shareholders' equity.

From	To	Rupees
Administrative expenses	Selling and distribution expenses	1,290,148
Administrative expenses	Cost of sales	879,955
Advances, deposits and prepayments - Securities - Current assets	Long term deposit - Non-Current assets	215,300
Advances, deposits and prepayments - Sales tax refundable	Sale tax refundable	1,952,187
Accrued and other liabilities	Trade and other payable	811,892

31 Number of persons employed	2023 Numbers	2022 Numbers
Total employees of the Company at year end	31	23
Average employees of the Company during the year	25	15

32 DATE OF AUTHORISATION OF FINANCIAL STATEMENTS

These financial statements were authorized for issue by the Board of Directors of the Company in their meeting held on ____________________.

~~CHIEF EXECUTIVE OFFICER~~

Director

~~DIRECTOR~~

Cheif Executive officer

NRTC ENERGIES (PVT) LTD

NRTC Energies

A Premium Energy Brand

Company Profile

NRTC ENERGIES (PVT) LTD

NRTC

National Radio and Telecom Corporation (NRTC)

- NRTC is a Federal Govt entity of Ministry of Defence Production (MoDP)
- Established in 1965
- Local Offices: Haripur, Isb, Rwp, Lhr, Pswr, Qta, Khi, Multan, Turbat
- Intl Offices: UAE and KSA
- Radar, Communication Equipment, Jammer, EW, IT Eqpt, NW Eqpt, **Renewable Energy**, Security & Surveillance/ Safe Cities

NRTC ENERGIES (PVT) LTD

NRTC ENERGIES

NRTC
Energies

- Established as a dedicated division to deal in energy and power projects
- Subsidiary of NRTC
- Services

➢ Utility Scale Solar System	➢ Mini Grid Stations
➢ Commercial and Industrial Scales	➢ Supply and Installation of Generations & Transformers
➢ Residential Solar System	➢ Energy Audis
➢ Solar Water Pump	➢ Power Purchase Agreements
➢ Car Parking Solar sheds	➢ Energy Selling Model
➢ Solar Street Lights	➢ Leasing/Financing Support
➢ Solar Parks	➢ Designing and Consultancy Services
➢ Building Electrifications	

NRTC ENERGIES (PVT) LTD

NRTC

REGISTRATIONS / CERTIFICATIONS

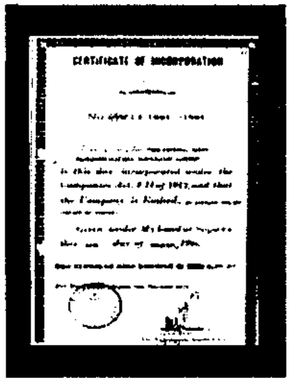
NRTC ENERGIES (PVT) LTD
NRTC

REGISTRATIONS / CERTIFICATIONS

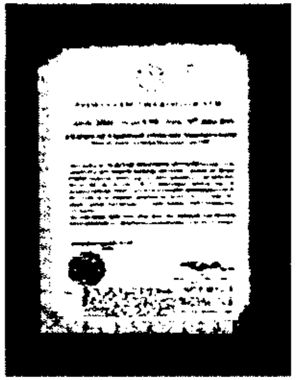
Sr No	Organization / Institute	Category	Description
1	SECP Security Exchange Commission of Pakistan		
2	PEC (Pakistan Engineering Council)	C-A	No Limit
3	AEDB (Alternate Energy Development Board)	C-1	Upto 1 MW Net-Metering
4	PSA Pakistan Solar Association		
5	P@SHA Pakistan Software House Association		
6	Quality Assurance	ISO 9001-2015	
7	Environmental Assurance	ISO 14001-2015	
8	OHSAS	OHSAS 18001-2007	
9	Development & Design	IPC-A-610, IPC-FC-250, IPC-4101/21	
10	Production & Test Standard	MIL-STD-810, MIL-C-55116/3, MIL-C-39012, MIL-C-5541	

NRTC ENERGIES (PVT) LTD

REGISTRATION & CERTIFICATIONS



SECP



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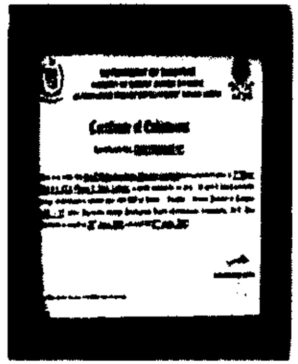
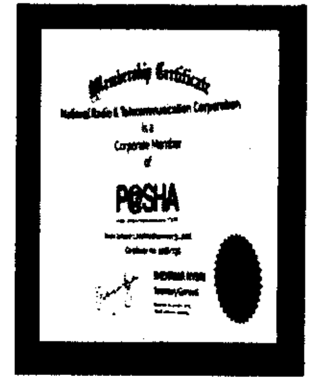
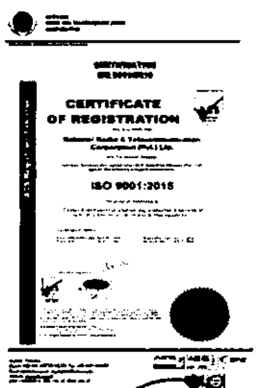


AEDB

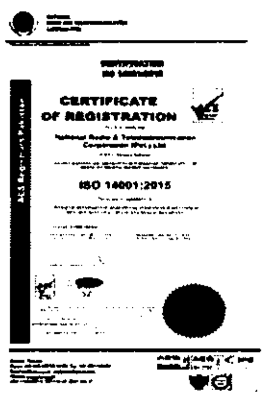
PSA



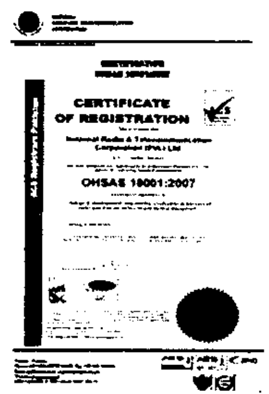
P@SHA



Quality



Environment



OHSAS

Development & Design

Production & Test Standard

BUSINESS PARTNERS

NRTC ENERGIES (PVT) LTD
NRTC

BUSINESS PARTNERS

NRTC Energies

Solar PV Modules

CanadianSolar

LONGi Solar

JinKO Solar

Trinasolar

JA SOLAR

Solar Inverters

HUAWEI

SUNGROW

Green and Effective

solis

Fronius

SMA

Solar LED Lights

PHILIPS

Batteries

PYLONTECH

Narada

NRTC ENERGIES (PVT) NRTC

CLIENTS & PROJECTS

NRTC ENERGIES (PVT) LTD
NRTC

NRTC Energies

Clients

Haier

FES

DANSUK

Lahore Care Hospital

BALOCHISTAN

MIN OF DEF PROD

DEFENCE HOUSING AUTHORITY

MULTAN

Bank Alfalah

PAKISTAN

NBP

National Bank of Pakistan

WHY NRTC ENERGIES

NRTC ENERGIES (P) LTD
NRTC

WHY NRTC ENERGIES

NRTC Energies

- Highly trained Engineers / Professional Staff
- Regional Offices
- Strategic relationship with all major OEMs/ brands
- Premium Quality Equipment
- Wears both hats govt and corporate
- Speedy installation and net-metering services

NRTC ENERGIES (PVT) LTD
NRTC

NRTC ENERGIES BENEFITS

NRTC Energies

- O&M - FOC for 2 Yrs. (Extendable up to entire project life)
- Product Warranties - Direct OEM (Extended Warranties)
- Performance Warranties - Undertakings supported by simulations & software reports
- Documentary proof/ evidence furnishing authenticity & genuineness of eqpt / products
- On-site spares
- In-situ technical teams
- NOC
- SLA / FOC Training

NRTC ENERGIES (PVT) LTD NRTC

NRTC ENERGIES

NRTC Energies

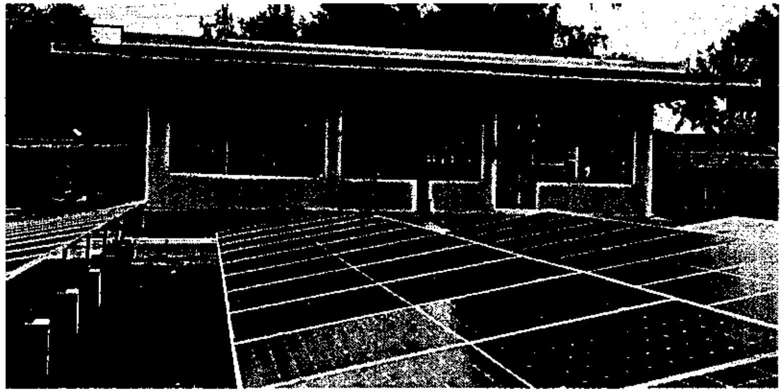
- Utility / Commercial / Industrial Scales
- Power Purchase Agreements
- Residential / Offices/ Mosques Solar System / DHA Housing Schemes / Villas
- Car Parking Solar Sheds
- Solar Parks
- Solar Water Pump
- Solar Street Lights
- Building Electrifications
- Mini Grid Stations Supply and Installation of Generations & Transformers
- Energy Audits / Designing / Consultancy Services

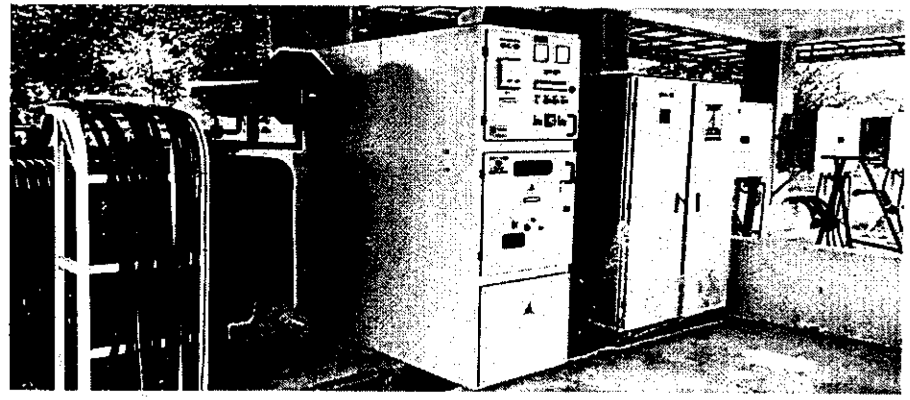
NRTC ENERGIES (PVT) LTD

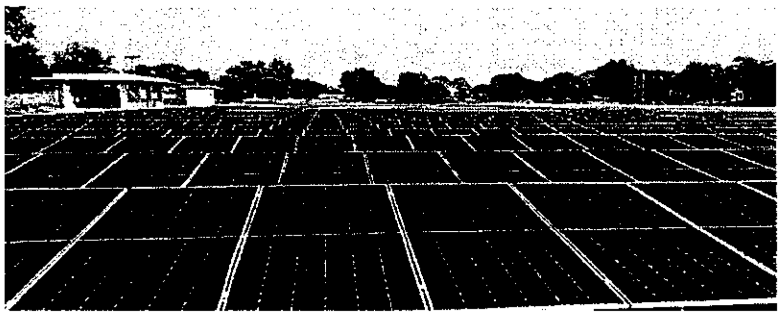
PROJECTS

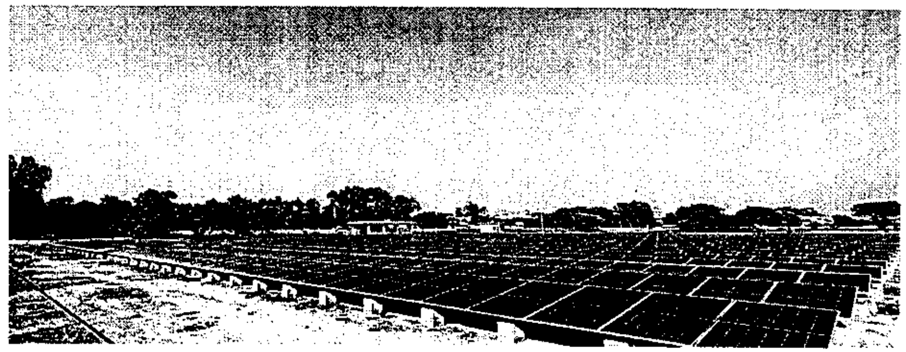
NRTC ENERGIES (P) LTD

PROJECTS



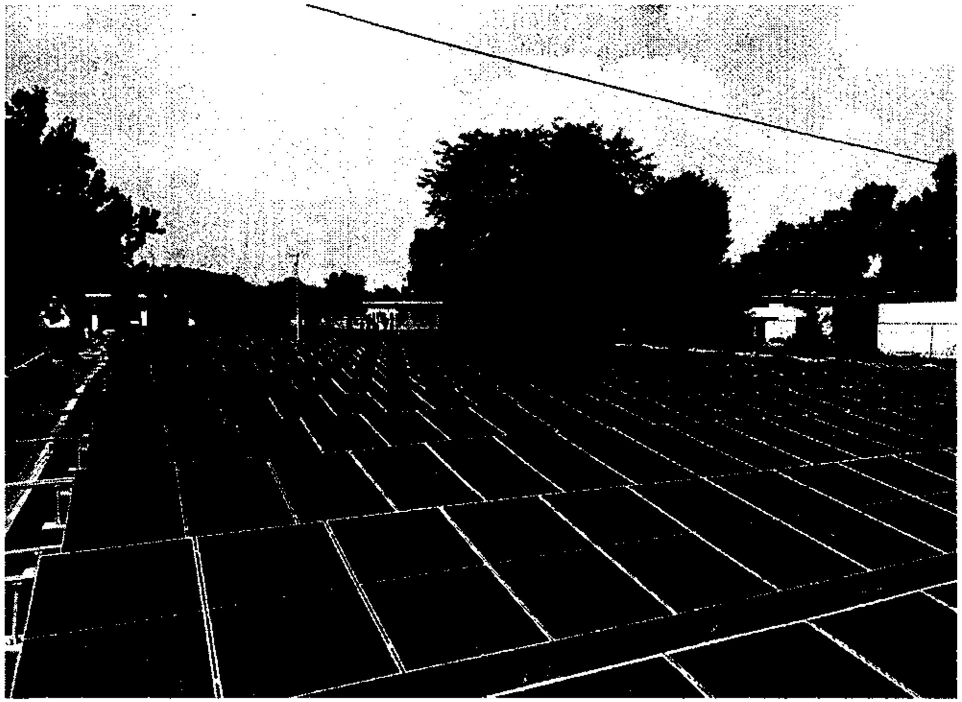


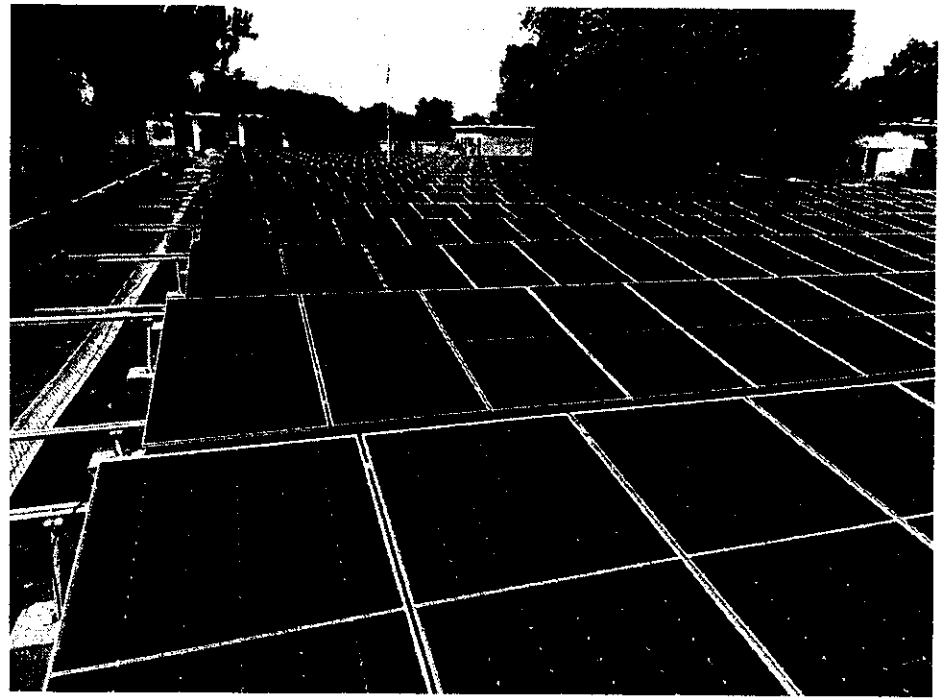




Client	4 Corps	**Location**	New Mazhar Line, Cantt, Lahore
System Type	On Grid	**Capacity**	1.0 MW
Panels	Canadian Solar	**Inverter**	Huawei

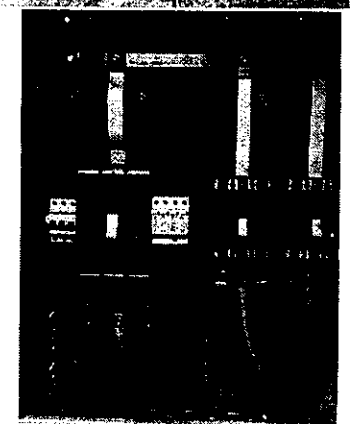
PROJECTS





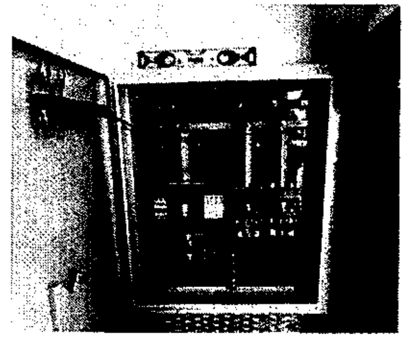
Client	4 Corps	**Location**	Chitral Lines, Cantt, Lahore
System Type	On Grid	**Capacity**	0.5 MW
Panels	Canadian Bifacial	**Inverter**	Huawei

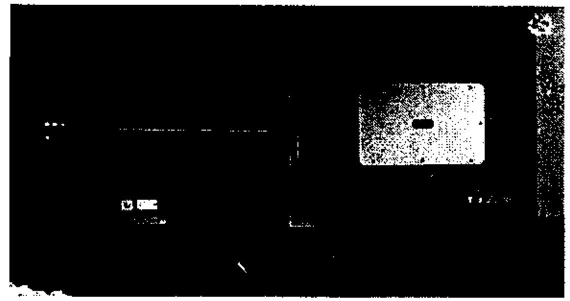
PROJECTS

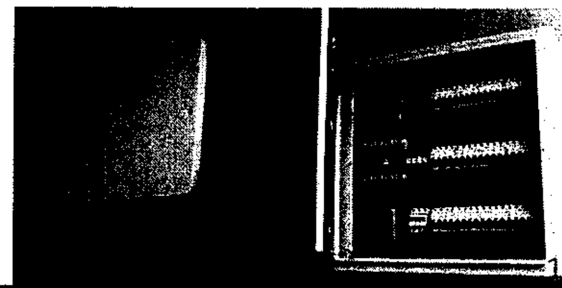


Client	Frontier Corps	**Location**	HQ FC (S), Turbat
System Type	On Grid	**Capacity**	250kW of 1.6 MW
Panels	Canadian Solar	**Inverter**	Huawei

PROJECTS



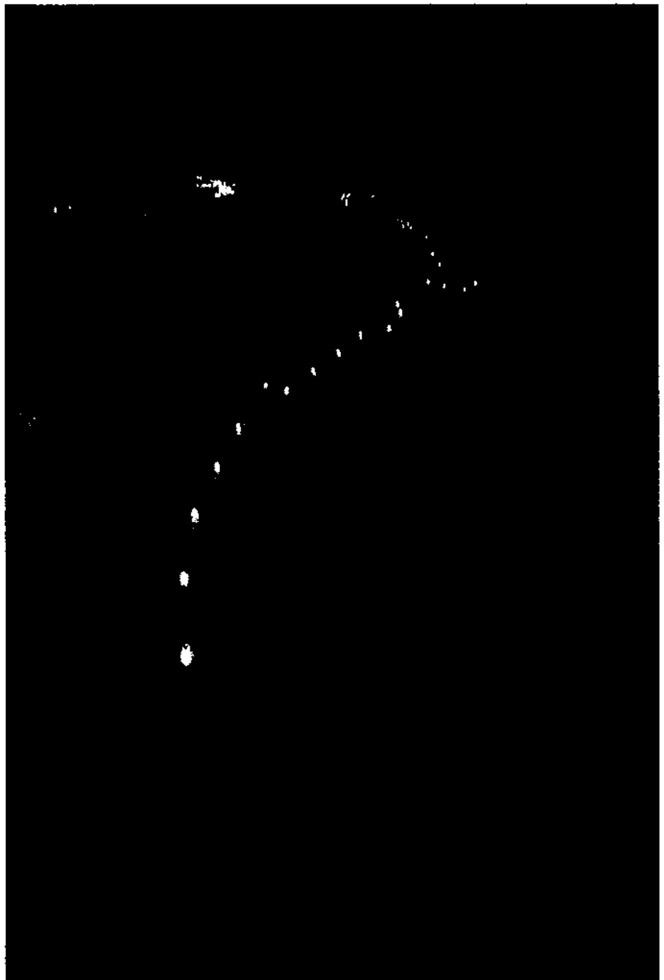


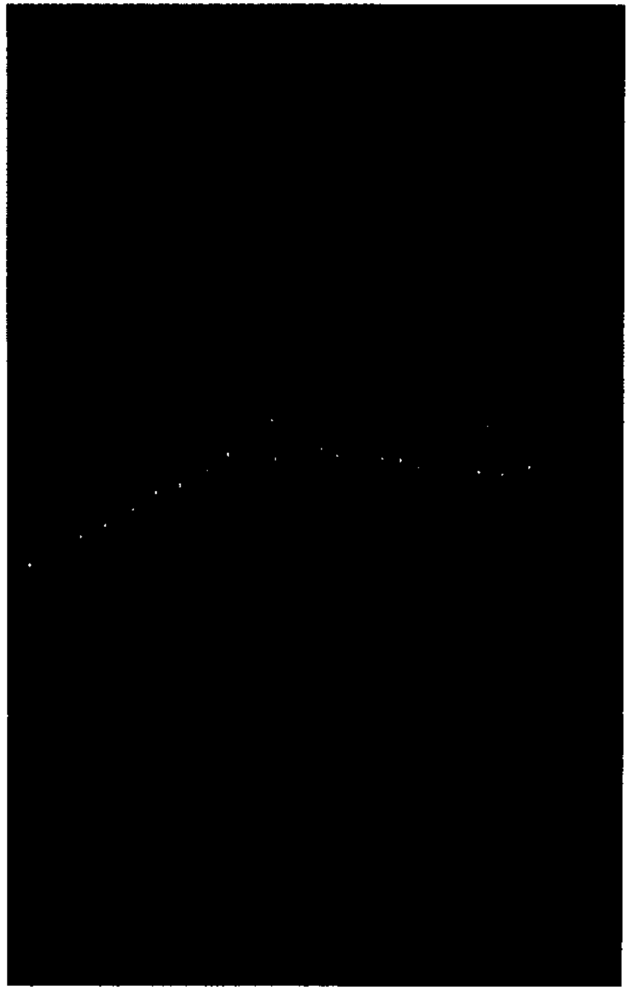


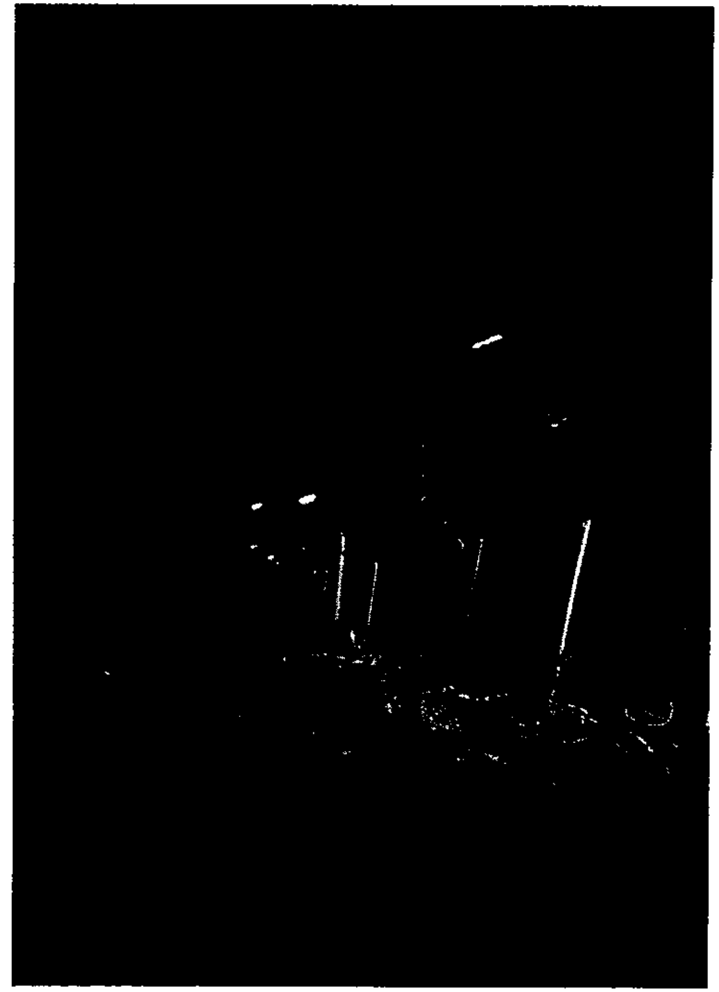
Client	Haier Pakistan	**Location**	Zalmi House, Raiwind
System Type	On Grid	**Capacity**	320 kW
Panels	Canadian Solar	**Inverter**	Huawei

PROJECTS

NRTC
Energies



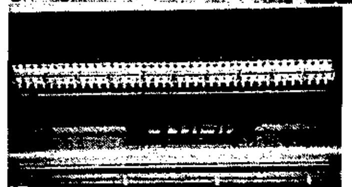




PROJECTS

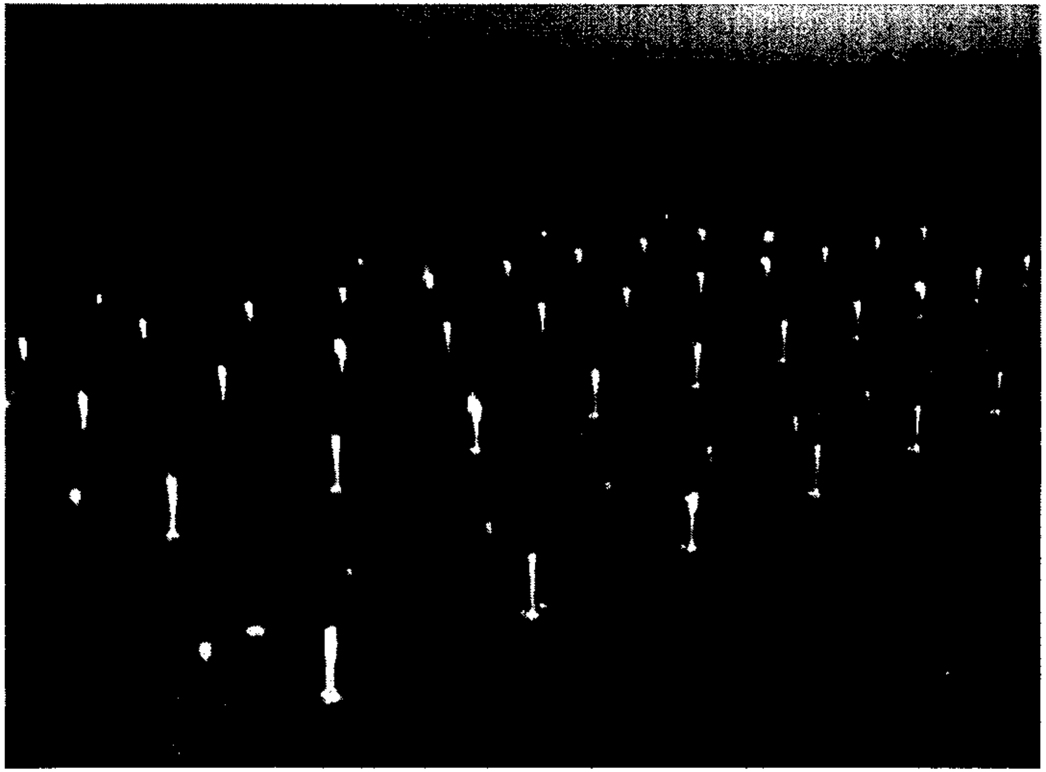
NRTC Energies



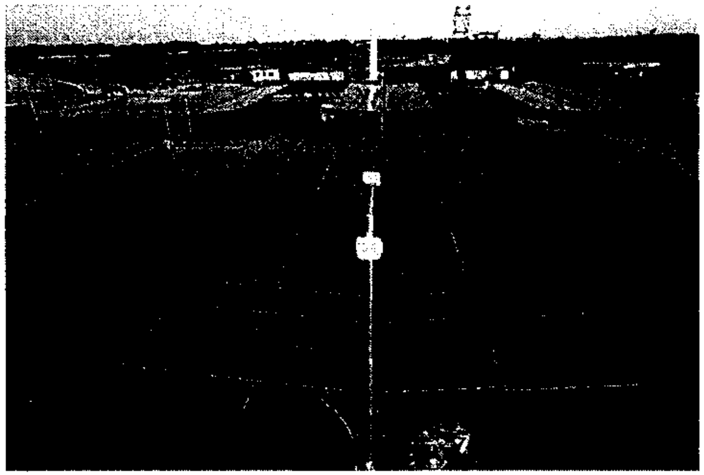

Client	DHA Multan	**Location**	Site Office DHA
System Type	On Grid	**Capacity**	210 kW
Panels	Longi Solar	**Inverter**	Huawei

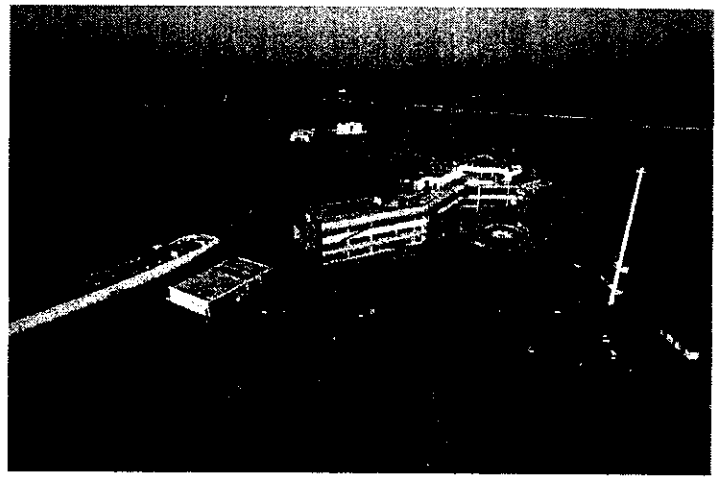
PROJECTS



Client	DHA Multan	**Location**	Romanza Golf Club
System Type	On Grid	**Capacity**	430 kW of 1.2 MW
Panels	Canadian Solar	**Inverter**	Huawei

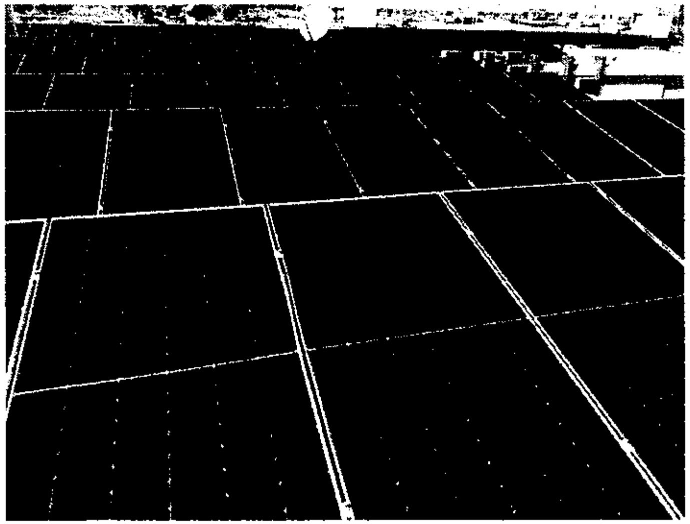
PROJECTS

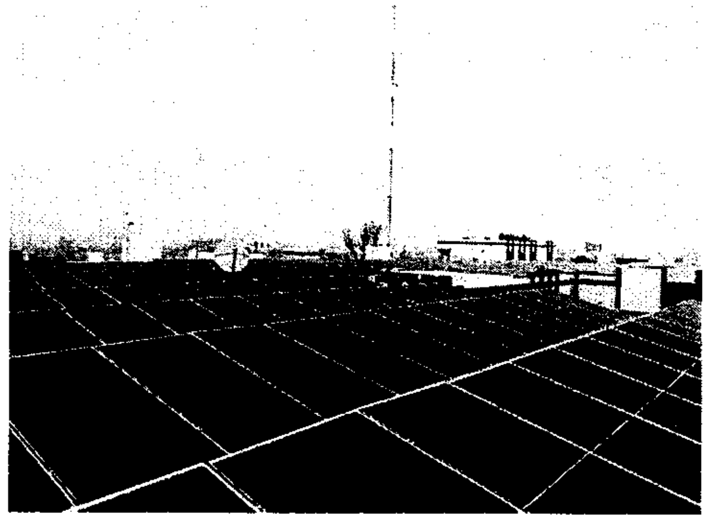




Client	DHA Multan	**Location**	Romanza Golf Club
System Type	On Grid	**Capacity**	430 kW of 1.2 MW
Panels	Canadian Solar	**Inverter**	Huawei

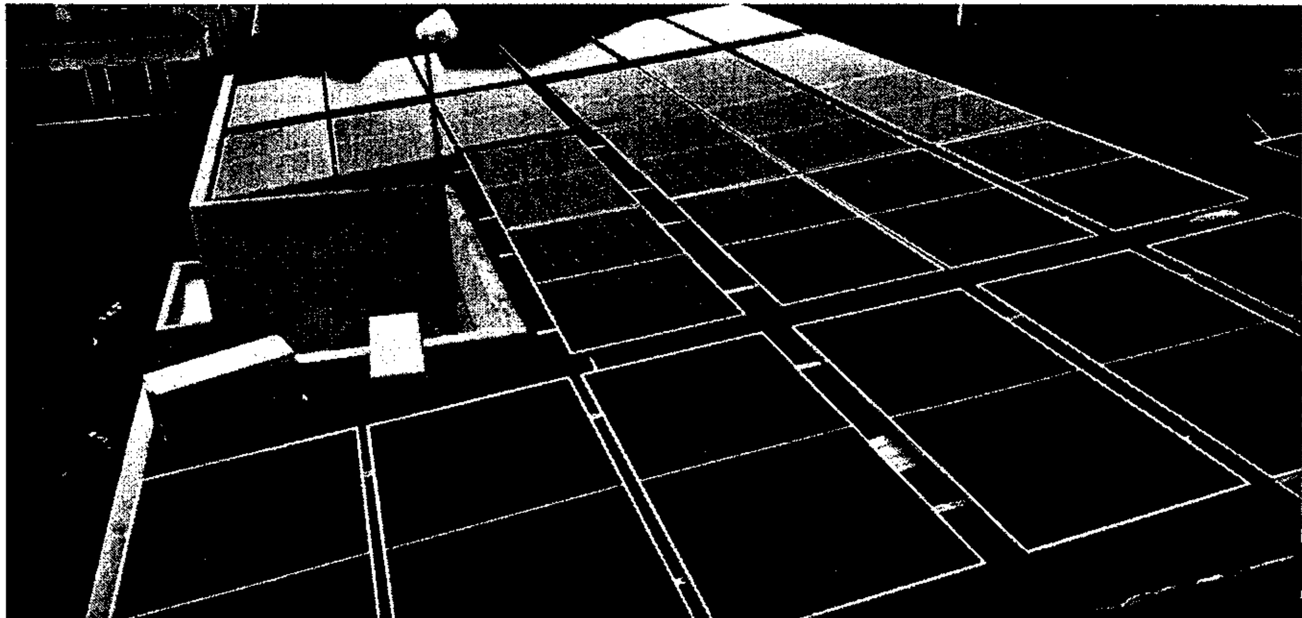
PROJECTS

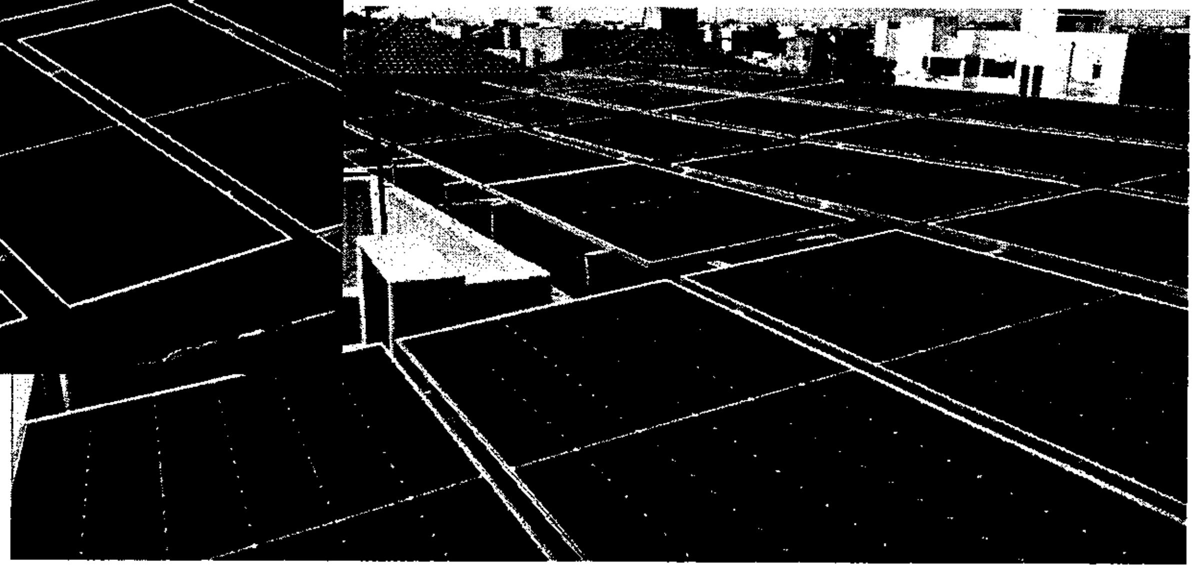




Client	DHA Multan	**Location**	Site Office DHA
System Type	On Grid	**Capacity**	465
Panels	Canadian Solar	**Inverter**	Huawei

PROJECTS

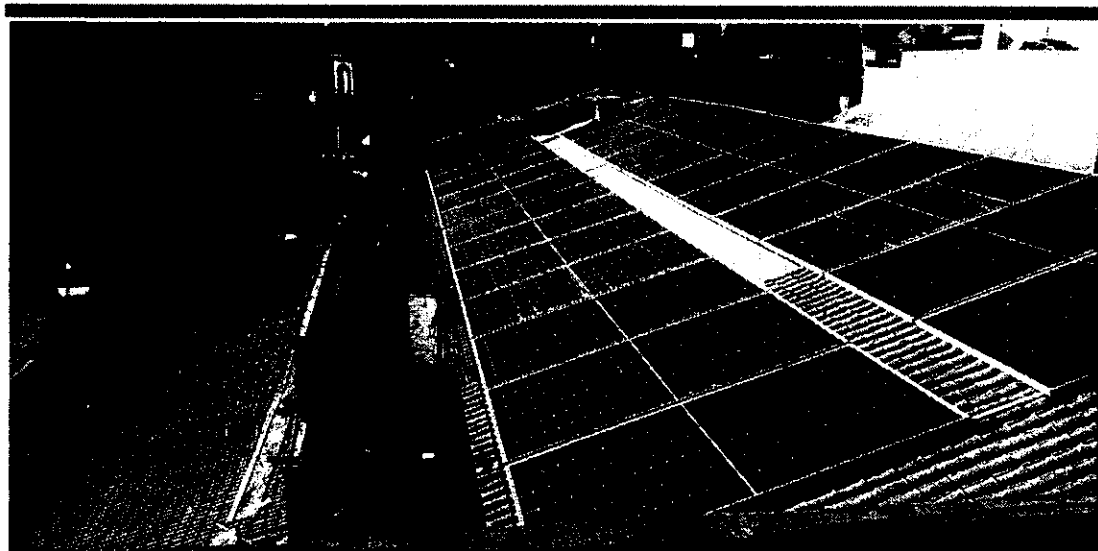


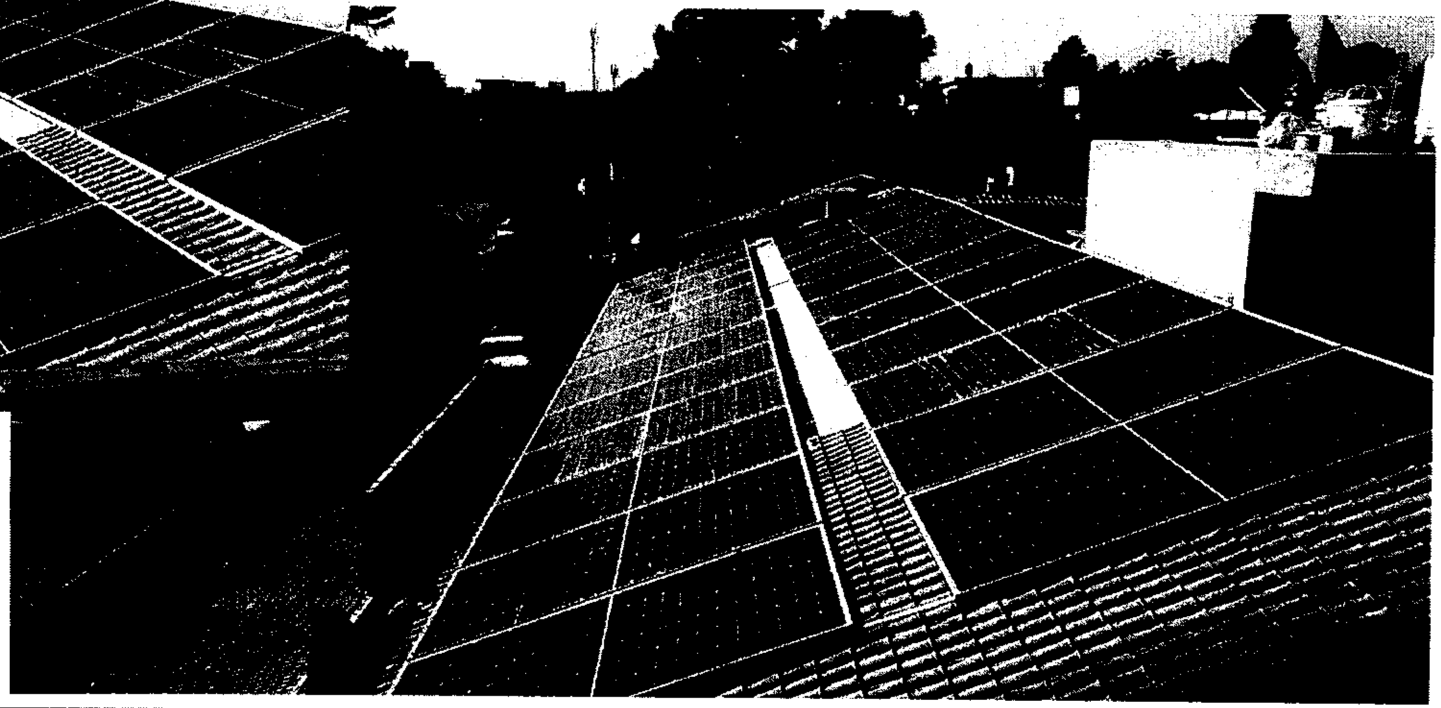


Client	DHA Lahore	**Location**	Phase 8
System Type	On Grid	**Capacity**	
Panels	Canadian Solar	**Inverter**	Huawei

NRTC Energies

PROJECTS





Client	Rawalpindi	**Location**	Chaklala
System Type	On Grid	**Capacity**	
Panels	Canadian Solar	**Inverter**	Huawei

Solar Office:
72 Block, Maulana Shaukat Ali Rd, Quaid e Azam Industrial Estate,
Lahore - Pakistan

Head Office:
NRTC, Haripur - Pakistan

PTCL : 042-5117304
Info@nrtcenergies.com.pk
www.nrtcenergies.com.pk

NRTC ENERGIES (PVT) LTD

THE COMPANIES ACT, 2017
THE COMPANIES (GENERAL PROVISIONS AND FORMS) REGULATIONS, 2018
[Section 197 and Regulations 4 and 20]
PARTICULARS OF DIRECTORS AND OFFICERS, INCLUDING THE CHIEF EXECUTIVE, SECRETARY, CHIEF FINANCIAL OFFICER, AUDITORS AND LEGAL ADVISER OR OF ANY CHANGE THEREIN

FORM 29

PART-I

Please Complete in Typescript or in Bold Block Capitals

1.1 CUIN (Incorporation Number)	0184244
1.2 Name of Company	NRTC ENERGIES (PRIVATE) LIMITED

1.3 Fee Payment Details

1.3.1 Challan Number	E-2022-1319269	1.3.2 Amount	4000.0

PART-II

2. Particulars*:

2.1. 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)	Nature of directorship (nominee/independent/additional/ other) (j)
Imran Gul	3420207444589	Muhammad Gul	House No. B-1, Ghaznawi Street, Garrison Adiala Road RAWALPINDI Punjab Pakistan	Chief Executive	Pakistan		28/10/2022	Re-Appointment /	
Muhammad Asim Ishaque	3520270242921	Chaudhary Muhammad Ishaque	H.No 284, Street No. 14,Township Sector A1, Lahore	Director	Pakistan	Director NRTC	28/10/2022	Appointed /	Nominee
Jawad Anjum	4230177998571	Anjum Parvez	Flat No. 43-G, Askari 3, School Road, Karachi South	Director	Pakistan	Chief Executive Officer	28/10/2022	Elected /	Nominee
Imran Gul	3420207444589	Muhammad Gul	House No. B-1, Ghaznawi Street, Garrison Adiala Road, Rawalpindi	Director	Pakistan	Director NRTC	28/10/2022	Elected /	Nominee
A.F.Ferguson and Co. Chartered Accountants			74-East , 2nd Floor, Blue Area, P.O Box 3021, Islamabad-44000, Pakistan	Auditor	Pakistan	Auditor	28/10/2022	Appointed /	

2.2. Ceasing of Officer/Retirement/Resignation

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)	Nature of directorship (nominee/independent/additional/ other) (j)
Jawad Anjum	4230177998571	Anjum Parvez	Flat No.43-G, Askari 3, School Road KARACHI SOUTH Sindh Pakistan 75530	Director	Pakistan	Chief Executive Officer	28/10/2022	Retired /	
Imran Gul	3420207444589	Muhammad Gul	House No. B-1, Ghaznawi Street, Garrison Adiala Road RAWALPINDI Punjab Pakistan	Director	Pakistan	Director NRTC	28/10/2022	Retired /	
Tofique Ahmed	3420236740021	Muhammad	Mohalla Cantt	Director	Pakistan	Director	28/10/2022	Resigned /	

NRTC ENERGIES (PVT) LTD

Tofique Ahmed	3420238740021	Muhammad Munir	Mohalla Cantt Railway station, Kharian GUJRAT Punjab Pakistan 50070	Director	Pakistan	Director NRTC, Director NRTC Itech (Pvt) Ltd	28/10/2022	Resigned /	

2.3. 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)	Nature of directorship (nominee/independent/additional/other)

* In the case of a firm, the full name, address and above mentioned particulars of each partner, and the date on which each became a partner.
** In case the nationality is not the nationality of origin, provide the nationality of origin as well.
*** Also provide particulars of other directorships or offices held, if any.".
**** In case of resignation of a director, the resignation letter and in case of removal of a director, member's resolution be attached
***** In case of a director nominated by a member or creditor the name of such nominating or appointing body shall also be mentioned in column (j), and a copy of resolution from the nominating or appointing body be attached.

PART-III

3.1 Declaration:

I do hereby solemnly, and sincerely declare that the information provided in the form is:
(i) true and correct to the best of my knowledge, in consonance with the record as maintained by the Company and nothing has been concealed and
(ii) hereby reported after complying with and fulfilling all requirements under the relevant provisions of law, rules, regulations, directives, circulars and notifications whichever is applicable.

3.2 Name of Authorized Officer with designation/ Authorized Intermediary	Imran Gul	Chief Executive
3.3 Signature	Electronically signed by Imran Gul	
3.4 Date (DD/MM/YYYY)	21/10/2023	
3.5 Registration No of Authorized Intermediary, if applicable		

NRTC ENERGIES (PVT) LTD

Form A
THE COMPANIES ACT, 2017
THE COMPANIES (GENERAL PROVISIONS AND FORMS) REGULATIONS, 2018
[Section 130(1) and Regulation 4)
ANNUAL RETURN OF COMPANY HAVING SHARE CAPITAL

PART-I

(Please complete in typescript or in bold block capitals)

1.1 CUIN (Registration Number)	0184244
1.2 Name of the Company	NRTC ENERGIES (PRIVATE) LIMITED
1.3 Fee payment details	1.3.1 Challan No E-2022-1319269 1.3.2. Amount 4000.0
1.4 Form A made upto (dd mm yyyy)	28/10/2022
1.5 Date of AGM	28/10/2022

PART - II

Section A

2.1 Registered Office Address	, Nasralla, Link Road Mumtaz City, Near Islamabad International Airport, Rawalpindi, Punjab
2.2 Email Address	imran.gul@nrtc.com.pk
2.3 Office Tel. No.	518431995
2.4 Office Fax No.	
2.5 Principle line of business	--ALTERNATE ENERGY
2.6 Mobile No. of Authorized officer (Chief Executive/ Director/ Company Secretary/ Chief Financial Officer)	03145064833

2.7 Authorized Share Capital

Classes and kinds of Shares	No. of Shares	Amount	Face Value
Ordinary Shares		10,000,000.00	

2.8 Paid up Share Capital

Classes and kinds of Shares	No. of Shares	Amount	Face Value
Ordinary Shares		10,000,000.00	

2.9 Particulars of the holding /subsidiary company, if any

Name of Company	Holding/Subsidiary	% Shares Held
The National Radio Telecommunication Corporation (Pvt) Ltd.		75

2.10 Chief Executive

Name	Imran Gul
Address	House No. B-1, Ghaznawi Street, Garrison Adiala Road RAWALPINDI Punjab Pakistan 46606
NIC No	3420207444589

[redacted]

NRTC ENERGIES (PVT) LTD

2.11 Chief Financial Officer

Name

Address

NIC No

2.12 Secretary

Name

Address

NIC No

2.13 Legal Advisor

Name

Address

NIC No

2.14 Particulars of Auditors

Name: A.F.Ferguson and Co. Chartered Accountant

Address: 74-East , 2nd Floor, Blue Area, P.O Box 3021, Islamabad-44000, Pakistan

2.15 Particulars of Shares Registrar (if applicable)

Name

Address

Email

Section-B

2.16 List of Directors on the date Annual return is made

S#	Name of Director	Residential Address	Nationality	NIC (Passport No. if foreigner)	Date of appointment /election	Name of Member/Creditors nominating/appointing
1	Muhammad Asim Ishaque	H.No 284, Street No. 14,Township Sector A1, Lahore	Pakistan	3520270242921	28/10/2022	The National Radio Telecomm
2	Jawad Anjum	Flat No. 43-G, Askari 3, School Road, Karachi South	Pakistan	4230177998571	28/10/2022	Onsun (Pvt) Ltd.
3	Imran Gul	House No. B-1, Ghaznawi Street, Garrison Adiala Road, Rawalpindi	Pakistan	3420207444589	28/10/2022	The National Radio Telecomm

NRTC ENERGIES (PVT) LTD

.MAJOR (R) ENGR. JAWAD ANJUM, psc, CMILT(UK)

·92-333-4677-166

jawadanjum1@gmail.com

362-F, Askari-10, Airport Road, Lahore Cantt

PROFILE A multi-skilled professional with a proven history of managing complex functional assignments in constrained environments for 18 years in Army as a result-oriented project manager, effective administrator and a seasoned HR manager. I am a self-driven individual who enjoys dynamic and diverse roles in multi-functional settings. Leveraging my sharp learning potential and adaptability, I can thrive working with experts from any industry. A natural leader and team player who generates excellent spirit and inspires people around him being a gifted speaker with an analytical mind set. I am always willing to go an extra mile looking for innovative solutions to achieve remarkable results. Seeking a challenging role in Rohde & Schwarz Pakistan, where I can grow professionally & personally and demonstrate my skills whilst benefiting the organization.

SKILL SETS

- Leadership/ Team Building
- Project Management
- Strategy & Planning
- Organisation
- Operations Continuity
- Telecommunication
- ICT
- Persuasion & Negotiation
- Service Delivery
- Analytical Thinking
- Stakeholder Management
- HRM

PROFESSIONAL EXPERIENCE HIGHLIGHTS

PROJECT MANAGEMENT

Planned, directed and co-ordinated activities of following organisational projects in areas of IT, Telecom, Software Development and Systems Integration. Allocated technical and human resources, resolved issues while managing clients/ end-users and vendors.

✓ **Shifting of Army School of Technician from Barian to Kohat** 2020

- Developed feasibility and implementation plan with a cost effect of PKR 290 Mn
- Achieving consensus by all major stake holders

✓ **Corps of Signals Training** 2019 - 20

- Developed concept paper to restructure Corps of Signals Trades in line with the latest and futuristic induction plan of technical equipment.
- Planned and directed expansion of STC to achieve 25% capacity enhancement to train 3000 new and experienced soldiers attending various technical courses every year.
- Established technical labs (OFC, microwave, radio, computer, networking & driving simulator)
- HR development of functional staff (training, operations, management and administration).

✓ **Renovation of GHQ Army Museum** 2019 - 20

- As a special project, renovated GHQ Army Museum Signals Gallery. Incorporated latest visual & interactive technologies like hyper-vision, holograms and interactive displays.

✓ **FM Radio Network (FM 89.6 & FM 96)** 2016

- Enhanced coverage of Suno FM Radio Network to outreach remote areas of Baluchistan, FATA & Kashmir region by establishing 85 self-sustained (500 – 2500 Watts) new stations.
- As controlling body for Suno FM network, handled regulatory affairs, rendered guidelines for content development and devised strategy to increase listenership.

NRTC ENERGIES (PVT) LTD. NRTC

- **Data Visualisation and Analytics** 2016
  - Conceived, developed and implemented customised data visualisation and analytics software to share actionable data for informed decision making by stakeholders across Pakistan.
- **Cloud-based Smart Verification System** 2014 - 15
  - Implemented a pilot project "Smart Verification and Alert System" to automate and speed-up screening process of returning TDPs/ individuals at key entry points in South Waziristan. System significantly reduced waiting time by 50 %. Project received appreciation at the highest level and was extended to all military garrisons
- **Solarization of Highly Remote Communication Hubs** 2014
  - Coordinated and supervised installation of solar systems at 27 remotely located communication nodes in difficult terrain of Waziristan.
- **Central Monitoring System** 2013
  - Established a joint monitoring & control centre for civil administration, police and army to monitor security situation of DI Khan, Tank, Lakki Marwat and Bannu. System encompassed comprehensive monitoring, self-healing automation, policy-based configuration management, detailed reporting, integrated AV, patch, backups and remote control.
- **Pakistan Army Office Automation System (OAS)** 2010 - 11
  - Supervised installation and configuration of Karachi Data Centre server rooms.
  - Directed deployment of fibre optic and wi-max networks in Karachi and Malir, to extend OAS to over 120 establishments in a record time of 8 months. Subsequently worked as project in charge for O&M of OFAN & wi-max sites.
  - Developed programs to support organisation's transition to new system.
  - Worked as a focal point for customers and vendors management.
  - Remained part of development teams of various enterprise applications and software.
- **Pakistan Army Telepresence System (PATS)** 2011/ 20
  - Implemented state of the art telepresence systems at Karachi (2011) and Kohat (2020)

- **CHIEF COMMUNICATION OFFICER**

  During my illustrious career in Pakistan Army I have managed large scale telecom systems.
  - Planned, deployed and maintained communication and data services for a large number of civilian, army and FC subscribers, by integrating PTCL and own MW & OFC systems in Waziristan.
  - Deployed and maintained PBX Systems MD-110 Ericsson in Lahore, Murree, SWA and Kohat.
  - Due Kashmir Earthquake 2005, complete communication infrastructure got destroyed. Restored communication network of over 70 sites spread in complete Kashmir Region.
  - Established new OFC network, deployed DAMA/ VSat systems (Hughes/Polar Sat/Paksat1-R) and NERA Microwave systems in hostile terrains.
  - Radio Communications
    - RF Planning and optimization to effectively manage HF, VHF and UHF radio networks (Harris, Aselsan, Ericsson, Motorola, R&S) for large size forces.
    - Liaison with Frequency Allocation Board and Pakistan Telecommunication Authority.
    - Cross-Border communication planning/ coordination with NATO/ ISAF.
  - Effectively managed the Information Operations Campaign in conflict zone and countered hostile radio networks both cis-frontier and trans-frontier. Judiciously employed 18 electronic warfare detachments comprising PR – 100 terminals, suppression transmitters and FM transmitters.

- **JOINT INFORMATION OPERATIONS COMMITTEE (JIOC)** 2016 - 18
  - JIOC is joint forum for tri-services, ISI & SPD for technical projects.

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- ✓ Advisor to top management of Army on technical matters of JHQ. Handled projects like COP for tri-services, OFC laying along west bank, tri-services mobile phone network, induction & technical evaluation of advanced communication systems and secure systems

HUMAN RESOURCE MANAGEMENT 2002 - 20

18 years of progressive experience in Human Resource Management. Remained responsible for

- ✓ Supplies of rations, clothing & ammunition and maintenance of weapons, vehicles & technical equipment to ensure smooth operations of the organisation
- ✓ Training & evaluations; career planning & promotions, discipline, and leave of employees.
- ✓ Affairs related to pay & benefits; accommodation; health & safety, medical; and welfare
- ✓ Providing consultation to superior management on related issues of organization

COACHING AND MENTORING

- ✓ **Signal Training Centre, Kohat** 2018 - 20
  - Member of core team designing new training regime for junior leaders of Army.
  - Training need analysis to design training programs of telecommunication cadres of troops of Army, PAF, Police, Rangers and FC.
- ✓ **Psychological and Motivational Training (PMT)** 2016 - 18
  - Organised PMT for Army/ FC employees going to, deployed in & coming from high threat zones. Also conducted PMT for PAF, Police and Rangers employees in various cities
- ✓ **Junior Leaders Academy (JLA), Shinkiari** 2011 - 12
  - Coached and groomed soldiers of Pakistan and foreign armies (KSA, Bahrain, UAE and Sri Lanka) at JLA . My squads got 1st position out of 40 squads in two consecutive courses
  - Prepared and organised demonstrations of training activities for top management and foreign delegates.

SECURITY AND SAFETY 2002 - 20

- ✓ Remained part of security management teams, providing security for top-level dignitaries like President, Prime Minister and COAS.
- ✓ Carried out threat, risk and vulnerability assessment of sites, programs and projects. Devised and issued response strategies accordingly.

DISASTER MANAGEMENT

- ✓ **Electoral Process** 2018
  - Supervision of General Elections – 2018 in the most befitting manner in Kohat District.
  - Maintained close liaison with civil administration and facilitated during the entire process
  - Managing the security of over 17 polling stations.
- ✓ **Tent Village for TDPs in Bannu** 2014
  - Assisted in establishing tent village to accommodate 20,000 temporarily displaced people.
  - Carried out registration & profiling ensuring camp security while giving due consideration to local culture and traditions.
- ✓ **Flood Relief Operations** 2010
  - Establishment of flood relief camps in remote areas of Sindh catering over 30,000 personal
  - Personally supervising the smooth functioning and establishment of medical camps on more than 22 sites within a short span of 3 days.
  - Voluntary gathering of funds and judicious distribution in close liaison with Red Cross representatives.
- ✓ **Earth Quake Relief Operations** 2005
  - Voluntarily initiated relief and rescue effort in my area of responsibility
  - Utilising limited available resources established relief camp to sustain 5000 people
  - Later on acted as lead facilitator for teams employed in Kashmir.

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- Ensured security management and humanitarian field skills training programs by maintaining close liaison with UNHCR teams operating in the area.

EDUCATION	MSc (Art and Science of Warfare), National Defence University, Islamabad	2014 – 16
	BE (Computer Software Engineering), NUST, Islamabad	2006 – 10
	PGD (Wire Communication Engineering), PLAUST, Nanjing, China	2012 – 13
	EMBA (Candidate), LUMS, Lahore	2021 – 23

COURSES AND CERTIFICATIONS

Command and Staff Course, Command and Staff College, Quetta
Mid-Career Signals Course, Military College of Signals, Rawalpindi
Junior Staff Course (Signals), Military College of Signals, Rawalpindi
Electronic Warfare Course, Military College of Signals, Rawalpindi
Young Officers Telecommunication Course, Military College of Signals, Rawalpindi
Project Management Course, OSP International LLC
Certification in Cabling Engineering, Nanjing College of Information Technology, China
Diploma in Cisco based Network Training, Harris Corporation
Certification in DSSS Telemetry and Auto Tracking System, COMTEC, Wah
Army Master Trainer in Information Assurance, Military College of Signals, Rawalpindi
Certified Secure Computer User, EC-Council
UN Military Observers Course, Centre for International Peace and Stability, Islamabad

PROFESSIONAL MEMBERSHIPS

Pakistan Engineering Council, Pakistan
The Institute of Engineers, Pakistan
Charted Institute of Logistics and Transport, UK
Project Management Institute, USA
AXELOS, UK

INETERESTS Reading, Travelling, Bridge, Hunting

REFERENCES Available on request

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HOD (Accounts & Finance)& Member ICMAP

(SAP B1, QUICK BOOKS, ERP)

An Experienced Accounts and Finance person with a demonstrated history of working experience of 10 years in the Manufacturing and Trading industry. Skilled in Financial Management, FP&A, Budgeting, Cost Controls, Accounting Cycle, Taxation Laws, and Decision Making.

SHOAIB BUTT

Contact

Phone:
+92 322 4332430

E-Mail:
buttacma@yahoo.com

Skype ID:
shoaib.butt32

Address:
House no 5, street no.4,
Boston Colony, Qainchi Stop
Ferozepur
Road Lahore Cantt. Pakistan.

Personal Info

DOB: 10th August 1987
Religion: Islam
Marital Status: Married
Membership / Reg. No.: A-6243
Father Name: Waheed Azam Butt

Skill Highlights

- Microsoft Office (Word, Excel, PowerPoint)
- Peachtree Accounting
- Typing Speed 40 wpm
- SAP B1, QUICK BOOKS, ERP

Experience

03/2022 to Present

HOD (Accounts & Finance) – The Punjab Club Lahore, Pakistan.
The Punjab Club was established in 1884 and was exclusively used by British and Europeans. The club was transferred to Pakistan in 1962. It is private social club that has elected members consisting of high ranking civil, leading industrialists, entrepreneurs and executives.

- Responsible for overall accounts, finance and taxation matters.
- Annual Budget, costing, Insurance, Provident Fund management.
- Managing Investment Portfolio with Banks.

04/2020 to 02/2022

Group CFO:

1- Siraj Din Energy (Pvt.) Ltd. (FMCG), Lahore, Pakistan
2- Solargy (Pvt.) Ltd.
3- Qazafi Batteries

Siraj Din Energy (Pvt.) Ltd & Solargy (Pvt.) Ltd. deal in retail and wholesale of commercial batteries (i.e., AGS, OSAKA, EXIDE, PHOENIX, TREET, BRIDGE POWER, MILLAT) for UPS, Autos and Solar Panels System. It has distribution network all over Pakistan.

- I am responsible for all financial planning, financial analysis, drafting financial Strategy, Cash Flow tracking & Taxation.
- Finalization of Annual/Periodic Financial Statements and Audited accounts from external auditors.
- Ensuring proper accounting practices, book keeping, internal audit, claim audit, financial audit, and other MIS reports.
- Comparative statements analysis and presenting reports to CEO.
- Preparing financial budgets, financial models for decision making.
- Compliance of business processes and finding ways of improvements.
- Supervision of All Taxation maters with coordination of consultant.
- Supervision of All SECP, PRA & FBR filing.

12/2014 to 03/2020

Manager Accounts - Element (Pvt.) Ltd., Lahore, Pakistan
Elmetec (Electrical & Mechanical Technologies) Pvt. Ltd. manufactures 11 KV Distribution Transformers from 10 KVA to 630 KVA as per WAPDA specifications and all other capacities up to 5000 KVA. In

addition to that, it also manufactures medium and low voltage switchgear incorporating Vacuum Circuit Breakers, Oil Circuit Breakers and Load Break Switches, Low & Medium Voltage Instrument Transformers. It has annual turnover Rs. 02 billion.

- Preparation of Financial Statements (Monthly, Quarterly, & Annual)
- Fixed Assets Management (Recording, Revaluation and Disposal of Assets). Liaison with External Auditor for annual audit of financials.
- Bank & GL Reconciliation Statements, AP, AR, Sales and Purchase Invoices, Internal Management Reporting.
- Compliance with FBR Notices (Rule 44(4)/161(1A) Monitoring)
- Notice u/s 161, Notice u/s 122 (Assessment), Notice u/s 177 Audit (Information and Evidence with supporting documents)
- Compliance with Sales Tax Audit. Supervision of Leasing of Assets.
- Costing Imported Materials.
- Bill Discounting and other Supervision of financing activities with banks

02/2012 to 11/2014

Account Officer - Rupali Group, Lahore, Pakistan

- Preparation of all kind of vouchers, GRN, costing of Imported Materials.
- Audit of Stores and Spares.
- Conducting Monthly Stock taking.
- Compilations of General Entries to accounts.

Education

2012

CMA (Cost & Management Accountant)
ICMAP – Institute of Cost & Management Accountants of Pakistan
Financial & Managerial, Accounting, Auditing, Companies Law & Financial Reporting

2007

B. Com (IT) (Bachelor of Commerce)
University of the Punjab, Lahore, Pakistan
Financial Accounting, Cost Accounting and Taxation

2005

I.Com (Commerce)
BISE, Lahore, Pakistan
Accounting, B. Math and Commerce.

2003

Matric (Science)
BISE, Lahore, Pakistan
Math, Physics, Bio, and Chemistry

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Certifications

MS Office Diploma (6month) NAVTIC program	2007
Typing Certificate	2007

CONTACTS

Pakistan

imrankhosa44@gmail.com

PAK: +923332876332

+923332876332

https://www.linkedin.com/in/engr-imran-khosa-12b63a189/

CAREER OBJECTIVE

Looking for an opportunity in the field of Power Plant Operation & Maintenance, Testing & Commissioning and Renewable (Solar) Project Executions in a re[illegible]able organization.

SOFT SKILLS

- Microsoft Project
- Microsoft Word
- Microsoft Excel
- Helioscope
- AutoCAD 2D
- Sketchup
- PVsyst

Engr. Imran Khan

Electrical Engineer

PROFESSIONAL BACKGROUND

Foundation Solar Engery Private Limited.

Projects Manager since 15th March 2022.

Sky ElectricPrivate Limited

Project Engineer 1st august 2018 till 13th march 2022.

KEY EXPERTISE

Project Management

- Execution of Megawatt Level Renewable energy projects.
- Microsoft project
- Ability of Team Management, Implementation, Project Planning, Project Pricing, Time Management, Problem Solving, Negotiation Skills, Managing Vendors, Defining Project RFP's, Conducting Technical Surveys and Dealing with Clients.

Testing and inspection

- Done SAT and FAT's for MV panels (short circuit test, high voltage test, earth fault test) and transformers (turn ratio test, insulation resistance test, no load losses and full load losses tests).
- Cables and conductor's tests (high pot, megger & continuity test).
- Reviewing the engineering design changes and resolving quality related problems associated with the design.
- Reviewing manufacture drawings.

Maintenance and trouble shooting

- Planning and effective preventive maintenance schedules of various machineries and instruments to increase machine up time and equipment reliability.
- Troubleshooting of the fault using engineering logic and testing.
- Routine inspections and monitoring of working equipment's.
- Preparing R&D based data to check the performance of motors, generators and transformers.
- Overhead and underground cable laying.

WORK EXPERIENCE

Projects Manager (Permanent/Fulltime)

EPC renewable energy (solar) projects upto 45MW execution and commissioning from initial surveys to the vendor managing and technical evaluations.

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CERTIFICATES & APPRECIATIONS

1. Fusion Solar Service Certificate
2. Installation and Manufacturing of PV module

MANAGERIAL SKILLS

a. Project Scheduling
b. Planning of material resources
c. Managing vendors
d. Management Reporting
e. Dealing with the client
f. Managing timeline
g. Controlling project pricing

LANGUAGES

English

Good

Urdu

Excellent

Punjabi

Excellent

Hindi

Good

Core responsibilities: Leading overall execution activities of the project.

1. Making RFQ's for the Project and Leading site surveys along with sub-contractors.
2. Prepare cost estimations for the different scopes of the project.
3. Prepared project implementation plans, helping draft man in design documents.
4. Managing vendors and ensuring of onsite implementation as per design.
5. Leading technical meetings and taking approval of design from client.
6. Reporting to the higher management regarding daily progress.
7. Assisting HOD in technical evaluations of the subcontractor's and costing negotiations.
8. Keeping record of line item and required ones.
9. Lead installation and testing of 3100KVA Transformers, Central Inverter installation, hot and cold commissioning, DC terminations and MV cable laying, MV terminations 6.3KV at ABB/Schneider MV Switch Gears.

<u>On-going Projects:</u>

7.5 MW: Fauji Cement Company Pvt ltd DG Khan.

5.5 MW: Beacon implex Faisalabad.

1MW: Fauji Akber Portia Marine Port Qasim Karachi.

<u>Projects</u>

6 MW: Rafhan Maize Product co. Mehran Plant Kotri.

11.25 MW: (Fauji Cement Company Limited Nizampur)

surveyed,designed, prepared project implementation plan and system layout, lead execution activities including mechanical, civil and electrical, carried outtesting and commissioning of the site

8.8MW: Solar Plant at Askari Cement Company Limited.

1MW: Solar Power Plant at Ashraf sugar Mill Bahawalpur, designed and executed
500KW or below: Solar Power Plant in south Punjab flour mills and cotton industries, designed and executed.

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PERSONAL PROFILE

DOB: 01/03/1995

Nationality: Pakistan

Marital Status: married

Passport Number: QY4141651

Project Engineer (Permanent/Full time)

Sky electric Pvt Limited
(56 months) 1st august 2018 to 14th march 2022
Operation and maintenance of residential system in South Punjab and based at Multan office. Leading the project execution team and complete the targets within the stipulated time frame.

Core Responsibilities:

1. Meeting client before work execution & formulation of SOW document.
2. Inspect residential/industrial facilities and analyze electrical data
3. BOQ verification, Procurement and Team Administration for residential/SME sites
4. Compile estimates for technical and material requirements for project development
5. Suggest process and technical design changes to improve performance and efficiency.
6. Monitor project progress, compliance with design specifications and safety standards.
7. Create work schedules and adjust as needed to meet project deadlines.
8. System Commissioning and handovering the project to client.

EDUCATION

Sr.No	Name of Course	Institute Name	Completion date
	Bachelors of Science in Electrical Engineering	Islamia University of Bahawalpur	2014--2018
2	Higher Secondary School Certificate (FSc Pre-Engineering)	Muslim College science and technology, Multan	2012--2014
3	Secondary School Certificate (Matriculation)	Shaheen Froce Public School Muzaffargarh.	2010-- 2012

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Lt Col (Retd) Sibtain Naseer Siddiqui, PMP®, P.E, MIE(Pak)

Program Manager, Civil Engineer

House No 107, Street No 7, Safari Valley Usman D Block Phase 8 Bahria Town Rawalpindi, Pakistan

+923365369331

Email: sibtain.naseer1@gmail.com

Linkedin: www.linkedin.com/in/sibtain-naseer-siddiqui-62625515b

Sex: Male | Date of birth 21/12/1983 | Nationality Pakistani

With 17+ years of experience as a General Manager/ Program/ Project/ Construction Manager and Civil Engineer, I possess the expertise and skills necessary to lead effectively. I am dedicated to optimizing operations, minimizing costs, and drivingorganizational efficiency, reflecting my commitment in achieving success. Safety is of paramount importance to me, and I maintain an unwavering focus on ensuring the well-being of all personnel involved in construction activities. Throughout my career, I have built a solid reputation for making independent decisions and exercising sound judgment, resulting in positive contributions to company performance. By consistently applying my problem-solving abilities and leadership acumen, I have been able to drive the overall success of the organizations I have worked with.

Work History

10-2024- Current	**Frontier Works Organization, Rawalpindi** **Program Manager Operations** Frontier Works Organization is today's most versatile and vibrant construction firm of Pakistan, was established on 31 October 1966. I was employed as Program Manager to oversee different projects executed by FWO. **Responsibilities and Achievements:** • Managed operations of Headquarters Frontier Works Organization • Oversaw construction and maintenance of Motorways by concerned Project Managers as per scope, schedule and cost. • Coordinated with all project managers for timely completion of projects. • Collaborated with contractors, suppliers, and other stakeholders to meet project requirements and specifications • Conducted rates verification and analysis of contracts, ensuring compliance with local market standards. • Conducted constructability analysis of contracts, identifying discrepancies and providing actionable recommendations for successful project execution in coordination with project managers. • Collaborated with on-site teams to assess and improve designs based on site-specific conditions, optimizing project outcomes.

	• Facilitated effective communication with local vendors, contractors, and material suppliers to ensure timely project execution and delivery. • Conducted comprehensive risk assessments for projects and implemented/ enforced safety procedures to minimize risks and ensure a safe working environment.
06-2020-09-2024	**Ministry Of Defence Kohat & FATA** **Program/ General Manager** **Responsibilities and Achievements:** • Oversaw the construction of 2 x schools with a capacity to accommodate 500 students along with associated facilities, ensuring a conducive learning environment. • Managed construction of a multi-sports complex, providing state-of-the-art facilities for various sports. • Oversaw construction of Rehabilitation Projects (including WASH activities) for erstwhile FATA worth over Rs 6 Billion. • Managed construction of more than 50 RCC bunkers/ structures. • Successfully completed construction of ammunition dumps/ depots, military equipment storage sheds and multi-storey accommodation. • Oversaw the fencing of 230 km perimeter to secure Pak-Afghan Border, enhancing safety and security measures. • Oversaw all phases of construction, ensuring adherence to safety protocols, quality standards, and project specifications. • Implemented strategies for efficient workflow, productivity, and fostering a positive work environment. • Currently supervising a team of 300 individuals, managing their day-to-day activities, performance, and ensuring effective teamwork.
10 – 2017 06 – 2020	**Military Engineering Services, Rawalpindi and Islamabad** **Project Manager** Military Engineering Services are providing construction services to Pakistan Army, Air force and Navy, dealing public funds of approximately 350 million dollars annually. I have managed two Military Garrisons being Project Manager. **Responsibilities and Achievements:** • Successfully completed projects worth over Rs 7 Billion, delivering quality outcomes within specified budgets and timelines. • Supervised the construction of over 150 km of flexible pavement and 15 km of rigid pavement, ensuring adherence to quality standards. • Construction and installation of sewerage disposal system for the residents. • Planning, awarding and execution of more than 500 contracts and ensuring engineering standards and practices to be followed at all stages. • Actively involved in design / contracting phase to mitigate the design and contract issues thus avoiding any financial effects and litigation. • Utilized multi-tasking skills to optimize project completion time and increase efficiency. • Defining different Standard Operation Procedures for optimum utilization of resources,mitigating risk and ensuring safety procedures at all levels. • Construction of different colonies (complete community development) with

more than 72 x Basement + Ground + 9 Floors accommodation flats, more than 60 x Ground + 3 Floors accommodation flats, 8 x bungalows, and maintenance of accommodation facilities.

- Managed construction of more than 80 multi-storey buildings, ammunition depots, military equipment storage sheds and underground RCC structures.
- Supervised construction of pre-fabricated steel structures, including warehouses, storage sheds, and industrial buildings.
- Construction of New Artillery Mess Rawalpindi Cantonment with cost of over $12 Million and construction of 30 x VIP Guest Rooms/ Hotels (Multi Storey Buildings) and allied facilities.
- Oversaw construction of simulator buildings for Air Defense Systems.
- Successfully executed water supply schemes and sewerage infrastructure for different colonies/ projects.
- Oversaw all phases of construction, ensuring adherence to safety protocols, quality standards, and project specifications.
- Implemented strategies for efficient workflow, productivity, and fostering a positive work environment.
- Successful completion of projects overseeing all aspects from excavation to final finishes.
- Organized and led a staff of 700 employees, managing their day-to-day activities, performance, and ensuring effective teamwork.

10 – 2015
10 – 2017

Frontier Works Organization, Panjgur, Nag & Gidder

Project Manager

Frontier Works Organization is today's most versatile and vibrant construction firm of Pakistan, was established on 31 October 1966. I was employed as Project Manager on different projects executed by FWO.

Responsibilities and Achievements:

- Managed construction and maintenance of 154 km stretch of CPEC National highway N-85 (Panjgur-Nag -Pishuk) overseeing a budgetof Rs 1.5 Billion.
- Construction/ maintenance of 102 x Concrete Culverts and 3 x Concrete Bridges along the route (Panjgur-Nag-Pishuk), conducting inspections, repairs, and preventive maintenance to ensure their structural integrity and safety.
- Managed construction and maintenance of 78 km stretch of CPEC National highway N-85 (Surab-Gidar-Kalgali), overseeing a budgetof Rs 1 Billion.
- Construction/ maintenance of 55 x Concrete Culverts and 1 x Concrete Bridge along the route (Surab-Gidar-Kalgali), conducting inspections, repairs, and preventive maintenance to ensure their structural integrity and safety.
- Construction of camps/ infrastructure at Nag, Gidar and Surab ensuring efficient and timely completion of the project.
- Oversaw the fencing of 3 km perimeter to secure different camps, enhancing safety and security measures.
- Installation/ Construction, operation and maintenance of 3 x Crush Plants and 2 x Asphalt Plants.
- Collaborated with a team of engineers and technicians to address any related issues effectively and ensured adherence to quality standards and timelines, coordinating with construction teams and suppliers.
- Collaborated with contractors, suppliers, and other stakeholders to meet project

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	requirements and specifications. • Managed the projects from planning to execution, coordinating with users, contractors, suppliers,and local authorities. • Conducted rates verification and analysis of contracts, ensuring compliance with local market standards. • Conducted constructability analysis of contracts, identifying discrepancies and providing actionable recommendations for successful project execution. • Reviewed designs, bill of quantities, and rate analysis provided by consultants, ensuring accuracy and adherence to project requirements. • Collaborated with on-site teams to assess and improve designs based on site-specific conditions, optimizing project outcomes. • Facilitated effective communication with local vendors, contractors, and material suppliers to ensure timely project execution and delivery. • Prepared weekly, monthly, and quarterly reports and returns, providing accurate updates on project progress and key performance indicators. Presented findings and project updates to higher Headquarters. • Conducted comprehensive risk assessments for projects and implemented/ enforced safety procedures to minimize risks and ensure a safe working environment. • Collaborated with local authorities and community leaders to address the social impact of projects, considering the needs and concerns of the local population. • Maintained approximately 200 km tracks, ensuring smooth operations and safety for transportation purposes. • Actively involved in WASH activities for the camps and developed a sewerage disposal scheme for 1800 troops at Nag, Gidar and Surab, promoting proper waste management and sanitation practices. • Constructed two helipads for emergency evacuations, ensuring safe and efficient landing and takeoff for helicopter operations. • Organized and led a staff of approx. 900 employees, ensuring efficient workflow, productivity and effective project execution. • Implemented regular inspections and scheduled maintenance activities to address any issues promptly. • Collaborated with local authorities and community leaders to address the social impact of the projects, considering the needs and concerns of the local population. • Implemented initiatives to promote community involvement and foster positive relationships between the organization and the community.

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11 – 2013 10 – 2015	**National Logistics Cell, Pearl NLC Qatar** **Project Manager** I have served in the Middle East/ Gulf with Qatar Branch of National Logistics Cell (Pearl NLC). The main role for my employment was infrastructure development and maintenance. **Responsibilities and Achievements:** • Construction of Pearl NLC Staff and labor camp/ infrastructure at Ash-Shahaniyah, ensuring efficient and timely completion of the project. Oversaw the erection of prefabricated accommodations, providing comfortable and functional living spaces for personnel. • Collaborated with contractors, suppliers, and other stakeholders to meet project requirements and specifications. • Successfully completed earthworks and miscellaneous infrastructure of Ras Laffan Hospital. • Successfully completed earthworks/ infrastructure development for Al-Matar Metro Station. • Successfully completed earthworks/ miscellaneous works of NOH (Orbital Highway) including dumping management and reuse of excavated material economizing cut and fill. • Implemented regular inspections and scheduled maintenance activities to address any issues promptly. • Collaborated with a team of engineers and technicians to address any related issues effectively. • Managed the project from planning to execution, coordinating with users, contractors, suppliers, and local authorities. • Ensured adherence to quality/ safety standards and timelines, coordinating with construction teams and suppliers.

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06 – 2009 10 – 2013	**Ministry Of Defence, Sialkot, FATA / NMD, Shinkiari** **Site Engineer** **Responsibilities and Achievements:** • Led the construction of Shopping Complex ex 15 Division, 15 x Posts and Upgradation/ rehabilitation of Army Public School valued at Rs 300 Million. • Managed construction of Perimeter Wall and fencing of Sialkot Cantonment to secure the garrison enhancing safety and security measures. • Construction of 17 x Watch Towers/ Posts along perimeter of Sialkot Garrison • Construction/ Maintenance of 10 Km of track ensuring smooth operations and safety for security, maintenance and transportation purposes along perimeter of Sialkot Garrison. • Constructed two helipads ensuring safe and efficient landing and takeoff for helicopter operations. • Rehabilitation/ upgradation of 70 x soldiers houses in Sialkot Garrison • Planning and preparation of Demolition of 3 x Bridges around Sialkot area • Organized and led a staff of 350 individuals • Managed local contractors and served as the site engineer for the construction of the college, ensuring adherence to project specifications and timelines. • Identified and mitigated risk and safety issues at the construction site, implementing measures to ensure the well-being of workers and project success. • Construction of Improvised Pedestrian Bridge at Jandola to facilitate the locals in their movement across the river • Launching/ construction and maintenance of Compact 200 Bridge to open the traffic for locals in Sararogha, South Waziristan • Construction/ maintenance of 950 Lightening Conductors for Camps/ Posts in South Waziristan • Led emergency response efforts for flood in South Waziristan, utilizing boats and OBMs to rescue affected individuals. • Construction of Basketball Court and Uplift/ Re-Construction of Main Entrance Gate in Junior Leadership Academy, Shinkiari.
04 – 2007 06 – 2009	**Frontier Works Organization, Jhal Magsi, Karachi and Coastal Highway** **Site Engineer** Frontier Works Organization is today's most versatile and vibrant construction firm of Pakistan, was established on 31 October 1966. I was employed as site manager on different projects executed by FWO. **Responsibilities and Achievements:** • Managed construction and maintenance of a 64 km stretch of Motorway M-8 (Shahdadkot-Qubo Saeed Khan-Kachi Pull- Barija), overseeing a budget of Rs 900 Million. • Construction/ maintenance of 74 x Concrete Culverts and 1 x Bridge along the route, conducting inspections,repairs, and preventive maintenance to ensure their structural integrity and safety. • Managed the project from planning to execution, coordinating with users, contractors, suppliers,and local authorities. • Conducted rates verification and analysis of contracts, ensuring compliance with local

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NRTC

market standards.

- Conducted constructability analysis of contracts, identifying discrepancies and providing actionable recommendations for successful project execution.
- Reviewed designs, bill of quantities, and rate analysis provided by consultants, ensuring accuracy and adherence to project requirements.
- Collaborated with on-site teams to assess and improve designs based on site-specific conditions, optimizing project outcomes.
- Facilitated effective communication with local vendors, contractors, and material suppliers to ensure timely project execution and delivery.
- Prepared weekly, monthly, and quarterly reports and returns, providing accurate updates on project progress and key performance indicators. Presented findings and project updates to higher Headquarters.
- Conducted comprehensive risk assessments for projects and implemented/ enforced safety procedures to minimize risks and ensure a safe working environment.
- Maintained 21 km tracks, ensuring smooth operations and safety for transportation purposes.
- Oversaw the fencing of 18 km perimeter to secure different camps, enhancing safety and security measures.
- Organized the emergency evacuation of flood victims from Jhal Magsi, ensuring their safety and well-being.
- Actively involved in WASH activities by managing construction and provision of 12 x water filtration plants, construction and installation of sewerage disposal plant for the local communities.
- Established camps for 8000 flood victims, providing basic necessities and support in challenging circumstances.
- Constructed three helipads for emergency evacuations, ensuring safe and efficient landing and takeoff for helicopter operations.
- Managed maintenance of a 230 km stretch of Makran Coastal Highway N-10 (Liari-Buzzi Top-Ormara) damaged during floods.
- Managed demolition of Shershah Bridge Karachi in record 1 Week in coordination with technical teams opening the route for local populace
- Supervision and management of camp/ offices temporarily established for Shershah Bridge Demolition
- Developed a sewerage disposal scheme for 1800 troops, promoting proper waste management and sanitation practices.
- Organized and led a staff of 350 employees, ensuring efficient workflow, productivity, and effective project execution.

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Education

12 – 2002
06 – 2006

Bachelor of Science: Civil Engineering
National University of Science and Technology - Islamabad

Skills

- Constructability analysis
- Cost estimation
- Preparation of Bill of Quantities
- Quality control and assurance
- Contract and tender documents
- Risk Management
- Sustainable construction
- Team leader
- Communication with different tiers
- Strategic planning and execution
- Process improvements
- Project/ Construction management
- Multinational and Gulf Experience
- Financial Management
- Negotiation

Software

Primavera P6, JIRA, ETABS, SAFE, Revit. Microsoft Office

Certifications & Licences

- WES (World Education Services) Verified Civil Engineer
- PMP®, Certified Project Management Professional
- Professional Engineer (P.E)/ Member Pakistan Engineering Council
- Member PMI
- MIE(Pak)
- ISO 45001: Occupational Health & Safety management system (Udemy)
- ISO 31000: Risk Manager Training (Udemy)
- Operational Risk Management Professional Masterclass (Udemy)
- IOSH Managing Safely
- OSHA 30 Hours
- HABC Fire Safety At Work
- HABC Risk Assessment
- HABC First Aid At Work

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Languages

- English (Fluent)
- French (Niveau-B1)
- Urdu (Fluent)

Syed Waqar Ali

+923024168716 | waqaraliee@gmail.com

SUMMARY

An Electrical Engineer with almost 8 years of experience in the field of Renewable Energy (Solar PV). Proven success in the aspects of the project performance; including management of the contracts, costing and interfaces with project stakeholders, as well as safety of personnel and equipment. Seeking an opportunity to lead and manage a team of engineers to design and build renewable energy systems that make a positive impact on the environment.

Specialties: Utility Projects Construction, Project origination, Project initiation, Project planning, Project execution and control, Construction management, Solar Asset Management, High Voltage, good understanding of Utility interfaces.

ACADEMIC CREDENTIALS

BSc Electrical Engineering | University of Engineering & Technology, Lahore (UET Lahore) | 2012 - 2016 |
CGPA 3.206/4.00
Major Courses: Power System Analysis, High Voltage, Power System Protections, Renewable Energy, Power electronics.

WORK EXPERIENCE

Ministry of Defense Production (NRTC Energies (Pvt.) Ltd) | (May-2023 – Present) | Head of Department (Design)

Job Summary

Responsible for leading the solar design team & Planning, overseeing the design and engineering of solar energy systems, and ensuring the successful execution of solar projects. This role involves strategic planning, technical expertise, project management, and team leadership.

Key Performance Areas

- Lead, mentor, and manage a team of solar design engineers.
- Provide technical guidance and support to team members.
- Manage the solar design department's project portfolio.
- Collaborate with project managers to ensure seamless project execution.
- Monitor project timelines, budgets, and quality standards.
- Identify and mitigate design-related risks.
- Oversee the design and engineering of solar PV systems, including rooftop and ground-mounted installations.
- Ensure that designs meet client requirements, industry standards, and regulatory compliance.
- Optimize solar panel layouts for maximum energy generation and efficiency.
- Review and approve design drawings, calculations, and specifications.
- Interface with clients to understand project requirements and expectations.
- Address client inquiries and concerns regarding the design phase.
- Ensure all designs adhere to local, state, and national regulations and building codes.
- Obtain necessary permits and approvals for solar projects.

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Prism Energy (InfraCo Asia – Singapore, PIDG, IAD) | (July-2021 – Present) | Manager Projects

Job Summary

Responsible for overseeing and managing all aspects of solar energy projects from conception to completion. This role involves project planning, execution, team leadership, client interaction, and ensuring projects are delivered on time, within budget, and to the highest quality standards.

Key Performance Areas

i. **Project Origination**
   - Development of Project Proposals
   - Evaluation of Project Proposals

ii. **Project Initiation and Planning**
   - Technical Due Diligence
   - IEE/EIA Assessment
   - Risk Assessment

iii. **Project Construction and Control**
   - Establishment of the project team
   - Coordination and management of project team
   - Efficient management of resources ensuring deliverables are achieved on time.
   - Support negotiations with Suppliers and Contractors
   - Ensure successful completion of the execution phase, and delivery to the Operation & Maintenance division.
   - Ensure accurate and continuous reporting of project progress to top management, key stakeholders and the SPV.
   - Ensure effective contracts management of suppliers and service providers during execution.
   - Identify contract breaches and manage project risks.

iv. **Project Closeout**
   - Manage administration and close out of contracts.
   - Ensure the Sub-EPC adherence to project processes and procedures.
   - Prepare contract change notices, monitor contract performance, including the reporting and status of the Project.

Prism Energy (InfraCo Asia – Singapore, PIDG, IAD) | (July-2020 – June 2021) | Senior Design Engineer

Key Performance Areas

- Feasibility studies of projects under development.
- Energy Production Assessment **(EPA)** of pre-construction projects.
- Solar technology review and assessment of site suitability of solar plant equipment.
- Assessment of **Balance of Plant** (civil and electrical infrastructure).
- Assessment grid connection and Power Purchase Agreements **(PPA).**
- **Due diligence** activity includes data analysis, documentation review and risk analysis.
- Technical analysis of construction and operation contracts.
- Develop proposals for work, including budgets, appropriate contractual terms, and undertaking negotiations on scope and price with customers.
- Construction monitoring to assess construction progress and control the quality of the work.
- Construction contracts, project quality plans.
- Work on multiple projects, managing own time to meet deadlines.

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Four Brothers Energy | (Nov-2019 – July 2021) | Senior Design Engineer

Key Performance Areas

- Experience of Large-scale systems and plant designs (up to 50 MW) on the basis of Solar PPA, Lease and EPC model.
- Conceptualization of the design and necessary engineering calculations and simulations using computer software i.e., PVsyst.
- Performing site visits and measuring sites with proper layout drawings.
- Provide accurate design, generation, and production of PV projects designs for electrical engineering aspects needed for the project.
- Perform detailed energy production modeling calculations.
- Generation of preliminary layouts on Helioscope, sketch up, Auto Cad.
- Maintain design requirements, knowledge of codes and standards, design procedures, methods, and process, improve the efficiency of project development and project selection process.
- Generation of Project Bill of Quantity for electrical, mechanical, and civil scope of works.
- Prepares product reports by collecting, analyzing, and summarizing information and trends.
- Following up with Utilities formalities and applications required for the project development.
- Tender's documentation preparations and attending meetings with project teams and follow up.

Guangdong Dynavolt Renewable Technology | (Nov-2018 – Nov 2019) | Project Engineer

Guangdong Dynavolt Renewable Technology | (Nov-2016 – Nov-2018) | Design Engineer

MAJOR PROJECTS UNDERTAKEN

A. UTILITY PROJECTS:

1. **168 MW Solar Power Project | July 2020 – November 2020 | Vietnam.**
2. **50 MW Solar Power Project | July 2022 – March 2023 | Pakistan.**
3. **DABS 20MW On Grid Solar Solution | Dec 2018 – Jan 2019 | Afghanistan**
4. **MAHAN 20MW On Grid Solar Solution | June 2015 – Sep 2016 | Iran**

B. C & I PROJECTS (Power Purchase Agreements):

5. **1500 kW Solar Power Project | Power Purchase Agreement (PPA) | May 2023 – Present | Pakistan**
6. **926 kW Solar Power Project | Power Purchase Agreement (PPA) | August 2023 – Present | Pakistan**
7. **1200 kW Solar Power Project | Power Purchase Agreement (PPA) | May 2022 – September 2022 | Pakistan**
8. **1850 kW Solar Power Project | Power Purchase Agreement (PPA) | Nov 2021 – April 2022 | Pakistan**
9. **2000 kW Solar Power Project | Power Purchase Agreement (PPA) | Nov 2021 – April 2022 | Pakistan**
10. **942 kW Solar Power Project | Power Purchase Agreement (PPA) | Nov 2020 – April 2021 | Pakistan**
11. **UET 1 MW Solar Power Project | Power Purchase Agreement (PPA) | Nov 2020 – April 2021 | Pakistan**

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C. C & I PROJECTS (EPC):

12. **1.5 MW Solar Power Project | EPC | May 2023 – September 2023 | Pakistan.**
13. **1 MW Solar Power Project | EPC | March 2018 – September 2018 | Pakistan.**
14. **ADB - PMIC Pre-Qualification Document for Solar Home Solutions | May 2019 – July 2019 | Pakistan.**

PROFESSIONAL & ACADEMIC ACHIEVEMENTS

- Got achievement award on management of project construction of more than 10 MW Solar projects during March 2021 - April 2022.
- 3rd position in Final year project- **"Remote Monitoring of Distribution Transformer with Remote Access".**
- Got Merit Scholarships at University and Intermediate levels.

TECHNICAL SKILLS

Software (Simulation/Layout/Generation Studies)

Auto-Cad PV-syst, SAM (NREL), Helioscope, Sketchup, K2 Base, PVCad MATLAB, Power World Simulation

Report writing

Office | Microsoft word, Latex

Trainings & Courses

Courses | PMP | In Progress
Courses | project Management and Quality Control by IAD Singapore.
Training | HSES – InfraCo Asia Singapore Quality Management Certification
Training | Pakistan Solar Quality Passport – Total Energies
Courses | Online Training Webinars by PV magazine and NABCEP.

PERSONAL INFORMATION

Co-Founder and Vice President of Project "SMILE"
Education Ambassador at "The Citizen Foundation"
Book reading on History, PV magazine, Technology advancements globally.

REFERENCES

To be provided on demand

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Sr. No.	Employee ID	Employee Name	Designation	Educational Qualification
1	100001	Jawad Anjum	CEO	MBA/ BE(CS Engineer)
2	100016	Zain ul abideen	Project Engineer	BS Electrical Engineering
3	100018	Ahmed Mujeeb	A.M Sales	BSC(Electrical)
4	100028	Adnan Raza	Technician	B.A and Electronic Diploma
5	100031	Syed Waqar Ali	Senior Manager Design	B.Sc Electrical Engineering
6	100059	Musa Ali	Site Engineer	BSC (ELECTRICAL)
7	100061	Fatima Syeda	Asst. Sales Manager	BSc(electrical)
8	100067	Israr Ahmad	Technician	dae- civil
9	100081	M. Nasir	Technician(resi)	DAE-electrical
10	100091	Farhan Ahmad	AM - Ops	BS Electrical Technology
11	100094	Jibrail Khalid	Senior Sales Manager	BSC(Electrical)
12	100099	Imran Khosa	Manager Operations-C&I	BSE-EE
13	100106	Tanzeel Ur Rehman	Site Engineer	BSC (ELECTRICAL)
14	100108	Hassan Bhatti	Business Development Off	BSC(Electrical)
15	100112	Asmar Iftikhar	Solution& Proposal Design	BSC. ENGINEER
16	100117	Rehan Mahmood Alvi	General Manager	PGD(LSCM)
17	100097	Maryam Tariq	Project Coordinator	MS Environmental Engineer
18	100121	Muhammad Iqbal	Civil Supervisor	DAE
19	100122	Muhammad Shakir	Project Engineer	BSC Electrical
20	100123	Ali Rahman	Site Engineer	DAE CIVIL
21	100124	Sibtain Naseer	Senior Manager - Projects	BE Civil Engineer
22	100126	Daniyal Khalid	Assistant Sales Manager	BS Electrical Engineering
23	100127	Muhammad Ansar	Business Development Off	PHD (Energy)
24	100128	Muhammad Umar Ro	Mnager Design	MSc (Renewable)

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ESSA (Environmental and Social Soundness Assessment)

Introduction:

Extensive fossil fuel consumption in almost all human activities has led to some undesirable phenomena such as atmospheric and environmental pollution, which have not been experienced before in known human history. Consequently, global warming, greenhouse effect, climate change, ozone layer depletion, and acid rain terminologies started to appear in the literature frequently. Since 1970, it has been understood scientifically by experiments and researches that these phenomena are closely related to fossil fuel use because they emit greenhouse gases such as carbon dioxide (CO2) and methane (CH4), which hinder the tong-wave terrestrial radiation escape into space, and, consequently, the earth troposphere becomes warmer. In order to avoid further impacts of these phenomena, the two concentrative alternatives are either to improve the fossil fuel quality with reductions in their harmful emissions into the atmosphere or, more significantly, to replace fossil fuel usage as much as possible with environmentally friendly, clean, and renewable energy sources. Among these sources, solar energy comes at the top of the list due to its abundance and more even distribution in nature than any other renewable energy type, such as wind, geothermal, hydro, wave, and tidal energies. Solar energy technologies are essential components of a sustainable energy future. Energy from fossil fuels may be inexpensive and assurances may have been given of the plentiful supplies of petroleum and other fossil fuels, but these fuels are finite in nature and a major source of greenhouse gas emissions.

Objective:

Pakistan is located in the Sunny Belt and can take advantage of its ideal situation for utilization of solar energy. The country's potential for solar generation is beyond doubt as it has high solar irradiation and enough space for installation of generation system those are ideal for PV and other solar energy applications. Villages and other areas which are away from grid or distribution system of utilities can also benefit from solar power generation which will also save the extra cost of laying the system and the losses. Every day, for example, the country receives an average of about 19 Mega Joules per square meter of solar energy Pakistan being in the Sun Belt is ideally located to take advantage of solarenergy technologies. This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200-250 watt per sq.m in a day, This amounts to about 2500- 3000 sun shine hours and 1.9-2.3 MWh per sq. meter in a year. It has an average daily global isolation of 19 to 20 Mi/sq. meter per day with annual mean sunshine duration

8 to 8.5 hours (6-7hrs in cold and 10-12 hrs. in hot season) and these values are among the highest in the world.

For daily global radiation up to 23MJ/m2, 24(80%) consecutive days are available in this area for solar energy. Such conditions are ideal for solar thermal applications. Pakistan receives about 15.5x1014 kwh of solar irradiance each year with most regions receiving approximately 8 to 10 sunlight hours per day. The installed capacity of solar photovoltaic power is estimated to be 1600 GW per year, providing approximately 3.5 PWh of electricity (a figure approximately 41 times that of current power generation in the country). To summarize, the sun shines for 250-300 days per years in Pakistan with average sunshine hours of 8- 10 per day. This gives huge amount of energy to be used for electricity generation by solar photovoltaic and solar thermal power plants.

Environment Assessment:

The Lahore and Okara project will be executed on within the premises of Purchaser, and the Applicant has carried out a detailed environment assessment of the site in preparation of the Solar PV Plant. The assessment of the Project has been considered for both positive and negative effects. The proposed photovoltaic Power Project has been located as per international guidelines. Adoption of green power generation with no emission and effluent discharge with have least impact on the ambient environment and on the host community.

The importance of the sustainable development concept has increased in the whole world. As a result, some new regulations enforce that all development projects should be compatible with the environmental criterions. An environmental impact assessment should be carried out to make sure that projects are compatible with the environmental criterions. Environmental Impact Assessment (EIA) can be defined as a process of environmental management, planning, and decision-making with a purpose of keeping and improving the quality of the environment. The main goal is to develop environmentally friendly industrialization. With this kind of environmentally friendly industrialization, "sustainable development" can be a possibility in the future by keeping the usage/protection balance between economic development and the environmental protection.

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

The use of solar power has additional positive implications such as:

- Reduction of the emissions of the greenhouse gases (mainly CO2, NOx) and prevention of toxic gas emissions (502, particulates)
- Reduction of the required transmission lines of the electricity grids.

Project Environmental Impacts & Mitigation Measure:

This Section discusses the potential environmental impacts, assesses the significance, recommends mitigation measure to minimize the adverse effect and identifies the residual impacts associated with the proposed activities of the project during the construction and operation phase of the proposed project at the proposed site and of secondary actions like potable, raw water and waste water lines. Solar energy is a lot cleaner when compared with conventional energy sources. Solar energy systems have many significant advantages, like being cheaper and not producing any pollutants during operation, and being almost an infinite energy source when compared with fossil fuels. Nevertheless, solar energy systems have some certain negative impacts on the environment just like any other energy system. Some of these impacts will be summarized in this section.

Identification of Potential Impacts:

a) Discharge of Pollutants
b) Visual Impacts
c) Impact on Natural Resources
d) Air Pollution
e) Noise Intrusion
f) Impact on Air
g) Impact on Ground Water! Surface Water
h) Impact on Solid Waste

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i) Impact on Soil

j) Impact on Natural Resources

Discharge of Pollutants:

Solar cells do not emit any pollutants during their operations. But solar cell modules contain some toxic substances, and there is a potential risk of releasing these chemicals to the environment during a fire. Necessary precautions will be taken for emergency situations like fire.

Visual Impacts:

There will be some visual impacts depending on the type of the scheme and the surroundings of the solar cells. Especially for applications on the buildings, solar cells can be used as a cladding material that could be integrated into the building during the construction phase. Solar cell applications after the construction phase of the buildings might cause negative visual impacts. However, through proper planning the Applicant will minimize this impact.

Impacts on Natural Resources:

Despite being a benign energy system during operation, solar cells have some negative impacts on the environment during their production phase like many other systems. The energy needed for the production of solar energy systems is still produced in conventional methods today. Some toxic chemical substances used during the production phase are produced as a by-product. However, the solar panels to be utilized for this project have been manufactured in China therefore, there is no direct impact on the designated vicinity.

Air Pollution:

Solar cells do not emit any substances to the air during operation. But there could be some emissions during manufacturing and transport. The emissions associated with the transport of the modules are insignificant when compared with the emissions associated with the manufacture, Transport emissions are 0.1-1% of the manufacturing emissions.

Noise Intrusion:

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Solar cells do not make a noise during operation. But during the construction phase, there will be a little noise as usual in other construction activities. However, since the solar panels to be utilized for this project have been manufactured in China, this is not a risk for the designated vicinity.

Impact on Air:

There would be no hazardous emissions at site as well as during construction phase except Motor Vehicle and Crane. Moreover, there are no objectionable odors as well as alternation of air temperature.

Impact on Ground Water/ Surface Water:

There would be no use of water during design phase except curing of civil pads during construction, which have no negative impact on environment.

Impact on Solid Waste:

It may only Create litter and trash waste which is recyclable and may be cleared from site after construction. Impact on Soil: No impacts as all installed systems are roof top.

Impact on Natural Resources:

There won't be any increase in the rate of usage of any natural resource like any minerals, additional fuel other than vehicles. But there would be increase in the amount of usage of Paper for mapping, enlisting items etc. However, paper may be recycled by throwing it in ordinary dustbin, further maximum usage of electronic system e.g., emails will be done.

Environment Assessment:

a) Almost all conventional methods of energy generation have varying degrees of adverse environmental impact. These methods have far reached detrimental effects on the climate, air, water, land and wildlife of the adjacent vicinities. However, Solar PV energy technology provides significant environmental advantages in comparison

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to the conventional energy sources while contributing to the sustainable development of human activities. Besides slowing down the depletion of natural resources, the main environmental advantage is zero air emissions, waste production and eventual reduction in emissions of greenhouse gases (COx, NOx) and toxic gases (SOx).

b) Solar power plants have zero fuel requirement and hence limit the depletion of natural resources, fossil fuels. Unlike conventional thermal power plants, no water consumption is required for cooling purposes. A very optimized quantity of water is occasionally used for plant maintenance / cleaning. As stated earlier, the proposed system of 5O7p DC will offset approximately 607 tons of carbon dioxide annually.

The Applicant has carried out environment assessment of the Site for installation of solar:

Environment Parameters	**Level of Impact**	**Reasons**	**Mitigation Measures**
Air Impact	Low	Solar Energy Carbon Free	No Emissions, however, during construction adequate measures to limit dust pollution will be taken.
Water	Low	Plant will require a very low quantity of water for cleaning purpose only	Specialized equipment that conserves water will be used to cleaning the PV modules.
Land	Low	No Impact on Land	The land being allocated for this facility is baren.
Ecosystem	Low	No ecologically sensitive area lies with in premises	There is no significant vegetation cover within the selected area, land is barren.

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Socio EcoSystem	Low	Total area identified for said project is adjacent to the plant premises and no acquisitions needed. No displacement will occur.	Not Applicable

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PVSYST
PHOTOVOLTAIC SOFTWARE

Version 7.3.1

PVsyst - Simulation report

Grid-Connected System

Project: Lahore Mes (CMH)

Variant: New simulation variant
No 3D scene defined, no shadings
System power: 1001 kWp
Lahore MES (CMH) - Pakistan

Author

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PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:37
with v7.3.1

Project summary

Geographical Site
Lahore MES (CMH)
Pakistan

Situation

Latitude	31.54 °N
Longitude	74.37 °E
Altitude	210 m
Time zone	UTC+5

Project settings

Albedo	0.20

Meteo data
Lahore MES (CMH)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array		**Inverters**	
Nb. of modules	1726 units	Nb. of units	3 units
Pnom total	1001 kWp	Pnom total	900 kWac
		Pnom ratio	1.112

Results summary

Produced Energy	1201970 kWh/year	Specific production	1201 kWh/kWp/year	Perf. Ratio PR	73.94 %

Table of contents

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General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation		**Sheds configuration**	**Models used**	
Fixed plane		No 3D scene defined	Transposition	Perez
Tilt/Azimuth	26 / 0 °		Diffuse	Perez, Meteonorm
			Circumsolar	separate

Horizon	**Near Shadings**	**User's needs**
Free Horizon	No Shadings	Unlimited load (grid)

PV Array Characteristics

PV module		**Inverter**	
Manufacturer	CSI Solar	Manufacturer	Huawei Technologies
Model	CS7L-580MB-AG 1500V	Model	SUN2000-330KTL-H2
(Original PVsyst database)		(Custom parameters definition)	
Unit Nom. Power	580 Wp	Unit Nom. Power	300 kWac
Number of PV modules	1726 units	Number of inverters	3 units
Nominal (STC)	1001 kWp	Total power	900 kWac

Array #1 - PV Array

Number of PV modules	868 units	Number of inverters	8 * MPPT 17% 1.3 unit
Nominal (STC)	503 kWp	Total power	400 kWac
Modules	31 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	463 kWp	Max. power (=>30°C)	330 kWac
U mpp	854 V	Pnom ratio (DC:AC)	1.26
I mpp	542 A	No Power sharing between MPPTs	

Array #2 - Sub-array #2

Number of PV modules	858 units	Number of inverters	10 * MPPT 17% 1.7 units
Nominal (STC)	498 kWp	Total power	500 kWac
Modules	33 Strings x 26 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	457 kWp	Max. power (=>30°C)	330 kWac
U mpp	793 V	Pnom ratio (DC:AC)	1.00
I mpp	577 A	No Power sharing between MPPTs	

Total PV power		**Total inverter power**	
Nominal (STC)	1001 kWp	Total power	900 kWac
Total	1726 modules	Number of inverters	3 units
Module area	4885 m²	Pnom ratio	1.11
		No Power sharing	

Array losses

Array Soiling Losses
Loss Fraction 4.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

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Array losses

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

DC wiring losses

Global wiring resistance 10 mΩ
Loss Fraction 1.5 % at STC

Array #1 - PV Array
Global array res. 26 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2
Global array res. 23 mΩ
Loss Fraction 1.5 % at STC

System losses

Unavailability of the system
Time fraction 3.4 %
12.4 days,
3 periods

Auxiliaries loss
Proportionnal to Power 5.0 W/kW
0.0 kW from Power thresh.
Night aux. cons. 500 W

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 800 Vac tri
Loss Fraction 0.08 % at STC

Inverter: SUN2000-330KTL-H2
Wire section (1 Inv.) Alu 1 x 3 x 240 mm²
Wires length 20 m

Inverter: SUN2000-330KTL-H2
Wire section (2 Inv.) Alu 2 x 3 x 150 mm²
Average wires length 0 m

MV line up to injection
MV Voltage 11 kV
Wires Alu 3 x 120 mm²
Length 100 m
Loss Fraction 0.02 % at STC

AC losses in transformers

MV transfo
Medium voltage 11 kV
Transformer from Datasheets
Nominal power 1250 kVA
Iron Loss (24/24 Connexion) 1.00 kVA
Iron loss fraction 0.08 % of PNom
Copper loss 20.00 kVA
Copper loss fraction 1.60 % at PNom
Coils equivalent resistance 3 x 8.19 mΩ

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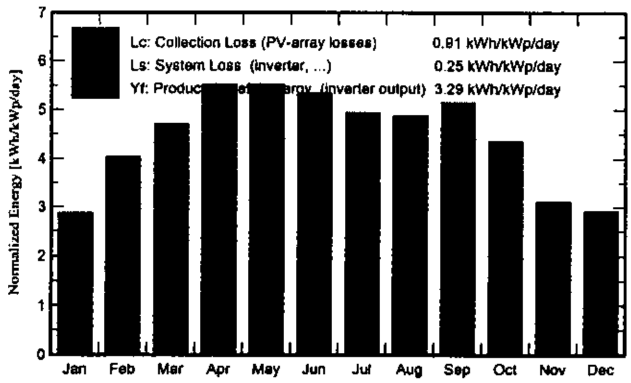
PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:37
with v7.3.1

Main results

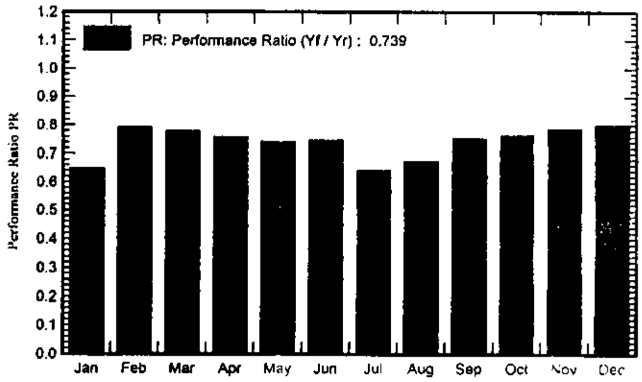
System Production

Produced Energy (P50)	1201970 kWh/year	Specific production (P50)	1201 kWh/kWp/year	Performance Ratio PR	73.94 %
Produced Energy (P90)	1103932 kWh/year	Produced Energy (P90)	1103 kWh/kWp/year		
Produced Energy (P99)	1024030 kWh/year	Produced Energy (P99)	1023 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	PR ratio
January	69.8	43.8	11.97	89.2	84.1	75051	0.648
February	91.5	47.0	16.08	112.8	106.6	93022	0.793
March	130.8	77.5	22.10	145.7	137.2	117704	0.779
April	160.2	87.6	27.05	165.9	156.2	130724	0.760
May	176.0	99.4	33.10	171.5	161.5	132088	0.742
June	169.5	102.6	33.05	160.2	150.7	124093	0.747
July	160.6	102.3	31.57	153.2	144.1	119855	0.641
August	151.4	95.3	30.79	151.6	142.7	118810	0.675
September	141.5	71.5	29.07	154.5	145.6	121017	0.755
October	115.7	69.5	26.00	135.2	127.6	107744	0.768
November	76.5	52.0	19.07	93.4	88.0	76644	0.788
December	68.5	41.9	13.92	90.7	85.5	75726	0.801
Year	1511.9	890.5	24.52	1623.8	1529.9	1292479	0.739

Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	PR	Performance Ratio
T_Amb	Ambient Temperature		
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

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Loss diagram

1512 kWh/m²		**Global horizontal irradiation**
	+7.4%	**Global incident in coll. plane**
	-1.86%	IAM factor on global
	-4.00%	Soiling loss factor
1530 kWh/m² * 4885 m² coll.		**Effective irradiation on collectors**
efficiency at STC = 20.58%		PV conversion
1538279 kWh		**Array nominal energy (at STC effic.)**
	-3.80%	Module Degradation Loss (for year #10)
	-0.27%	PV loss due to irradiance level
	-6.53%	PV loss due to temperature
	+0.43%	Module quality loss
	-2.00%	LID - Light induced degradation
	-3.91%	Mismatch loss, modules and strings (including 1.8% for degradation dispersion
	-0.93%	Ohmic wiring loss
1292479 kWh		**Array virtual energy at MPP**
	-1.66%	Inverter Loss during operation (efficiency)
	0.00%	Inverter Loss over nominal inv. power
	0.00%	Inverter Loss due to max. input current
	0.00%	Inverter Loss over nominal inv. voltage
	-0.01%	Inverter Loss due to power threshold
	0.00%	Inverter Loss due to voltage threshold
	-0.01%	Night consumption
1270870 kWh		**Available Energy at Inverter Output**
	-0.66%	Auxiliaries (fans, other)
	-0.03%	AC ohmic loss
	-1.24%	Medium voltage transfo loss
	-0.01%	MV line ohmic loss
	-3.55%	System unavailability
1201970 kWh		**Energy injected into grid**

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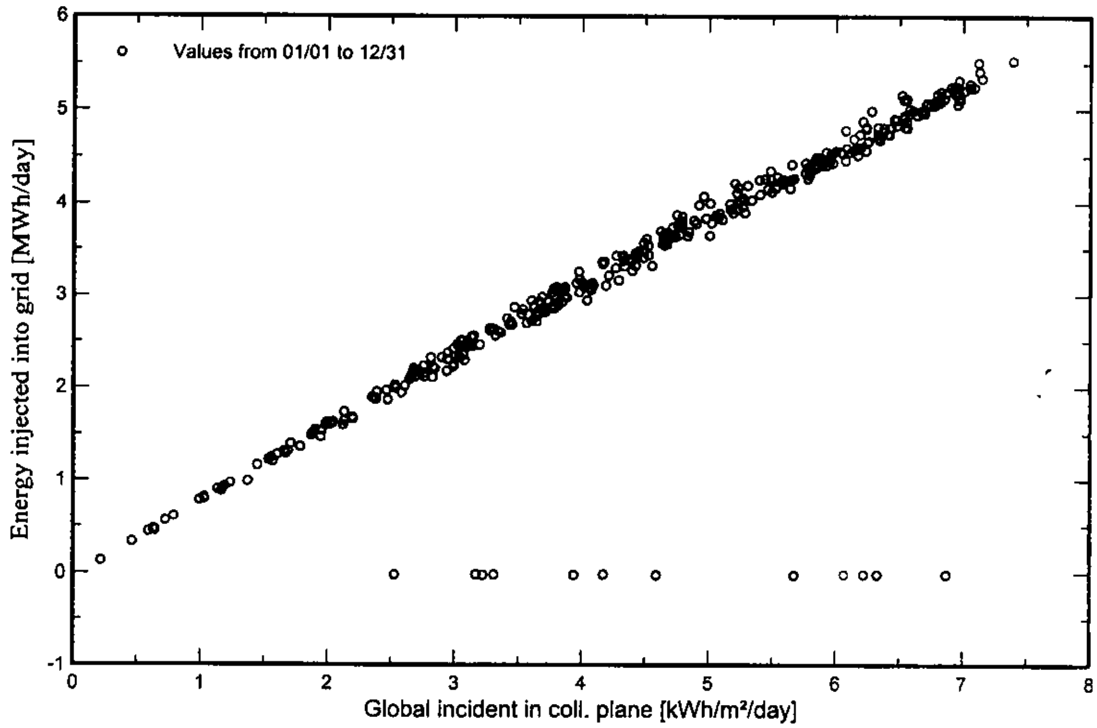
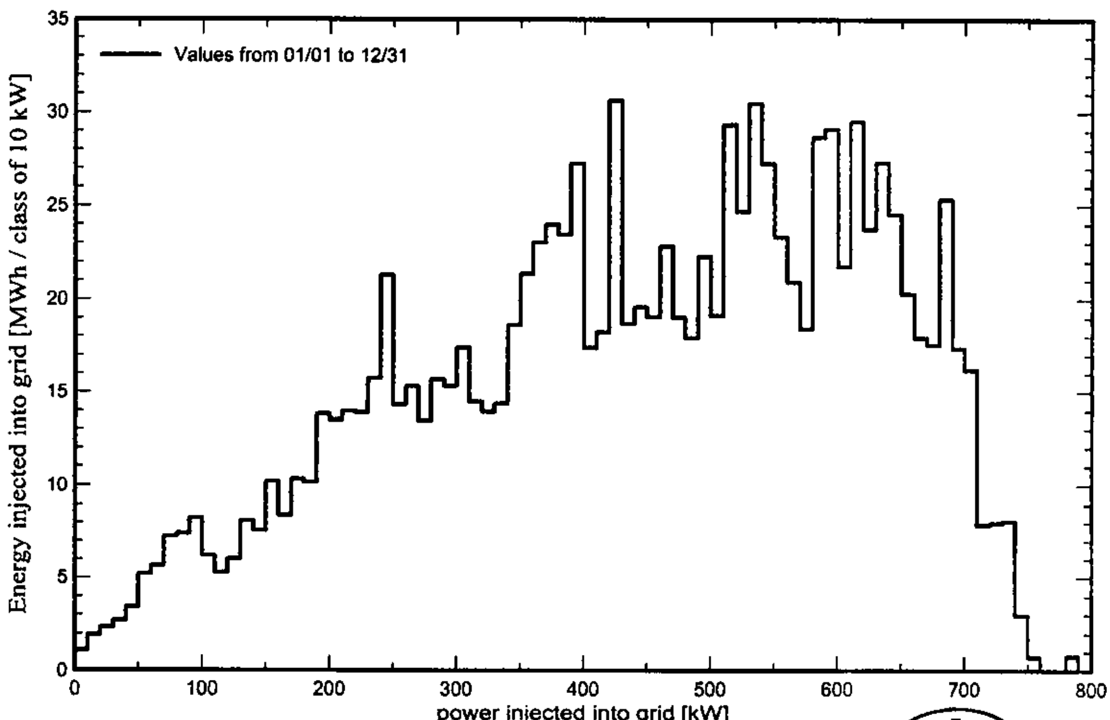
Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



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with v7.3.1

P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	6.1 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	6.4 %

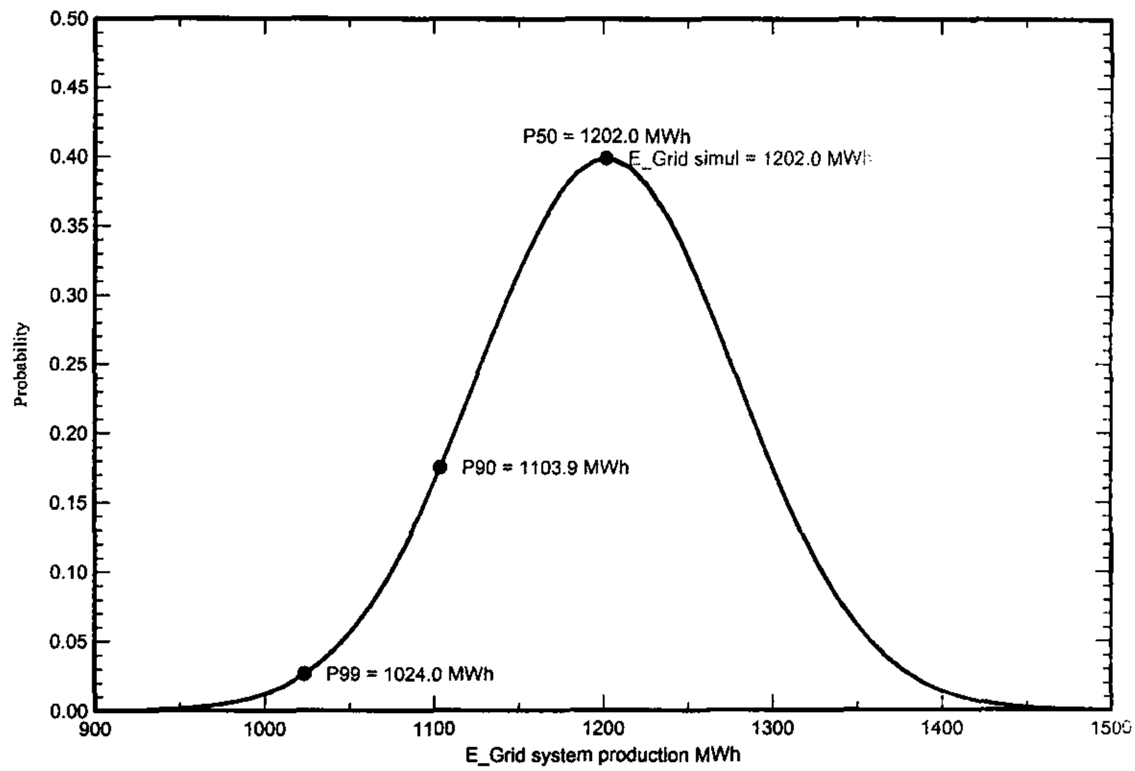
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

Annual production probability

Variability	76.5 MWh
P50	1202.0 MWh
P90	1103.9 MWh
P99	1024.0 MWh

Probability distribution



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Version 7.3.1

PVsyst - Simulation report

Grid-Connected System

Project: MES Lahore (MM Line)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 501 kWp

Lahore MES (MM Line) - Pakistan

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Author

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08/01/24 10:48
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Project summary

Geographical Site	Situation		Project settings	
Lahore MES (MM Line)	Latitude	31.51 °N	Albedo	0.20
Pakistan	Longitude	74.36 °E		
	Altitude	207 m		
	Time zone	UTC+5		

Meteo data
Lahore MES (MM Line)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation		Near Shadings	User's needs
Fixed plane		No Shadings	Unlimited load (grid)
Tilt/Azimuth	26 / 0 °		

System information

PV Array		Inverters	
Nb. of modules	864 units	Nb. of units	2 units
Pnom total	501 kWp	Pnom total	600 kWac
		Pnom ratio	0.835

Results summary

Produced Energy	593959 kWh/year	Specific production	1185 kWh/kWp/year	Perf. Ratio PR	72.74 %

Table of contents

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General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation		Sheds configuration	Models used	
Fixed plane		No 3D scene defined	Transposition	Perez
Tilt/Azimuth	26 / 0 °		Diffuse	Perez, Meteonorm
			Circumsolar	separate

Horizon
Free Horizon

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	CSI Solar
Model	CS7L-580MB-AG 1500V
(Original PVsyst database)	
Unit Nom. Power	580 Wp
Number of PV modules	864 units
Nominal (STC)	501 kWp
Modules	32 Strings x 27 In series
At operating cond. (50°C)	
Pmpp	460 kWp
U mpp	823 V
I mpp	559 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H2
(Custom parameters definition)	
Unit Nom. Power	300 kWac
Number of inverters	2 units
Total power	600 kWac
Operating voltage	500-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	0.84
Power sharing within this inverter	

Total PV power

Nominal (STC)	501 kWp
Total	864 modules
Module area	2445 m²

Total inverter power

Total power	600 kWac
Number of inverters	2 units
Pnom ratio	0.84

Array losses

Array Soiling Losses
Loss Fraction 4.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 24 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year

Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

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System losses

Unavailability of the system

Time fraction	3.4 %
	12.4 days,
	3 periods

Auxiliaries loss

Proportionnal to Power	5.0 W/kW
0.0 kW from Power thresh.	
Night aux. cons.	500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.10 % at STC
Inverter: SUN2000-330KTL-H2	
Wire section (2 Inv.)	Alu 2 x 3 x 240 mm²
Average wires length	20 m

MV line up to injection

MV Voltage	11 kV
Wires	Alu 3 x 95 mm²
Length	100 m
Loss Fraction	0.01 % at STC

AC losses in transformers

MV transfo

Medium voltage	11 kV
Transformer from Datasheets	
Nominal power	630 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.16 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	3.17 % at PNom
Coils equivalent resistance	3 x 32.25 mΩ

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08/01/24 10:48
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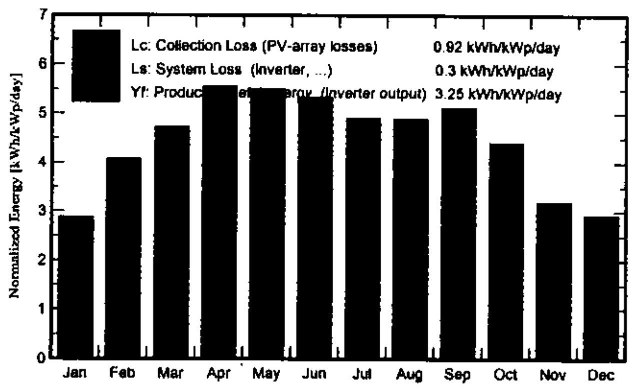
Main results

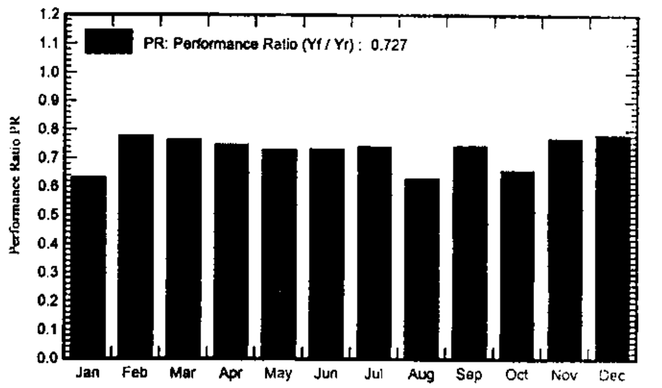
System Production

Produced Energy (P50)	593959 kWh/year	Specific production (P50)	1185 kWh/kWp/year	Performance Ratio PR	72.74 %
Produced Energy (P90)	556330 kWh/year	Produced Energy (P90)	1110 kWh/kWp/year		
Produced Energy (P99)	525662 kWh/year	Produced Energy (P99)	1049 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	69.8	43.7	11.88	89.2	84.1	37531	28331	0.634
February	92.3	46.7	16.09	114.0	107.7	46962	44484	0.779
March	131.6	77.3	22.10	146.8	138.3	59265	56348	0.766
April	161.0	87.3	27.05	166.8	157.0	65711	62574	0.749
May	176.7	96.9	32.91	170.8	160.7	65704	62568	0.731
June	169.5	100.5	32.80	160.2	150.8	61926	58956	0.735
July	160.5	102.3	31.45	152.3	143.1	59594	56715	0.743
August	151.5	96.0	30.72	151.7	142.8	59496	48077	0.633
September	141.8	76.6	29.06	154.1	145.1	60591	57635	0.746
October	116.4	68.0	25.94	136.8	129.1	54502	45298	0.661
November	77.4	49.9	19.09	96.0	90.5	39361	37144	0.772
December	68.6	41.9	13.95	90.9	85.7	38037	35830	0.786
Year	1517.1	887.0	24.46	1629.4	1535.0	648681	593959	0.727

Legends

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

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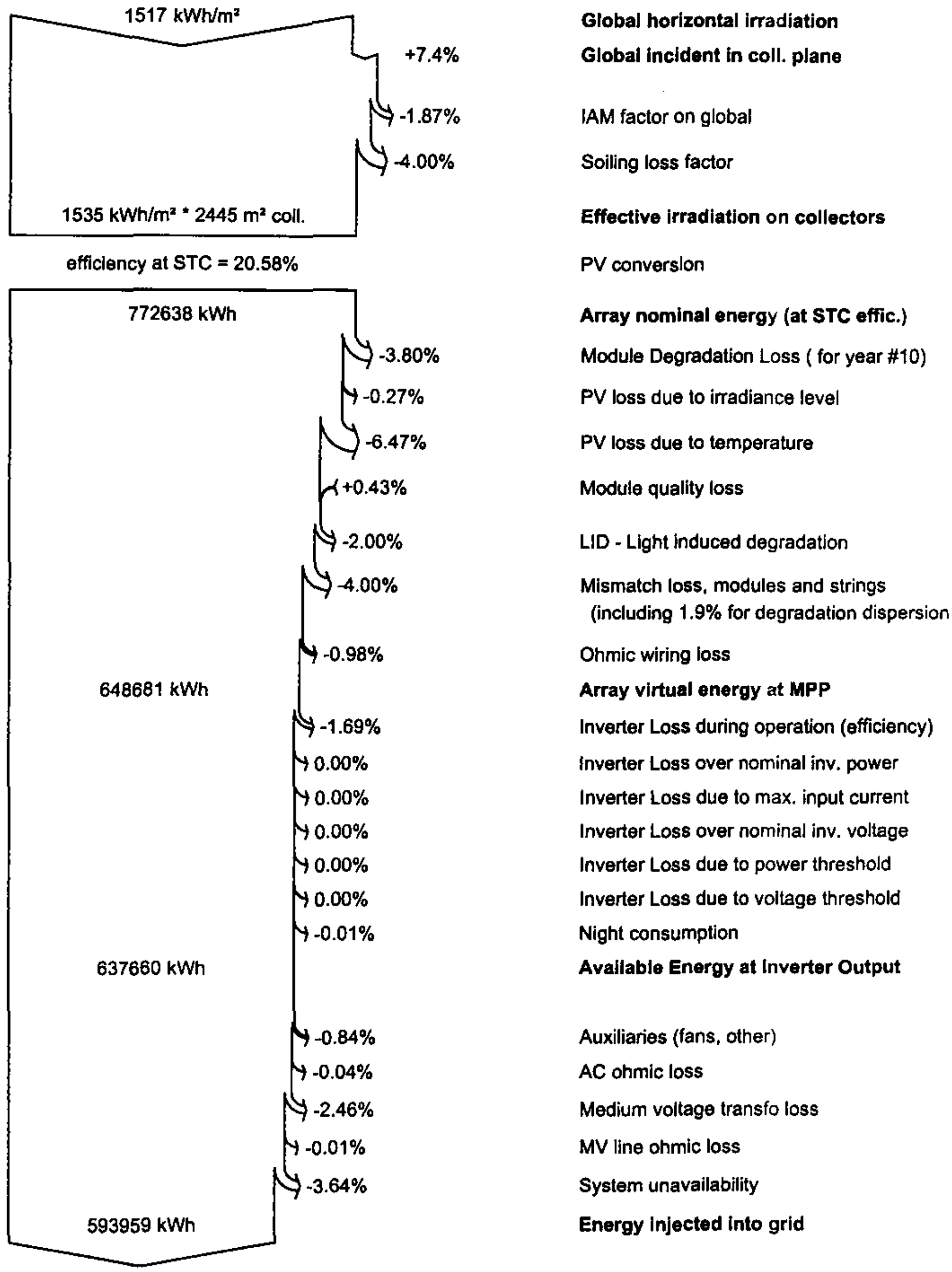
Loss diagram



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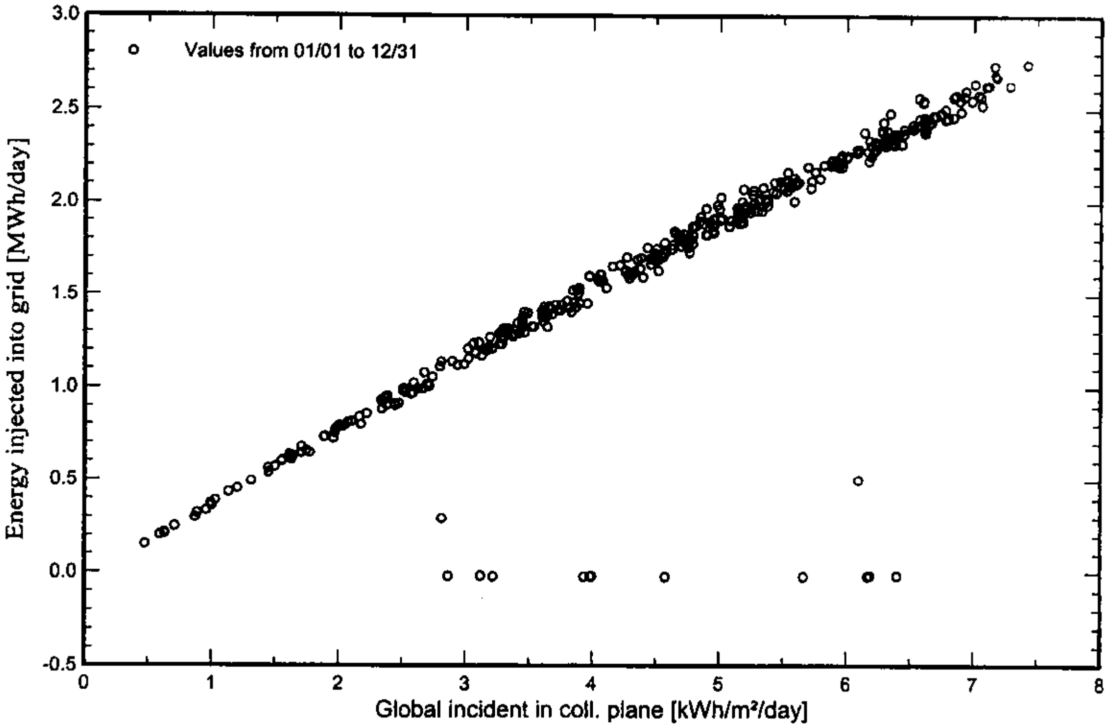
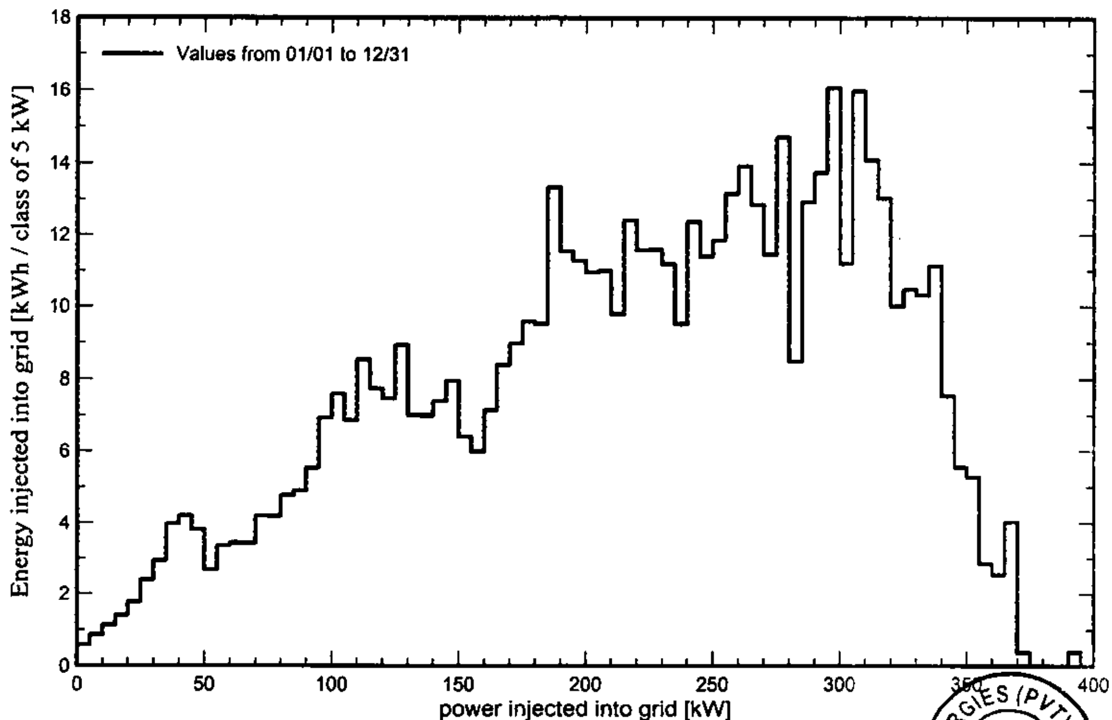
Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%	
Kind	Monthly averages	
Synthetic - Multi-year average		
Year-to-year variability(Variance)		4.6 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.9 %

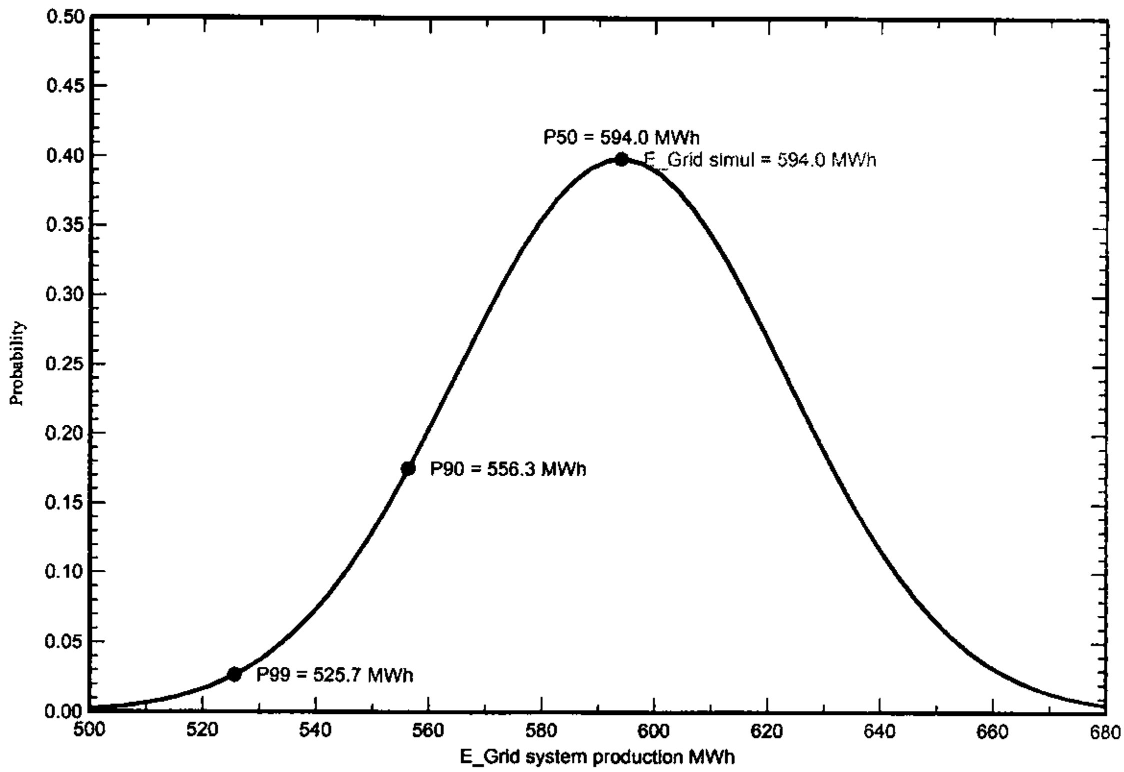
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

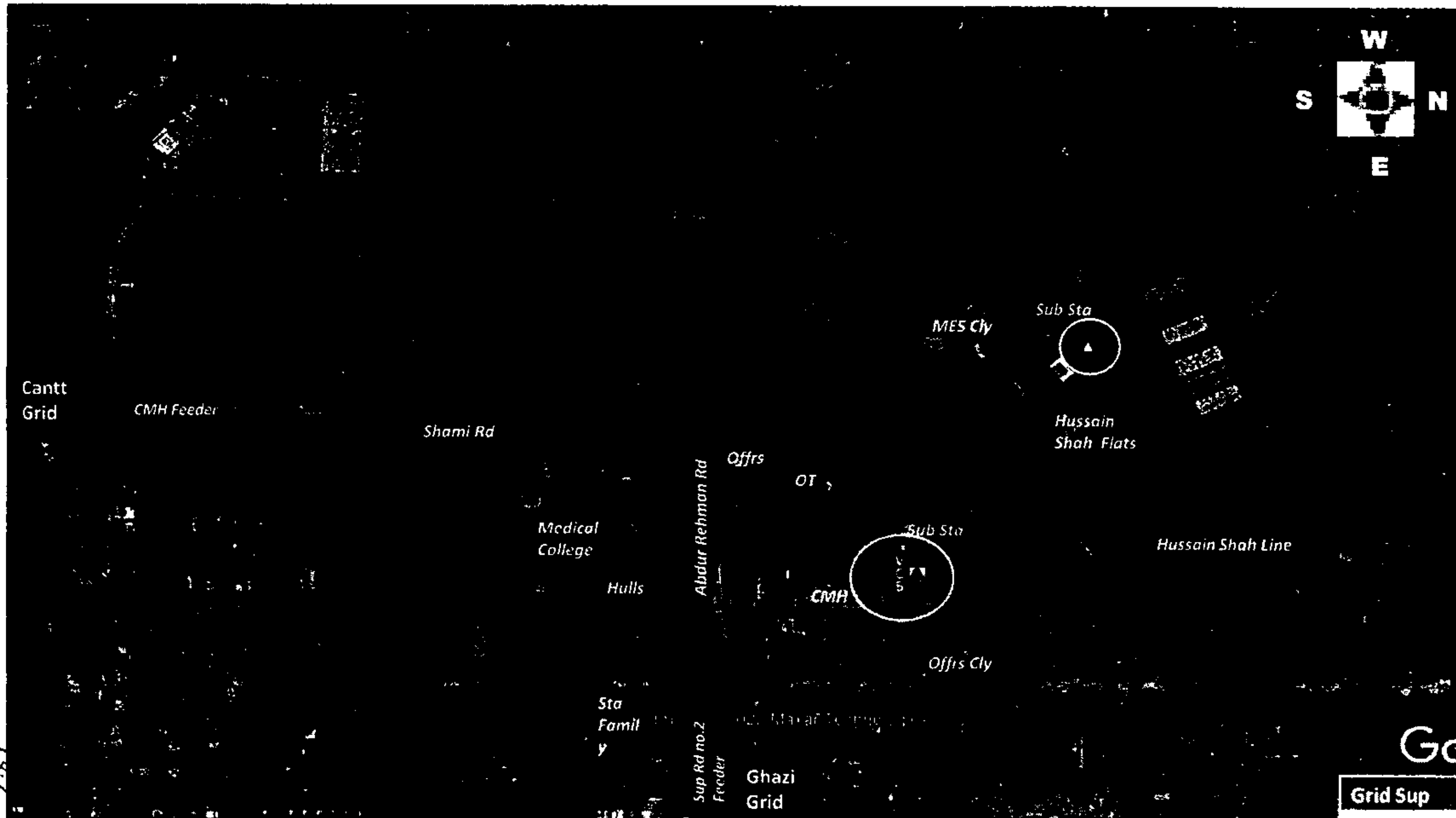
Annual production probability

Variability	29.3 MWh
P50	594.0 MWh
P90	556.3 MWh
P99	525.7 MWh

Probability distribution

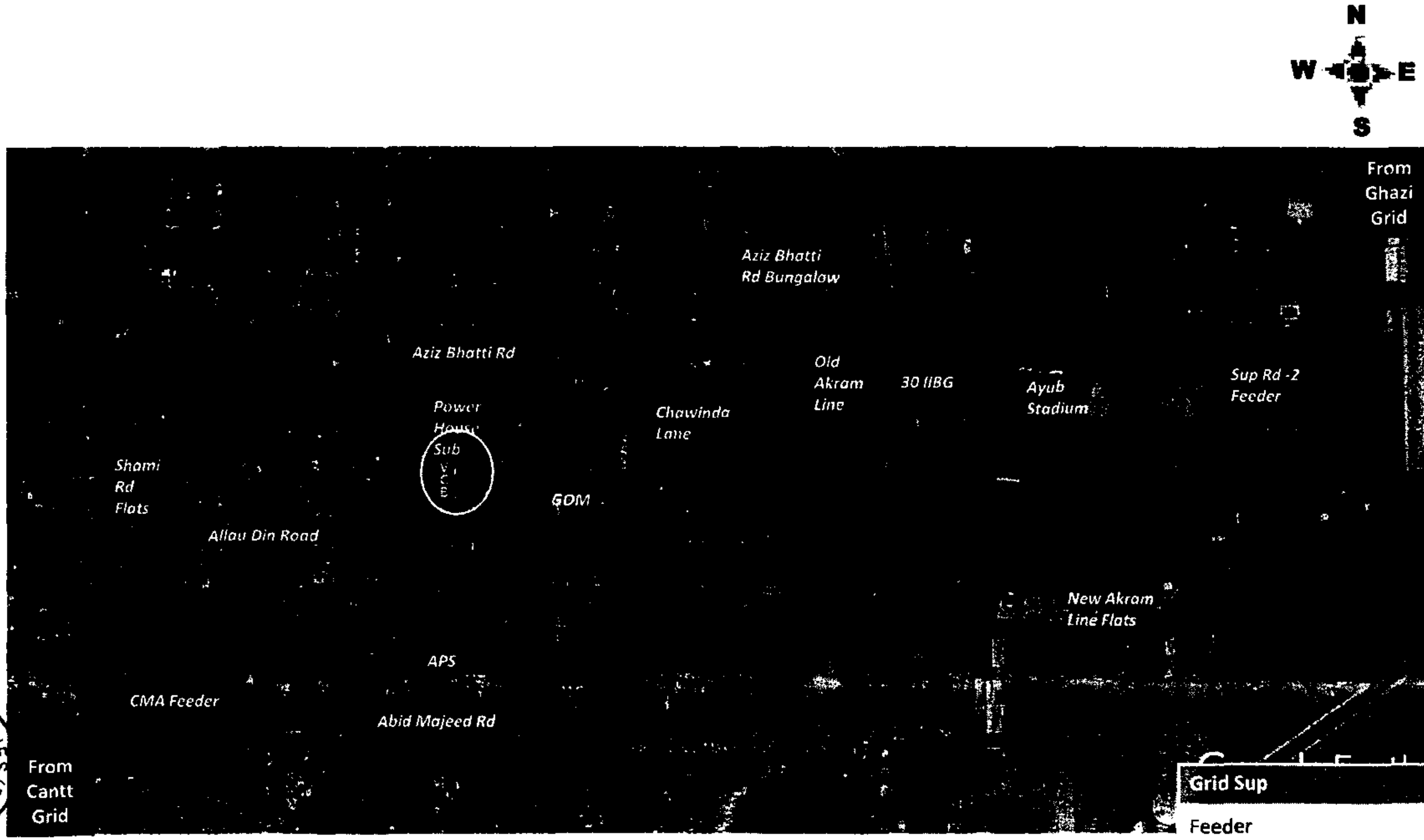


Proposed Solar 1 MW – CMH Feeder from Cantt Grid



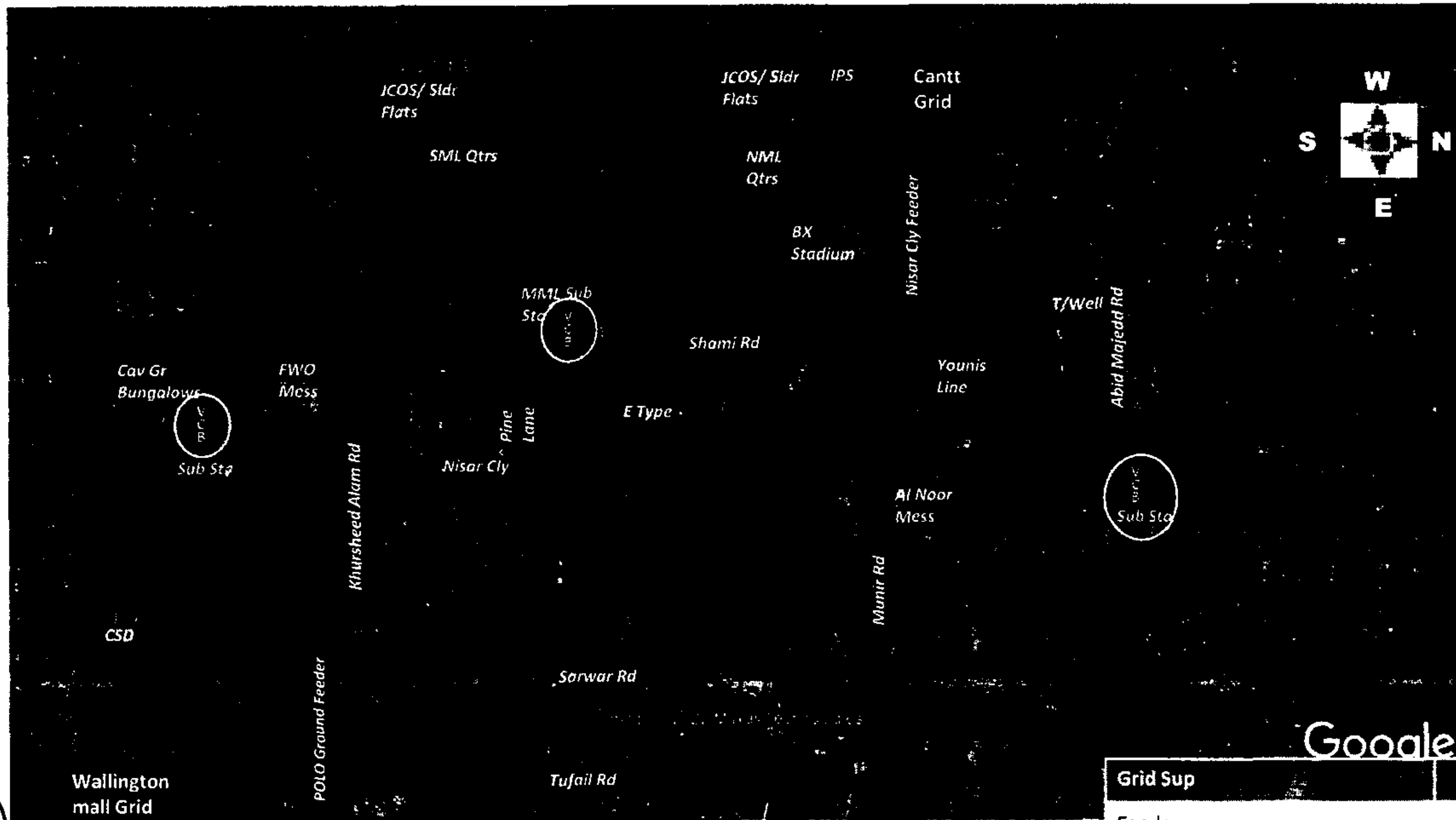
Grid Sup	3 nos
Feeder	4 nos
Transformer	50 nos
Sanctioned Ld	12635 Kw

Proposed Solar 0.5 MW – Akram Line - CMA Feeder from Cantt Grid



Grid Sup	2 nos
Feeder	2 nos
Transformer	33 nos
Sanctioned Ld	500 Kw

Proposed Solar 0.5 MW – MM Line – Nisar Cly Feeder from Cantt Grid



Grid Sup	2 nos
Feeder	2 nos
Transformer	58 nos
Sanctioned Ld	1918 Kw

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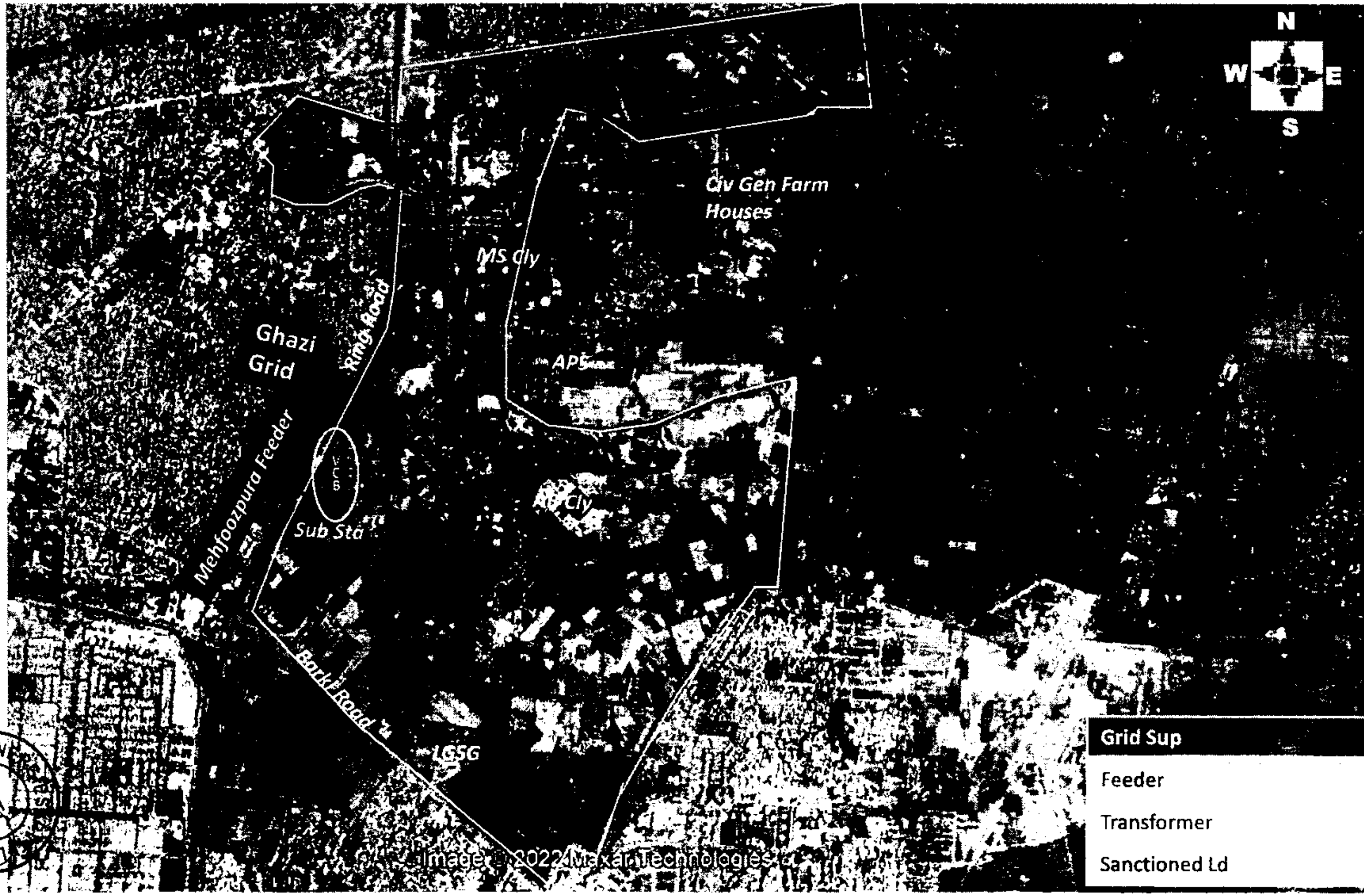
Proposed Solar 0.5 MW – MSG – Mehfoozpura Feeder from Ghazi Grid



Grid Sup	1 no
Feeder	1 no
Transformer	76 nos
Sanctioned Ld	2690 Kw

Capacity and Degradation Factor (3.5MW)						
Sr. No.	Description	CMH Lahore	Okara	MM Lines	Akram Lines	MSG
		1MW	1MW	500kW	500kW	500kW
1	Total Installed Capacity of the Generation Facility/Solar Power Plant! Ground Mount Solar	1,000	1,000	500	500	500
2	Average Sun Hour Availability/ Day (Irradiation on Inclined Surface)	5 - 5.5 Hrs	5 - 5.5 Hrs	5 - 5.5 Hrs	5 - 5.5 Hrs	- 5.5 Hrs
3	No. of days per year	365	365	365	365	365
4	Annual generating capacity of Generation Facility/Solar Power Plant! Ground Mount Solar (As Per Simulation) (MW)	1,391.4	1,391.4	695.7	695.7	695.7
5	Total expected generation of the Generation Facility/Solar Power Plant! Ground Mount Solar during the twenty-five (25) years term of this license (MW) with Degradation Factor	28,524	28,629	14,088	14,175	14,227
7	Net Capacity Factor of Generation Facility/Solar Power Plant! Ground Mount Solar	15.86	15.90	15.76	15.80	15.82
8	Degradation Factor after 25 years	18.00	17.70	19.00	18.50	18.20

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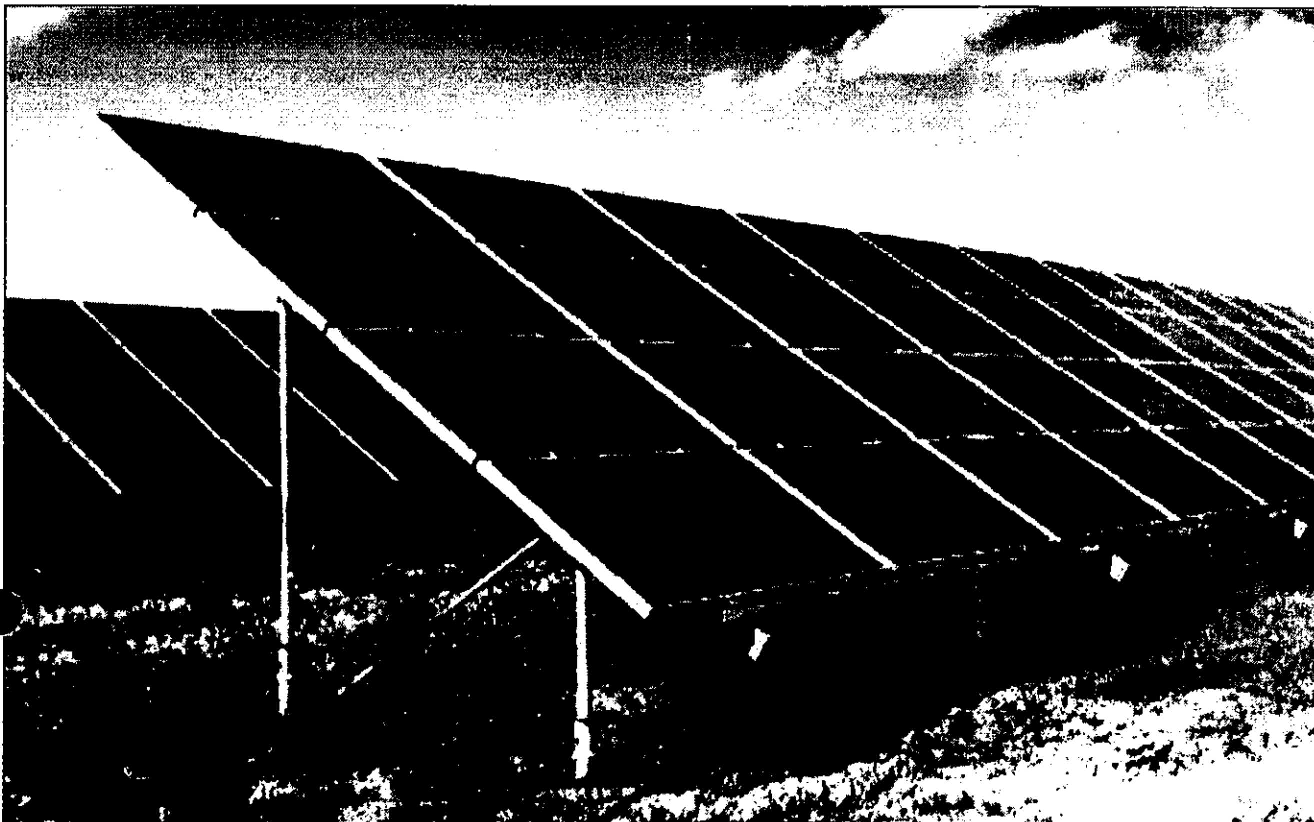


SYSTEM STUDY ANALYSIS OF COMBINED MILITARY HOSPITAL (CMH) 999kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
Tel: +92-300-8827101

CONTENTS

EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 999kW Solar PV Power Generation project at Combined Military Hospital (CMH) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 999kW Solar PV based system connected with the power network of CMH. The '999kW CMH solar PV Power Generation project' is located at CMH, Cantt, Lahore, Punjab, Pakistan.

The integration of solar power generation at the CMH premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. CMH currently receives a single point supply from LESCO with a sanctioned load of 4.6MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 4.6MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the CMH premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 999kW CMH solar PV system with sanctioned load in service.
- With 999kW CMH solar PV system with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of CMH. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the CMH distribution system. The power flow results for the system intact shows that the power flows on all the CMH transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for CMH. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with CMH and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 999kW CMH solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Combined Military Hospital (CMH) ("Project Owner" or "PO") for the interconnection of a 999kWp Solar PV Power Generation project ("Project") to the CMH power System at 11kV.

The '999kW CMH solar PV Power Generation project' is located at CMH, Cantt, Lahore, Punjab, Pakistan. Figure 1.1 shows Google site map of the project.

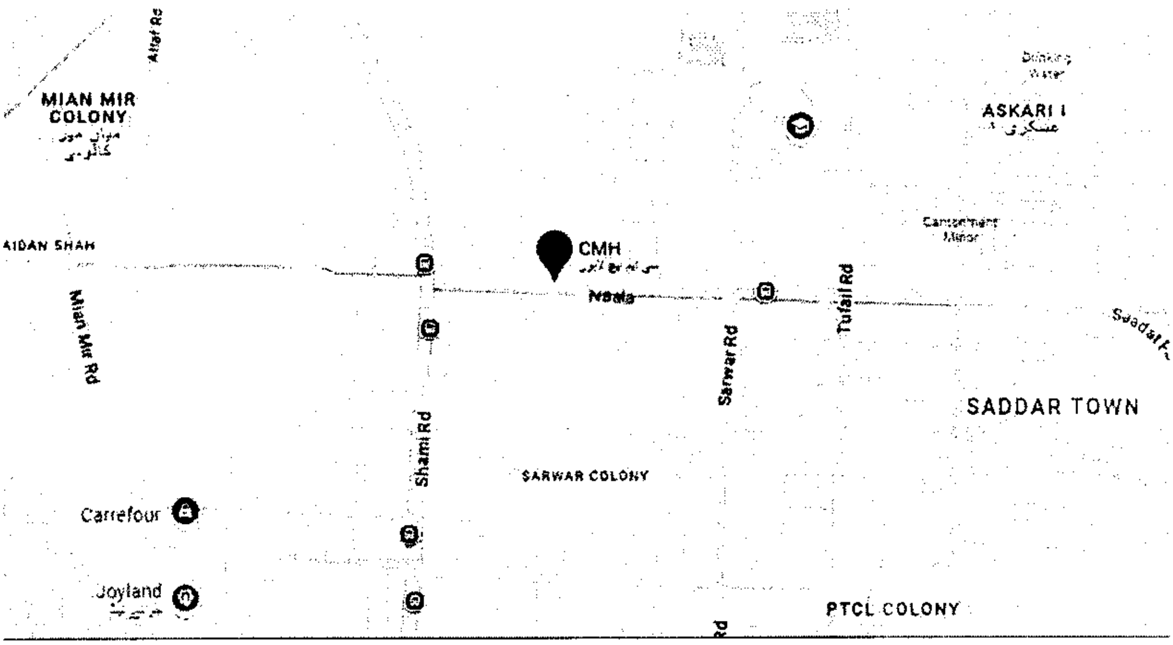


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

CMH aims to integrate solar power generation into its existing electrical infrastructure. CMH currently receives a single-point power supply from LESCO with a sanctioned load of 4.6MW. The entire solar generation within the CMH premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the CMH transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within CMH premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

999kW solar PV system is modelled into the CMH distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling

ii) Steady state analysis

iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 999kW CMH solar PV system with sanctioned load in service.
- With 999kW CMH solar PV system with sanctioned load in service.

This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 999kW solar PV system to the distribution system of CMH and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kVand above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within CMH.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	841
Active Power of each collector Pgen. (kW)	799
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.2626, 0.2626
Rated Frequency	50 Hz
Generation Voltage	440V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	1250
% Reactance (X)	5 %
CMH	
Sanctioned Load (LESCO)	4600 kW

Steady state power flow assessment has been performed using the network data of CMH.

3.2 Power Flow Assessment Without CMH PP and with Sanctioned Load In Service

Power flow study without CMH solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of CMH network. This base case included a detailed representation of the CMH transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the CMH distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with CMH PP

Power flow study of CMH solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 999kW CMH solar project on the CMH distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at CMH solar for peak loading summer (June) 2025 that allow us to judge the impact of CMH solar project on the CMH network.
Project power flow analysis has been performed after the connection of the project with the CMH distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at CMH solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted

with sanctioned load in service after the interconnection of the Solar project with the CMH distribution system. The power flow results for the system intact shows that the power flows on all the CMH distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without CMH solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with CMH solar and with sanctioned load in service with CMH distribution system. Power flow results showed that the power flows on all the CMH distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 999kW CMH solar PV system with CMH Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

LIST OF ANNEXURES

Annexure-A

Project Specific Data

Annexure-A-1

Project Site Map

NRTC ENERGIES (PVT) LTD
NRTC

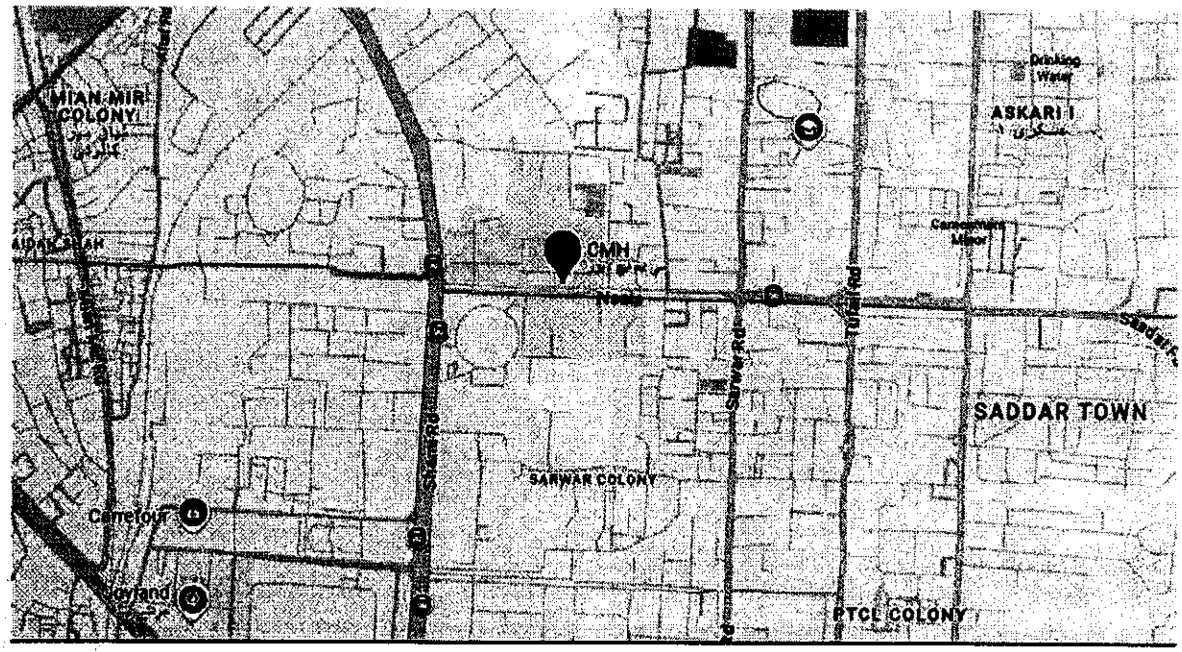


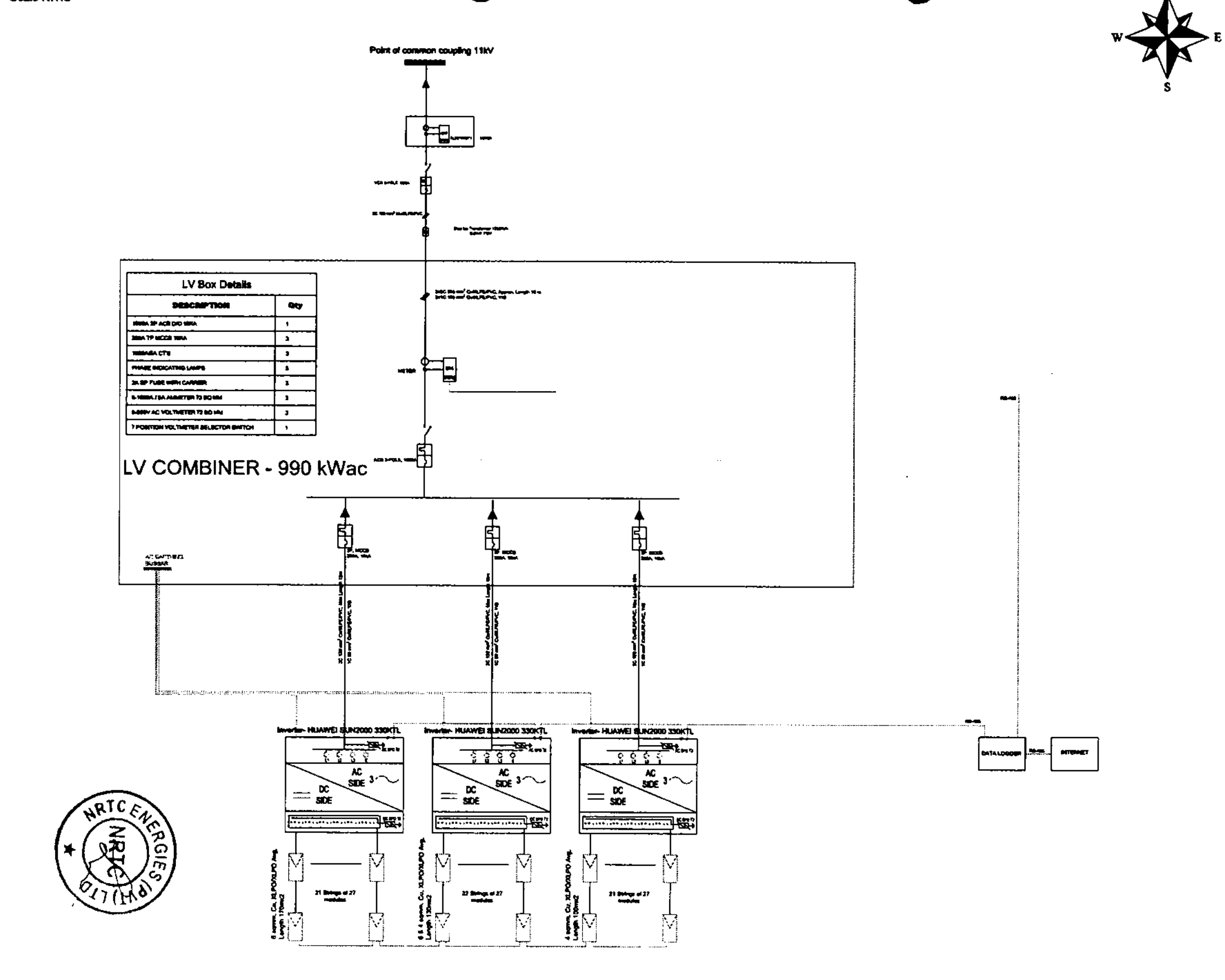
Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

Annexure-A-2

Power Plant Data

MRTC ENERGIE

Single Line DIAGRAM
Scale N.T.S



LV Box Details	
DESCRIPTION	Qty
[illegible] 3P ACB D/O [illegible]	1
[illegible] TP MCCB [illegible]	3
[illegible] CTS	3
PHASE INDICATING LAMPS	3
2A SP FUSE WITH CARRIER	3
[illegible] AMMETER 72 SQ MM	3
0-500V AC VOLTMETER 72 SQ MM	3
7 POSITION VOLTMETER SELECTOR SWITCH	1

SITE LOCATION
Co-ordinates: 31.5438831646, 74.37144796

GENERAL NOTES
1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. [illegible] will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Solar PV Module
	Inverter
	ACB, VCB
	Contactor
	Current Transformer
	Voltage Transformer

ARRAY INFORMATION

	Array
Total Installed Capacity	1.0 MW
Total Number of PV Modules	1728
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
[illegible] Inverter Nominal Power	330kWAC
Total Number of Inverters	3
Total AC Power	990kW
Total Area utilized	121294 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	20°
Azimuth	0° ± 3
Pitch of Structure	34.5 ft

PROJECT :
MES Solarization P-III
CMH - Lahore
Co-ordinates: 31.5438831646, 74.37144796

CLIENT :
Military Engineering Services

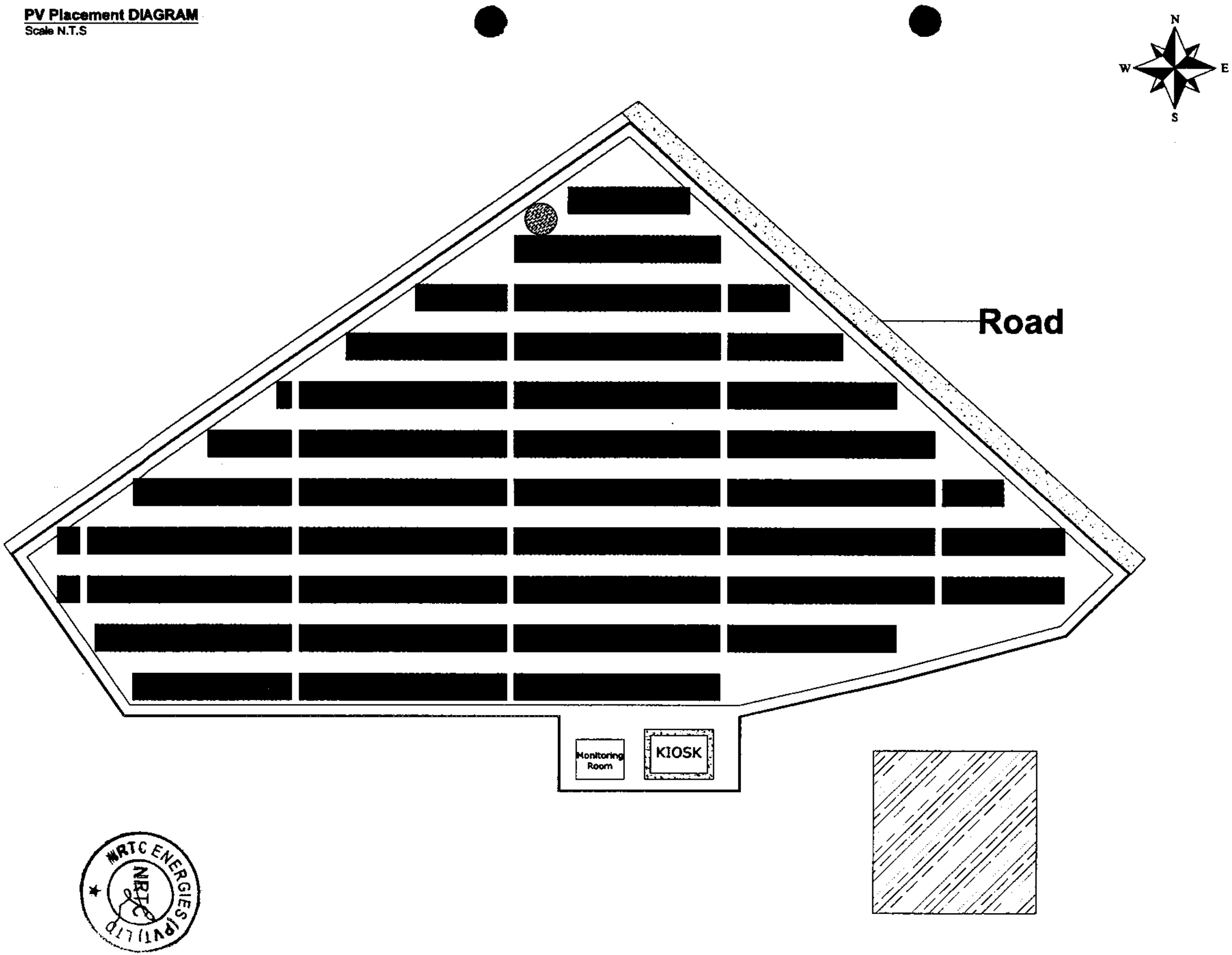
DEVELOPER :
NRTC Energies
Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate Lahore || Tel: 042 36117304

REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING : **SINGLE LINE DIAGRAM**

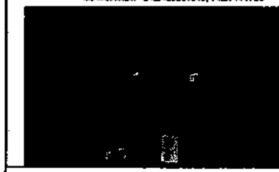
SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION

Co-ordinates: 31.5438831646, 74.37144786



GENERAL NOTES

1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. KIOSK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Ground mounted
	P2 Piling Structure

ARRAY INFORMATION

	Array
Total Installed Capacity	1.0 MW
Total Number of PV Modules	1728
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1408V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	3
Total AC Power	990kW
Total Area utilized	121254 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	35°
Azimuth	9° ± 3
Pitch of Strucure	24.5 ft

PROJECT :
MES Solarization P-III
CMH - Lahore
Co-ordinates: 31.5438831646, 74.37144786

CLIENT :
Military Engineering Services

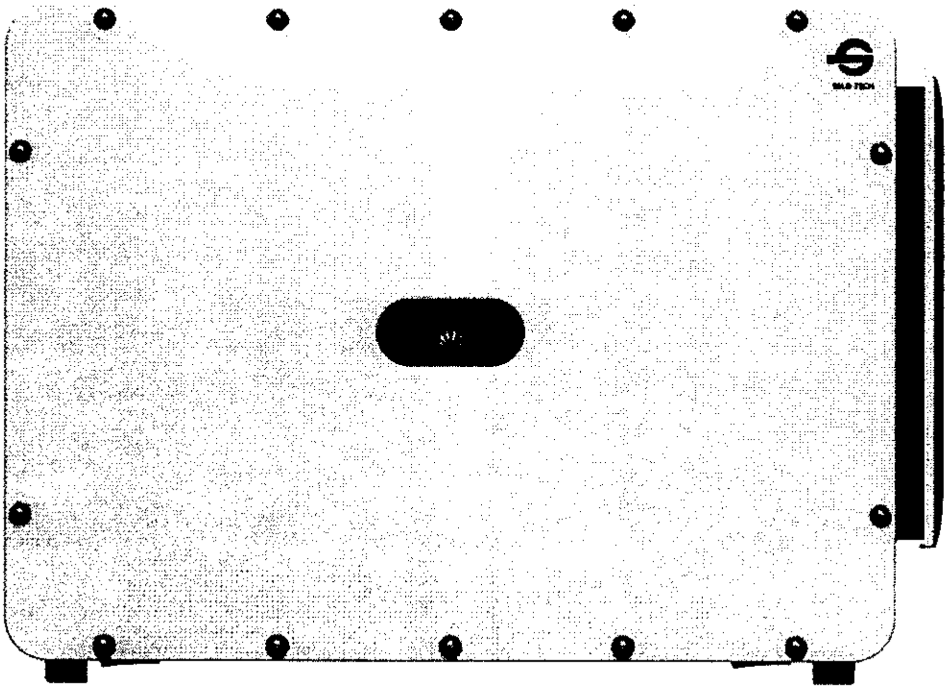
DEVELOPER :
NRTC Energies
Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate Lahore || Tel: 042 35117304

REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING :
SINGLE LINE DIAGRAM

SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

SUN2000-330KTL-H1
Smart String Inverter



Max. Efficiency ≥99.0%

Smart Connector-level Detection (SCLD)

Smart Self-cleaning Fan (SSCF)

IP66 Protection

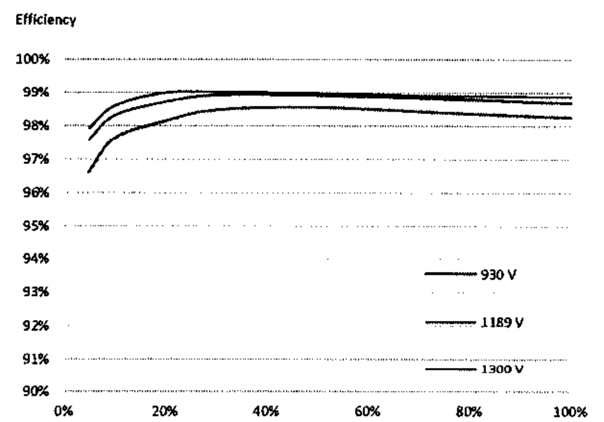
MBUS Supported

Smart String-level Disconnection (SSLD)

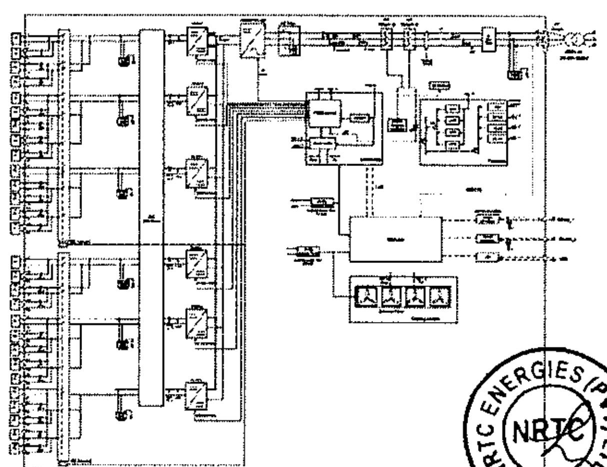
Smart IV Curve Diagnosis Supported

Surge Arresters for DC & AC

Efficiency Curve



Circuit Diagram



NRTC ENERGIES (PVT) LTD
NRTC

SUN2000-330KTL-H1

Technical Specifications

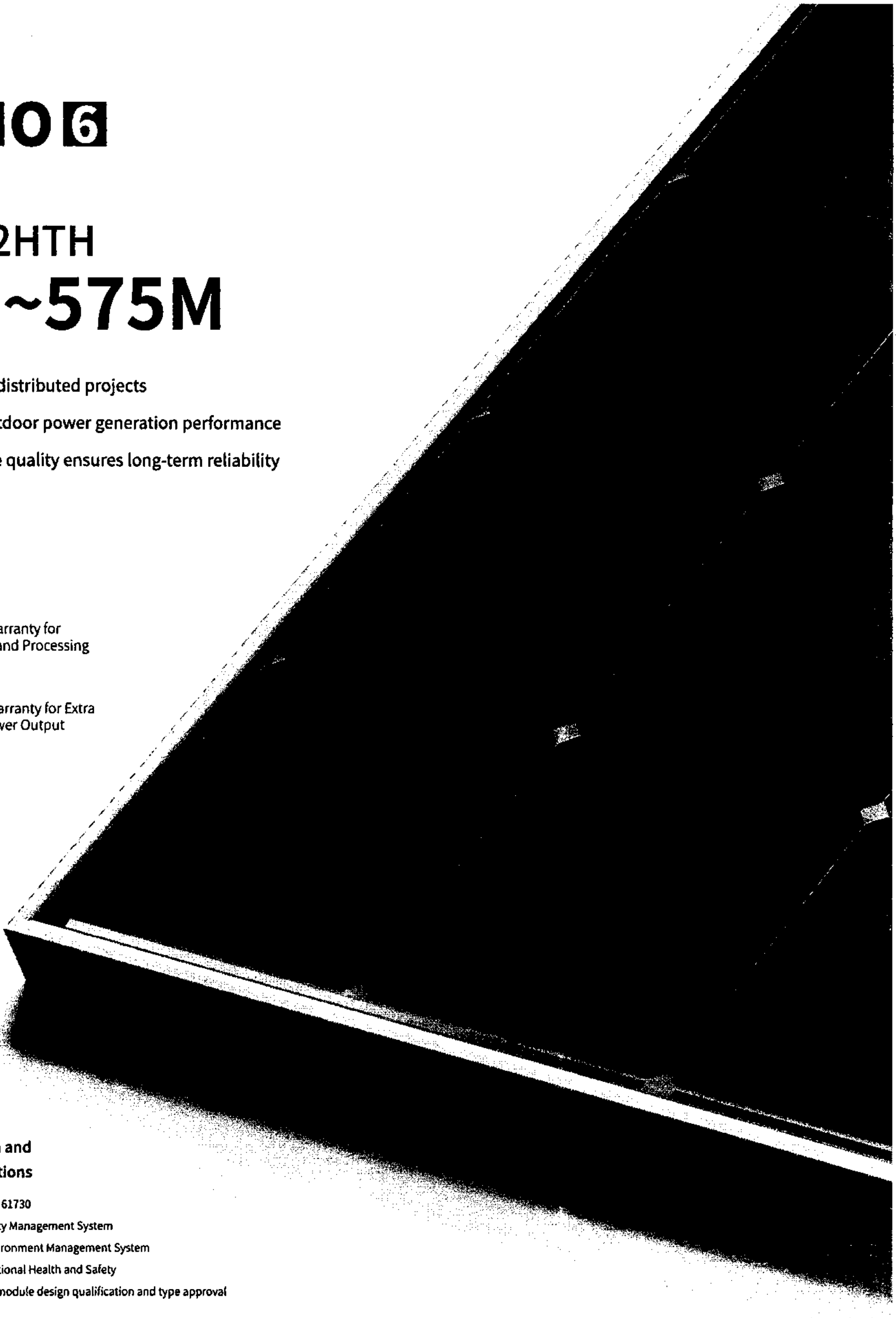
Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosϕ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 ℃ ~ 60 ℃
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

NRTC ENERGIES (PVT) LTD

Hi-MO 6
Explorer

LR5-72HTH
560~575M

- Suitable for distributed projects
- Excellent outdoor power generation performance
- High module quality ensures long-term reliability



15 15-year Warranty for Materials and Processing

25 25-year Warranty for Extra Linear Power Output

Complete System and Product Certifications

IEC 61215, IEC 61730, UL 61730
ISO9001:2015: ISO Quality Management System
ISO14001: 2015: ISO Environment Management System
ISO45001: 2018: Occupational Health and Safety
IEC62941: Guideline for module design qualification and type approval

LONGi

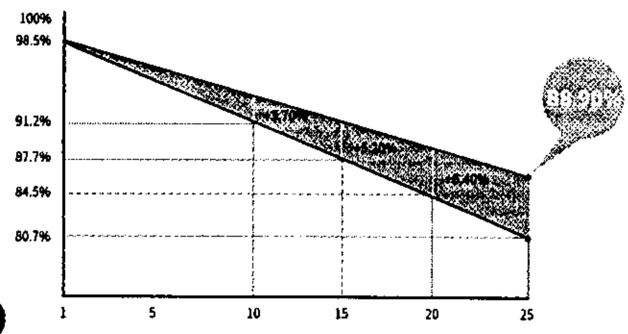
Hi-MO 6

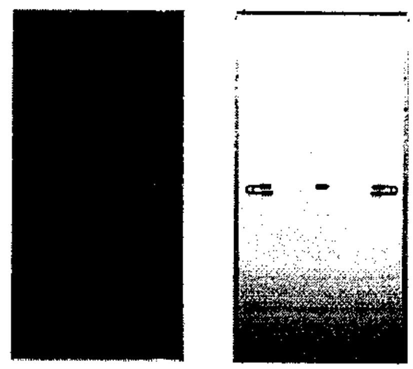
LR5-72HTH 560~575M

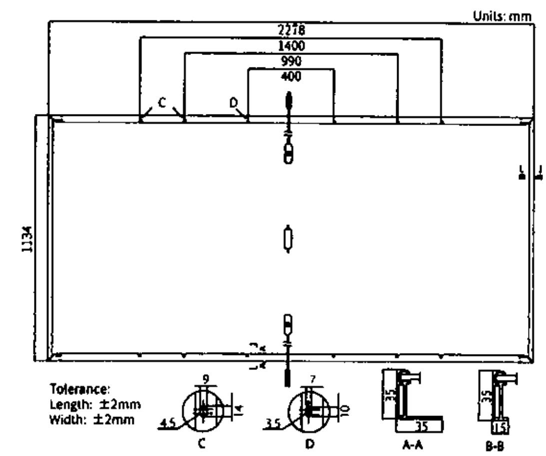
22.3%	0~3%	<1.5%	0.40%

Additional Value

25-Year Power Warranty







Mechanical Parameters

Cell Orientation	144 (6×24)
Junction Box	IP68, three diodes
Output Cable	4mm², +400, -200mm/±1400mm length can be customized
Glass	Single glass, 3.2mm coated tempered glass
Frame	Anodized aluminum alloy frame
Weight	27.5kg
Dimension	2278×1134×35mm
Packaging	31pcs per pallet / 155pcs per 20' GP / 620pcs per 40' HC

Electrical Characteristics

STC : AM1.5 1000W/m² 25°C NOCT : AM1.5 800W/m² 20°C 1m/s Test uncertainty for Pmax: ±3%

Module Type	LR5-72HTH-560M		LR5-72HTH-565M		LR5-72HTH-570M		LR5-72HTH-575M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	560	418	565	422	570	426	575	430
Open Circuit Voltage (Voc/V)	51.61	48.46	51.76	48.60	51.91	48.74	52.06	48.88
Short Circuit Current (Isc/A)	13.94	11.26	14.01	11.31	14.07	11.36	14.14	11.42
Voltage at Maximum Power (Vmp/V)	43.46	39.66	43.61	39.79	43.76	39.93	43.91	40.07
Current at Maximum Power (Imp/A)	12.89	10.55	12.96	10.61	13.03	10.67	13.10	10.72
Module Efficiency(%)	21.7		21.9		22.1		22.3	

Operating Parameters

Operational Temperature	-40°C ~ +85°C
Power Output Tolerance	0 ~ 3%
Voc and Isc Tolerance	±3%
Maximum System Voltage	DC1500V (IEC/UL)
Maximum Series Fuse Rating	25A
Nominal Operating Cell Temperature	45±2°C
Protection Class	Class II
Fire Rating	UL type 1 or 2 IEC Class C

Mechanical Loading

Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

Temperature Ratings (STC)

Temperature Coefficient of Isc	+0.050%/°C
Temperature Coefficient of Voc	-0.230%/°C
Temperature Coefficient of Pmax	-0.290%/°C

LONGi

No.8369 Shangyuan Road, Xi'an Economic And Technological Development Zone, Xi'an, Shaanxi, China.
Web: www.longi.com

Annexure-B

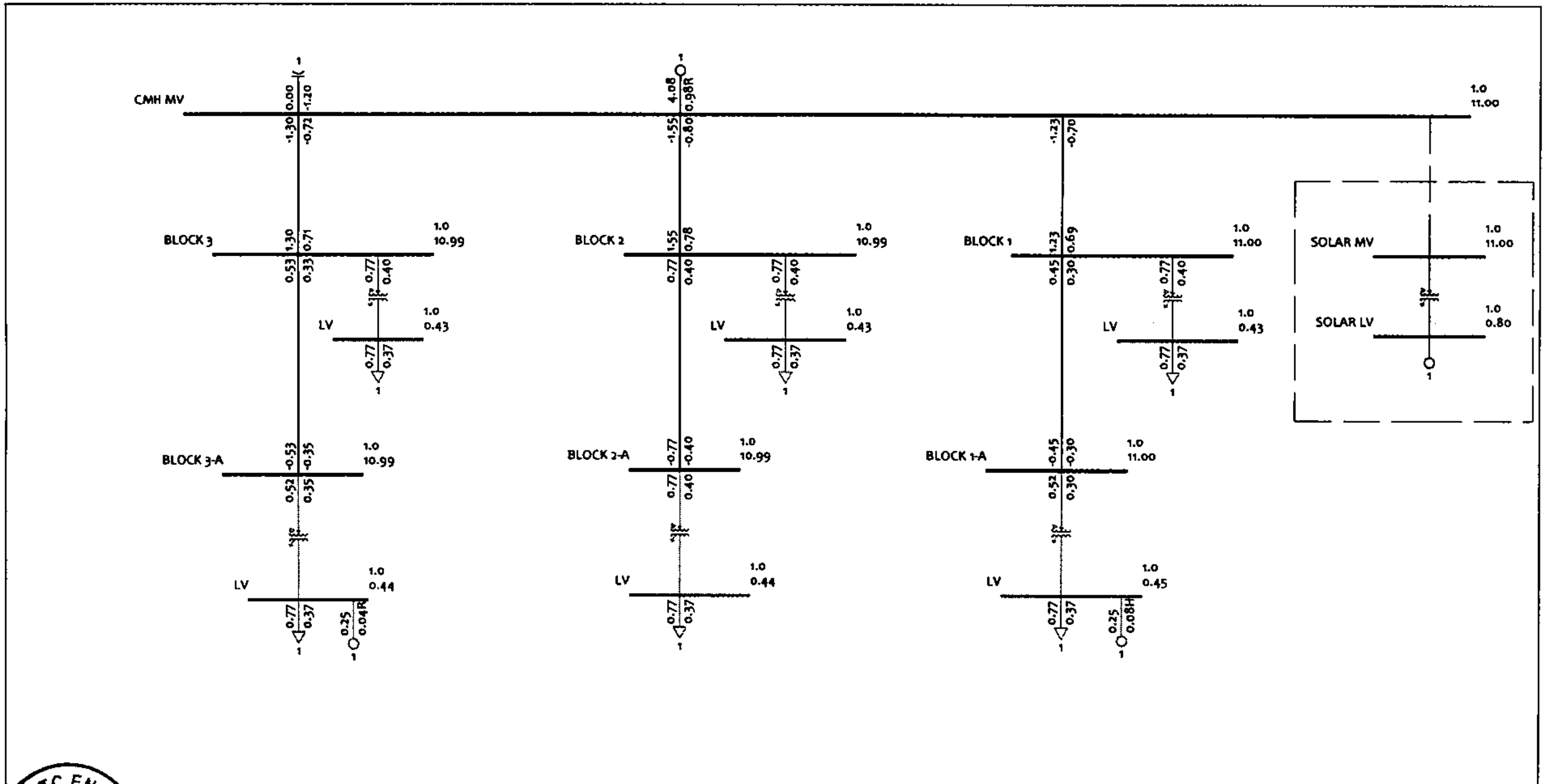
Steady State Analysis Results

NRTC ENERGIES (PVT) LTD
NRTC

Load Flow Analysis of 999kW Solar PV System at Combined Military Hospital (CMH)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

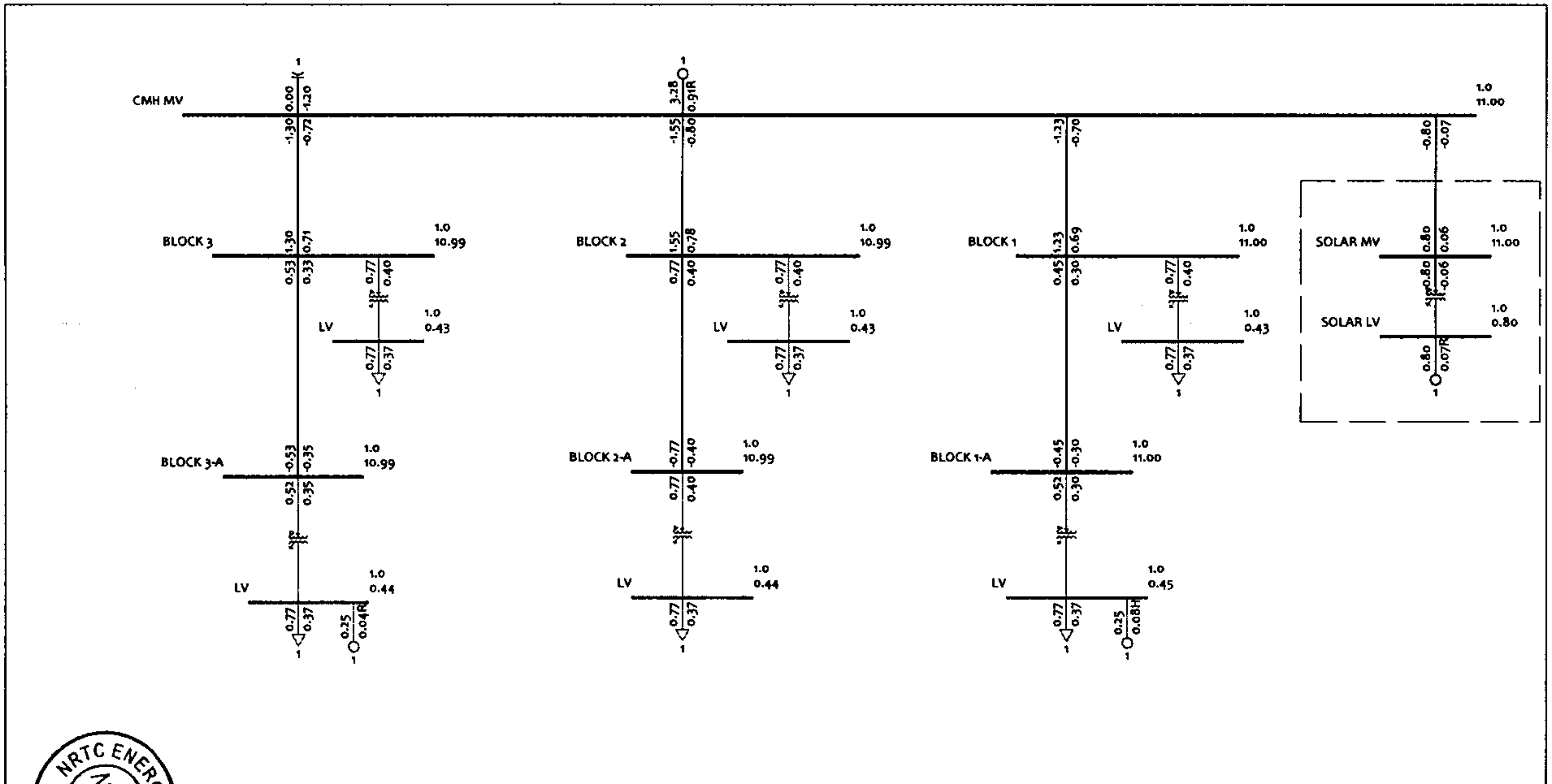
Figure: B-1



Load Flow Analysis of 990kW Solar PV System at Combined Military Hospital (CMH)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



NRTC ENERGIES (PVT) LTD

Annexure-C

Assessment of bus voltages

NRTC ENERGIES (PVT) LTD
NRTC

Annexure-C-1

Without CMH PP and With Sanctioned Load

In Service

```
                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:10
           CMH SOLAR PV SYSTEM                                           %MVA FOR TRANSFORMERS
                                                                         % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT            GEN     LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 CMH MV      11.000    4 1.0000   0.0     4.1     0.0     0.0 ----------------------------------------------------------
---------------------
                              1 11.000           1.0R    0.0    -1.2  41001 BLOCK 1     11.000    4  1      1.2     0.7
14     10
                                                                      41005 BLOCK 2     11.000    4  1      1.5     0.8
17     10
                                                                      41009 BLOCK 3     11.000    4  1      1.3     0.7
15     10
  41001 BLOCK 1     11.000    4 0.9997  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
---------------------
                              1 10.997           0.0     0.0     0.0   4100 CMH MV      11.000    4  1     -1.2    -0.7
14     10
                                                                      41002 LV          0.4400    4  1      0.8     0.4
1.000LK          54     2
                                                                      41003 BLOCK 1-A   11.000    4  1      0.5     0.3
5    10
  41002 LV          0.4400    4 0.9875  -1.4     0.0     0.8     0.0 ----------------------------------------------------------
---------------------
                              1 0.4345           0.0     0.4     0.0  41001 BLOCK 1     11.000    4  1     -0.8    -0.4
1.000UN          54     2

  41003 BLOCK 1-A   11.000    4 0.9996  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
---------------------
                              1 10.995           0.0     0.0     0.0  41001 BLOCK 1     11.000    4  1     -0.5    -0.3
5    10
                                                                      41004 LV          0.4400    4  1      0.5     0.3
0.975LK          38     2
  41004 LV          0.4400    4 1.0160  -0.9     0.2     0.8     0.0 ----------------------------------------------------------
---------------------
                              1 0.4470           0.1H    0.4     0.0  41003 BLOCK 1-A   11.000    4  1     -0.5    -0.3
1.000UN          38     2

  41005 BLOCK 2     11.000    4 0.9993  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
---------------------
                              1 10.992           0.0     0.0     0.0   4100 CMH MV      11.000    4  1     -1.5    -0.8
17     10
                                                                      41006 LV          0.4400    4  1      0.8     0.4
1.000LK          54     2
```

NRTC ENERGIES (PVT) LTD
NRTC

```
                                                                                 41007 BLOCK 2-A   11.000    4  1      0.8     0.4
9     10
 41006 LV           0.4400    4 0.9870   -1.4     0.0      0.8      0.0 ----------------------------------------------------------
---------------------
                              1 0.4343            0.0      0.4      0.0  41005 BLOCK 2     11.000    4  1     -0.8    -0.4
1.000UN          54     2

 41007 BLOCK 2-A    11.000    4 0.9993   -0.0     0.0      0.0      0.0 ----------------------------------------------------------
---------------------
                              1 10.992            0.0      0.0      0.0  41005 BLOCK 2     11.000    4  1     -0.8    -0.4
9     10
                                                                         41008 LV          0.4400    4  1      0.8     0.4
0.988LK          54     2
 41008 LV           0.4400    4 0.9999   -1.4     0.0      0.8      0.0 ----------------------------------------------------------
---------------------
                              1 0.4399            0.0      0.4      0.0  41007 BLOCK 2-A   11.000    4  1     -0.8    -0.4
1.000UN          54     2

 41009 BLOCK 3      11.000    4 0.9991   -0.0     0.0      0.0      0.0 ----------------------------------------------------------
---------------------
                              1 10.990            0.0      0.0      0.0   4100 CMH MV      11.000    4  1     -1.3    -0.7
15    10
                                                                        410010 LV          0.4400    4  1      0.8     0.4
1.000LK          54     2
                                                                        410011 BLOCK 3-A   11.000    4  1      0.5     0.3
6     10
 410010 LV          0.4400    4 0.9868   -1.5     0.0      0.8      0.0 ----------------------------------------------------------
---------------------
                              1 0.4342            0.0      0.4      0.0  41009 BLOCK 3     11.000    4  1     -0.8    -0.4
1.000UN          54     2

 410011 BLOCK 3-A   11.000    4 0.9987   -0.1     0.0      0.0      0.0 ----------------------------------------------------------
---------------------
                              1 10.985            0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1     -0.5    -0.3
6     10
                                                                        410012 LV          0.4400    4  1      0.5     0.3
0.988LK          21     3
 410012 LV          0.4400    4 1.0045   -0.6     0.2      0.8      0.0 ----------------------------------------------------------
---------------------
                              1 0.4420            0.0R     0.4      0.0 410011 BLOCK 3-A   11.000    4  1     -0.5    -0.3
1.000UN          21     3
```

Annexure-C-2

With CMH PP and With Sanctioned Load

In Service

NRTC ENERGIES (PVT) LTD
NRTC

```
                PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:12
     CMH SOLAR PV SYSTEM                                              %MVA FOR TRANSFORMERS
                                                                      % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 CMH MV      11.000    4 1.0000    0.0     3.3     0.0     0.0 -------------------------------------------------------
---------------------
                              1 11.000            0.9R    0.0    -1.2  41001 BLOCK 1     11.000    4  1      1.2     0.7
14     10
                                                                       41005 BLOCK 2     11.000    4  1      1.5     0.8
17     10
                                                                       41009 BLOCK 3     11.000    4  1      1.3     0.7
15     10
                                                                      410013 SOLAR MV    11.000    4  1     -0.8    -0.1
8    10
  41001 BLOCK 1     11.000    4 0.9997   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.997            0.0     0.0     0.0   4100 CMH MV      11.000    4  1     -1.2    -0.7
14     10
                                                                       41002 LV          0.4400    4  1      0.8     0.4
1.000LK           54      2
                                                                       41003 BLOCK 1-A   11.000    4  1      0.5     0.3
5    10
  41002 LV          0.4400    4 0.9875   -1.4     0.0     0.8     0.0 -------------------------------------------------------
---------------------
                              1 0.4345            0.0     0.4     0.0  41001 BLOCK 1     11.000    4  1     -0.8    -0.4
1.000UN           54      2

  41003 BLOCK 1-A   11.000    4 0.9996   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.995            0.0     0.0     0.0  41001 BLOCK 1     11.000    4  1     -0.5    -0.3
5    10
                                                                       41004 LV          0.4400    4  1      0.5     0.3
0.975LK           38      2
  41004 LV          0.4400    4 1.0160   -0.9     0.2     0.8     0.0 -------------------------------------------------------
---------------------
                              1 0.4470            0.1H    0.4     0.0  41003 BLOCK 1-A   11.000    4  1     -0.5    -0.3
1.000UN           38      2

  41005 BLOCK 2     11.000    4 0.9993   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.992            0.0     0.0     0.0   4100 CMH MV      11.000    4  1     -1.5    -0.8
17     10
```

NRTC ENERGIES (PVT) LTD
NRTC

41006 LV 0.4400 4 1 0.8 0.4
1.000LK 54 2
41007 BLOCK 2-A 11.000 4 1 0.8 0.4
9 10
41006 LV 0.4400 4 0.9870 -1.4 0.0 0.8 0.0 --
----
1 0.4343 0.0 0.4 0.0 41005 BLOCK 2 11.000 4 1 -0.8 -0.4
1.000UN 54 2
41007 BLOCK 2-A 11.000 4 0.9993 -0.0 0.0 0.0 0.0 --
----
1 10.992 0.0 0.0 0.0 41005 BLOCK 2 11.000 4 1 -0.8 -0.4
9 10
41008 LV 0.4400 4 1 0.8 0.4
0.988LK 54 2
41008 LV 0.4400 4 0.9999 -1.4 0.0 0.8 0.0 --
----
1 0.4399 0.0 0.4 0.0 41007 BLOCK 2-A 11.000 4 1 -0.8 -0.4
1.000UN 54 2
41009 BLOCK 3 11.000 4 0.9991 -0.0 0.0 0.0 0.0 --
----
1 10.990 0.0 0.0 0.0 4100 CMH MV 11.000 4 1 -1.3 -0.7
15 10
410010 LV 0.4400 4 1 0.8 0.4
1.000LK 54 2
410011 BLOCK 3-A 11.000 4 1 0.5 0.3
6 10
410010 LV 0.4400 4 0.9868 -1.5 0.0 0.8 0.0 --
----
1 0.4342 0.0 0.4 0.0 41009 BLOCK 3 11.000 4 1 -0.8 -0.4
1.000UN 54 2
410011 BLOCK 3-A 11.000 4 0.9987 -0.1 0.0 0.0 0.0 --
----
1 10.985 0.0 0.0 0.0 41009 BLOCK 3 11.000 4 1 -0.5 -0.3
6 10
410012 LV 0.4400 4 1 0.5 0.3
0.988LK 21 3
410012 LV 0.4400 4 1.0045 -0.6 0.2 0.8 0.0 --
----
1 0.4420 0.0R 0.4 0.0 410011 BLOCK 3-A 11.000 4 1 -0.5 -0.3
1.000UN 21 3
410013 SOLAR MV 11.000 4 1.0002 0.0 0.0 0.0 0.0 --
----
1 11.002 0.0 0.0 0.0 4100 CMH MV 11.000 4 1 0.8 0.1
8 10

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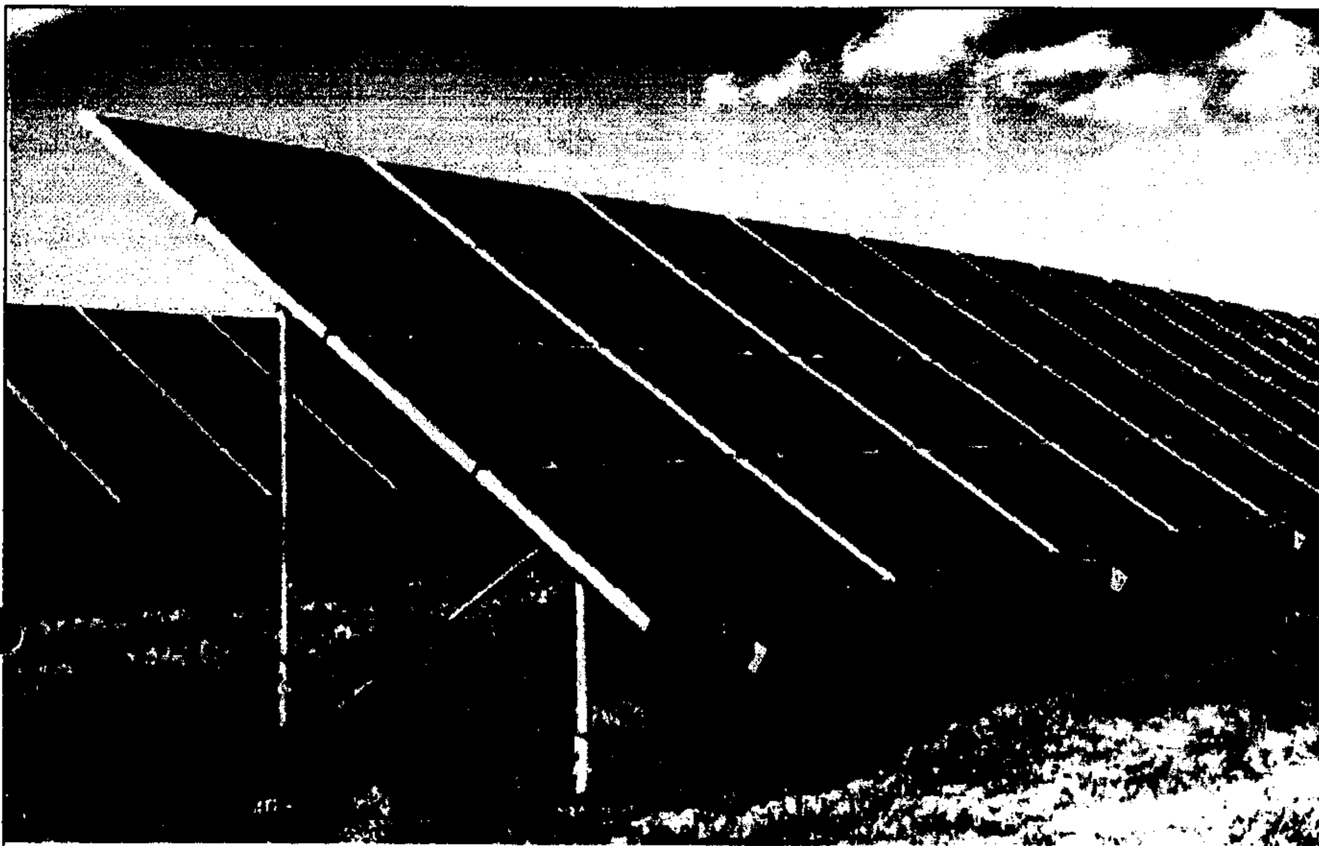
```
                                                                          410014 SOLAR LV    0.8000    4  1     -0.8     -0.1
1.000LK             64    1
 410014 SOLAR LV    0.8000    4 1.0015    0.9     0.8     0.0     0.0 -----------------------------------------------------------
--------------------
                              1 0.8012            0.1R    0.0     0.0 410013 SOLAR MV    11.000    4  1      0.8      0.1
1.000UN             64    1
```



ARCO Energy

Akram Line

SYSTEM STUDY ANALYSIS OF NEW AKRAM LINE (NAL) 500kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
Tel: +92-300-8827101

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CONTENTS

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EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 500kW Solar PV Power Generation project at New Akram Line (NAL) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 500kW Solar PV based system connected with the power network of NAL. The '500kW NAL solar PV Power Generation project' is located at G9FV+RF5, Abid Majeed Rd, Cantt, Lahore, Punjab, Pakistan.

The integration of solar power generation at the NAL premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. NAL currently receives a single point supply from LESCO with a sanctioned load of 0.5MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 0.5MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the NAL premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 500kW NAL solar PV with sanctioned load in service.
- With 500kW NAL solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of NAL. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the NAL distribution system. The power flow results for the system intact shows that the

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power flows on all the NAL transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for NAL. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with NAL and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 500kW NAL solar PV Power Generation project meets the NEPRA grid code planning criteria.

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1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by New Akram Line (NAL) ("Project Owner" or "PO") for the interconnection of a 500kWp Solar PV Power Generation project ("Project") to the NAL power System at 11kV.

The '500kW NAL solar PV Power Generation project' is located at G9FV+RF5, Abid Majeed Rd, Cantt, Lahore, Punjab, Pakistan. Figure 1.1 shows Google site map of the project.

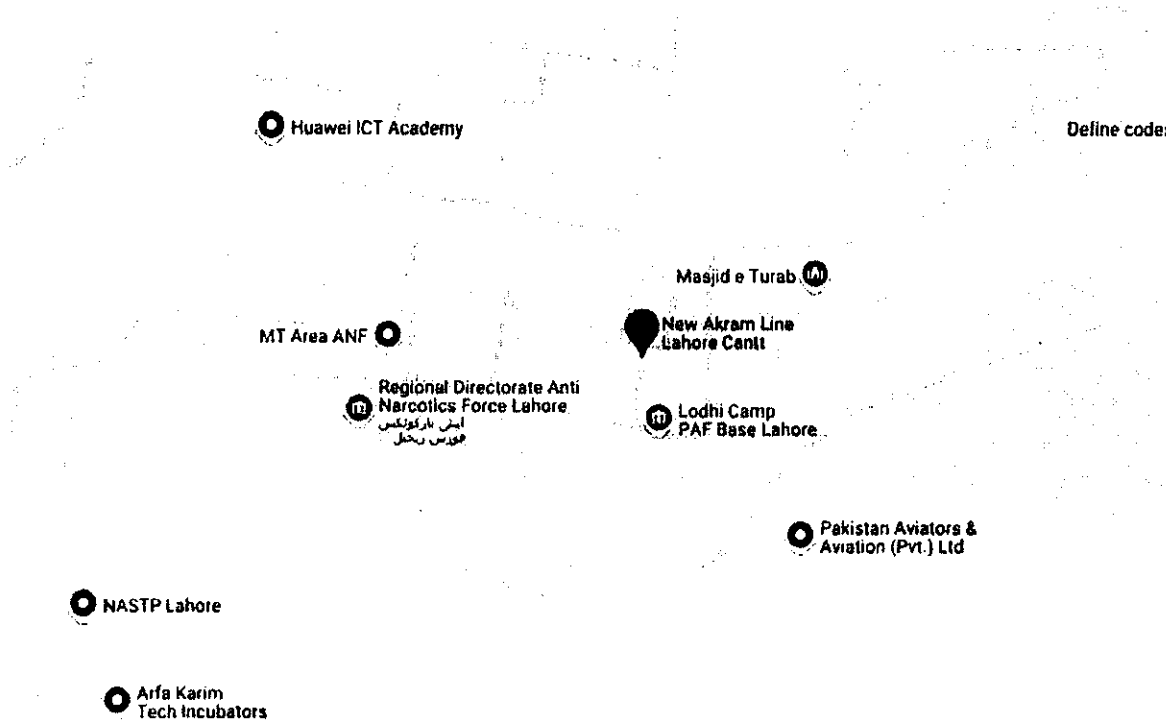

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

NAL aims to integrate solar power generation into its existing electrical infrastructure. NAL currently receives a single-point power supply from LESCO with a sanctioned load of 0.5MW. The entire solar generation within the NAL premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the NAL transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within NAL premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

500kW solar PV system is modelled into the NAL distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling
ii) Steady state analysis
iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 500kW NAL solar PV with sanctioned load in service.
- With 500kW NAL solar PV with sanctioned load in service.

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This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 500kW solar PV system to the distribution system of NAL and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kVand above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within NAL.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

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2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

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3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	421
Active Power of each collector Pgen. (kW)	400
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.1315, 0.1315
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	630
% Reactance (X)	5 %
New Akram Line	
Sanctioned Load (LESCO)	500 kW

Steady state power flow assessment has been performed using the network data of NAL.

3.2 Power Flow Assessment Without NAL PP and with Sanctioned Load In Service

Power flow study without NAL solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

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3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of NAL network. This base case included a detailed representation of the NAL transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the NAL distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with NAL PP

Power flow study of NAL solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 500kW NAL solar project on the NAL distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at NAL solar for peak loading summer (June) 2025 that allow us to judge the impact of NAL solar project on the NAL network.
Project power flow analysis has been performed after the connection of the project with the NAL distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at NAL solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted

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with sanctioned load in service after the interconnection of the Solar project with the NAL distribution system. The power flows results for the system intact shows that the power flows on all the NAL distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without NAL solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with NAL solar and with sanctioned load in service with NAL distribution system. Power flow results showed that the power flows on all the NAL distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 500kW New Akram Line solar PV system with NAL Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

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LIST OF ANNEXURES

Annex A: Project Specific Data.

- **Annex A-1:** Project Site Map.
- **Annex A-2:** Power Plant Data.

Annex B: Power Flow Steady State Analysis Result

- **Figure B-1:** Base Year 2025 - Peak loading summer without NAL solar and Sanctioned load in service.
- **Figure B-2:** Base Year 2025 - Peak loading summer with NAL solar and Sanctioned load in service.

Annex C: Assessment of Bus Voltages.

- **Annex C-1:** Without NAL solar and with Sanctioned Load In Service.
- **Annex C-2:** With NAL solar and with Sanctioned Load In Service.

Annexure-A

Project Specific Data

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Annexure-A-1

Project Site Map

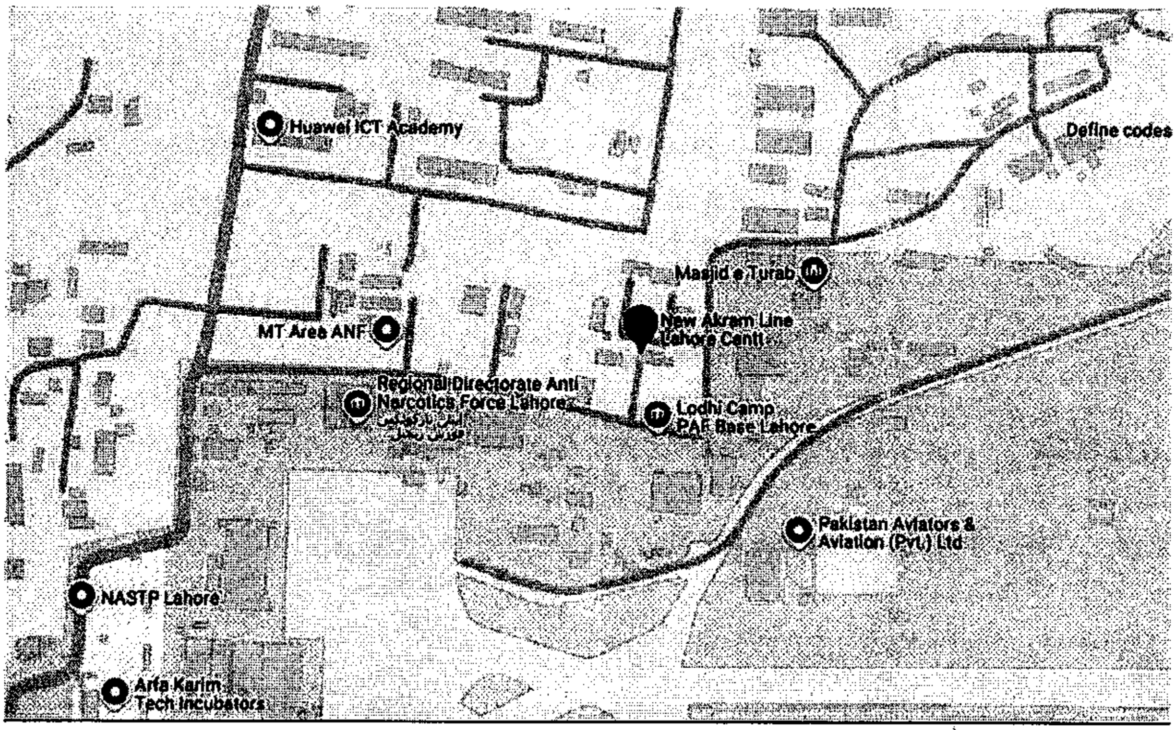

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

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Annexure-A-2

Power Plant Data

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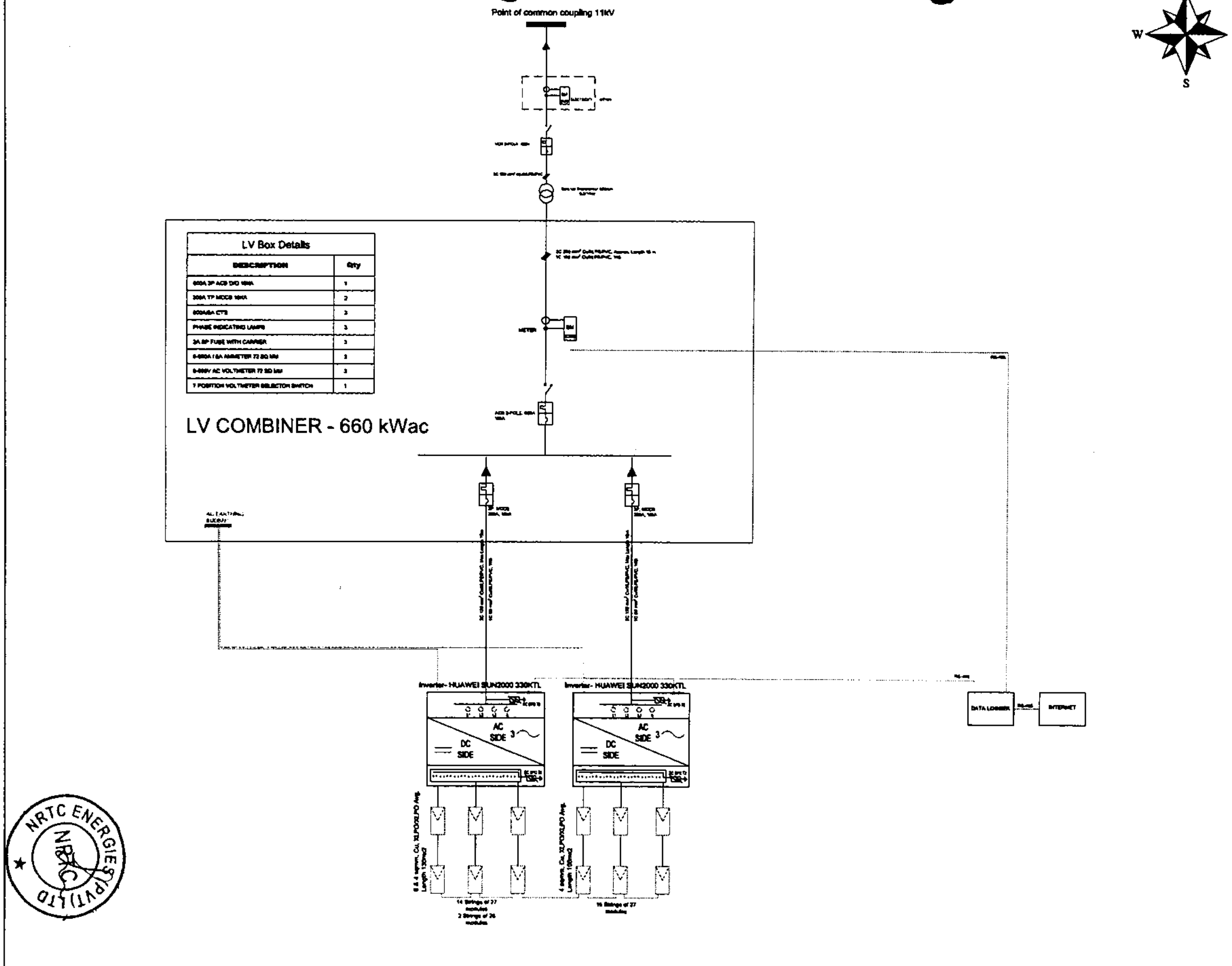
Single Line DIAGRAM

Scale N.T.S



LV Box Details	
DESCRIPTION	Qty
600A 3P ACB D/O 16kA	1
300A TP MCCB 16kA	2
600A/5A CTS	3
PHASE INDICATING LAMPS	3
2A SP FUSE WITH CARRIER	3
0-600A / 5A AMMETER 72 SQ MM	3
0-500V AC VOLTMETER 72 SQ MM	3
7 POSITION VOLTMETER SELECTOR SWITCH	1

SITE LOCATION

Co-ordinates: 31.529040, 74.383170

[redacted]

GENERAL NOTES

1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. KIOSK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

Symbol	Description
	Solar PV Module
	Inverter
	ACB, VCB
	Contactor
	Current Transformer
	Voltage Transformer

ARRAY INFORMATION

	Array
Total Installed Capacity	800 kW
Total Number of PV Modules	862
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltage	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	2
Total AC Power	660kW
Total Area utilized	73146 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	20°
Azimuth	0° ± 3
Pitch of Structure	26.5 ft

PROJECT :

MES Solarization P-III

New Akram Lines - Lahore

Co-ordinates: 31.529040, 74.383170

CLIENT :

Military Engineering Services

DEVELOPER :

NRTC Energies

Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate Lahore || Tel: 042 35117304

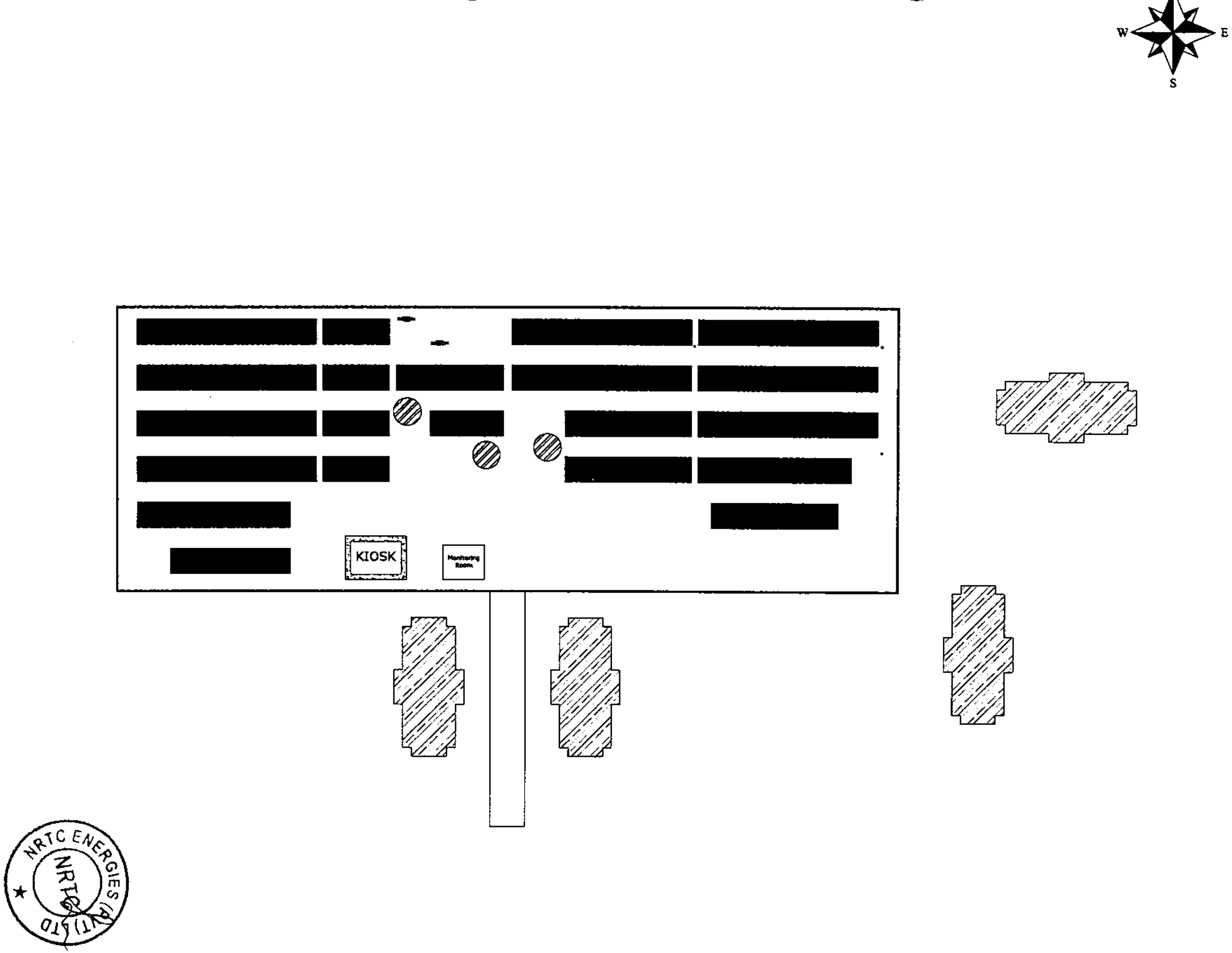
REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING :

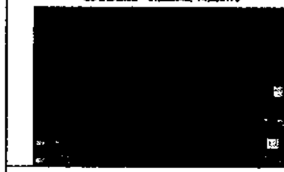
SINGLE LINE DIAGRAM

SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION
Co-ordinates: 31.525040, 74.383170



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3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes	
	Ground mounted
	P2 Piling Structure

ARRAY INFORMATION	
	Array
Total Installed Capacity	500 kW
Total Number of PV Modules	862
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	2
Total AC Power	660kW
Total Area utilized	73146 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	26°
Azimuth	0° ± 3
Pitch of Structure	26.5 ft

PROJECT :

MES Solarization P-III

New Akram Lines - Lahore

Co-ordinates: 31.525040, 74.383170

CLIENT :

Military Engineering Services

DEVELOPER :

NRTC Energies

Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate
Lahore || Tel: 042 36117304

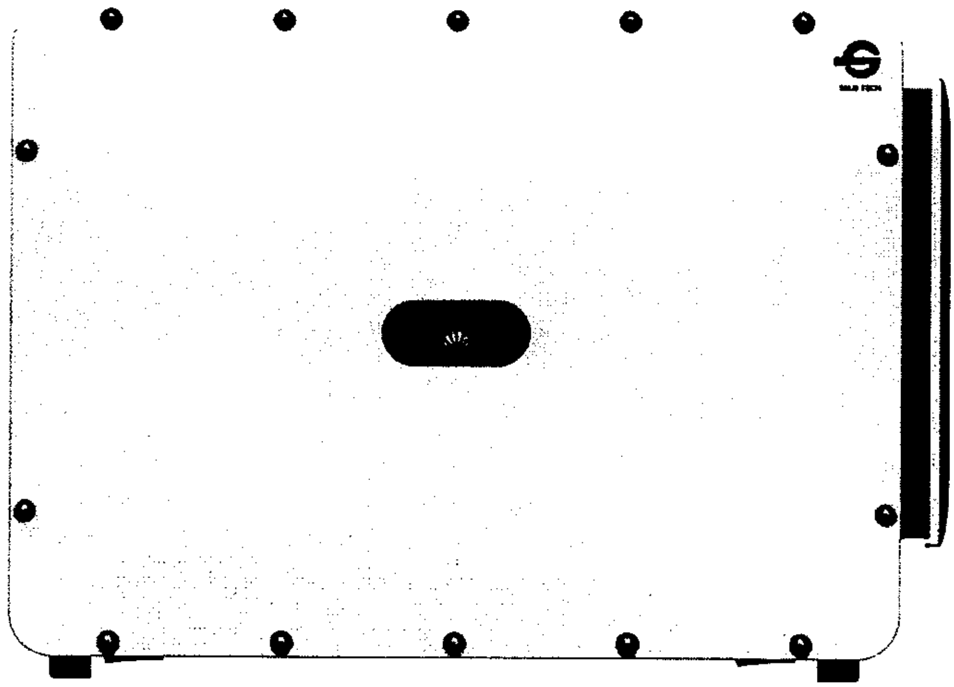
REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING :

SINGLE LINE DIAGRAM

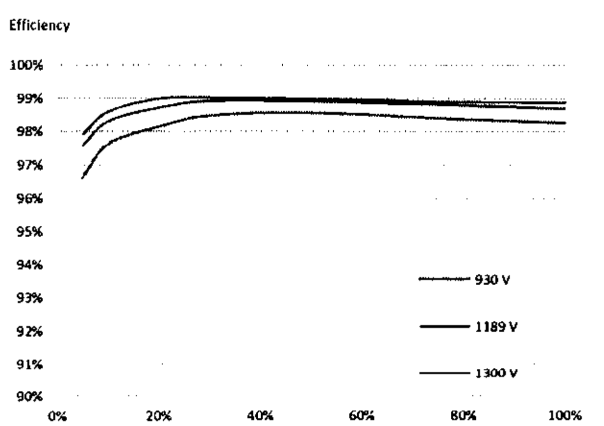
SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

SUN2000-330KTL-H1
Smart String Inverter

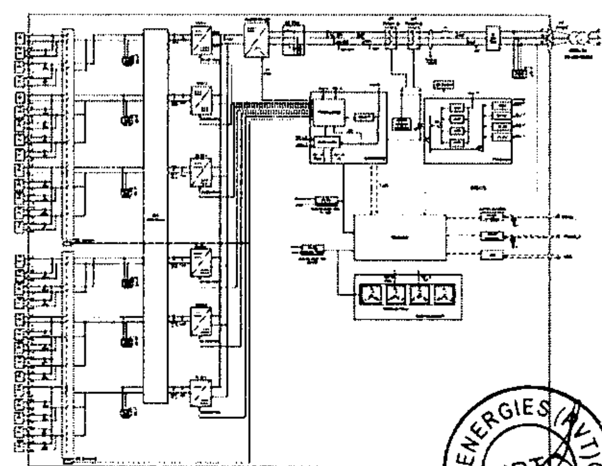


Max. Efficiency ≥99.0%	Smart Connector-level Detection (SCLD)	Smart Self-cleaning Fan (SSCF)	IP66 Protection
MBUS Supported	Smart String-level Disconnection (SSLD)	Smart IV Curve Diagnosis Supported	Surge Arresters for DC & AC

Efficiency Curve



Circuit Diagram



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SUN2000-330KTL-H1

Technical Specifications

Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosϕ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 °C ~ 60 °C
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

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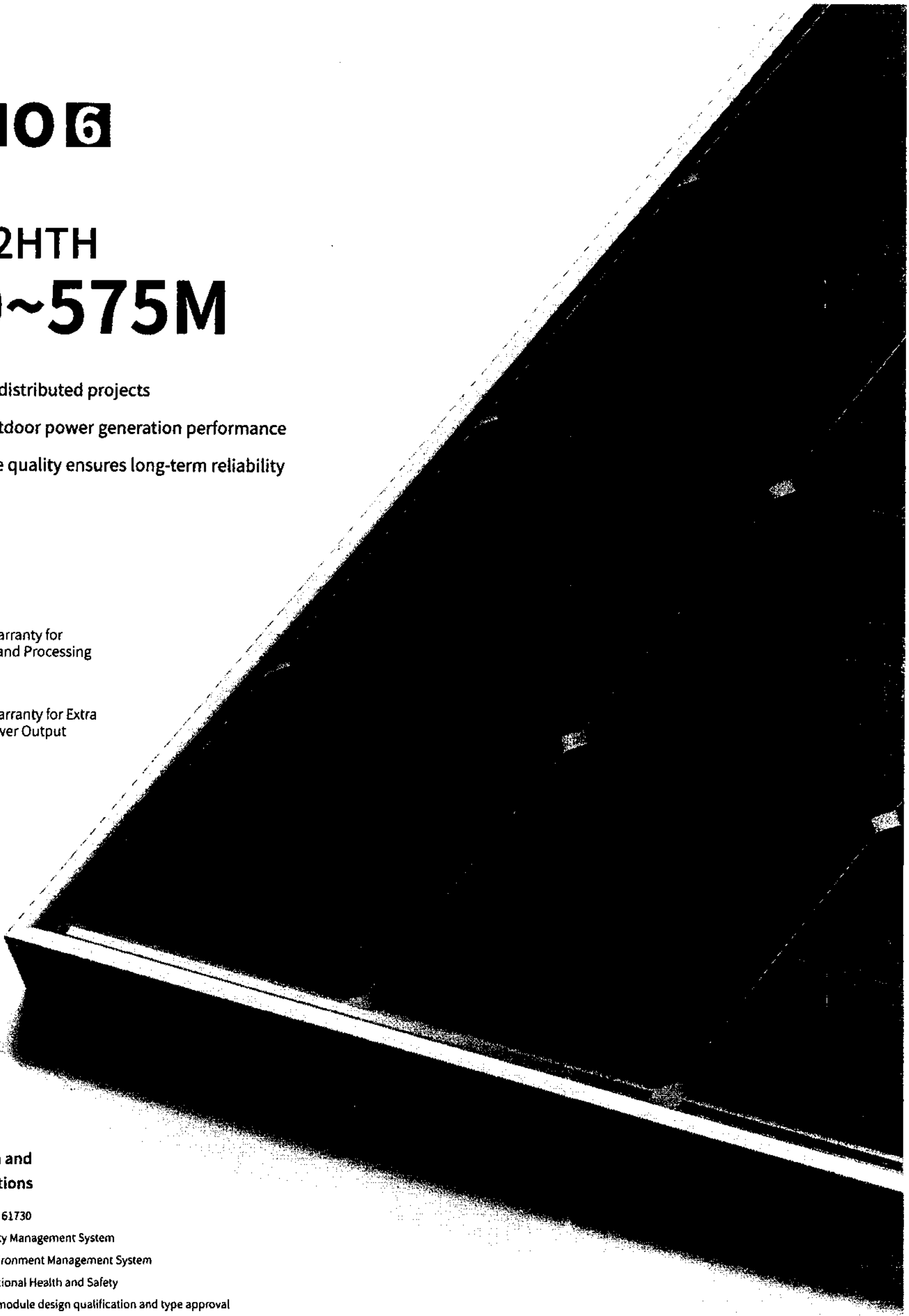
NRTC

Hi-MO 6
Explorer

LR5-72HTH
560~575M

- Suitable for distributed projects
- Excellent outdoor power generation performance
- High module quality ensures long-term reliability



15 15-year Warranty for Materials and Processing

25 25-year Warranty for Extra Linear Power Output

Complete System and Product Certifications

IEC 61215, IEC 61730, UL 61730
ISO9001:2015: ISO Quality Management System
ISO14001: 2015: ISO Environment Management System
ISO45001: 2018: Occupational Health and Safety
IEC62941: Guideline for module design qualification and type approval

LONGi

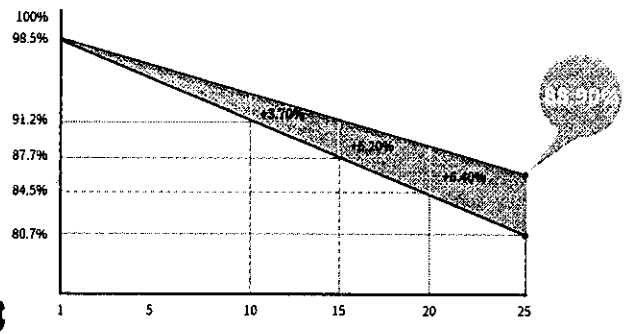
Hi-MO 6

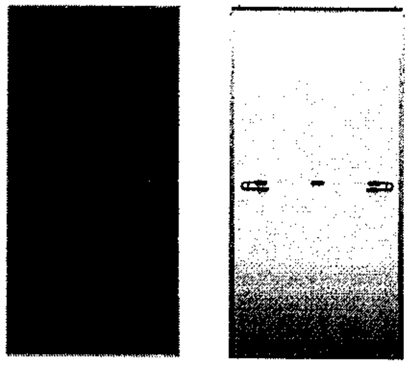
LR5-72HTH 560~575M

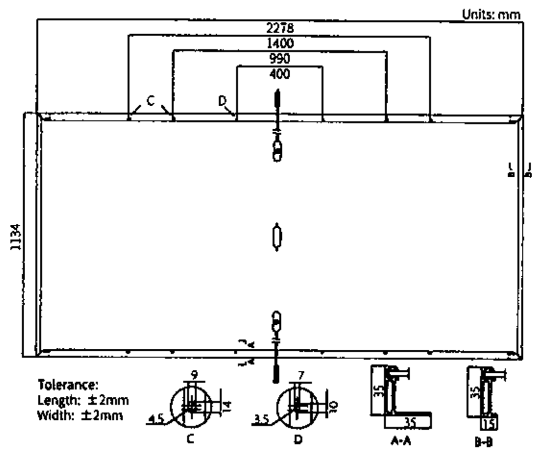
22.3%	0~3%	<1.5%	0.40%

Additional Value

25-Year Power Warranty







Mechanical Parameters

Cell Orientation	144 (6×24)
Junction Box	IP68, three diodes
Output Cable	4mm², +400, -200mm/±1400mm length can be customized
Glass	Single glass, 3.2mm coated tempered glass
Frame	Anodized aluminum alloy frame
Weight	27.5kg
Dimension	2278×1134×35mm
Packaging	31pcs per pallet / 155pcs per 20' GP / 620pcs per 40' HC

Electrical Characteristics STC : AM1.5 1000W/m² 25°C NOCT : AM1.5 800W/m² 20°C 1m/s Test uncertainty for Pmax: ±3%

Module Type	LR5-72HTH-560M		LR5-72HTH-565M		LR5-72HTH-570M		LR5-72HTH-575M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	560	418	565	422	570	426	575	430
Open Circuit Voltage (Voc/V)	51.61	48.46	51.76	48.60	51.91	48.74	52.06	48.88
Short Circuit Current (Isc/A)	13.94	11.26	14.01	11.31	14.07	11.36	14.14	11.42
Voltage at Maximum Power (Vmp/V)	43.46	39.66	43.61	39.79	43.76	39.93	43.91	40.07
Current at Maximum Power (Imp/A)	12.89	10.55	12.96	10.61	13.03	10.67	13.10	10.72
Module Efficiency(%)	21.7		21.9		22.1		22.3	

Operating Parameters

Operational Temperature	-40°C ~ +85°C
Power Output Tolerance	0 ~ 3%
Voc and Isc Tolerance	±3%
Maximum System Voltage	DC1500V (IEC/UL)
Maximum Series Fuse Rating	25A
Nominal Operating Cell Temperature	45±2°C
Protection Class	Class II
Fire Rating	UL type 1 or 2 IEC Class C

Mechanical Loading

Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

Temperature Ratings (STC)

Temperature Coefficient of Isc	+0.050%/°C
Temperature Coefficient of Voc	-0.230%/°C
Temperature Coefficient of Pmax	-0.290%/°C

LONGi

No.8369 Shangyuan Road, Xi'an Economic And Technological Development Zone, Xi'an, Shaanxi, China.
Web: www.longi.com

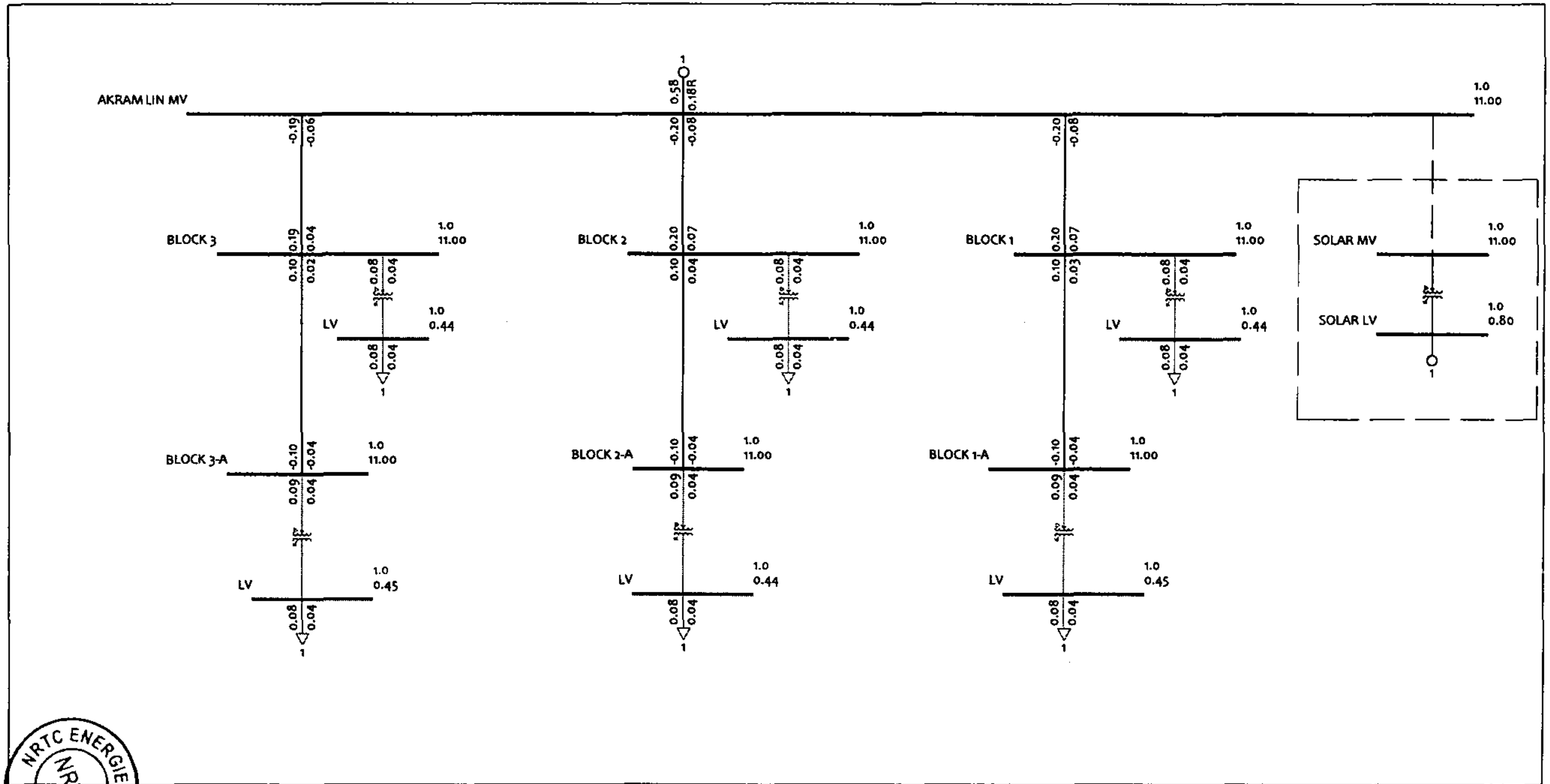
Annexure-B

Steady State Analysis Results

Load Flow Analysis of 500kWp Solar PV System at New Akram Line (NAL)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

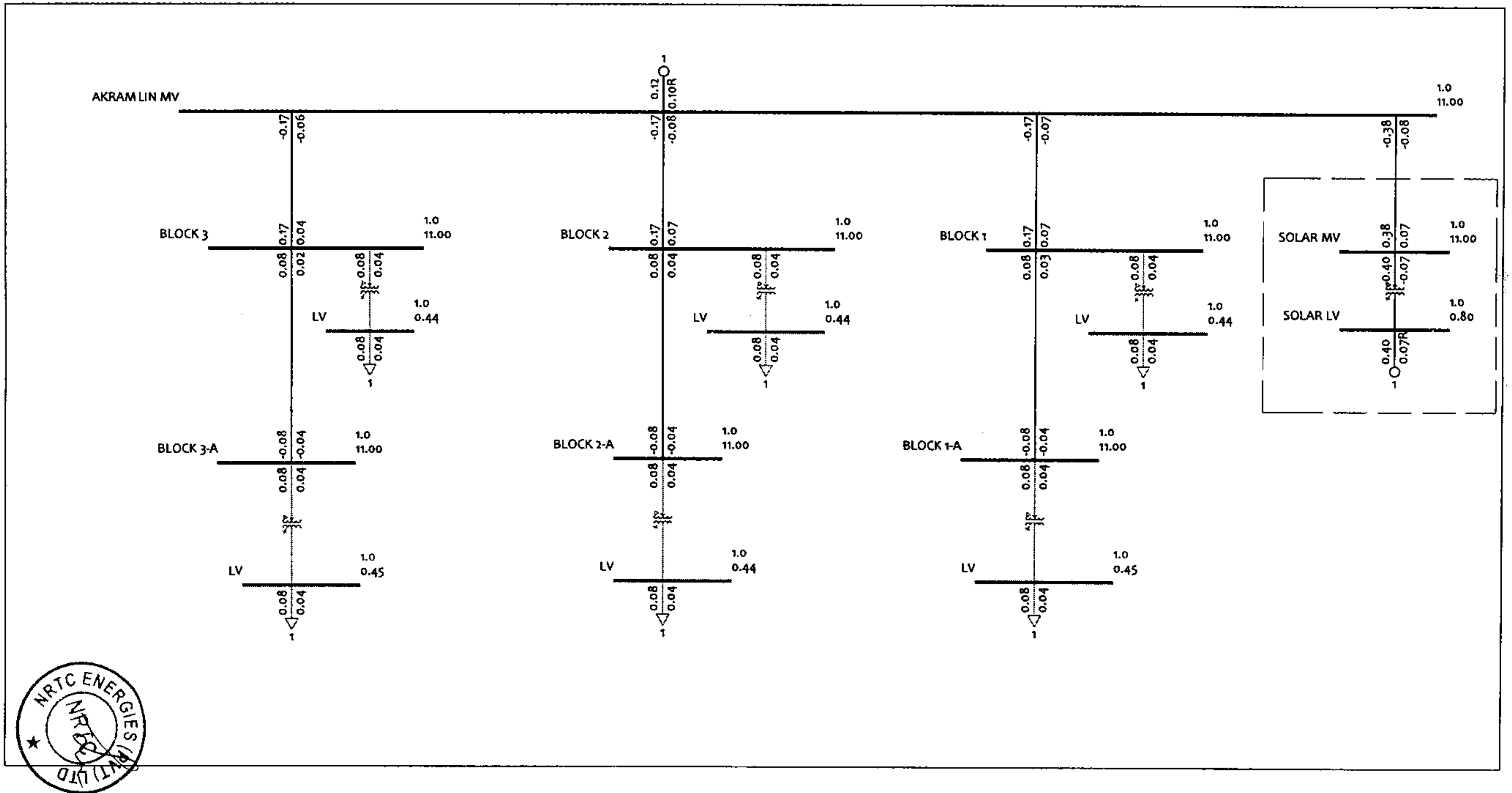
Figure: B-1



Load Flow Analysis of 500kWp Solar PV System at New Akram Line (NAL)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without NAL PP and With Sanctioned Load

In Service

```
                          PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:14
                     AKRAM LINE SOLAR PV SYSTEM                                 %MVA FOR TRANSFORMERS
                                                                                % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT            GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 AKRAM LIN MV11.000    4 1.0000   0.0     0.6     0.0     0.0 --------------------------------------------------------
--------------------
                              1 11.000           0.2R    0.0     0.0  41001 BLOCK 1     11.000   4  1      0.2     0.1
2    10
                                                                      41005 BLOCK 2     11.000   4  1      0.2     0.1
2    10
                                                                      41009 BLOCK 3     11.000   4  1      0.2     0.0
2    10
  41001 BLOCK 1     11.000    4 1.0000  -0.0     0.0     0.0     0.0 --------------------------------------------------------
--------------------
                              1 11.000           0.0     0.0     0.0   4100 AKRAM LIN MV11.000   4  1     -0.2    -0.1
2    10
                                                                      41002 LV          0.4400   4  1      0.1     0.0
1.000LK          6     2
                                                                      41003 BLOCK 1-A   11.000   4  1      0.1     0.0
1    10
  41002 LV          0.4400    4 0.9987  -0.2     0.0     0.1     0.0 --------------------------------------------------------
--------------------
                              1 0.4394           0.0     0.0     0.0  41001 BLOCK 1     11.000   4  1     -0.1    -0.0
1.000UN          6     2

  41003 BLOCK 1-A   11.000    4 0.9999  -0.0     0.0     0.0     0.0 --------------------------------------------------------
--------------------
                              1 10.999           0.0     0.0     0.0  41001 BLOCK 1     11.000   4  1     -0.1    -0.0
1    10
                                                                      41004 LV          0.4400   4  1      0.1     0.0
0.975LK          6     2
  41004 LV          0.4400    4 1.0243  -0.2     0.0     0.1     0.0 --------------------------------------------------------
--------------------
                              1 0.4507           0.0     0.0     0.0  41003 BLOCK 1-A   11.000   4  1     -0.1    -0.0
1.000UN          6     2

  41005 BLOCK 2     11.000    4 0.9999  -0.0     0.0     0.0     0.0 --------------------------------------------------------
--------------------
                              1 10.999           0.0     0.0     0.0   4100 AKRAM LIN MV11.000   4  1     -0.2    -0.1
2    10
                                                                      41006 LV          0.4400   4  1      0.1     0.0
1.000LK          6     2
```

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41007 BLOCK 2-A 11.000 4 1 0.1 0.0

1 10

41006 LV 0.4400 4 0.9986 -0.2 0.0 0.1 0.0 --

----

1 0.4394 0.0 0.0 0.0 41005 BLOCK 2 11.000 4 1 -0.1 -0.0

1.000UN 6 2

41007 BLOCK 2-A 11.000 4 0.9999 -0.0 0.0 0.0 0.0 --

----

1 10.999 0.0 0.0 0.0 41005 BLOCK 2 11.000 4 1 -0.1 -0.0

1 10

41008 LV 0.4400 4 1 0.1 0.0

0.988LK 6 2

41008 LV 0.4400 4 1.0113 -0.2 0.0 0.1 0.0 --

----

1 0.4450 0.0 0.0 0.0 41007 BLOCK 2-A 11.000 4 1 -0.1 -0.0

1.000UN 6 2

41009 BLOCK 3 11.000 4 0.9999 -0.0 0.0 0.0 0.0 --

----

1 10.999 0.0 0.0 0.0 4100 AKRAM LIN MV11.000 4 1 -0.2 -0.1

2 10

410010 LV 0.4400 4 1 0.1 0.0

1.000LK 6 2

410011 BLOCK 3-A 11.000 4 1 0.1 0.0

1 10

410010 LV 0.4400 4 0.9986 -0.2 0.0 0.1 0.0 --

----

1 0.4394 0.0 0.0 0.0 41009 BLOCK 3 11.000 4 1 -0.1 -0.0

1.000UN 6 2

410011 BLOCK 3-A 11.000 4 0.9999 -0.0 0.0 0.0 0.0 --

----

1 10.998 0.0 0.0 0.0 41009 BLOCK 3 11.000 4 1 -0.1 -0.0

1 10

410012 LV 0.4400 4 1 0.1 0.0

0.988LK 3 3

410012 LV 0.4400 4 1.0117 -0.1 0.0 0.1 0.0 --

----

1 0.4451 0.0 0.0 0.0 410011 BLOCK 3-A 11.000 4 1 -0.1 -0.0

1.000UN 3 3

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Annexure-C-2

With NAL PP and With Sanctioned Load

In Service

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NRTC

```
                          PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:15
                    AKRAM LINE SOLAR PV SYSTEM                                  %MVA FOR TRANSFORMERS
                                                                                % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT          GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 AKRAM LIN MV11.000   4 1.0000   0.0     0.1     0.0     0.0 -----------------------------------------------------
---------------------
                             1 11.000           0.1R    0.0     0.0  41001 BLOCK 1      11.000    4  1      0.2     0.1
2    10
                                                                     41005 BLOCK 2      11.000    4  1      0.2     0.1
2    10
                                                                     41009 BLOCK 3      11.000    4  1      0.2     0.0
2    10
                                                                    410013 SOLAR MV     11.000    4  1     -0.4    -0.1
4    10
  41001 BLOCK 1      11.000   4 1.0000  -0.0     0.0     0.0     0.0 -----------------------------------------------------
---------------------
                             1 11.000           0.0     0.0     0.0   4100 AKRAM LIN MV11.000    4  1     -0.2    -0.1
2    10
                                                                     41002 LV           0.4400    4  1      0.1     0.0
1.000LK          6     2
                                                                     41003 BLOCK 1-A    11.000    4  1      0.1     0.0
1    10
  41002 LV           0.4400   4 0.9987  -0.2     0.0     0.1     0.0 -----------------------------------------------------
---------------------
                             1 0.4394           0.0     0.0     0.0  41001 BLOCK 1      11.000    4  1     -0.1    -0.0
1.000UN          6     2

  41003 BLOCK 1-A    11.000   4 0.9999  -0.0     0.0     0.0     0.0 -----------------------------------------------------
---------------------
                             1 10.999           0.0     0.0     0.0  41001 BLOCK 1      11.000    4  1     -0.1    -0.0
1    10
                                                                     41004 LV           0.4400    4  1      0.1     0.0
0.975LK          6     2
  41004 LV           0.4400   4 1.0243  -0.1     0.0     0.1     0.0 -----------------------------------------------------
---------------------
                             1 0.4507           0.0     0.0     0.0  41003 BLOCK 1-A    11.000    4  1     -0.1    -0.0
1.000UN          6     2

  41005 BLOCK 2      11.000   4 0.9999  -0.0     0.0     0.0     0.0 -----------------------------------------------------
---------------------
                             1 10.999           0.0     0.0     0.0   4100 AKRAM LIN MV11.000    4  1     -0.2    -0.1
2    10
```

RTC ENERGIES

```
                                                                      41006 LV         0.4400    4  1      0.1     0.0
1.000LK          6     2
                                                                      41007 BLOCK 2-A  11.000    4  1      0.1     0.0
1    10
  41006 LV          0.4400   4 0.9987  -0.2     0.0       0.1      0.0 ----------------------------------------------------
---------------------
                             1 0.4394           0.0       0.0      0.0  41005 BLOCK 2    11.000    4  1     -0.1    -0.0
1.000UN          6     2

  41007 BLOCK 2-A   11.000   4 0.9999  -0.0     0.0       0.0      0.0 ----------------------------------------------------
---------------------
                             1 10.999           0.0       0.0      0.0  41005 BLOCK 2    11.000    4  1     -0.1    -0.0
1    10
                                                                      41008 LV         0.4400    4  1      0.1     0.0
0.988LK          6     2
  41008 LV          0.4400   4 1.0113  -0.2     0.0       0.1      0.0 ----------------------------------------------------
---------------------
                             1 0.4450           0.0       0.0      0.0  41007 BLOCK 2-A  11.000    4  1     -0.1    -0.0
1.000UN          6     2

  41009 BLOCK 3     11.000   4 0.9999  -0.0     0.0       0.0      0.0 ----------------------------------------------------
---------------------
                             1 10.999           0.0       0.0      0.0   4100 AKRAM LIN MV11.000   4  1     -0.2    -0.1
2    10
                                                                     410010 LV         0.4400    4  1      0.1     0.0
1.000LK          6     2
                                                                     410011 BLOCK 3-A  11.000    4  1      0.1     0.0
1    10
 410010 LV          0.4400   4 0.9986  -0.2     0.0       0.1      0.0 ----------------------------------------------------
---------------------
                             1 0.4394           0.0       0.0      0.0  41009 BLOCK 3    11.000    4  1     -0.1    -0.0
1.000UN          6     2

 410011 BLOCK 3-A   11.000   4 0.9999  -0.0     0.0       0.0      0.0 ----------------------------------------------------
---------------------
                             1 10.998           0.0       0.0      0.0  41009 BLOCK 3    11.000    4  1     -0.1    -0.0
1    10
                                                                     410012 LV         0.4400    4  1      0.1     0.0
0.988LK          3     3
 410012 LV          0.4400   4 1.0117  -0.1     0.0       0.1      0.0 ----------------------------------------------------
---------------------
                             1 0.4452           0.0       0.0      0.0 410011 BLOCK 3-A  11.000    4  1     -0.1    -0.0
1.000UN          3     3

 410013 SOLAR MV    11.000   4 1.0001   0.0     0.0       0.0      0.0 ----------------------------------------------------
---------------------
                             1 11.001           0.0       0.0      0.0   4100 AKRAM LIN MV11.000   4  1      0.4     0.1
4    10
```

NRTC ENERGIES

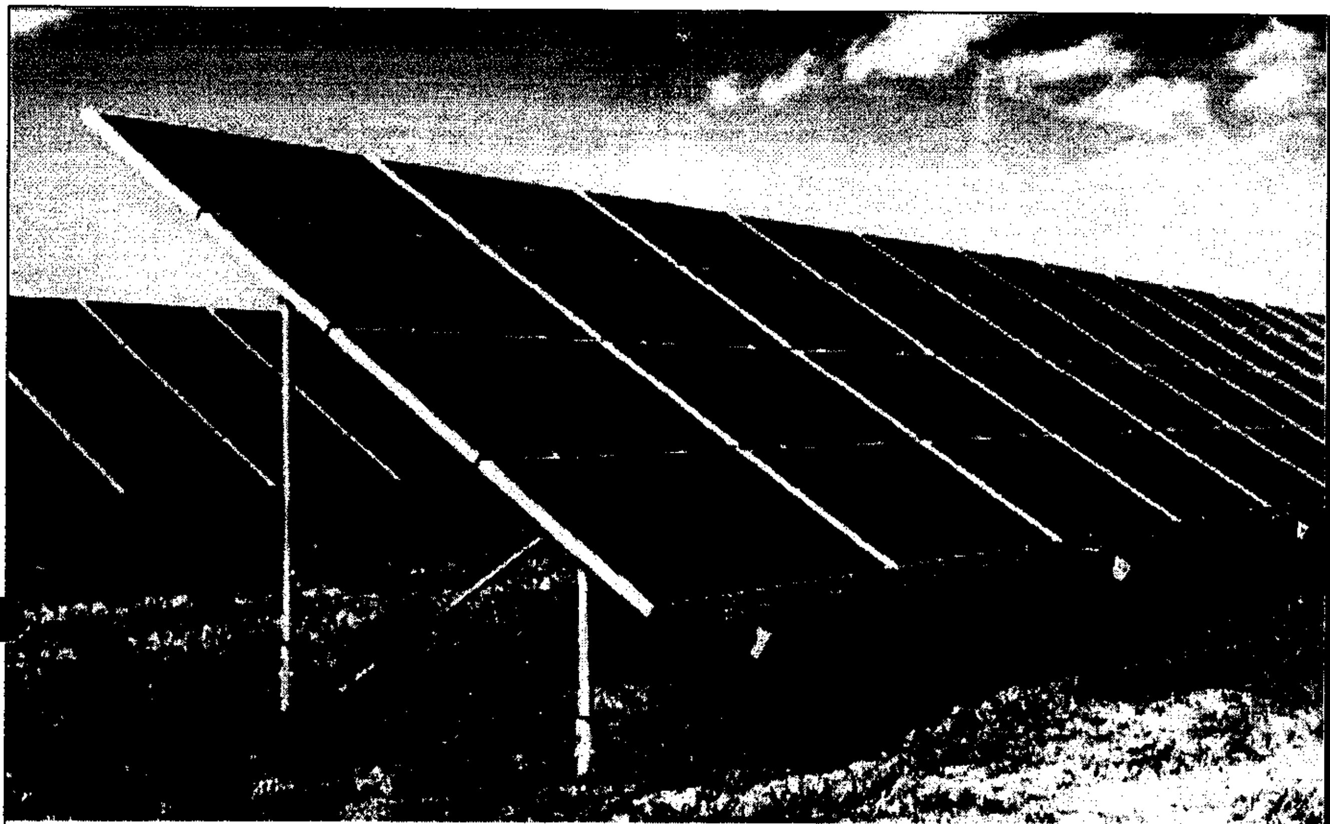
410014 SOLAR LV 0.8000 4 1 -0.4 -0.1

1.000LK 64 1

410014 SOLAR LV 0.8000 4 1.0015 0.5 0.4 0.0 0.0

1 0.8012 0.1R 0.0 0.0 410013 SOLAR MV 11.000 4 1 0.4 0.1

1.000UN 64 1



ARCO Energy

MIAN MIR LINE

SYSTEM STUDY ANALYSIS OF MIAN MIR LINE (MML) 500kW SOLAR PV SYSTEM

Report

ARCO Energy

PAKISTAN

Tel: +92-300-8827101

NRTC

CONTENTS

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EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 500kW Solar PV Power Generation project at Mian Mir Line (MML) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 500kW Solar PV based system connected with the power network of MML. The '500kW MML solar PV Power Generation project' is located at Ground of 17 NLI / HQ 106 Bde North Mian Mir Line, Shami Rd, Cantt, Lahore, Pakistan.

The integration of solar power generation at the MML premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. MML currently receives a single point supply from LESCO with a sanctioned load of 1.918MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 1.918MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the MML premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 500kW MML solar PV with sanctioned load in service.
- With 500kW MML solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of MML. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the MML distribution system. The power flow results for the system intact shows that

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the power flows on all the MML transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for MML. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with MML and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 500kW MML solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Mian Mir Line (MML) ("Project Owner" or "PO") for the interconnection of a 500kWp Solar PV Power Generation project ("Project") to the MML power System at 11kV.

The '500kW MML solar PV Power Generation project' is located at Ground of 17 NLI / HQ 106 Bde North Mian Mir Line, Shami Rd, Cantt, Lahore, Pakistan. Figure 1.1 shows Google site map of the project.

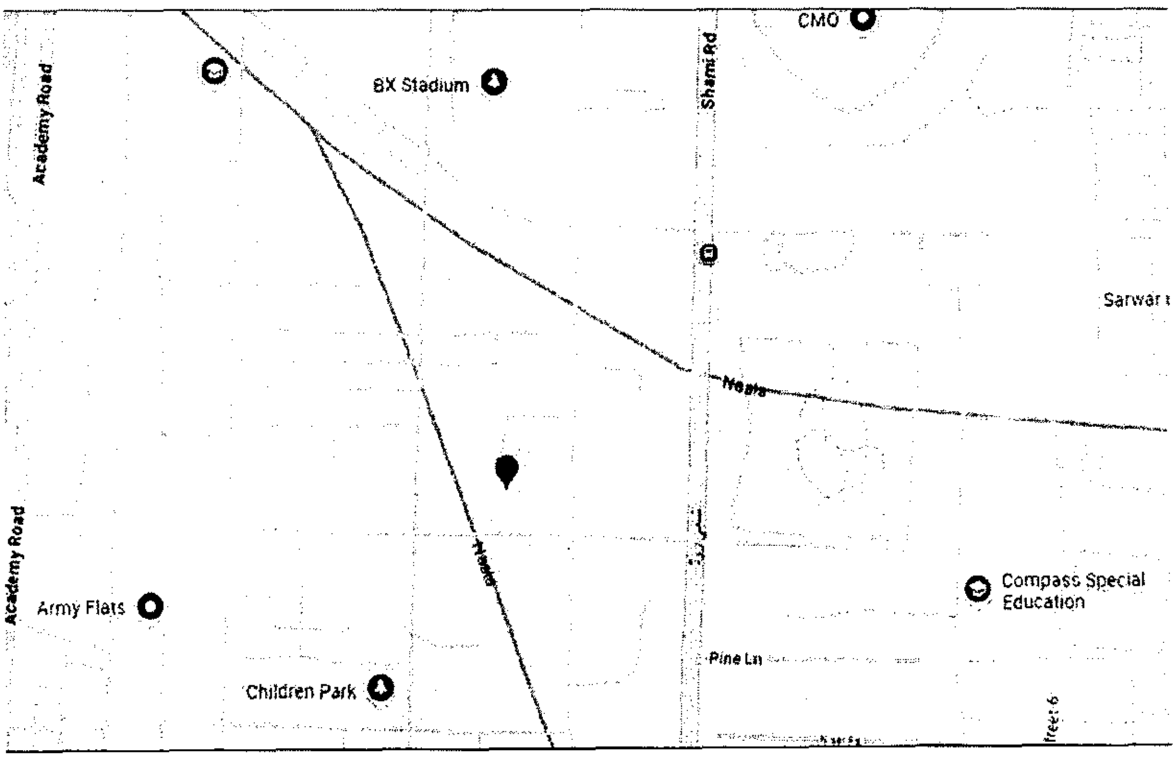

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

MML aims to integrate solar power generation into its existing electrical infrastructure. MML currently receives a single-point power supply from LESCO with a sanctioned load of 1.918MW. The entire solar generation within the MML premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the MML transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within MML premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

500kW solar PV system is modelled into the MML distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling
ii) Steady state analysis
iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 500kW MML solar PV with sanctioned load in service.
- With 500kW MML solar PV with sanctioned load in service.

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This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 500kW solar PV system to the distribution system of MML and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kVand above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within MML.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

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2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	421
Active Power of each collector Pgen. (kW)	400
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.1315, 0.1315
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	630
% Reactance (X)	5 %
Mian Mir Line	
Sanctioned Load (LESCO)	1918 kW

Steady state power flow assessment has been performed using the network data of MML.

3.2 Power Flow Assessment Without MML PP and with Sanctioned Load In Service

Power flow study without MML solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

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3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of MML network. This base case included a detailed representation of the MML transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the MML distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with MML PP

Power flow study of MML solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 500kW MML solar project on the MML distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at MML solar for peak loading summer (June) 2025 that allow us to judge the impact of MML solar project on the MML network.
Project power flow analysis has been performed after the connection of the project with the MML distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at MML solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted

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with sanctioned load in service after the interconnection of the Solar project with the MML distribution system. The power flow results for the system intact shows that the power flows on all the MML distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

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4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without MML solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with MML solar and with sanctioned load in service with MML distribution system. Power flow results showed that the power flows on all the MML distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 500kW Mian Mir Line solar PV system with MML Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

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LIST OF ANNEXURES

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Annexure-A

Project Specific Data

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Annexure-A-1

Project Site Map

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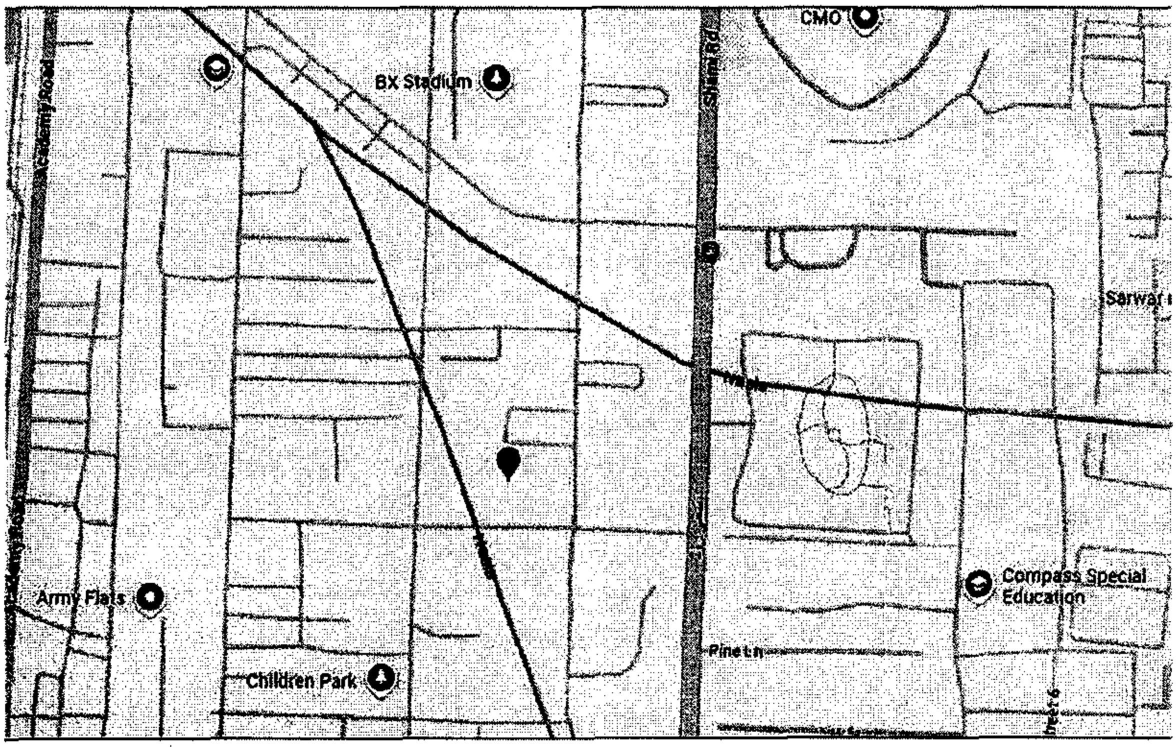

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

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Annexure-A-2

Power Plant Data

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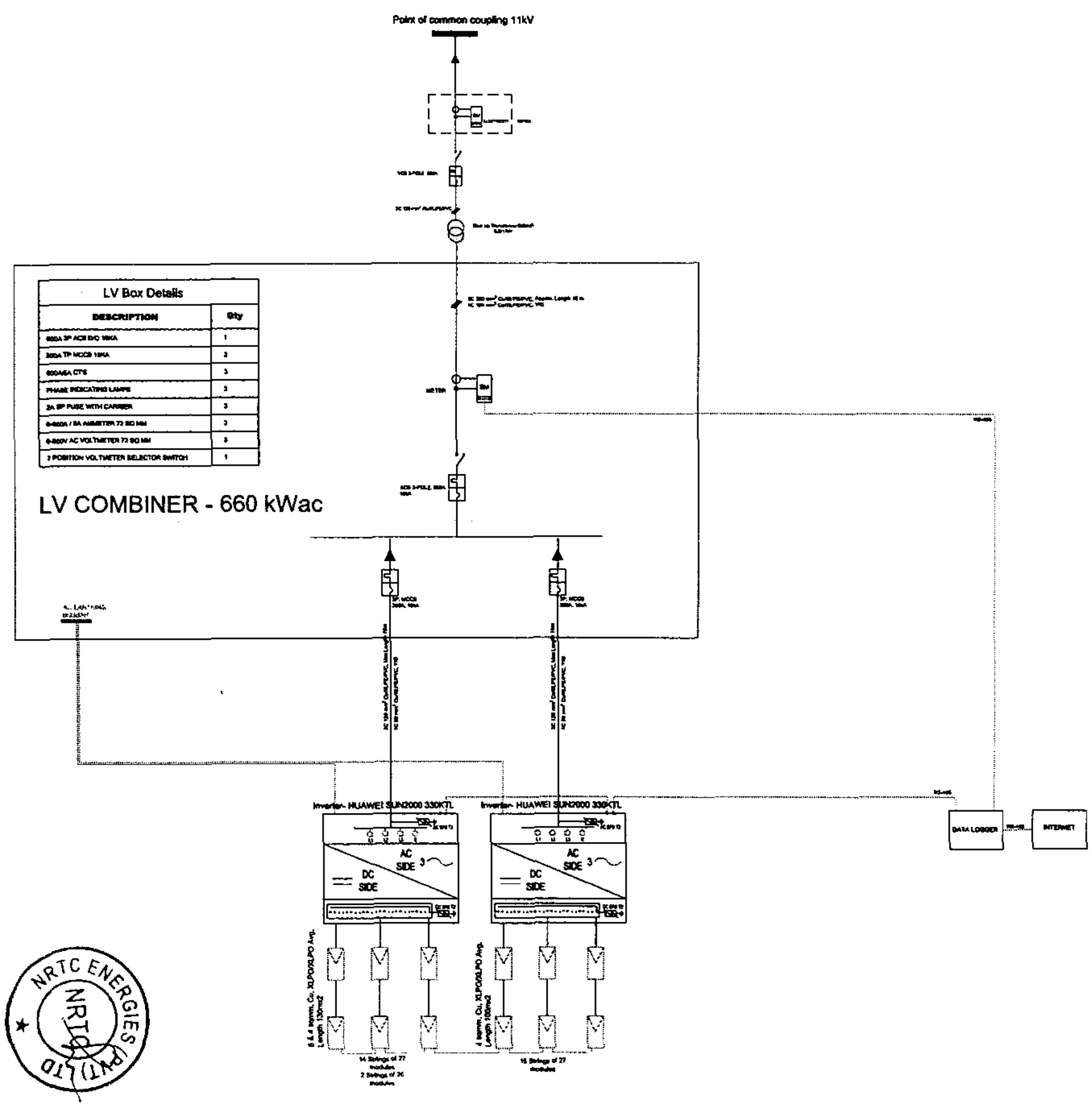
Single Line DIAGRAM

Scale N.T.S



LV Box Details	
DESCRIPTION	Qty
800A 3P ACB D/O 18KA	1
300A TP MCCB 18KA	2
800A/5A CT'S	3
PHASE INDICATING LAMPS	3
2A SP FUSE WITH CARRIER	3
0-800A / 5A AMMETER 72 SQ MM	3
0-500V AC VOLTMETER 72 SQ MM	3
7 POSITION VOLTMETER SELECTOR SWITCH	1

SITE LOCATION

Co-ordinates: 31.507475, 74.361199

GENERAL NOTES

1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. KIOSK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Solar PV Module
	Inverter
	ACB, VCB
	Contactor
	Current Transformer
	Voltage Transformer

ARRAY INFORMATION

	Array
Total Installed Capacity	800KW
Total Number of PV Modules	862
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	2
Total AC Power	660kW
Total Area utilized	62754 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	20°
Azimuth	0° ± 3
Pitch of Structure	20.5 ft

PROJECT :

MES Solarization P-III

Mian Mir Lines - Lahore

Co-ordinates: 31.507475, 74.361199

CLIENT :

Military Engineering Services

DEVELOPER :

NRTC Energies

Block 72 Moulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate Lahore || Tel: 042 35117304

REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

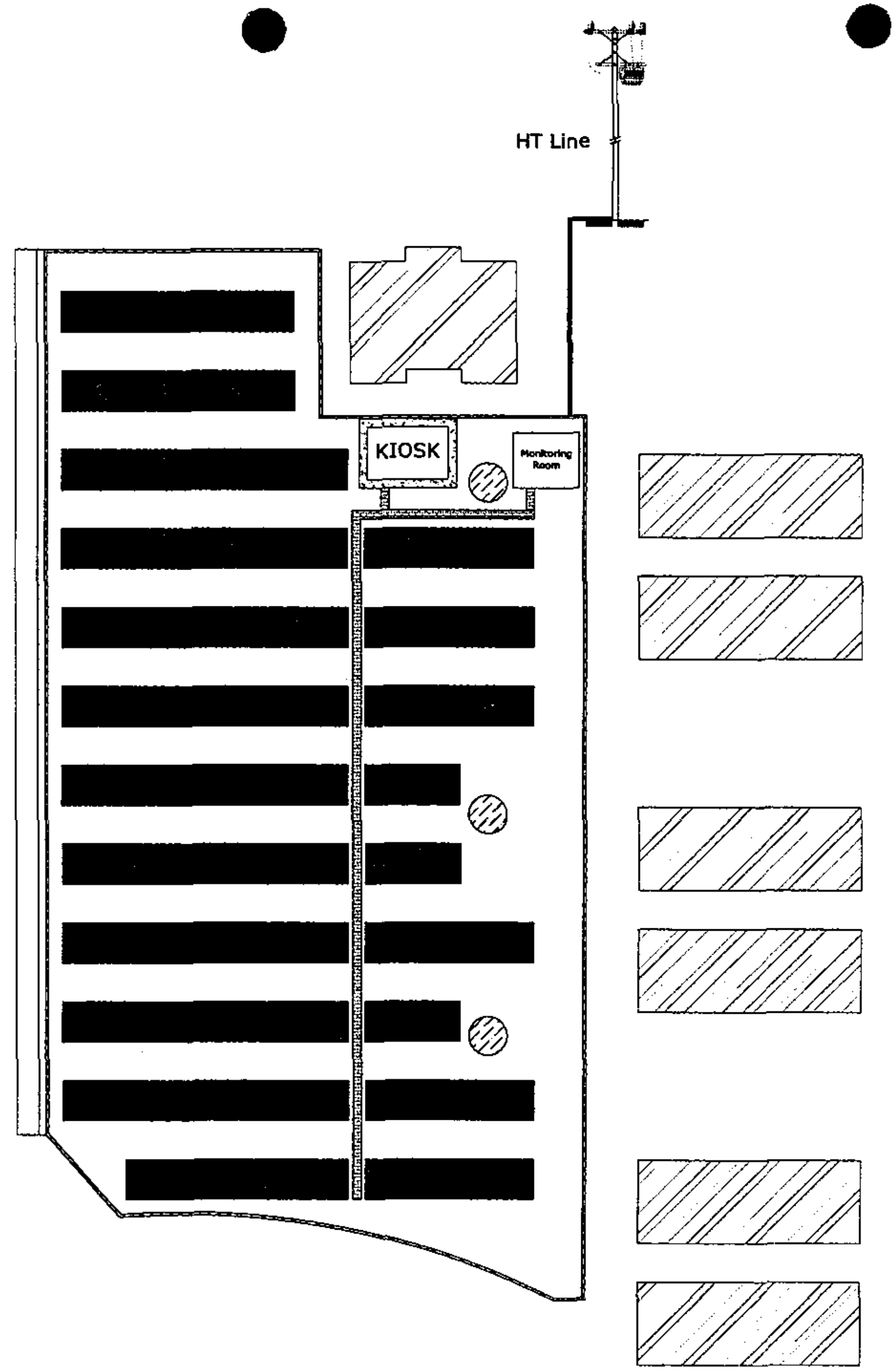
DRAWING :

SINGLE LINE DIAGRAM

SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

PV Placement DIAGRAM

Scale N.T.S



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SITE LOCATION

Co-ordinates: 31.507475, 74.361199

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1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. KIOSK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Ground mounted
	P2 Piling Structure

ARRAY INFORMATION

	Array
Total Installed Capacity	500KW
Total Number of PV Modules	862
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	2
Total AC Power	660KW
Total Area utilized	62754 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	20°
Azimuth	0° ± 3
Pitch of Structure	20.5 ft

PROJECT :
MES Solarization P-III
Mian Mir Lines
Co-ordinates: 31.507475, 74.361199

CLIENT :
Military Engineering Services

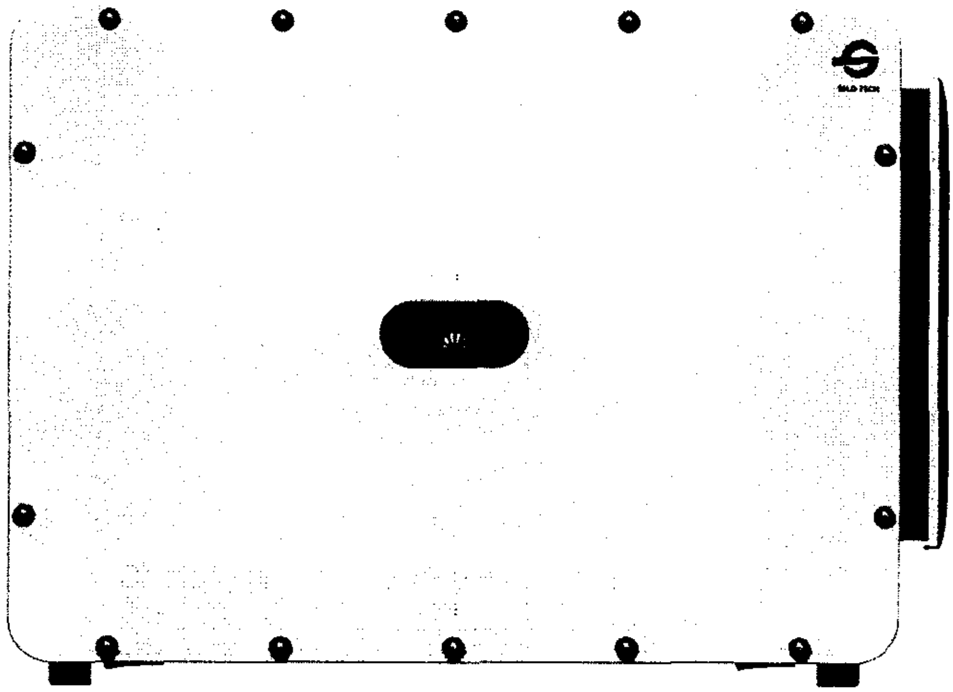
DEVELOPER :
NRTC Energies
Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate Lahore || Tel: 042 35117304

REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING :
SINGLE LINE DIAGRAM

SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

SUN2000-330KTL-H1
Smart String Inverter



Max. Efficiency
≥99.0%

Smart Connector-level
Detection (SCLD)

Smart Self-cleaning
Fan (SSCF)

IP66
Protection

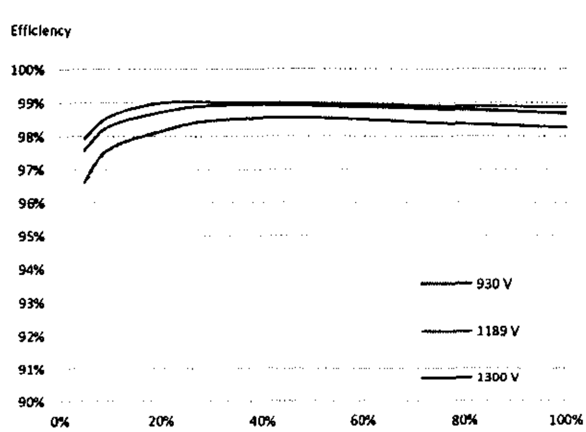
MBUS
Supported

Smart String-level
Disconnection (SSLD)

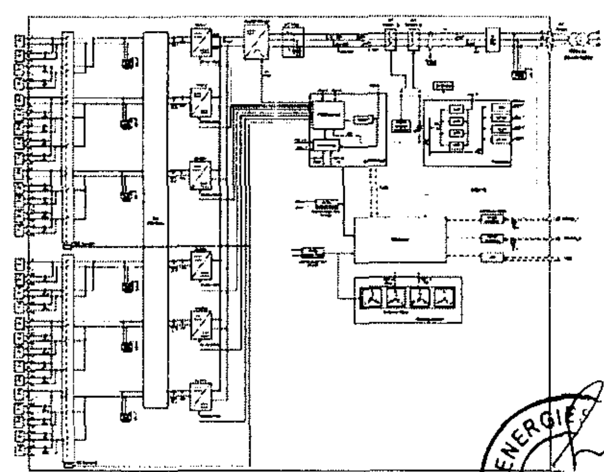
Smart IV Curve Diagnosis
Supported

Surge Arresters for
DC & AC

Efficiency Curve



Circuit Diagram



SUN2000-330KTL-H1

Technical Specifications

Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power ($\cos\phi$=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 °C ~ 60 °C
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

NRTC ENERGIES (PVT) LTD
NRTC

Hi-MO 6
Explorer

LR5-72HTH
560~575M

- Suitable for distributed projects
- Excellent outdoor power generation performance
- High module quality ensures long-term reliability

15 — 15-year Warranty for Materials and Processing

25 — 25-year Warranty for Extra Linear Power Output

Complete System and Product Certifications

IEC 61215, IEC 61730, UL 61730
ISO9001:2015: ISO Quality Management System
ISO14001: 2015: ISO Environment Management System
ISO45001: 2018: Occupational Health and Safety
IEC62941: Guideline for module design qualification and type approval

LONGi

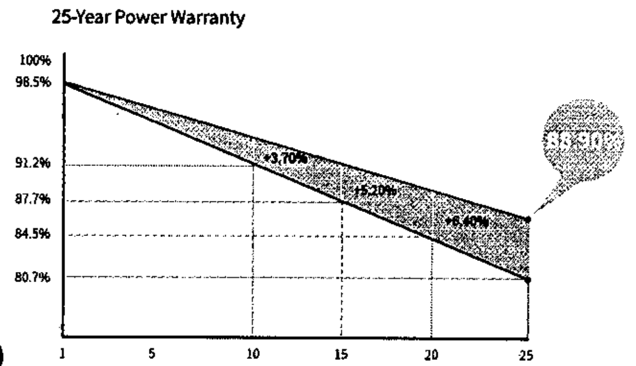
NRTC ENERGIES (PVT) LTD
NRTC

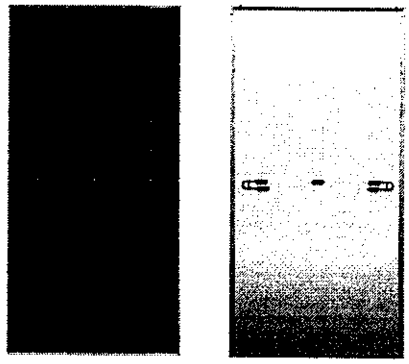
Hi-MO 6

LR5-72HTH 560~575M

22.3%	0~3%	<1.5%	0.40%

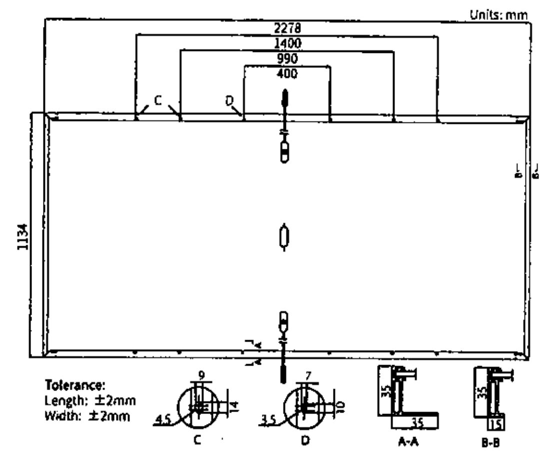
Additional Value





Mechanical Parameters

Cell Orientation	144 (6×24)
Junction Box	IP68, three diodes
Output Cable	$4mm^2$, +400, -200mm/±1400mm length can be customized
Glass	Single glass, 3.2mm coated tempered glass
Frame	Anodized aluminum alloy frame
Weight	27.5kg
Dimension	2278×1134×35mm
Packaging	31pcs per pallet / 155pcs per 20' GP / 620pcs per 40' HC



Electrical Characteristics

STC : AM1.5 1000W/m² 25°C NOCT : AM1.5 800W/m² 20°C 1m/s Test uncertainty for Pmax: ±3%

Module Type	LR5-72HTH-560M		LR5-72HTH-565M		LR5-72HTH-570M		LR5-72HTH-575M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	560	418	565	422	570	426	575	430
Open Circuit Voltage (Voc/V)	51.61	48.46	51.76	48.60	51.91	48.74	52.06	48.88
Short Circuit Current (Isc/A)	13.94	11.26	14.01	11.31	14.07	11.36	14.14	11.42
Voltage at Maximum Power (Vmp/V)	43.46	39.66	43.61	39.79	43.76	39.93	43.91	40.07
Current at Maximum Power (Imp/A)	12.89	10.55	12.96	10.61	13.03	10.67	13.10	10.72
Module Efficiency(%)	21.7		21.9		22.1		22.3	

Operating Parameters

Operational Temperature	-40°C ~ +85°C
Power Output Tolerance	0 ~ 3%
Voc and Isc Tolerance	±3%
Maximum System Voltage	DC1500V (IEC/UL)
Maximum Series Fuse Rating	25A
Nominal Operating Cell Temperature	45±2°C
Protection Class	Class II
Fire Rating	UL type 1 or 2 IEC Class C

Mechanical Loading

Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

Temperature Ratings (STC)

Temperature Coefficient of Isc	+0.050%/°C
Temperature Coefficient of Voc	-0.230%/°C
Temperature Coefficient of Pmax	-0.290%/°C

ENERGIES NRTC

LONGi

No.8369 Shangyuan Road, Xi'an Economic And Technological Development Zone, Xi'an, Shaanxi, China.
Web: www.longi.com

Annexure-B

Steady State Analysis Results

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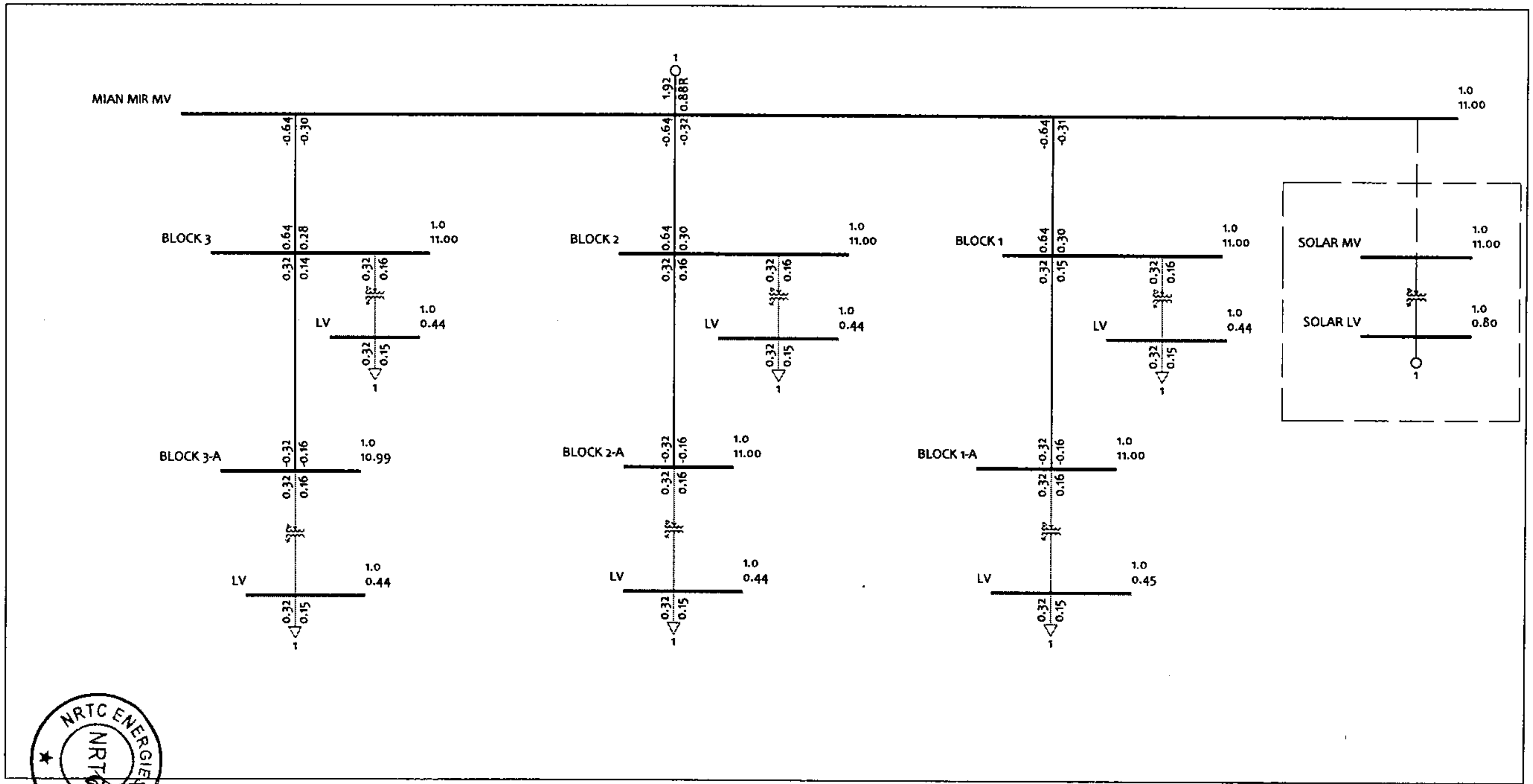
Load Flow Analysis of 500kW Solar PV System at Mian Mir (MM)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

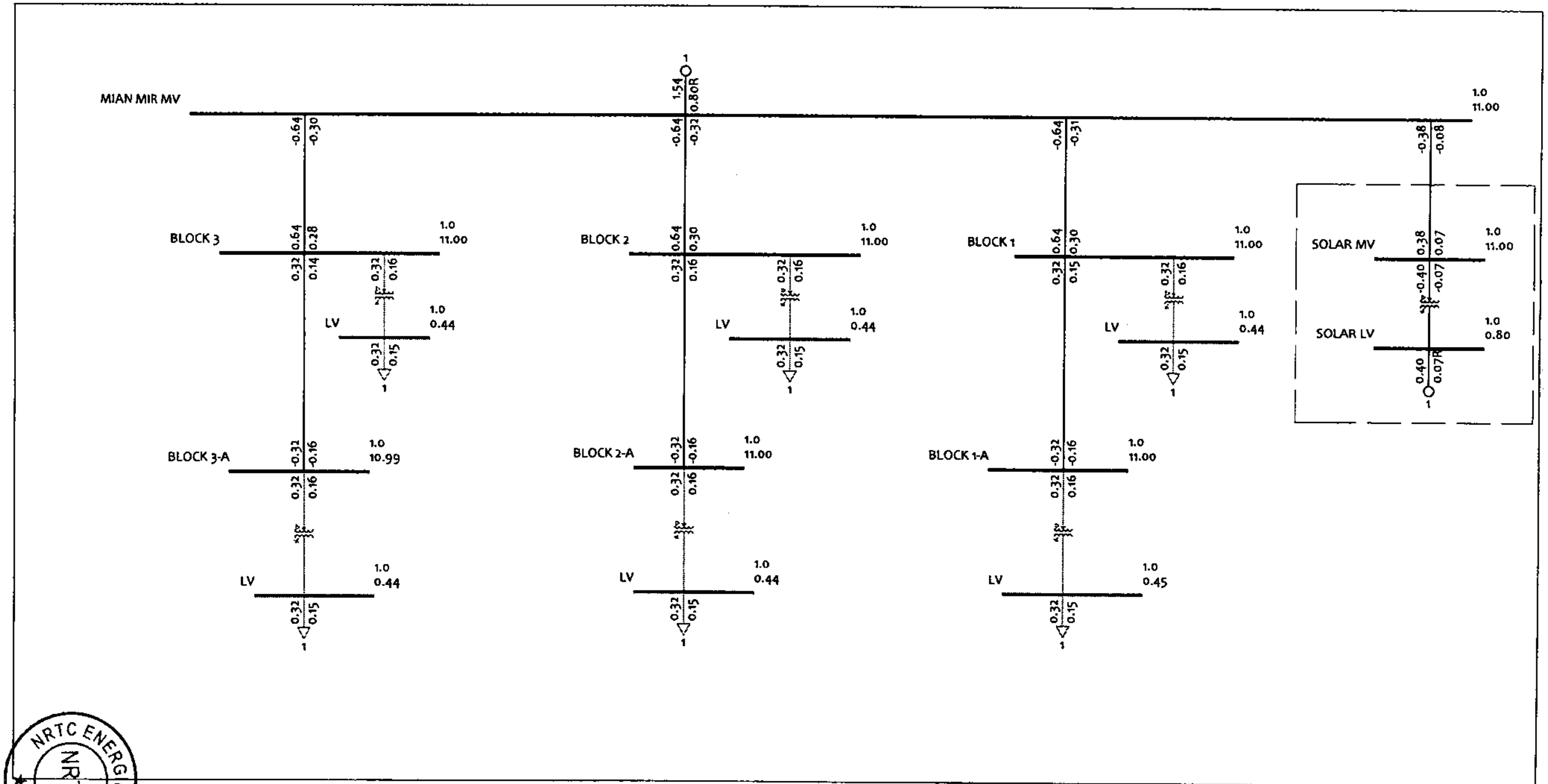
Figure: B-1



Load Flow Analysis of 500kW Solar PV System at Mian Mir (MM)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without MML PP and With Sanctioned Load

In Service

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```
                  PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:17
           MIAN MEER SOLAR PV SYSTEM                                   %MVA FOR TRANSFORMERS
                                                                       % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 MIAN MEER MV11.000    4 1.0000    0.0     1.9     0.0     0.0 -------------------------------------------------------
---------------------
                              1 11.000            0.9R    0.0     0.0  41001 BLOCK 1      11.000    4  1      0.6     0.3
7    10
                                                                        41005 BLOCK 2      11.000    4  1      0.6     0.3
7    10
                                                                        41009 BLOCK 3      11.000    4  1      0.6     0.3
7    10
  41001 BLOCK 1     11.000    4 0.9999   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.998            0.0     0.0     0.0   4100 MIAN MEER MV11.000    4  1     -0.6    -0.3
7    10
                                                                        41002 LV           0.4400    4  1      0.3     0.2
1.000LK          22     2
                                                                        41003 BLOCK 1-A    11.000    4  1      0.3     0.2
4    10
  41002 LV          0.4400    4 0.9949   -0.6     0.0     0.3     0.0 -------------------------------------------------------
---------------------
                              1 0.4378            0.0     0.2     0.0  41001 BLOCK 1      11.000    4  1     -0.3    -0.2
1.000UN          22     2

  41003 BLOCK 1-A   11.000    4 0.9998   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.998            0.0     0.0     0.0  41001 BLOCK 1      11.000    4  1     -0.3    -0.2
4    10
                                                                        41004 LV           0.4400    4  1      0.3     0.2
0.975LK          22     2
  41004 LV          0.4400    4 1.0206   -0.6     0.0     0.3     0.0 -------------------------------------------------------
---------------------
                              1 0.4491            0.0     0.2     0.0  41003 BLOCK 1-A    11.000    4  1     -0.3    -0.2
1.000UN          22     2

  41005 BLOCK 2     11.000    4 0.9997   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.997            0.0     0.0     0.0   4100 MIAN MEER MV11.000    4  1     -0.6    -0.3
     10
                                                                        41006 LV           0.4400    4  1      0.3     0.2
1.000LK          22     2
```

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```
                                                                                  41007 BLOCK 2-A   11.000    4  1      0.3     0.2
4    10
  41006 LV           0.4400   4 0.9948   -0.6      0.0      0.3      0.0 ---------------------------------------------------------
--------------------
                              1 0.4377             0.0      0.2      0.0  41005 BLOCK 2     11.000    4  1     -0.3    -0.2
1.000UN           22      2

  41007 BLOCK 2-A   11.000    4 0.9997   -0.0      0.0      0.0      0.0 ---------------------------------------------------------
--------------------
                              1 10.997             0.0      0.0      0.0  41005 BLOCK 2     11.000    4  1     -0.3    -0.2
4    10
                                                                          41008 LV          0.4400    4  1      0.3     0.2
0.988LK           22      2
  41008 LV           0.4400   4 1.0075   -0.6      0.0      0.3      0.0 ---------------------------------------------------------
--------------------
                              1 0.4433             0.0      0.2      0.0  41007 BLOCK 2-A   11.000    4  1     -0.3    -0.2
1.000UN           22      2

  41009 BLOCK 3     11.000    4 0.9996   -0.0      0.0      0.0      0.0 ---------------------------------------------------------
--------------------
                              1 10.996             0.0      0.0      0.0   4100 MIAN MEER MV11.000    4  1     -0.6    -0.3
7    10
                                                                          410010 LV         0.4400    4  1      0.3     0.2
1.000LK           22      2
                                                                          410011 BLOCK 3-A  11.000    4  1      0.3     0.1
3    10
 410010 LV           0.4400   4 0.9946   -0.6      0.0      0.3      0.0 ---------------------------------------------------------
--------------------
                              1 0.4376             0.0      0.2      0.0  41009 BLOCK 3     11.000    4  1     -0.3    -0.2
1.000UN           22      2

 410011 BLOCK 3-A   11.000    4 0.9994   -0.0      0.0      0.0      0.0 ---------------------------------------------------------
--------------------
                              1 10.993             0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1     -0.3    -0.2
4    10
                                                                          410012 LV         0.4400    4  1      0.3     0.2
0.988LK           12      3
 410012 LV           0.4400   4 1.0089   -0.4      0.0      0.3      0.0 ---------------------------------------------------------
--------------------
                              1 0.4439             0.0      0.2      0.0 410011 BLOCK 3-A   11.000    4  1     -0.3    -0.2
1.000UN           12      3
```

Annexure-C-2

With MML PP and With Sanctioned

Load In Service

NRTC ENERGIES (PVT) LTD
NRTC

```
                 PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E      SAT, FEB 15 2025  17:18
           MIAN MEER SOLAR PV SYSTEM                                   %MVA FOR TRANSFORMERS
                                                                       % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN     LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 MIAN MEER MV11.000    4 1.0000    0.0     1.5      0.0     0.0 ------------------------------------------------------
--------------------
                              1 11.000            0.8R     0.0     0.0  41001 BLOCK 1      11.000    4  1      0.6     0.3
7    10
                                                                        41005 BLOCK 2      11.000    4  1      0.6     0.3
7    10
                                                                        41009 BLOCK 3      11.000    4  1      0.6     0.3
7    10
                                                                       410013 SOLAR MV     11.000    4  1     -0.4    -0.1
4    10
  41001 BLOCK 1      11.000    4 0.9999   -0.0     0.0      0.0     0.0 ------------------------------------------------------
--------------------
                              1 10.998            0.0      0.0     0.0   4100 MIAN MEER MV11.000    4  1     -0.6    -0.3
7    10
                                                                        41002 LV            0.4400   4  1      0.3     0.2
1.000LK         22     2
                                                                        41003 BLOCK 1-A    11.000    4  1      0.3     0.2
4    10
  41002 LV            0.4400   4 0.9949   -0.6     0.0      0.3     0.0 ------------------------------------------------------
--------------------
                              1 0.4378            0.0      0.2     0.0  41001 BLOCK 1      11.000    4  1     -0.3    -0.2
1.000UN         22     2

  41003 BLOCK 1-A    11.000    4 0.9998   -0.0     0.0      0.0     0.0 ------------------------------------------------------
--------------------
                              1 10.998            0.0      0.0     0.0  41001 BLOCK 1      11.000    4  1     -0.3    -0.2
4    10
                                                                        41004 LV            0.4400   4  1      0.3     0.2
0.975LK         22     2
  41004 LV            0.4400   4 1.0206   -0.6     0.0      0.3     0.0 ------------------------------------------------------
--------------------
                              1 0.4491            0.0      0.2     0.0  41003 BLOCK 1-A    11.000    4  1     -0.3    -0.2
1.000UN         22     2

  41005 BLOCK 2      11.000    4 0.9997   -0.0     0.0      0.0     0.0 ------------------------------------------------------
--------------------
                              1 10.997            0.0      0.0     0.0   4100 MIAN MEER MV11.000    4  1     -0.6    -0.3
7    10
```

```
                                                                    41006 LV          0.4400   4  1    0.3    0.2
1.000LK        22    2
                                                                    41007 BLOCK 2-A   11.000   4  1    0.3    0.2
4    10
 41006 LV         0.4400   4 0.9948  -0.6    0.0    0.3    0.0 ----------------------------------------------------------
---------------------
                           1 0.4377          0.0    0.2    0.0  41005 BLOCK 2     11.000   4  1   -0.3   -0.2
1.000UN        22    2

 41007 BLOCK 2-A  11.000   4 0.9997  -0.0    0.0    0.0    0.0 ----------------------------------------------------------
---------------------
                           1 10.997          0.0    0.0    0.0  41005 BLOCK 2     11.000   4  1   -0.3   -0.2
4    10
                                                                41008 LV          0.4400   4  1    0.3    0.2
0.988LK        22    2
 41008 LV         0.4400   4 1.0075  -0.6    0.0    0.3    0.0 ----------------------------------------------------------
---------------------
                           1 0.4433          0.0    0.2    0.0  41007 BLOCK 2-A   11.000   4  1   -0.3   -0.2
1.000UN        22    2

 41009 BLOCK 3    11.000   4 0.9996  -0.0    0.0    0.0    0.0 ----------------------------------------------------------
---------------------
                           1 10.996          0.0    0.0    0.0   4100 MIAN MEER MV11.000   4  1   -0.6   -0.3
7    10
                                                               410010 LV          0.4400   4  1    0.3    0.2
1.000LK        22    2
                                                               410011 BLOCK 3-A   11.000   4  1    0.3    0.1
3    10
410010 LV         0.4400   4 0.9946  -0.6    0.0    0.3    0.0 ----------------------------------------------------------
---------------------
                           1 0.4376          0.0    0.2    0.0  41009 BLOCK 3     11.000   4  1   -0.3   -0.2
1.000UN        22    2

410011 BLOCK 3-A  11.000   4 0.9994  -0.0    0.0    0.0    0.0 ----------------------------------------------------------
---------------------
                           1 10.993          0.0    0.0    0.0  41009 BLOCK 3     11.000   4  1   -0.3   -0.2
4    10
                                                               410012 LV          0.4400   4  1    0.3    0.2
0.988LK        12    3
410012 LV         0.4400   4 1.0089  -0.4    0.0    0.3    0.0 ----------------------------------------------------------
---------------------
                           1 0.4439          0.0    0.2    0.0 410011 BLOCK 3-A   11.000   4  1   -0.3   -0.2
1.000UN        12    3

410013 SOLAR MV   11.000   4 1.0001   0.0    0.0    0.0    0.0 ----------------------------------------------------------
---------------------
                           1 11.001          0.0    0.0    0.0   4100 MIAN MEER MV11.000   4  1    0.4    0.1
     10
```

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```
                                                                         410014-SOLAR LV    0.8000   4  1     -0.4     -0.1
1.000LK         64     1
 410014 SOLAR LV     0.8000    4 1.0015     0.5     0.4      0.0     0.0 ------------------------------------------------------------
--------------------
                               1 0.8012             0.1R     0.0     0.0 410013 SOLAR MV    11.000   4  1      0.4      0.1
1.000UN         64     1
```

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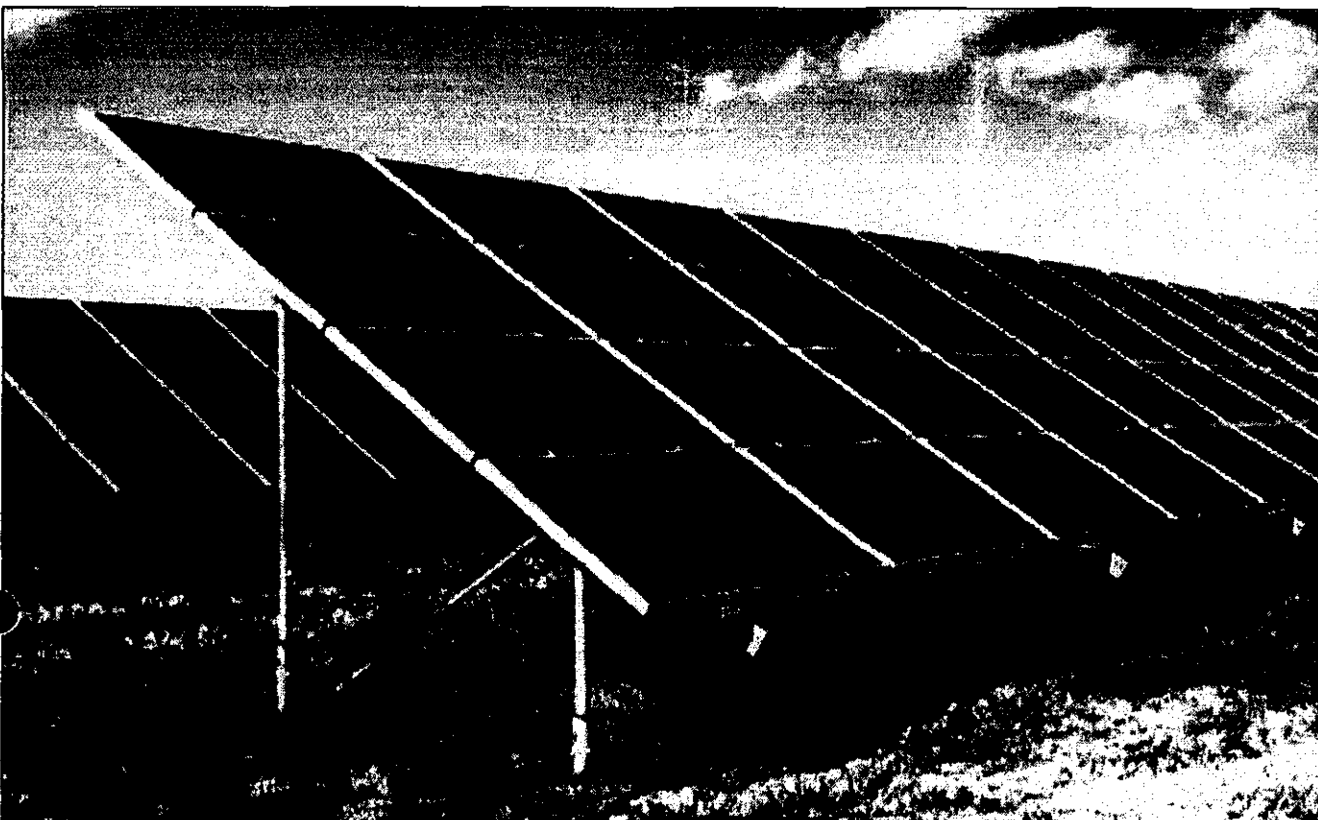

Mehfooz Shaheed Garrison

SYSTEM STUDY ANALYSIS OF MEHFOOZ SHAHEED GARRISON (MSG) 500kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
Tel: +92-300-8827101

CONTENTS

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EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 500kW Solar PV Power Generation project at Mehfooz Shaheed Garrison (MSG) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 500kW Solar PV based system connected with the power network of MSG. The '500kW MSG solar PV Power Generation project' is located at GCWM+2G5, Aziz Bhatti Town, Lahore, Pakistan.

The integration of solar power generation at the MSG premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. MSG currently receives a single point supply from LESCO with a sanctioned load of 2.690MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 2.690MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the MSG premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 500kW MSG solar PV with sanctioned load in service.
- With 500kW MSG solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of MSG. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the MSG distribution system. The power flow results for the system intact shows that the power flows on all the MSG transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for MSG. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with MSG and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 500kW MSG solar PV Power Generation project meets the NEPRA grid code planning criteria.

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1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Mehfooz Shaheed Garrison (MSG) ("Project Owner" or "PO") for the interconnection of a 500kWp Solar PV Power Generation project ("Project") to the MSG power System at 11kV.

The '500kW MSG solar PV Power Generation project' is located at GCWM+2G5, Aziz Bhatti Town, Lahore, Pakistan. Figure 1.1 shows Google site map of the project.

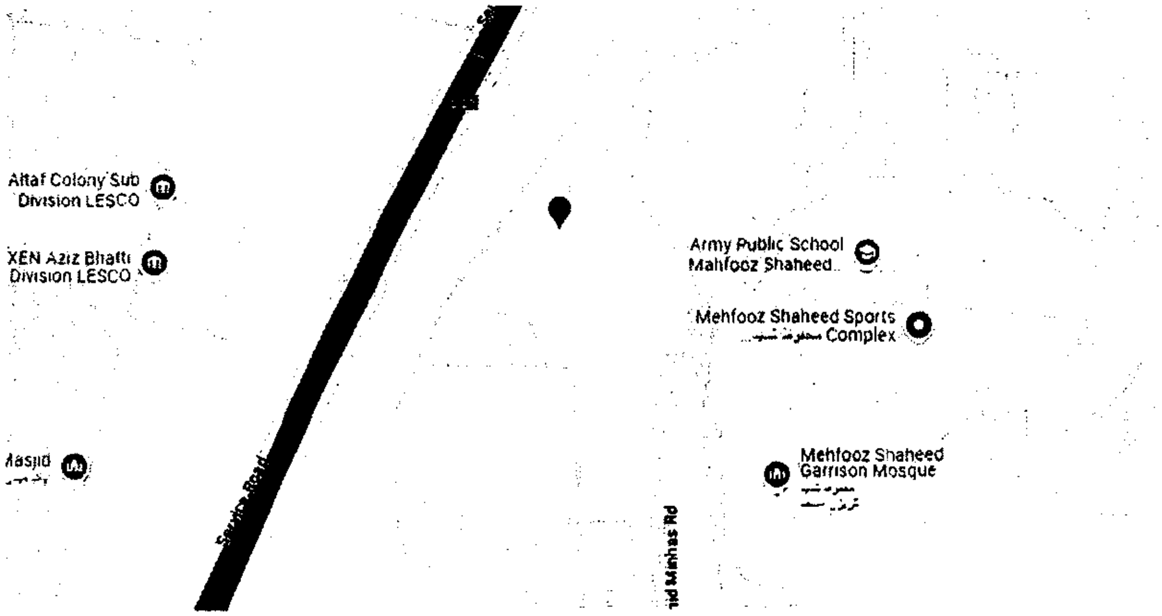

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

MSG aims to integrate solar power generation into its existing electrical infrastructure. MSG currently receives a single-point power supply from LESCO with a sanctioned load of 2.690MW. The entire solar generation within the MSG premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the MSG transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within MSG premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

500kW solar PV system is modelled into the MSG distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling

ii) Steady state analysis

iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 500kW MSG solar PV with sanctioned load in service.
- With 500kW MSG solar PV with sanctioned load in service.

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This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 500kW solar PV system to the distribution system of MSG and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kVand above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within MSG.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

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3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	421
Active Power of each collector Pgen. (kW)	400
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.1315, 0.1315
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	630
% Reactance (X)	5 %
Mehfooz Shaheed Garrison	
Sanctioned Load (LESCO)	2690 kW

Steady state power flow assessment has been performed using the network data of MSG.

3.2 Power Flow Assessment Without MSG PP and with Sanctioned Load In Service

Power flow study without MSG solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

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3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of MSG network. This base case included a detailed representation of the MSG transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the MSG distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with MSG PP

Power flow study of MSG solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 500kW MSG solar project on the MSG distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at MSG solar for peak loading summer (June) 2025 that allow us to judge the impact of MSG solar project on the MSG network.
Project power flow analysis has been performed after the connection of the project with the MSG distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at MSG solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted

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with sanctioned load in service after the interconnection of the Solar project with the MSG distribution system. The power flow results for the system intact shows that the power flows on all the MSG distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without MSG solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with MSG solar and with sanctioned load in service with MSG distribution system. Power flow results showed that the power flows on all the MSG distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 500kW Mehfooz Shaheed Garrison solar PV system with MSG Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

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LIST OF ANNEXURES

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Annexure-A

Project Specific Data

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Annexure-A-1

Project Site Map

NRTC ENERGIES

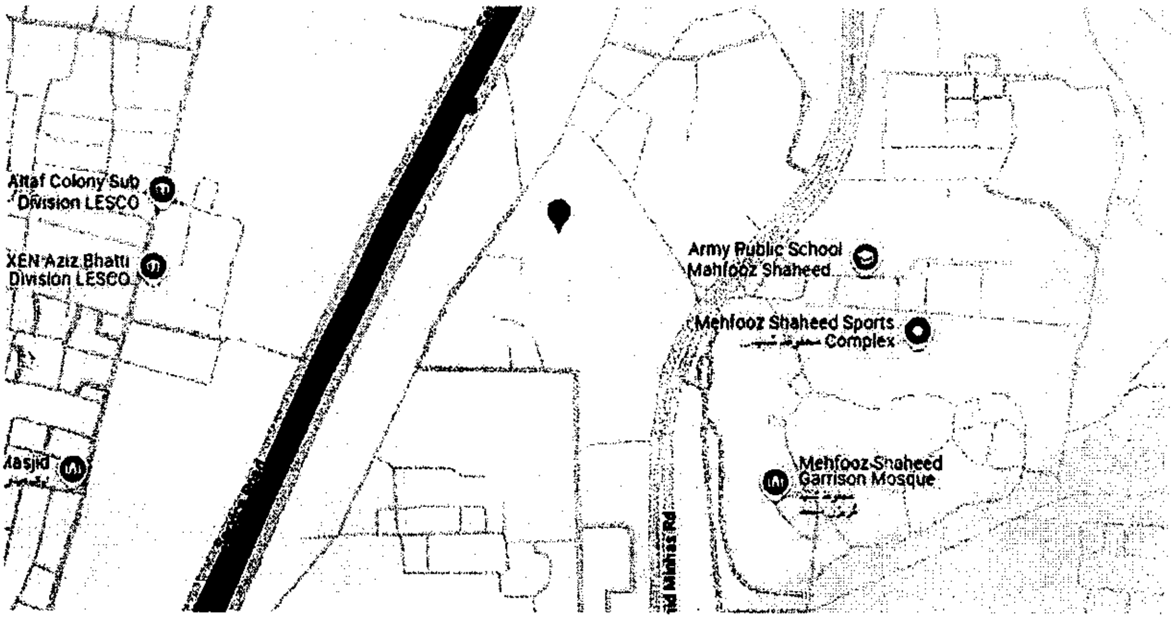

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

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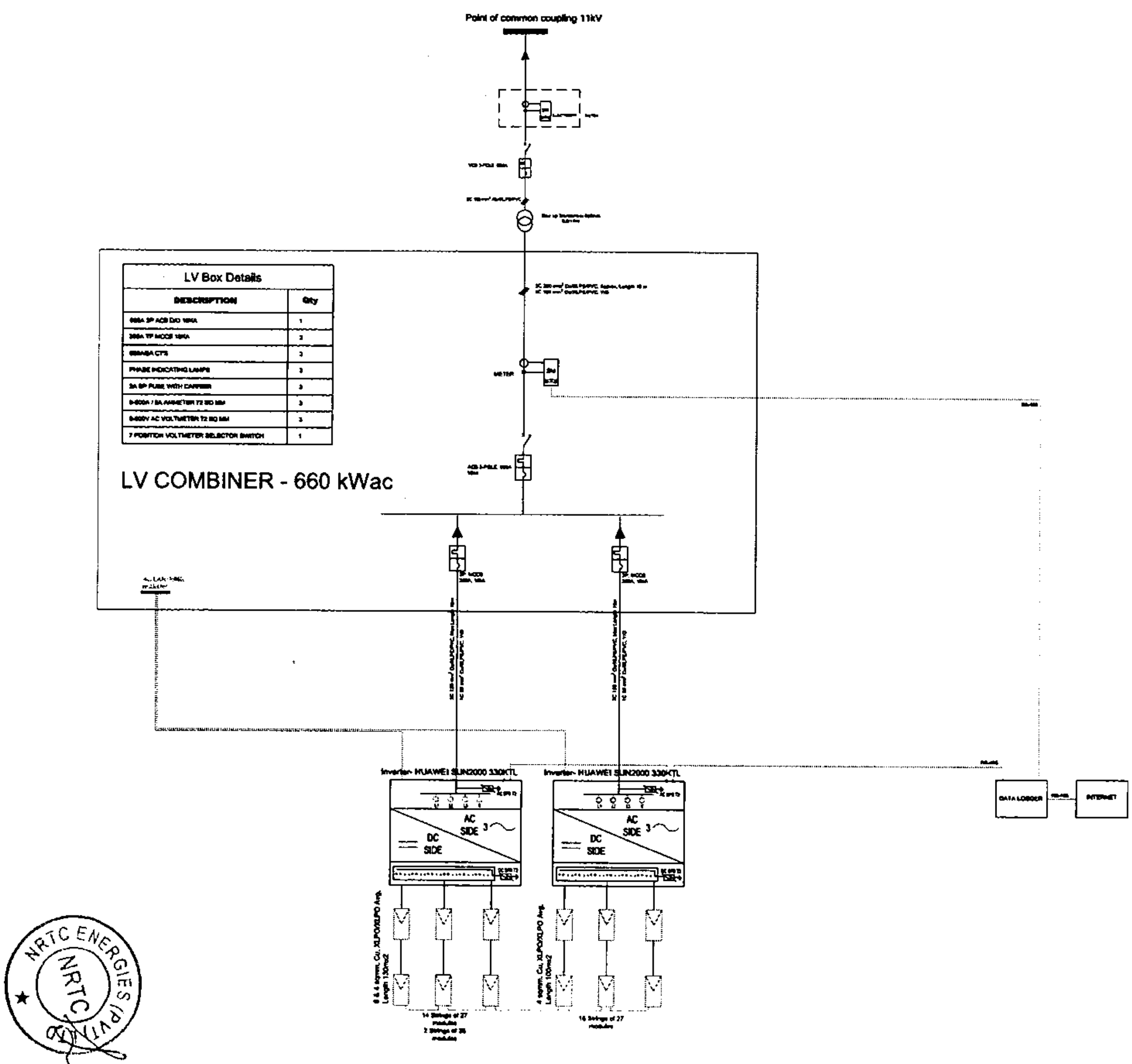
Annexure-A-2

Power Plant Data

Single Line DIAGRAM
Scale N.T.S



LV Box Details	
DESCRIPTION	Qty
800A 3P ACB D/O 18KA	1
300A TP MCCB 18KA	2
800A/5A CT'S	3
PHASE INDICATING LAMPS	3
2A SP FUSE WITH CARRIER	3
0-800A / 5A AMMETER 72 SQ MM	3
0-600V AC VOLTMETER 72 SQ MM	3
7 POSITION VOLTMETER SELECTOR SWITCH	1

SITE LOCATION

Co-ordinates: 31.548410, 74.431333

[redacted]

GENERAL NOTES

1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. KIOSK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Solar PV Module
	Inverter
	ACB, VCB
	Contactor
	Current Transformer
	Voltage Transformer

ARRAY INFORMATION

	Array
Total Installed Capacity	600KW
Total Number of PV Modules	862
No. of Modules in Series (Hybrid)	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	2
Total AC Power	660kW
Total Area utilized	67784 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	26°
Azimuth	0° ± 3
Pitch of Structure	26.5 ft

PROJECT :
MES Solarization P-III
MSG - Lahore
Co-ordinates: 31.548410, 74.431333

CLIENT :
Military Engineering Services

DEVELOPER :
NRTC Energies
Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate Lahore || Tel: 042 35117304

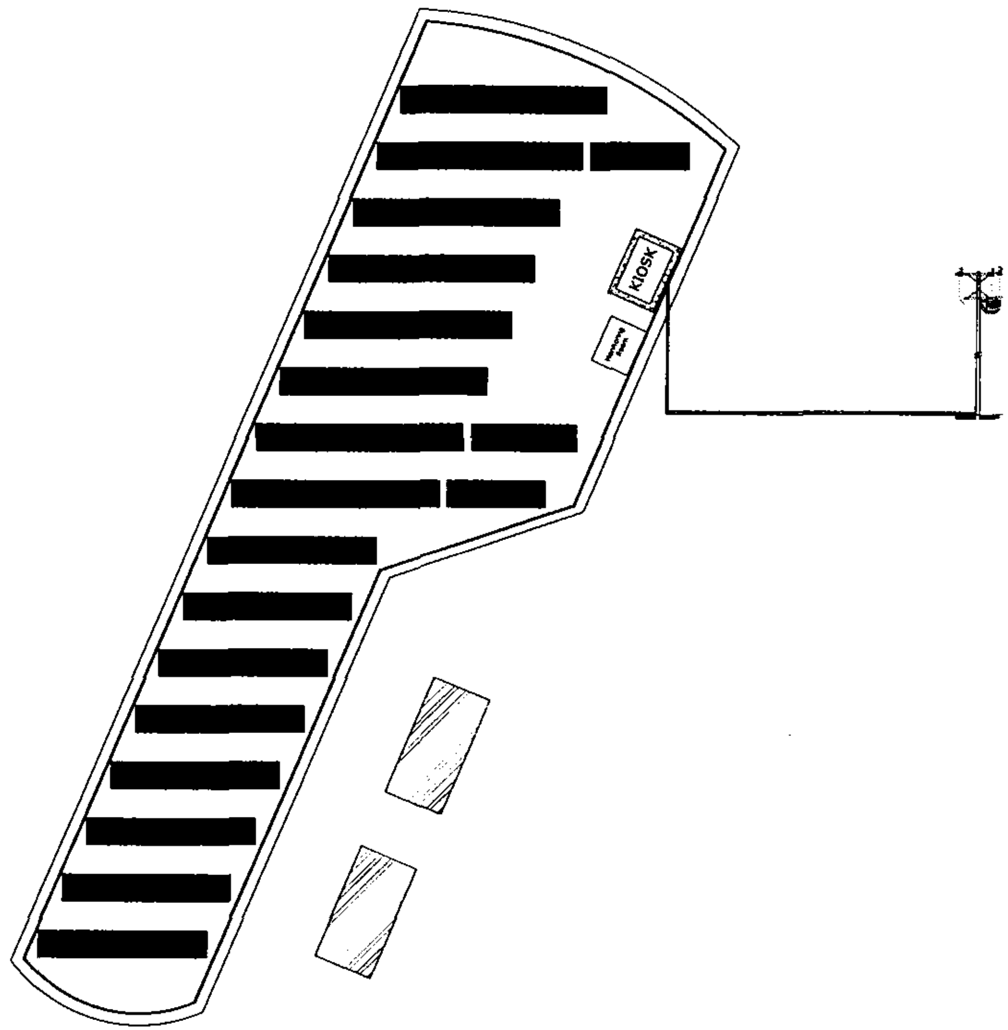
REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING : **SINGLE LINE DIAGRAM**

SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

PV Placement DIAGRAM

Scale N.T.S



NRTC ENERGIES (PVT) LTD

NRTC

SITE LOCATION

Co-ordinates: 31.548410, 74.431333

[redacted]

GENERAL NOTES

1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. KIOSK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may very from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Ground mounted
	P2 Piling Structure

ARRAY INFORMATION

	Array
Total Installed Capacity	500KW
Total Number of PV Modules	882
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	2
Total AC Power	660kW
Total Area utilized	62754 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	28°
Azimuth	0° ± 3
Pitch of Structure	28.5 ft

PROJECT :

MES Solarization P-III

MSG - Lahore

Co-ordinates: 31.548410, 74.431333

CLIENT :

Military Engineering Services

DEVELOPER :

NRTC Energies

Block 72 Maulana Shaukat Ali Rd. Quaid-e-Azam Industrial Estate Lahore || Tel: 042 35117304

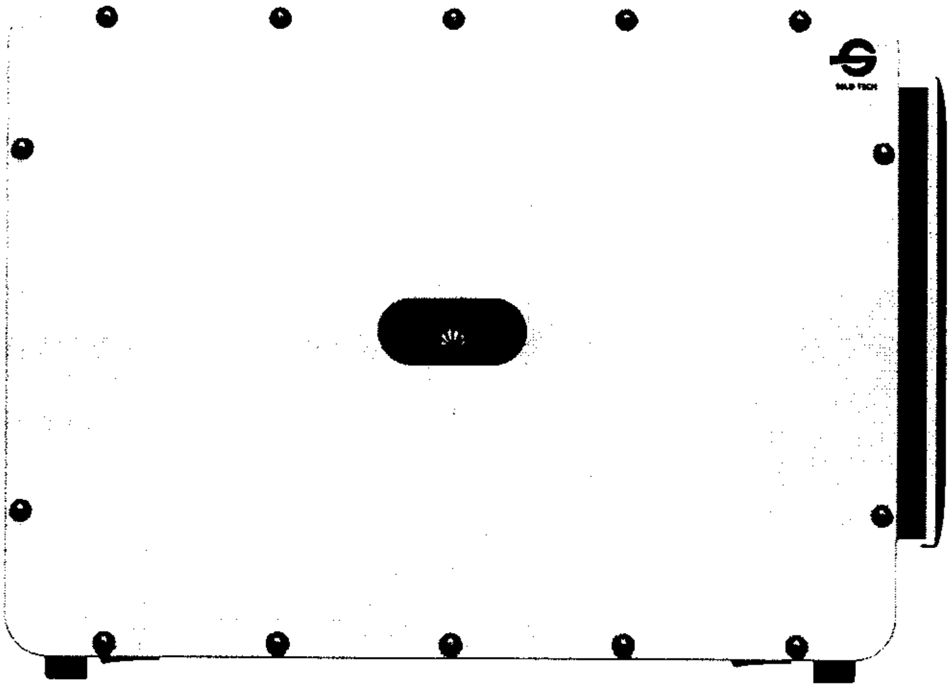
REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

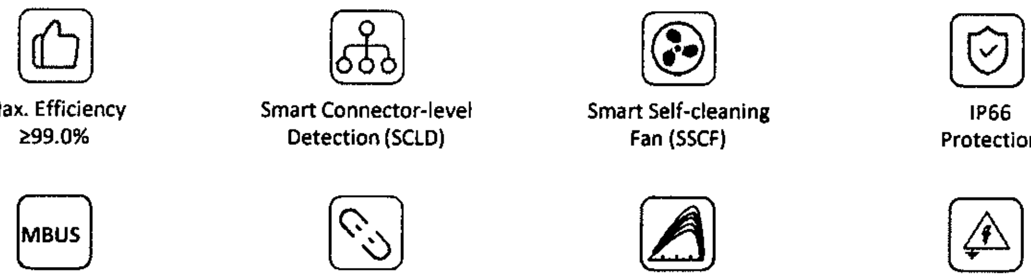
DRAWING :

SINGLE LINE DIAGRAM

SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

SUN2000-330KTL-H1
Smart String Inverter





Max. Efficiency
≥99.0%

Smart Connector-level
Detection (SCLD)

Smart Self-cleaning
Fan (SSCF)

IP66
Protection

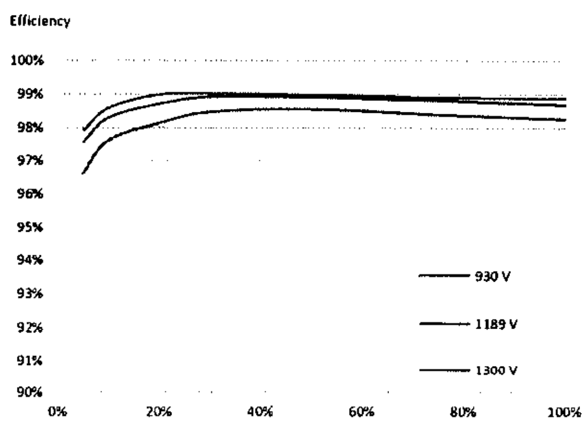
MBUS
Supported

Smart String-level
Disconnection (SSLD)

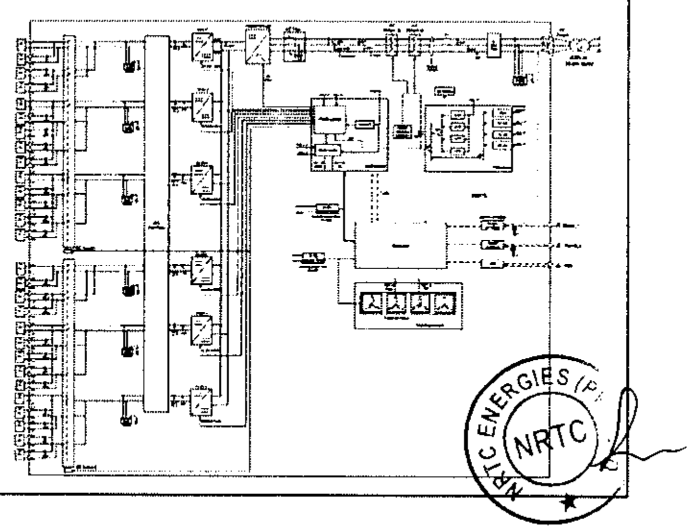
Smart IV Curve Diagnosis
Supported

Surge Arresters for
DC & AC

Efficiency Curve



Circuit Diagram



SUN2000-330KTL-H1

Technical Specifications

Efficiency

Max. Efficiency	≥99.0%
European Efficiency	≥98.8%

Input

Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V

Output

Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosϕ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%

Protection

Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes

Communication

Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes

General

Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 ℃ ~ 60 ℃
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

NRTC ENERGIES (PVT) LTD

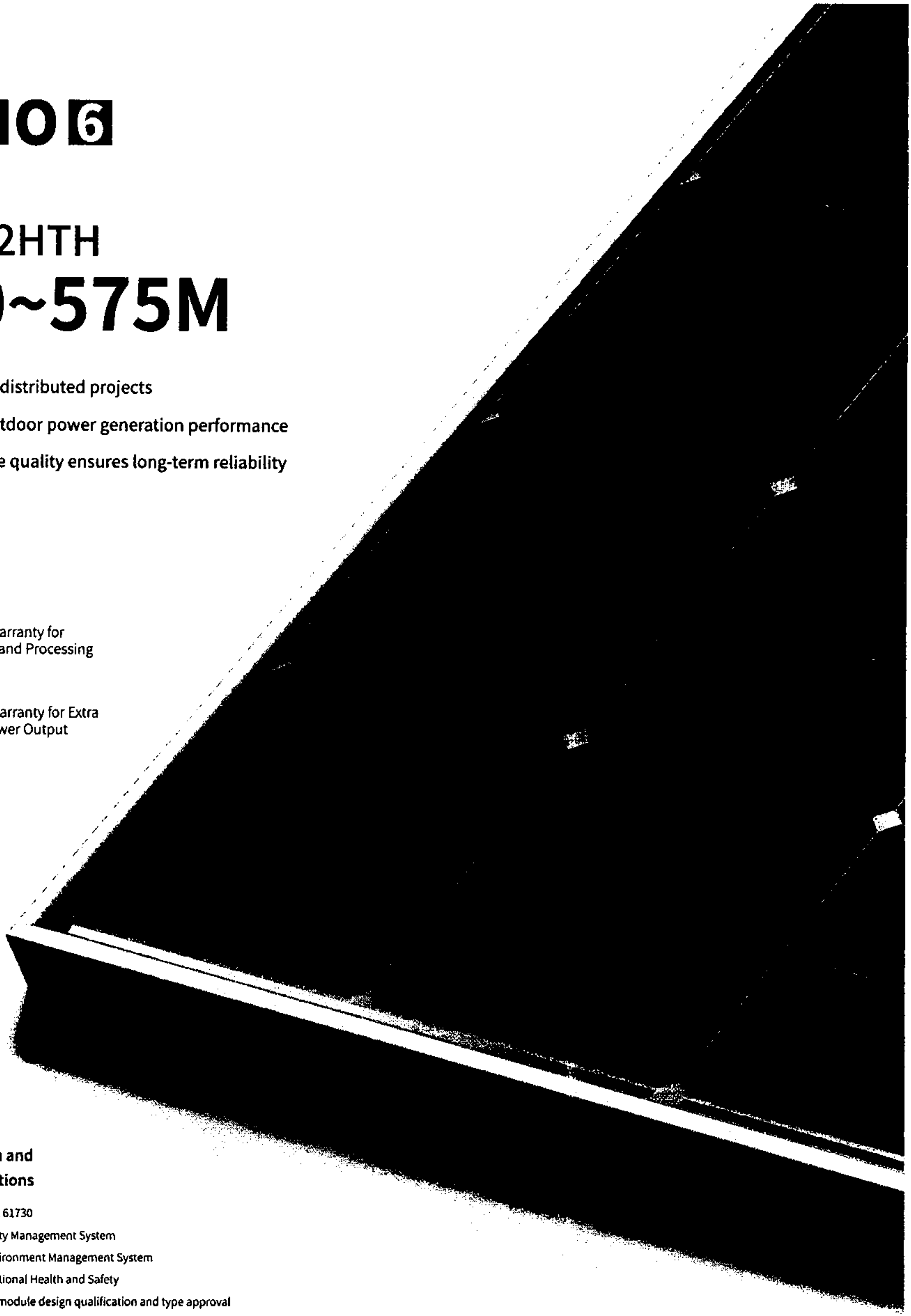
Hi-MO 6
Explorer

LR5-72HTH
560~575M

- Suitable for distributed projects
- Excellent outdoor power generation performance
- High module quality ensures long-term reliability

15-year Warranty for Materials and Processing

25-year Warranty for Extra Linear Power Output



Complete System and Product Certifications

IEC 61215, IEC 61730, UL 61730
ISO9001:2015: ISO Quality Management System
ISO14001: 2015: ISO Environment Management System
ISO45001: 2018: Occupational Health and Safety
IEC62941: Guideline for module design qualification and type approval

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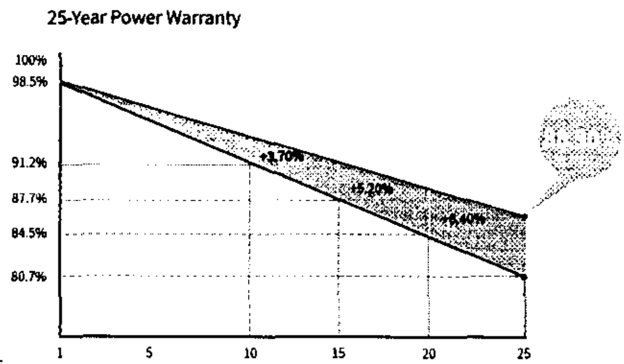
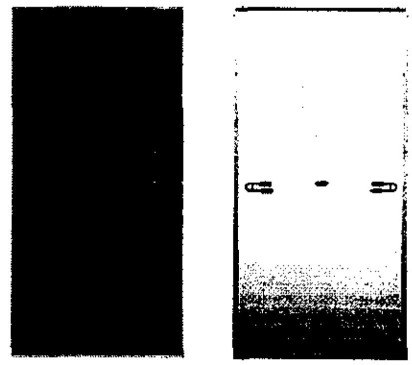
Hi-MO 6

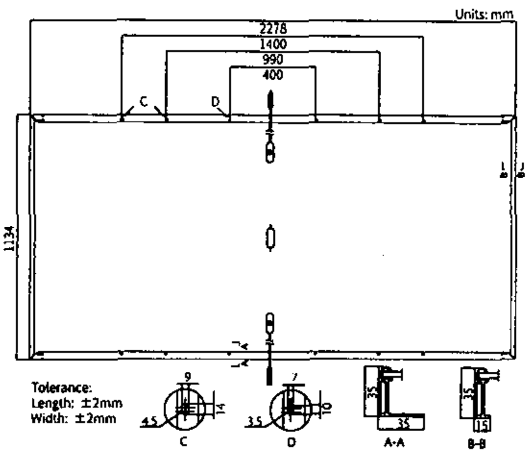
LR5-72HTH 560~575M

22.3%	0~3%	<1.5%	0.40%

Additional Value







Mechanical Parameters

Cell Orientation	144 (6×24)
Junction Box	IP68, three diodes
Output Cable	4mm², +400, -200mm/±1400mm length can be customized
Glass	Single glass, 3.2mm coated tempered glass
Frame	Anodized aluminum alloy frame
Weight	27.5kg
Dimension	2278×1134×35mm
Packaging	31pcs per pallet / 155pcs per 20' GP / 620pcs per 40' HC

Electrical Characteristics STC : AM1.5 1000W/m² 25°C NOCT : AM1.5 800W/m² 20°C 1m/s Test uncertainty for Pmax: ±3%

Module Type	LR5-72HTH-560M		LR5-72HTH-565M		LR5-72HTH-570M		LR5-72HTH-575M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	560	418	565	422	570	426	575	430
Open Circuit Voltage (Voc/V)	51.61	48.46	51.76	48.60	51.91	48.74	52.06	48.88
Short Circuit Current (Isc/A)	13.94	11.26	14.01	11.31	14.07	11.36	14.14	11.42
Voltage at Maximum Power (Vmp/V)	43.46	39.66	43.61	39.79	43.76	39.93	43.91	40.07
Current at Maximum Power (Imp/A)	12.89	10.55	12.96	10.61	13.03	10.67	13.10	10.72
Module Efficiency(%)	21.7		21.9		22.1		22.3	

Operating Parameters

Operational Temperature	-40°C ~ +85°C
Power Output Tolerance	0 ~ 3%
Voc and Isc Tolerance	±3%
Maximum System Voltage	DC1500V (IEC/UL)
Maximum Series Fuse Rating	25A
Nominal Operating Cell Temperature	45±2°C
Protection Class	Class II
Fire Rating	UL type 1 or 2 IEC Class C

Mechanical Loading

Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

Temperature Ratings (STC)

Temperature Coefficient of Isc	+0.050%/°C
Temperature Coefficient of Voc	-0.230%/°C
Temperature Coefficient of Pmax	-0.290%/°C

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No.8369 Shangyuan Road, Xi'an Economic And Technological Development Zone, Xi'an, Shaanxi, China.
Web: www.longi.com

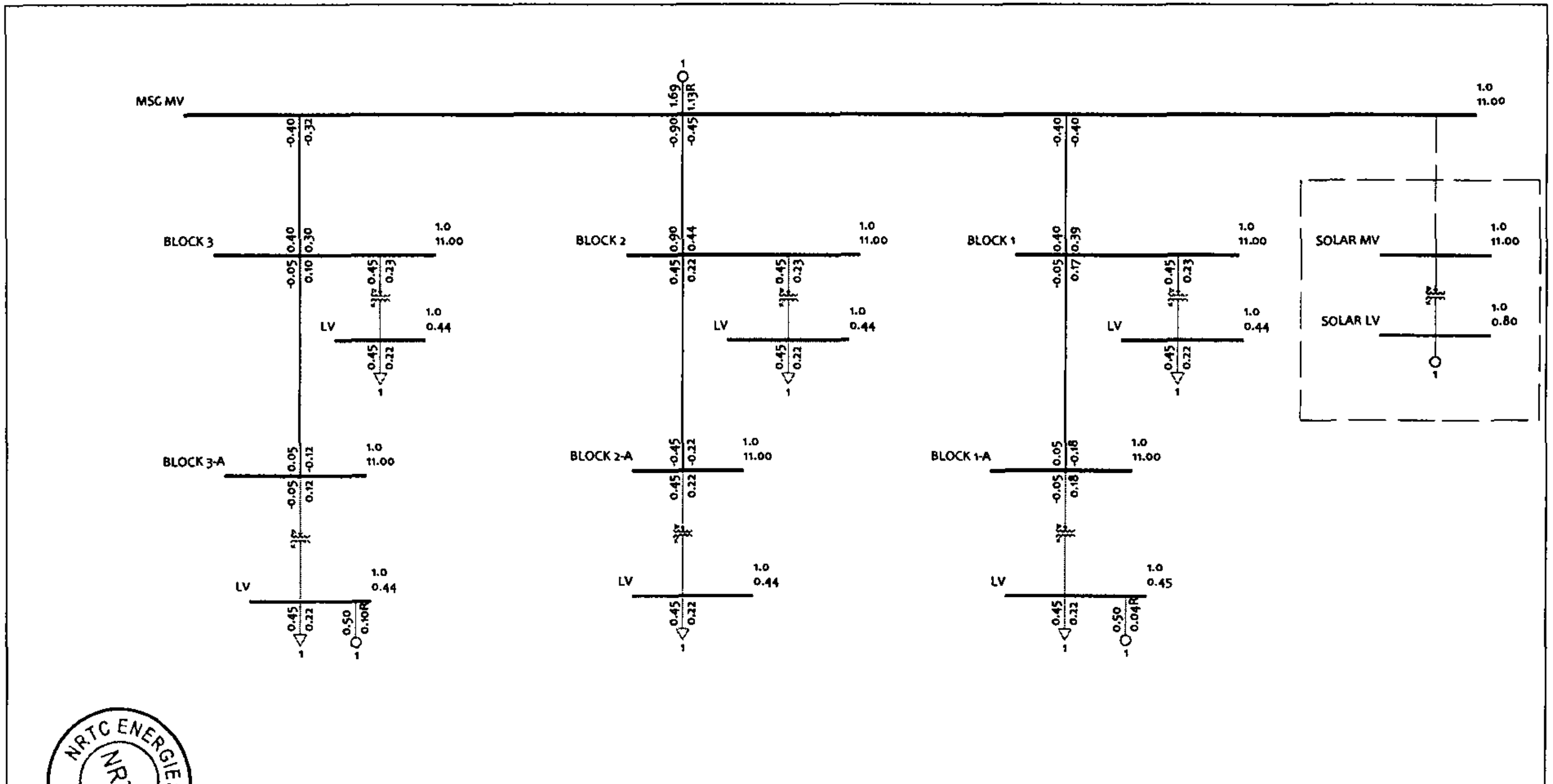
Annexure-B

Steady State Analysis Results

Load Flow Analysis of 500kW Solar PV System at Mehfooz Shaheed Garrison (MSG)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

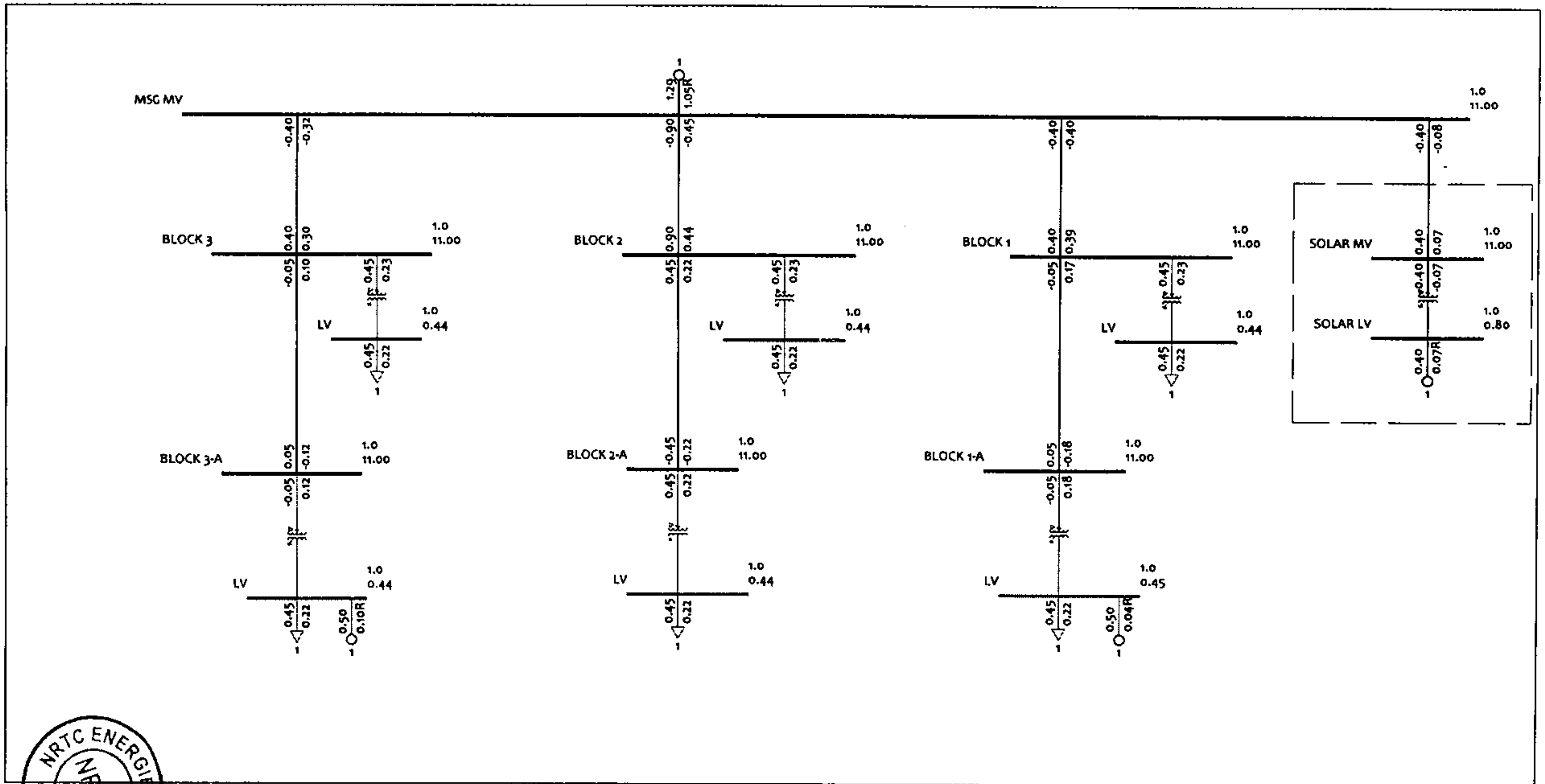
Figure: B-1



Load Flow Analysis of 500kW Solar PV System at Mehfooz Shaheed Garison (MSG)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without MSG PP and With Sanctioned Load

In Service

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```
                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:20
              MSG SOLAR PV SYSTEM                                         %MVA FOR TRANSFORMERS
                                                                          % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR  BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 MSG MV      11.000    4 1.0000   0.0    1.7     0.0     0.0 --------------------------------------------------------
---------------------
                          1 11.000            1.1R    0.0     0.0  41001 BLOCK 1     11.000    4  1     0.4     0.4
6    10
                                                                   41005 BLOCK 2     11.000    4  1     0.9     0.4
10    10
                                                                   41009 BLOCK 3     11.000    4  1     0.4     0.3
5    10
  41001 BLOCK 1     11.000    4 0.9999  -0.0    0.0     0.0     0.0 --------------------------------------------------------
---------------------
                          1 10.998            0.0     0.0     0.0   4100 MSG MV      11.000    4  1    -0.4    -0.4
6    10
                                                                   41002 LV          0.4400    4  1     0.4     0.2
1.000LK          31      2
                                                                   41003 BLOCK 1-A   11.000    4  1    -0.1     0.2
2    10
  41002 LV          0.4400    4 0.9929  -0.8    0.0     0.4     0.0 --------------------------------------------------------
---------------------
                          1 0.4369            0.0     0.2     0.0  41001 BLOCK 1     11.000    4  1    -0.4    -0.2
1.000UN          31      2

  41003 BLOCK 1-A   11.000    4 0.9998  -0.0    0.0     0.0     0.0 --------------------------------------------------------
---------------------
                          1 10.998            0.0     0.0     0.0  41001 BLOCK 1     11.000    4  1     0.1    -0.2
2    10
                                                                   41004 LV          0.4400    4  1    -0.1     0.2
0.975LK          12      2
  41004 LV          0.4400    4 1.0199   0.1    0.5     0.4     0.0 --------------------------------------------------------
---------------------
                          1 0.4488            0.0R    0.2     0.0  41003 BLOCK 1-A   11.000    4  1     0.1    -0.2
1.000UN          12      2

  41005 BLOCK 2     11.000    4 0.9996  -0.0    0.0     0.0     0.0 --------------------------------------------------------
---------------------
                          1 10.996            0.0     0.0     0.0   4100 MSG MV      11.000    4  1    -0.9    -0.5
10    10
                                                                   41006 LV          0.4400    4  1     0.4     0.2
1.000LK          31      2
```

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```
                                                                                        41007 BLOCK 2-A   11.000    4  1      0.4      0.2
5    10
 41006 LV          0.4400   4 0.9926   -0.8      0.0      0.4      0.0 ----------------------------------------------------------
---------------------
                            1 0.4367             0.0      0.2      0.0  41005 BLOCK 2     11.000    4  1     -0.4     -0.2
1.000UN          31     2

 41007 BLOCK 2-A   11.000   4 0.9996   -0.0      0.0      0.0      0.0 ----------------------------------------------------------
---------------------
                            1 10.996             0.0      0.0      0.0  41005 BLOCK 2     11.000    4  1     -0.4     -0.2
5    10
                                                                        41008 LV          0.4400    4  1      0.4      0.2
0.988LK          31     2
 41008 LV          0.4400   4 1.0053   -0.8      0.0      0.4      0.0 ----------------------------------------------------------
---------------------
                            1 0.4424             0.0      0.2      0.0  41007 BLOCK 2-A   11.000    4  1     -0.4     -0.2
1.000UN          31     2

 41009 BLOCK 3     11.000   4 0.9996   -0.0      0.0      0.0      0.0 ----------------------------------------------------------
---------------------
                            1 10.996             0.0      0.0      0.0   4100 MSG MV      11.000    4  1     -0.4     -0.3
5    10
                                                                       410010 LV          0.4400    4  1      0.4      0.2
1.000LK          31     2
                                                                       410011 BLOCK 3-A   11.000    4  1     -0.1      0.1
1    10
 410010 LV         0.4400   4 0.9927   -0.8      0.0      0.4      0.0 ----------------------------------------------------------
---------------------
                            1 0.4368             0.0      0.2      0.0  41009 BLOCK 3     11.000    4  1     -0.4     -0.2
1.000UN          31     2

 410011 BLOCK 3-A  11.000   4 0.9996   -0.0      0.0      0.0      0.0 ----------------------------------------------------------
---------------------
                            1 10.995             0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1      0.1     -0.1
1    10
                                                                       410012 LV          0.4400    4  1     -0.1      0.1
0.988LK           4     3
 410012 LV         0.4400   4 1.0099    0.1      0.5      0.4      0.0 ----------------------------------------------------------
---------------------
                            1 0.4444             0.1R     0.2      0.0 410011 BLOCK 3-A   11.000    4  1      0.1     -0.1
1.000UN           4     3
```

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Annexure-C-2

With MSG PP and With Sanctioned

Load In Service

```
                           PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:22
                     MSG SOLAR PV SYSTEM                                         %MVA FOR TRANSFORMERS
                                                                                 % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR  BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 MSG MV      11.000    4 1.0000   0.0     1.3     0.0     0.0 -------------------------------------------------------
---------------------
                              1 11.000           1.1R    0.0     0.0  41001 BLOCK 1     11.000    4  1      0.4     0.4
6    10
                                                                      41005 BLOCK 2     11.000    4  1      0.9     0.4
10    10
                                                                      41009 BLOCK 3     11.000    4  1      0.4     0.3
5    10
                                                                     410013 SOLAR MV    11.000    4  1     -0.4    -0.1
4    10
  41001 BLOCK 1     11.000    4 0.9999  -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.998           0.0     0.0     0.0   4100 MSG MV      11.000    4  1     -0.4    -0.4
6    10
                                                                      41002 LV          0.4400    4  1      0.4     0.2
1.000LK          31     2
                                                                      41003 BLOCK 1-A   11.000    4  1     -0.1     0.2
2    10
  41002 LV          0.4400    4 0.9929  -0.8     0.0     0.4     0.0 -------------------------------------------------------
---------------------
                              1 0.4369           0.0     0.2     0.0  41001 BLOCK 1     11.000    4  1     -0.4    -0.2
1.000UN          31     2

  41003 BLOCK 1-A   11.000    4 0.9998  -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.998           0.0     0.0     0.0  41001 BLOCK 1     11.000    4  1      0.1    -0.2
2    10
                                                                      41004 LV          0.4400    4  1     -0.1     0.2
0.975LK          12     2
  41004 LV          0.4400    4 1.0199   0.1     0.5     0.4     0.0 -------------------------------------------------------
---------------------
                              1 0.4488           0.0R    0.2     0.0  41003 BLOCK 1-A   11.000    4  1      0.1    -0.2
1.000UN          12     2

  41005 BLOCK 2     11.000    4 0.9996  -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                              1 10.996           0.0     0.0     0.0   4100 MSG MV      11.000    4  1     -0.9    -0.5
10    10
```

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41006 LV 0.4400 4 1 0.4 0.2

1.000LK 31 2

41007 BLOCK 2-A 11.000 4 1 0.4 0.2

5 10

41006 LV 0.4400 4 0.9926 -0.8 0.0 0.4 0.0 --

----

1 0.4367 0.0 0.2 0.0 41005 BLOCK 2 11.000 4 1 -0.4 -0.2

1.000UN 31 2

41007 BLOCK 2-A 11.000 4 0.9996 -0.0 0.0 0.0 0.0 --

----

1 10.996 0.0 0.0 0.0 41005 BLOCK 2 11.000 4 1 -0.4 -0.2

5 10

41008 LV 0.4400 4 1 0.4 0.2

0.988LK 31 2

41008 LV 0.4400 4 1.0053 -0.8 0.0 0.4 0.0 --

----

1 0.4424 0.0 0.2 0.0 41007 BLOCK 2-A 11.000 4 1 -0.4 -0.2

1.000UN 31 2

41009 BLOCK 3 11.000 4 0.9996 -0.0 0.0 0.0 0.0 --

----

1 10.996 0.0 0.0 0.0 4100 MSG MV 11.000 4 1 -0.4 -0.3

5 10

410010 LV 0.4400 4 1 0.4 0.2

1.000LK 31 2

410011 BLOCK 3-A 11.000 4 1 -0.1 0.1

1 10

410010 LV 0.4400 4 0.9927 -0.8 0.0 0.4 0.0 --

----

1 0.4368 0.0 0.2 0.0 41009 BLOCK 3 11.000 4 1 -0.4 -0.2

1.000UN 31 2

410011 BLOCK 3-A 11.000 4 0.9996 -0.0 0.0 0.0 0.0 --

----

1 10.995 0.0 0.0 0.0 41009 BLOCK 3 11.000 4 1 0.1 -0.1

1 10

410012 LV 0.4400 4 1 -0.1 0.1

0.988LK 4 3

410012 LV 0.4400 4 1.0099 0.1 0.5 0.4 0.0 --

----

1 0.4444 0.1R 0.2 0.0 410011 BLOCK 3-A 11.000 4 1 0.1 -0.1

1.000UN 4 3

410013 SOLAR MV 11.000 4 1.0001 0.0 0.0 0.0 0.0 --

----

1 11.001 0.0 0.0 0.0 4100 MSG MV 11.000 4 1 0.4 0.1

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4 10

410014 SOLAR LV 0.8000 4 1 -0.4 -0.1

1.000LK 64 1

410014 SOLAR LV 0.8000 4 1.0015 0.5 0.4 0.0 0.0 ---

----

1 0.8012 0.1R 0.0 0.0 410013 SOLAR MV 11.000 4 1 0.4 0.1

1.000UN 64 1

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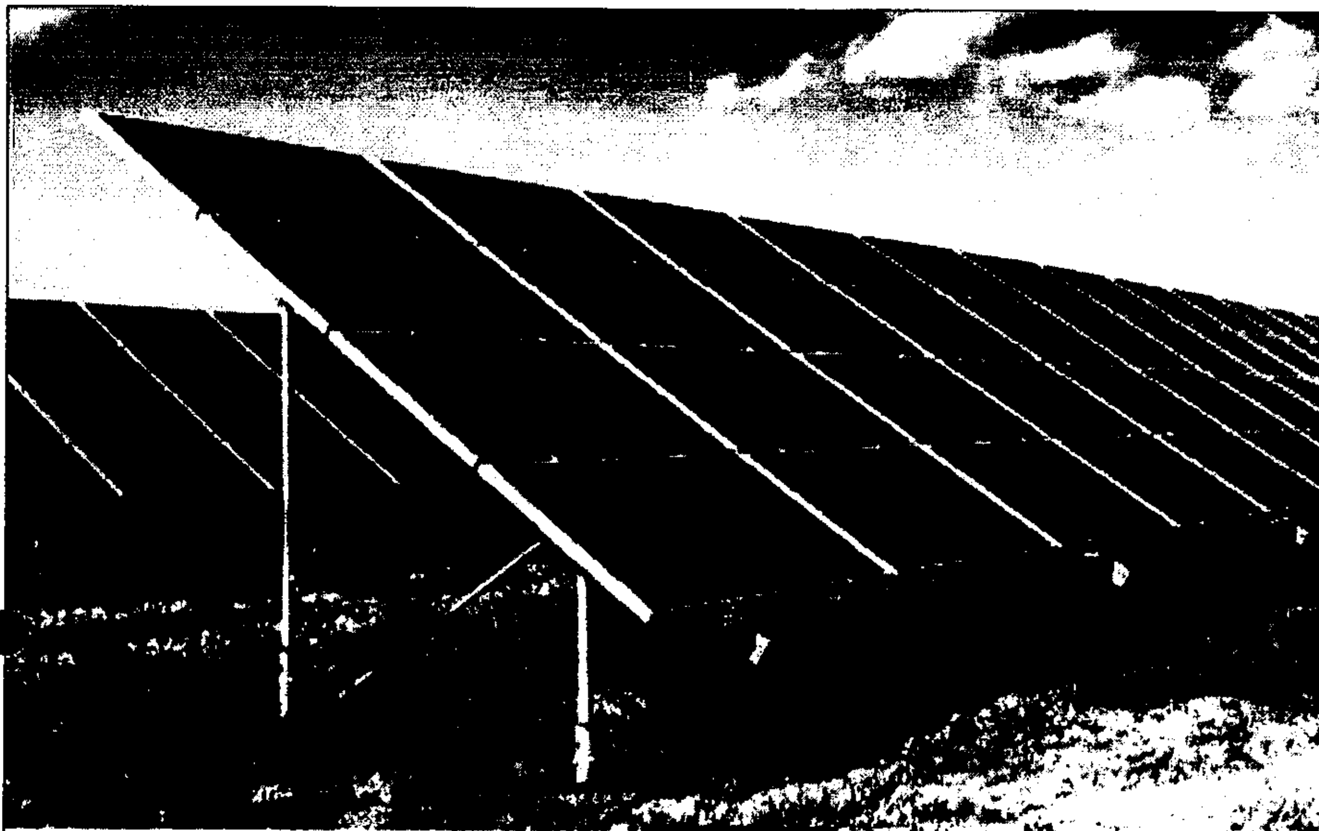

Okara Cantt

SYSTEM STUDY ANALYSIS OF OKARA CANTT (OC) 999kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
Tel: +92-300-8827101

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CONTENTS

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EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 999kW Solar PV Power Generation project at Okara Cantt (OC) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 999kW Solar PV based system connected with the power network of OC. The '999kW OC solar PV Power Generation project' is located at Q943+J56, Okara Cantonment, Okara, Pakistan.

The integration of solar power generation at the Okara Cantt premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. Okara Cantt currently receives a single point supply from LESCO with a sanctioned load of 4.5MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 4.5MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the Okara Cantt premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 999kW Okara Cantt solar PV with sanctioned load in service.
- With 999kW Okara Cantt solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of Okara Cantt. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the Okara Cantt distribution system. The power flow results for the system intact shows that the power flows on all the Okara Cantt transmission and distribution

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line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for Okara Cantt. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with Okara Cantt and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 999kW Okara Cantt solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Okara Cantt (OC) ("Project Owner" or "PO") for the interconnection of a 999kWp Solar PV Power Generation project ("Project") to the OC power System at 11kV.

The '999kW Okara Cantt solar PV Power Generation project' is located at Q943+J56, Okara Cantonment, Okara, Pakistan. Figure 1.1 shows Google site map of the project.

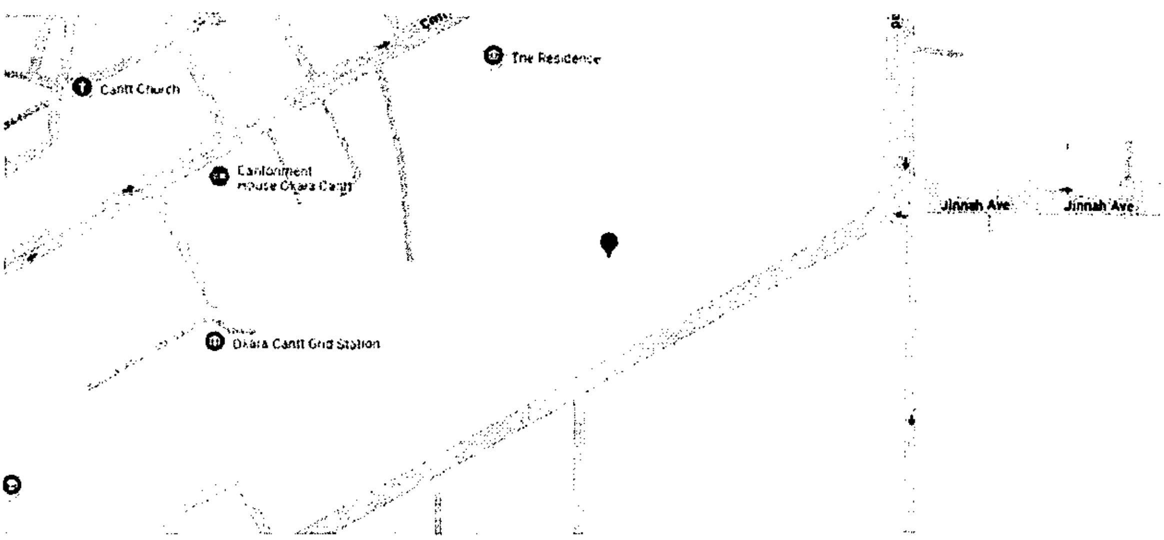

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

Okara Cantt aims to integrate solar power generation into its existing electrical infrastructure. Okara Cantt currently receives a single-point power supply from LESCO with a sanctioned load of 4.5MW. The entire solar generation within the Okara Cantt premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the Okara Cantt transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within Okara Cantt premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

999kW solar PV system is modelled into the Okara Cantt distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling
ii) Steady state analysis
iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 999kW Okara Cantt solar PV with sanctioned load in service.
- With 999kW Okara Cantt solar PV with sanctioned load in service.

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This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 999kW solar PV system to the distribution system of Okara Cantt and vice versa.

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2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kVand above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within Okara Cantt.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

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2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	841
Active Power of each collector Pgen. (kW)	799
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.2626, 0.2626
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	1250
% Reactance (X)	5 %
Okara Cantt	
Sanctioned Load (LESCO)	4500 kW

Steady state power flow assessment has been performed using the network data of OC.

3.2 Power Flow Assessment Without Okara Cantt PP and with Sanctioned Load In Service

Power flow study without Okara Cantt solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

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3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of Okara Cantt network. This base case included a detailed representation of the Okara Cantt transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the Okara Cantt distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with Okara Cantt PP

Power flow study of Okara Cantt solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 999kW Okara Cantt solar project on the Okara Cantt distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at Okara Cantt solar for peak loading summer (June) 2025 that allow us to judge the impact of Okara Cantt solar project on the Okara Cantt network.

Project power flow analysis has been performed after the connection of the project with the Okara Cantt distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at Okara Cantt solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.

Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

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3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the Okara Cantt distribution system. The power flow results for the system intact shows that the power flows on all the Okara Cantt distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

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4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without Okara Cantt solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with Okara Cantt solar and with sanctioned load in service with Okara Cantt distribution system. Power flow results showed that the power flows on all the Okara Cantt distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 999kW Okara Cantt solar PV system with Okara Cantt Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

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LIST OF ANNEXURES

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Annexure-A

Project Specific Data

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Annexure-A-1

Project Site Map

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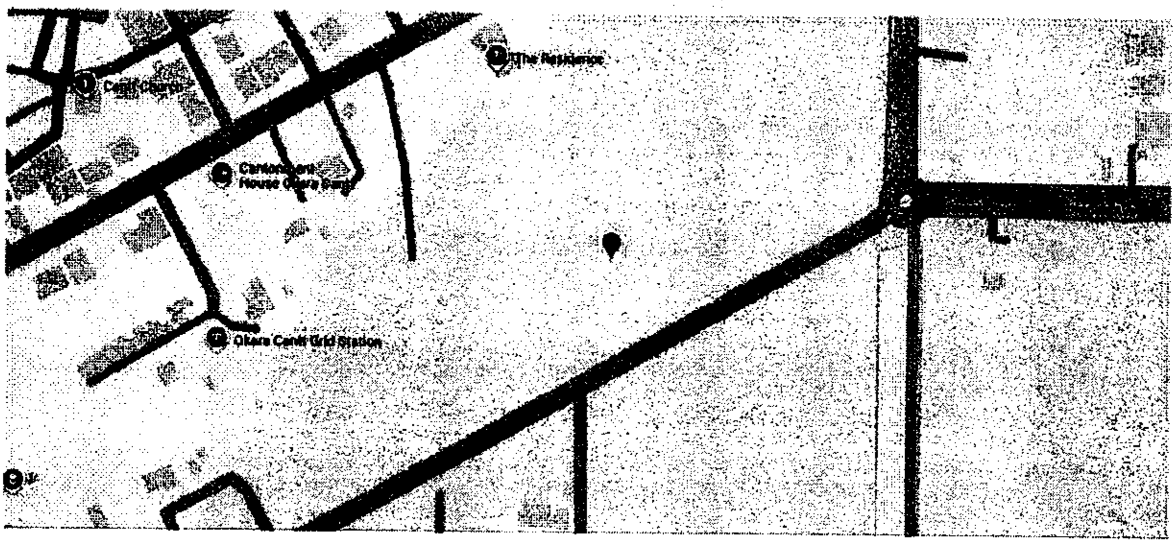

Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

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Annexure-A-2

Power Plant Data

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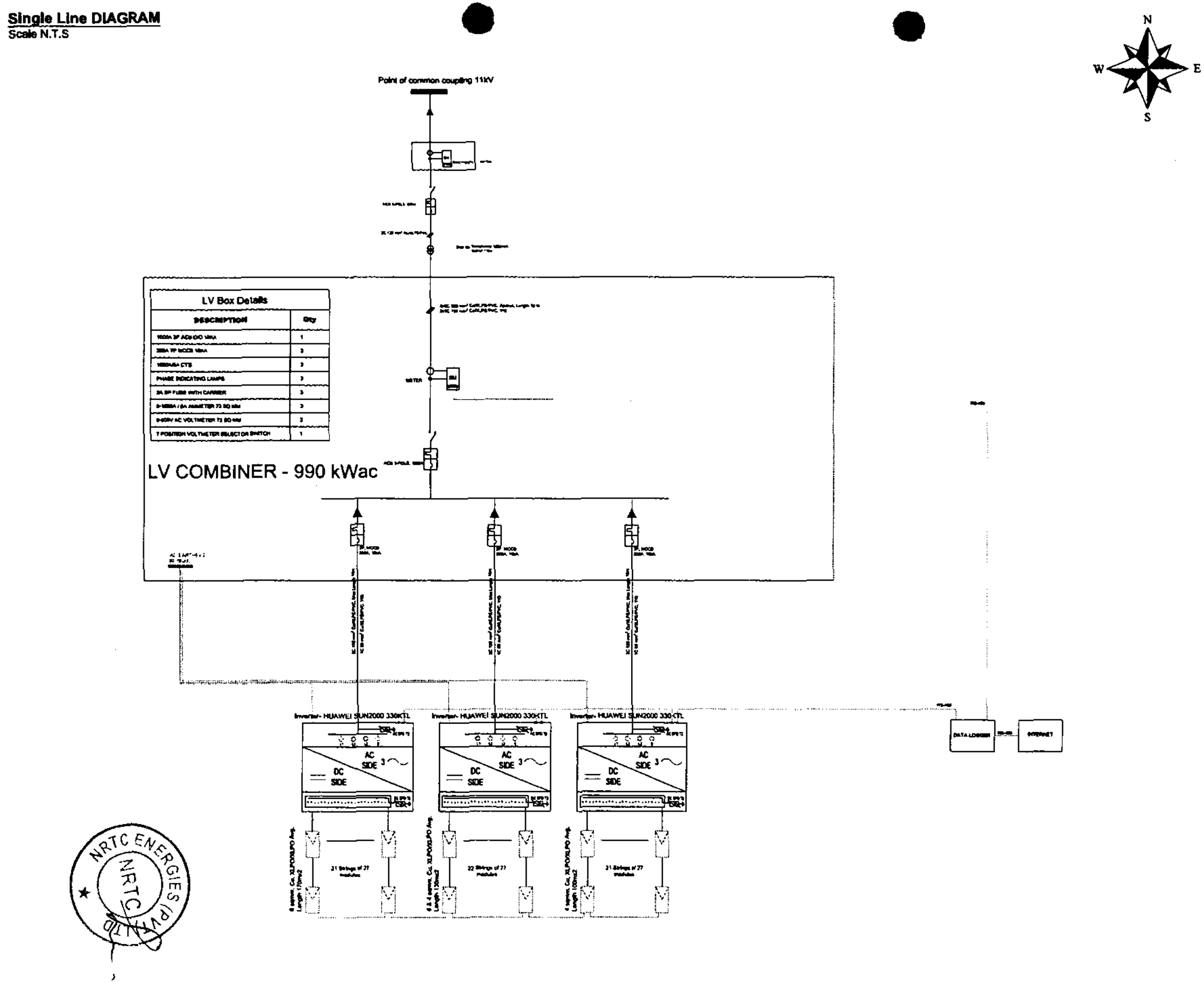
Single Line DIAGRAM

Scale N.T.S



LV Box Details	
DESCRIPTION	Qty
1600A 3P ACB D/O 18kA	1
300A TP MCCB 18kA	3
1600A/5A CTS	3
PHASE INDICATING LAMPS	3
2A SP FUSE WITH CARRIER	3
0-1600A / 5A AMMETER 72 SQ MM	3
0-500V AC VOLTMETER 72 SQ MM	3
7 POSITION VOLTMETER SELECTOR SWITCH	1

SITE LOCATION

Co-ordinates: 30.766757, 73.354118

[redacted]

GENERAL NOTES

1. This drawing is the copyright of and must not be retained, copied or used without the above company's authority.
2. IGOBK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Solar PV Module
	Inverter
	ACB, VCB
	Contactor
	Current Transformer
	Voltage Transformer

ARRAY INFORMATION

	Array
Total Installed Capacity	1 MW
Total Number of PV Modules	1728
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	3
Total AC Power	990kW
Total Area utilized	121915 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	30°
Azimuth	0° ± 3
Pitch of Structure	25.5 ft

PROJECT :

MES Solarization P-III

Okara Cantt

Co-ordinates: 30.766757, 73.354118

CLIENT :

Military Engineering Services

DEVELOPER :

NRTC Energies

Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate, Lahore || Tel: 042 35117304

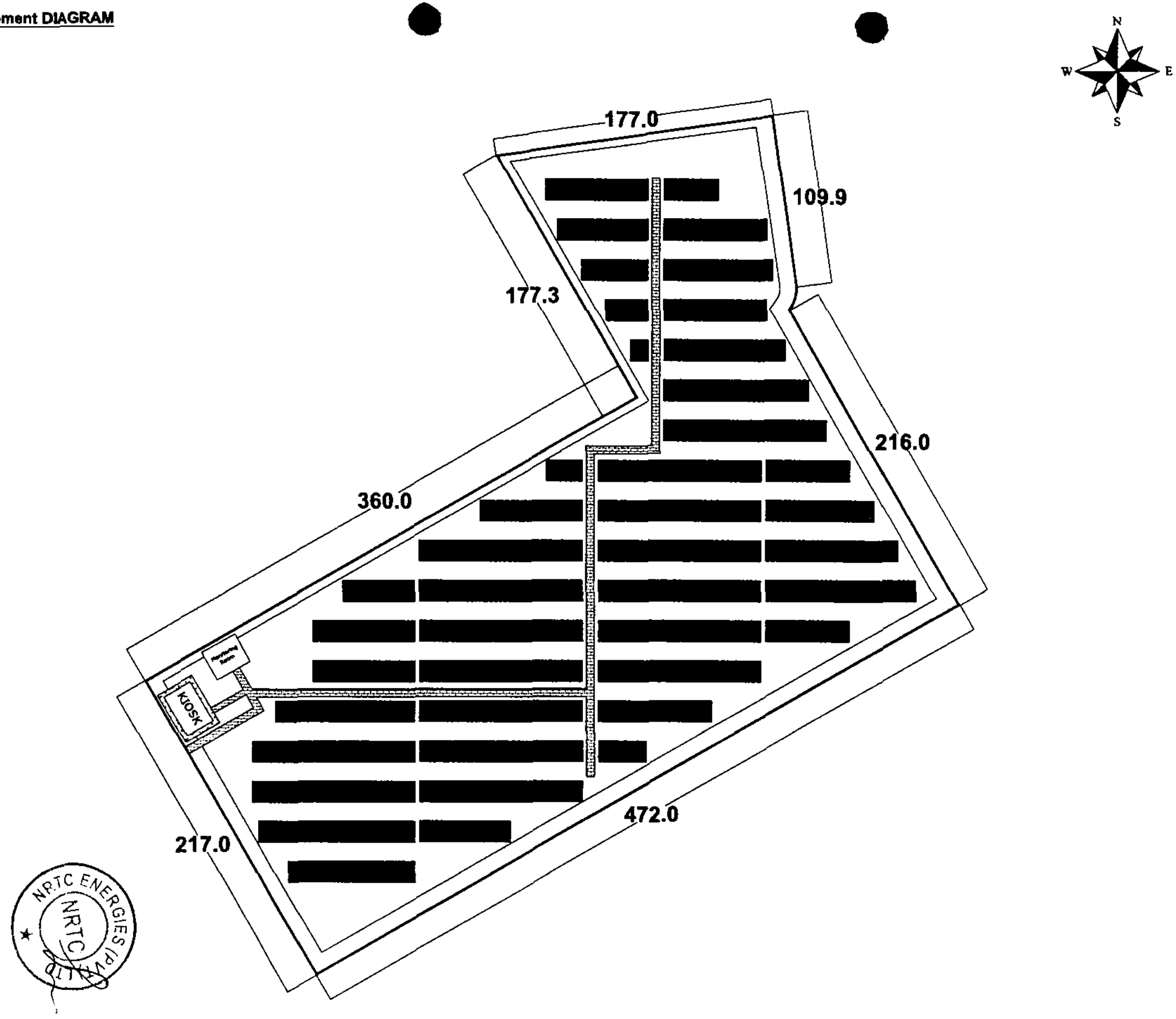
REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING : **SINGLE LINE DIAGRAM**

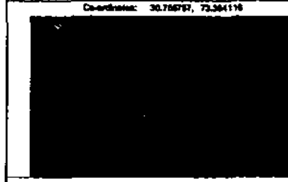
SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

PV Placement DIAGRAM

Scale N.T.S



SITE LOCATION
Co-ordinates: 30.756757, 73.354116



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2. KIOSK will be place in PV ground and Termination at HT line
3. This drawing is for Preliminary analysis only. Final design may vary from this Preliminary design.
4. Do not scale from this drawing.

Notes

	Ground mounted
	P2 Piling Structure

ARRAY INFORMATION

	Array
Total Installed Capacity	1 MW
Total Number of PV Modules	1728
No. of Modules in Series	26-27
PV Module Peak Power	575-580Wp
Maximum String Voltages	1400V
Inverter	Huawei SUN2000-330KTL
GT Inverter Nominal Power	330kWAC
Total Number of Inverters	3
Total AC Power	990kW
Total Area utilized	121915 sq.ft
Mounting Structure Type	Ground Piling Mounted
Tilt Angle	26°
Azimuth	0° ± 3
Pitch of Structure	25.5 ft

PROJECT :
MES Solarization P-III
Okara Cantt
Co-ordinates: 30.756757, 73.354116

CLIENT :
Military Engineering Services

DEVELOPER : NRTC Energies
Block 72 Maulana Shaukat Ali Rd, Quaid-e-Azam Industrial Estate Lahore || Tel: 042 35117304

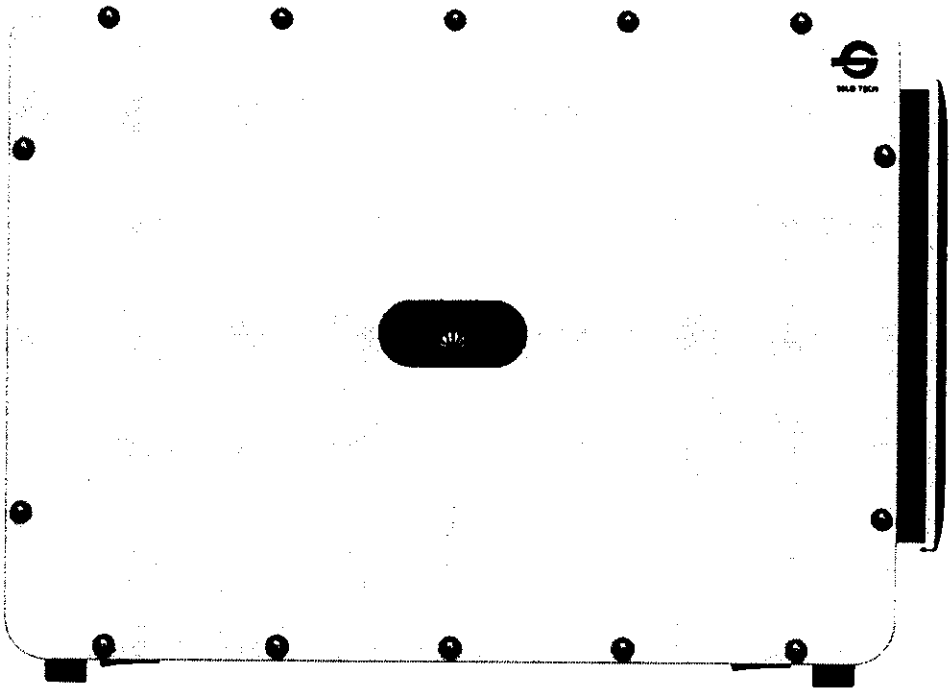
REV	DESCRIPTION	DATE	DRAWN BY
V0	Preliminary Submission	27-Jan-25	Design Team
—	—	—	—
—	—	—	—

DRAWING : **SINGLE LINE DIAGRAM**

SCALE : N.T.S	PAPER SIZE : A3	SHEET : 1/3
DRAWN :	CHECKED :	APPROVED :

SUN2000-330KTL-H1

Smart String Inverter



Max. Efficiency
≥99.0%

Smart Connector-level
Detection (SCLD)

Smart Self-cleaning
Fan (SSCF)

IP66
Protection

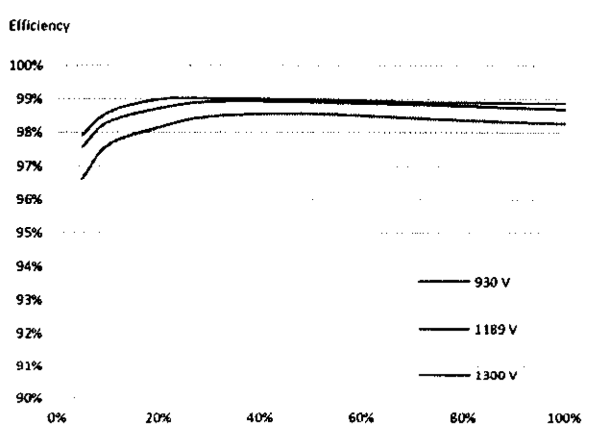
MBUS
Supported

Smart String-level
Disconnection (SSLD)

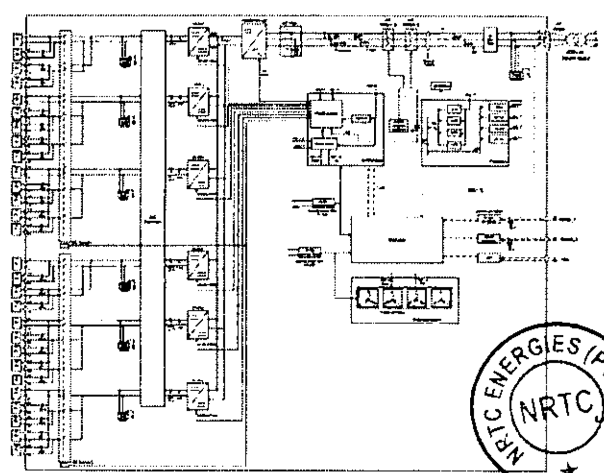
Smart IV Curve Diagnosis
Supported

Surge Arresters for
DC & AC

Efficiency Curve



Circuit Diagram



SUN2000-330KTL-H1

Technical Specifications

Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosϕ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 °C ~ 60 °C
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

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Hi-MO 6
Explorer

LR5-72HTH
560~575M

- Suitable for distributed projects
- Excellent outdoor power generation performance
- High module quality ensures long-term reliability

15-year Warranty for Materials and Processing

25-year Warranty for Extra Linear Power Output

Complete System and Product Certifications

IEC 61215, IEC 61730, UL 61730
ISO9001:2015: ISO Quality Management System
ISO14001: 2015: ISO Environment Management System
ISO45001: 2018: Occupational Health and Safety
IEC62941: Guideline for module design qualification and type approval

LONGi

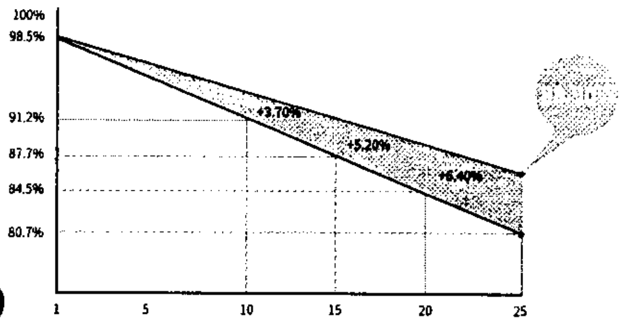
Hi-MO 6

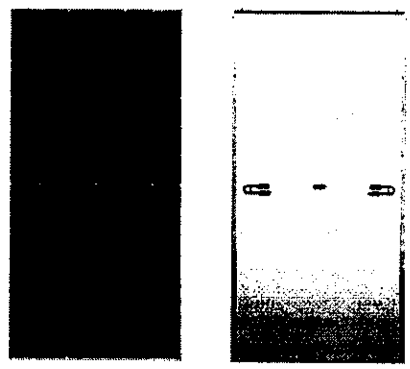
LR5-72HTH 560~575M

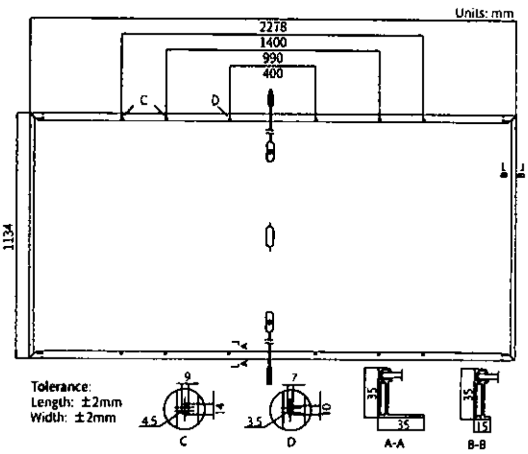
22.3%	0~3%	<1.5%	0.40%

Additional Value

25-Year Power Warranty







Mechanical Parameters

Cell Orientation	144 (6×24)
Junction Box	IP68, three diodes
Output Cable	$4mm^2$, +400, -200mm/±1400mm length can be customized
Glass	Single glass, 3.2mm coated tempered glass
Frame	Anodized aluminum alloy frame
Weight	27.5kg
Dimension	2278×1134×35mm
Packaging	31pcs per pallet / 155pcs per 20' GP / 620pcs per 40' HC

Electrical Characteristics

STC : AM1.5 $1000W/m^2$ 25°C NOCT : AM1.5 $800W/m^2$ 20°C 1m/s Test uncertainty for Pmax: ±3%

Module Type	LR5-72HTH-560M		LR5-72HTH-565M		LR5-72HTH-570M		LR5-72HTH-575M	
Testing Condition	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax/W)	560	418	565	422	570	426	575	430
Open Circuit Voltage (Voc/V)	51.61	48.46	51.76	48.60	51.91	48.74	52.06	48.88
Short Circuit Current (Isc/A)	13.94	11.26	14.01	11.31	14.07	11.36	14.14	11.42
Voltage at Maximum Power (Vmp/V)	43.46	39.66	43.61	39.79	43.76	39.93	43.91	40.07
Current at Maximum Power (Imp/A)	12.89	10.55	12.96	10.61	13.03	10.67	13.10	10.72
Module Efficiency(%)	21.7		21.9		22.1		22.3	

Operating Parameters

Operational Temperature	-40°C ~ +85°C
Power Output Tolerance	0 ~ 3%
Voc and Isc Tolerance	±3%
Maximum System Voltage	DC1500V (IEC/UL)
Maximum Series Fuse Rating	25A
Nominal Operating Cell Temperature	45±2°C
Protection Class	Class II
Fire Rating	UL type 1 or 2 IEC Class C

Mechanical Loading

Front Side Maximum Static Loading	5400Pa
Rear Side Maximum Static Loading	2400Pa
Hailstone Test	25mm Hailstone at the speed of 23m/s

Temperature Ratings (STC)

Temperature Coefficient of Isc	+0.050%/°C
Temperature Coefficient of Voc	-0.230%/°C
Temperature Coefficient of Pmax	-0.290%/°C

LONGi

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Web: www.longi.com

Annexure-B

Steady State Analysis Results

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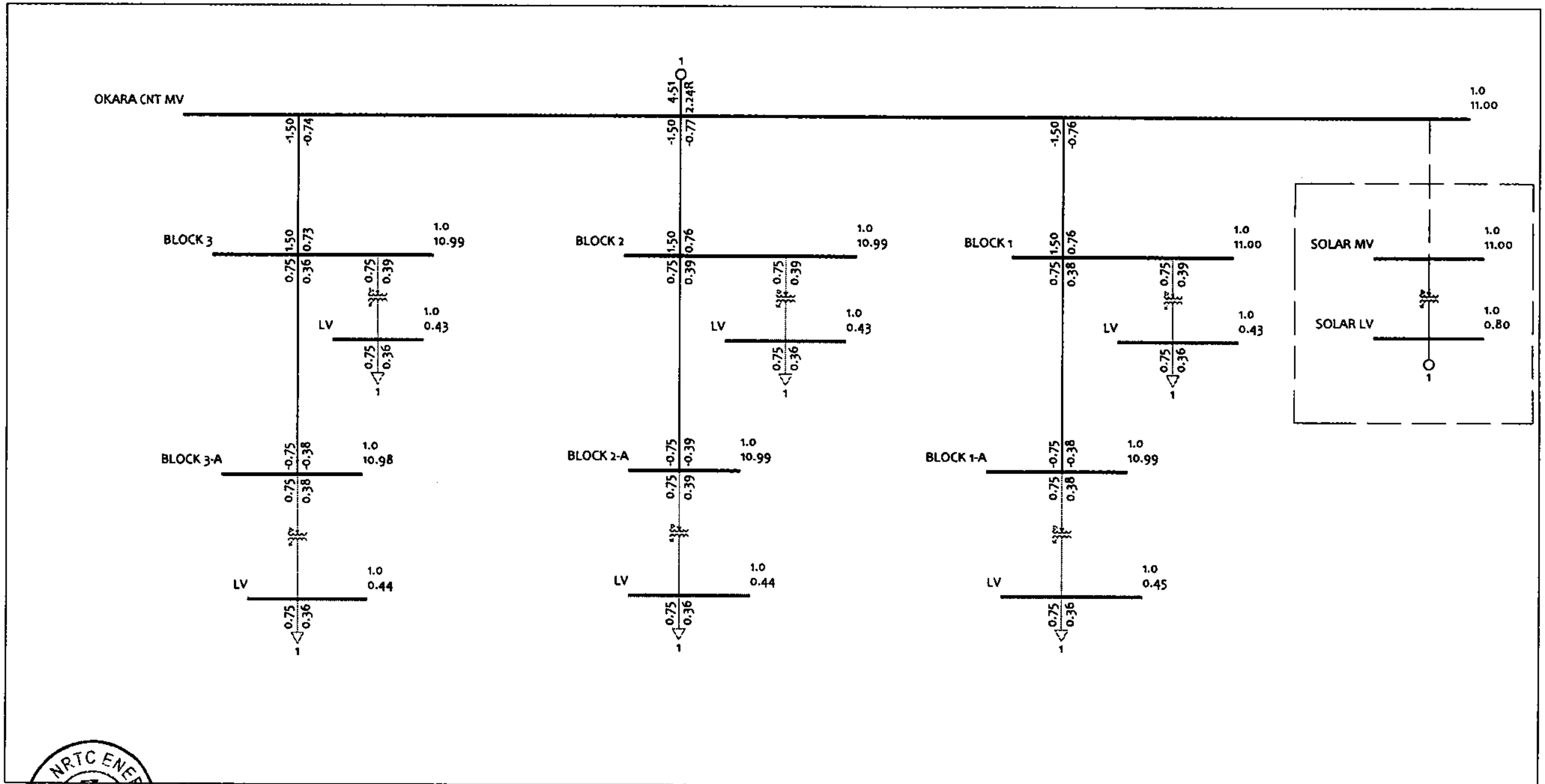
Load Flow Analysis of 999kW Solar PV System at Okara Cantt (OC)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-1

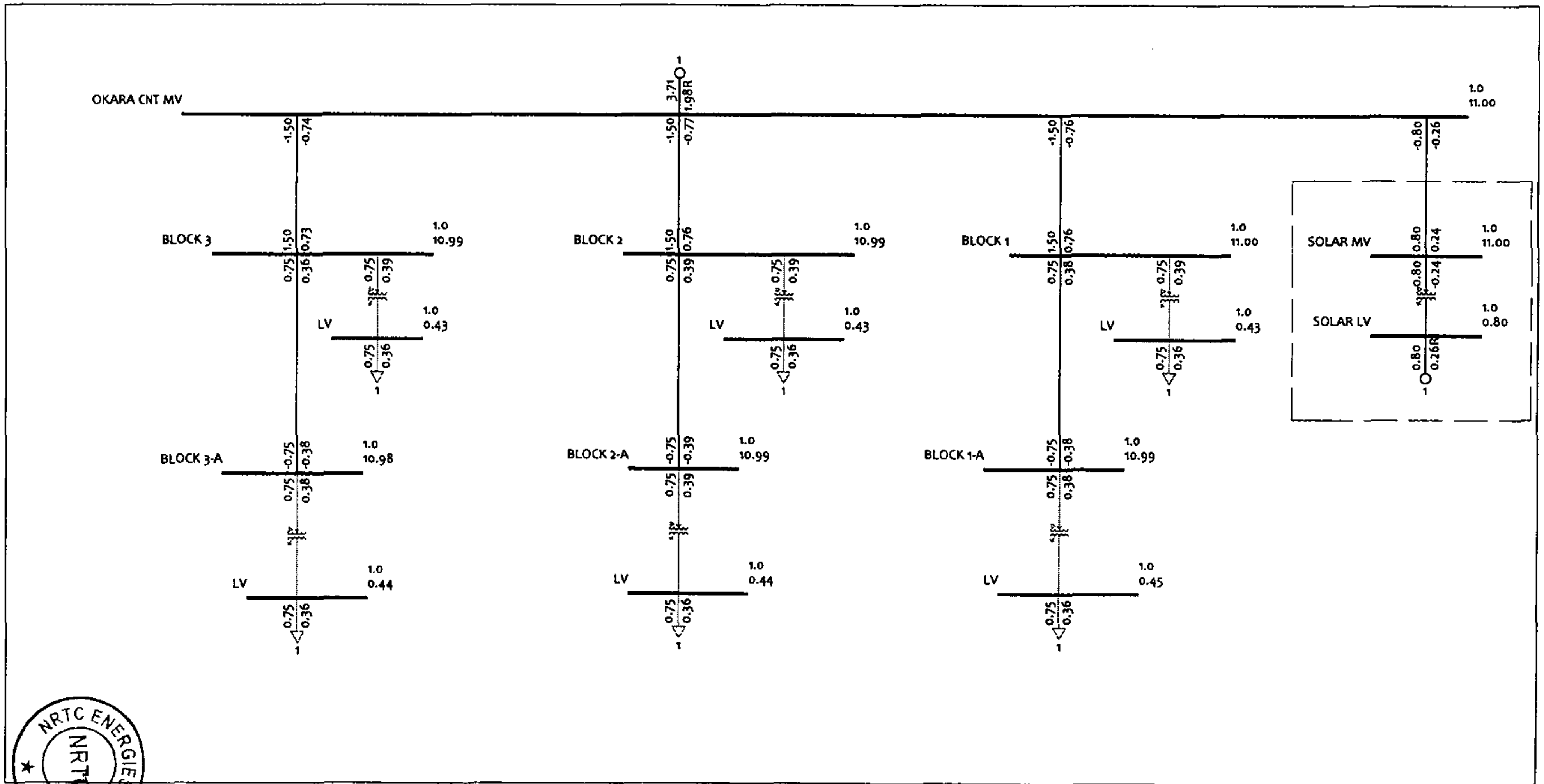


NRTC ENERGIES (PVT) LTD

Load Flow Analysis of 999kW Solar PV System at Okara Cantt (OC)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

NRTC ENERGIES (PVT) LTD
NRTC

Annexure-C-1

Without Okara Cantt PP and With Sanctioned Load In Service

NRTC ENERGIES (PVT) LTD
NRTC

```
                 PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:25
      OKARA CANTT SOLAR PV SYSTEM                                     %MVA FOR TRANSFORMERS
                                                                      % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 OKARA CNT MV11.000    4 1.0000    0.0     4.5     0.0     0.0 --------------------------------------------------------
---------------------
                              1 11.000            2.2R    0.0     0.0  41001 BLOCK 1     11.000    4  1      1.5      0.8
17     10
                                                                       41005 BLOCK 2     11.000    4  1      1.5      0.8
17     10
                                                                       41009 BLOCK 3     11.000    4  1      1.5      0.7
17     10
  41001 BLOCK 1     11.000    4 0.9997   -0.0     0.0     0.0     0.0 --------------------------------------------------------
---------------------
                              1 10.996            0.0     0.0     0.0   4100 OKARA CNT MV11.000    4  1     -1.5     -0.8
17     10
                                                                       41002 LV          0.4400    4  1      0.7      0.4
1.000LK         53     2
                                                                       41003 BLOCK 1-A   11.000    4  1      0.7      0.4
8    10
  41002 LV          0.4400    4 0.9878   -1.4     0.0     0.8     0.0 --------------------------------------------------------
---------------------
                              1 0.4346            0.0     0.4     0.0  41001 BLOCK 1     11.000    4  1     -0.7     -0.4
1.000UN         52     2

  41003 BLOCK 1-A   11.000    4 0.9995   -0.0     0.0     0.0     0.0 --------------------------------------------------------
---------------------
                              1 10.994            0.0     0.0     0.0  41001 BLOCK 1     11.000    4  1     -0.7     -0.4
8    10
                                                                       41004 LV          0.4400    4  1      0.7      0.4
0.975LK         53     2
  41004 LV          0.4400    4 1.0136   -1.3     0.0     0.8     0.0 --------------------------------------------------------
---------------------
                              1 0.4460            0.0     0.4     0.0  41003 BLOCK 1-A   11.000    4  1     -0.7     -0.4
1.000UN         52     2

  41005 BLOCK 2     11.000    4 0.9993   -0.0     0.0     0.0     0.0 --------------------------------------------------------
---------------------
                              1 10.992            0.0     0.0     0.0   4100 OKARA CNT MV11.000    4  1     -1.5     -0.8
17     10
                                                                       41006 LV          0.4400    4  1      0.7      0.4
1.000LK         53     2
```

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NRTC

41007 BLOCK 2-A 11.000 4 1 0.8 0.4
8 10
41006 LV 0.4400 4 0.9874 -1.4 0.0 0.8 0.0 ---
----
1 0.4345 0.0 0.4 0.0 41005 BLOCK 2 11.000 4 1 -0.7 -0.4
1.000UN 52 2
41007 BLOCK 2-A 11.000 4 0.9993 -0.0 0.0 0.0 0.0 ---
----
1 10.992 0.0 0.0 0.0 41005 BLOCK 2 11.000 4 1 -0.8 -0.4
8 10
41008 LV 0.4400 4 1 0.7 0.4
0.988LK 53 2
41008 LV 0.4400 4 1.0002 -1.4 0.0 0.8 0.0 ---
----
1 0.4401 0.0 0.4 0.0 41007 BLOCK 2-A 11.000 4 1 -0.7 -0.4
1.000UN 52 2
41009 BLOCK 3 11.000 4 0.9990 -0.1 0.0 0.0 0.0 ---
----
1 10.989 0.0 0.0 0.0 4100 OKARA CNT MV11.000 4 1 -1.5 -0.7
17 10
410010 LV 0.4400 4 1 0.7 0.4
1.000LK 53 2
410011 BLOCK 3-A 11.000 4 1 0.7 0.4
8 10
410010 LV 0.4400 4 0.9871 -1.4 0.0 0.8 0.0 ---
----
1 0.4343 0.0 0.4 0.0 41009 BLOCK 3 11.000 4 1 -0.7 -0.4
1.000UN 52 2
410011 BLOCK 3-A 11.000 4 0.9985 -0.1 0.0 0.0 0.0 ---
----
1 10.983 0.0 0.0 0.0 41009 BLOCK 3 11.000 4 1 -0.7 -0.4
8 10
410012 LV 0.4400 4 1 0.8 0.4
0.988LK 28 3
410012 LV 0.4400 4 1.0038 -0.9 0.0 0.8 0.0 ---
----
1 0.4417 0.0 0.4 0.0 410011 BLOCK 3-A 11.000 4 1 -0.8 -0.4
1.000UN 28 3

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NRTC

Annexure-C-2

With Okara Cantt PP and With Sanctioned Load In Service

NRTC ENERGIES (PVT) LTD
NRTC

```
                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:33
           OKARAR CANTT SOLAR PV SYSTEM                                  %MVA FOR TRANSFORMERS
                                                                         % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR  BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 OKARA CNT MV11.000   4 1.0000    0.0     3.7     0.0     0.0 -------------------------------------------------------
---------------------
                             1 11.000            2.0R    0.0     0.0  41001 BLOCK 1     11.000    4  1      1.5     0.8
17     10
                                                                      41005 BLOCK 2     11.000    4  1      1.5     0.8
17     10
                                                                      41009 BLOCK 3     11.000    4  1      1.5     0.7
17     10
                                                                     410013 SOLAR MV    11.000    4  1     -0.8    -0.3
8    10
  41001 BLOCK 1      11.000   4 0.9997   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                             1 10.996            0.0     0.0     0.0   4100 OKARA CNT MV11.000    4  1     -1.5    -0.8
17     10
                                                                      41002 LV          0.4400    4  1      0.7     0.4
1.000LK          53     2
                                                                      41003 BLOCK 1-A   11.000    4  1      0.7     0.4
8    10
  41002 LV           0.4400   4 0.9878   -1.4     0.0     0.8     0.0 -------------------------------------------------------
---------------------
                             1 0.4346            0.0     0.4     0.0  41001 BLOCK 1     11.000    4  1     -0.7    -0.4
1.000UN          52     2

  41003 BLOCK 1-A    11.000   4 0.9995   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                             1 10.994            0.0     0.0     0.0  41001 BLOCK 1     11.000    4  1     -0.7    -0.4
8    10
                                                                      41004 LV          0.4400    4  1      0.7     0.4
0.975LK          53     2
  41004 LV           0.4400   4 1.0136   -1.3     0.0     0.8     0.0 -------------------------------------------------------
---------------------
                             1 0.4460            0.0     0.4     0.0  41003 BLOCK 1-A   11.000    4  1     -0.7    -0.4
1.000UN          52     2

  41005 BLOCK 2      11.000   4 0.9993   -0.0     0.0     0.0     0.0 -------------------------------------------------------
---------------------
                             1 10.992            0.0     0.0     0.0   4100 OKARA CNT MV11.000    4  1     -1.5    -0.8
17     10
```

NRTC ENERGIES

```
                                                                                  41006 LV           0.4400    4  1      0.7     0.4
1.000LK          53     2
                                                                                  41007 BLOCK 2-A   11.000     4  1      0.8     0.4
8    10
 41006 LV         0.4400     4 0.9874   -1.4      0.0       0.8      0.0 -------------------------------------------------------
--------------------
                             1 0.4345             0.0       0.4      0.0  41005 BLOCK 2     11.000     4  1     -0.7    -0.4
1.000UN          52     2

 41007 BLOCK 2-A  11.000     4 0.9993   -0.0      0.0       0.0      0.0 -------------------------------------------------------
--------------------
                             1 10.992             0.0       0.0      0.0  41005 BLOCK 2     11.000     4  1     -0.8    -0.4
8    10
                                                                          41008 LV           0.4400    4  1      0.7     0.4
0.988LK          53     2
 41008 LV         0.4400     4 1.0002   -1.4      0.0       0.8      0.0 -------------------------------------------------------
--------------------
                             1 0.4401             0.0       0.4      0.0  41007 BLOCK 2-A   11.000     4  1     -0.7    -0.4
1.000UN          52     2

 41009 BLOCK 3    11.000     4 0.9990   -0.1      0.0       0.0      0.0 -------------------------------------------------------
--------------------
                             1 10.989             0.0       0.0      0.0   4100 OKARA CNT MV11.000     4  1     -1.5    -0.7
17    10
                                                                         410010 LV           0.4400    4  1      0.7     0.4
1.000LK          53     2
                                                                         410011 BLOCK 3-A   11.000     4  1      0.7     0.4
8    10
410010 LV         0.4400     4 0.9871   -1.4      0.0       0.8      0.0 -------------------------------------------------------
--------------------
                             1 0.4343             0.0       0.4      0.0  41009 BLOCK 3     11.000     4  1     -0.7    -0.4
1.000UN          52     2

410011 BLOCK 3-A  11.000     4 0.9985   -0.1      0.0       0.0      0.0 -------------------------------------------------------
--------------------
                             1 10.983             0.0       0.0      0.0  41009 BLOCK 3     11.000     4  1     -0.7    -0.4
8    10
                                                                         410012 LV           0.4400    4  1      0.8     0.4
0.988LK          28     3
410012 LV         0.4400     4 1.0038   -0.9      0.0       0.8      0.0 -------------------------------------------------------
--------------------
                             1 0.4417             0.0       0.4      0.0 410011 BLOCK 3-A   11.000     4  1     -0.8    -0.4
1.000UN          28     3

410013 SOLAR MV   11.000     4 1.0003    0.0      0.0       0.0      0.0 -------------------------------------------------------
--------------------
                             1 11.003             0.0       0.0      0.0   4100 OKARA CNT MV11.000     4  1      0.8     0.2
     10
```

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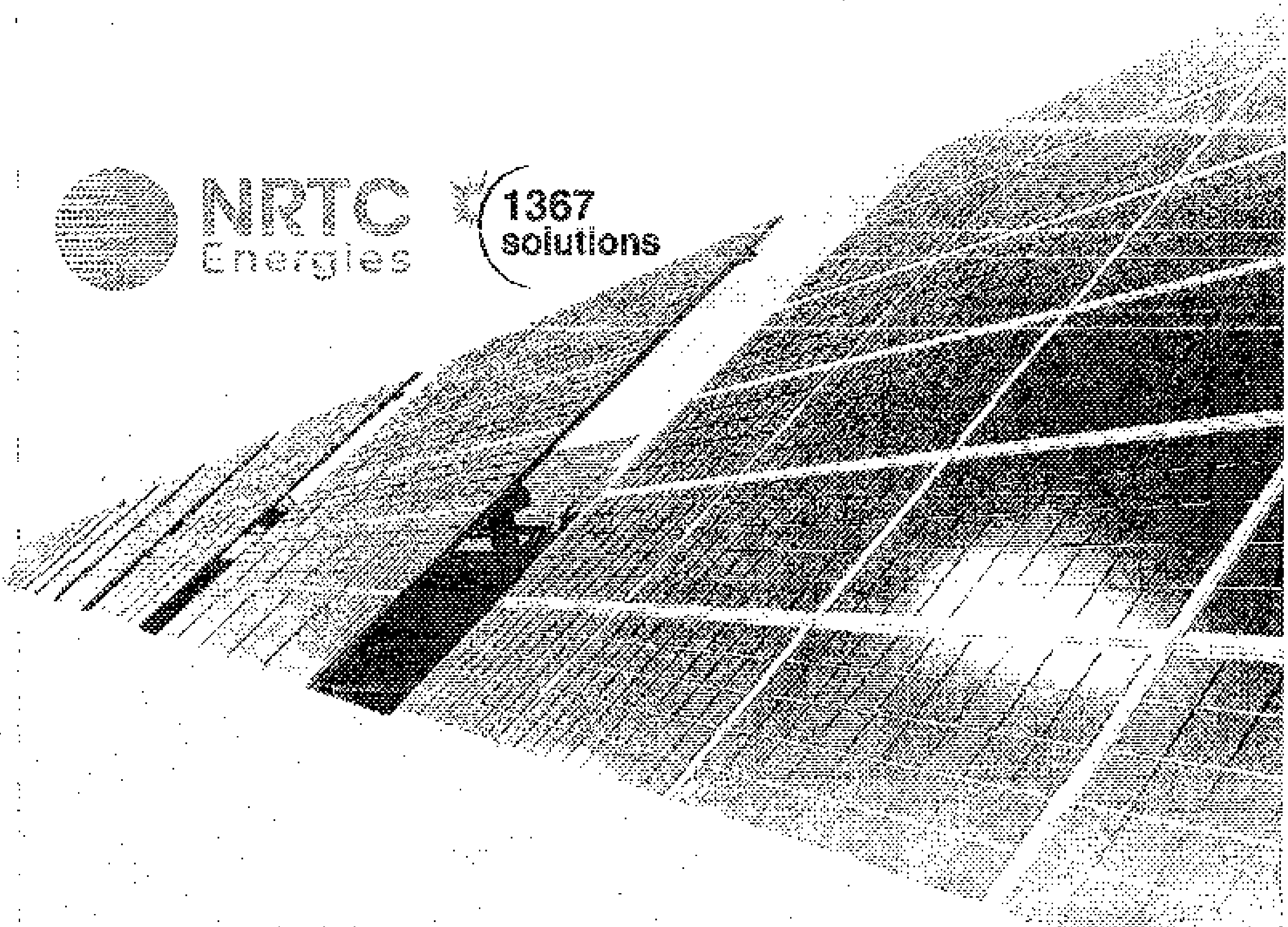
								410014 SOLAR LV	0.8000	4	1	-0.8	-0.2	
1.000LK	67	1												
410014 SOLAR LV	0.8000		4 1.0053	0.9	0.8	0.0	0.0	---						
--------------------														
			1 0.8042		0.3R	0.0	0.0	410013 SOLAR MV	11.000	4	1	0.8	0.3	
1.000UN	67	1												

NRTC ENERGIES (I) LTD
NRTC



Feasibility Study 3.5 MWp

Head Office:

72 Block, PECO Road, Lahore – Pakistan

Regional Offices:

Islamabad | Karachi | Peshawar | Quetta | Multan

FEASIBILITY STUDY

3.5 MWp SOLAR PLANT INSTALLATION

AT

MILITARY ENGINEERING SERVICES (MES) PAKISTAN

By

NRTC Energies (Pvt.) Ltd.

1. Executive Summary

The feasibility examines the costs, practicality, and likely outcome of a Solar Photovoltaic (PV) installation at MES Pakistan sites.

The main outcomes of the feasibility report are given below;

Technical Site Analysis: The project site (s) is suitable for a solar PV energy system. For the purpose of estimation of power generation potential, solar insolation is assumed to be "good" (1,705 kWh/ square meter/ year). Panel azimuths (0 degrees), panel tilt (26 degrees) and satisfactory ground and roof condition and structure are also assumed..

Anticipated System information: The project will accommodate a 3.5 MWp solar PV system with a projected annual production of 5,110 MWh/ year. Use of a JA Solar JAM72D40-580/G B (580 Watt) n-type bifacial double glass high efficiency mono PV module, the system will offset approximately 2,366 tons of carbon dioxide annually.

Financial Analysis: The total estimated project cost is **USD 1,796,164.** The sponsors of NRTC Energies (Private) Limited have agreed to finance the project on 80:20% equity. Based on the technical and financial analysis, the installation of a 3.5 MWp Solar PV System at MES Pakistan sites is deemed to be feasible.

2. Introduction

A 3.5 MWp Solar PV system will be installed at five (05) site of MES, Pakistan including four (04) nos. sites in Lahore and One (01) no in Okara.

Sr. No.	Site	Capacity (MW)
1	CMH (Lahore)	1
2	MM Lines (Lahore)	0.5
3	Akram Lines (Lahore)	0.5
4	MSG (Lahore)	0.5
5	Okara Cantt (Okara)	1
Total		**3.5**

NRTC Energies

1367 solutions

CMH Lahore

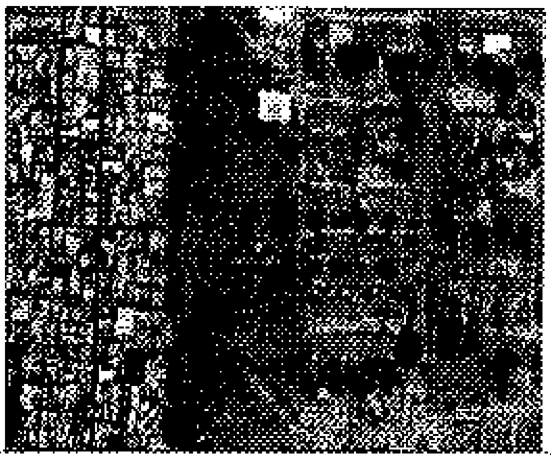
Co-ordinates: 31.5438931846, 74.37144798

Akram Line

Co-ordinates: 31.525040, 74.393170

MM Line

Co-ordinates: 31.507475, 74.361193

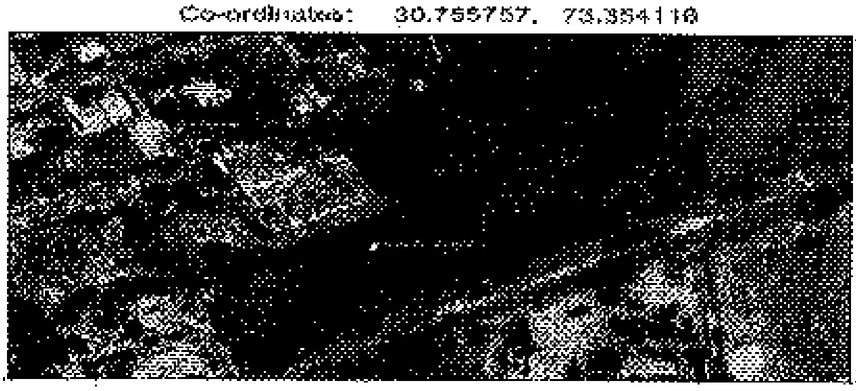


MSG

Co-ordinates: 31.548410, 74.431333

Okara Cantt

Co-ordinates: 30.755757, 73.354110



3. Technical Details

3.1 Site Conditions:

The following tasks were carried out:

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

3.2 Technology Review and Selection:

3.2.1 Technology Selection

Type of Technology	Photovoltaic (PV) Cell				
System Type	On-Grid				
Site	MM LINE	MSC	CMH Lahore	Akram Line	Okara Cantt
Installed Capacity (MW)	0.5	0.5	1	0.5	1
Modules (No.)	864	864	1726	864	1726
PV Array (No.)	1	1	2	1	2
Strings (No.)	32 X 27 in series	32 X 27 in series	31 Strings x 28 in series 33 Strings x 26 in series	27 Strings x 32 in series	31 Strings x 28 in series 33 Strings x 26 in series
Inverters (kW Ac)	300	300	300	300	300
Quantity (Nos.)	2	2	3	2	3
Make	Huawei Technologies				
Module area (m^2)	2,445	2,445	4,885	2,445	4,885

3.2.2 Technical Details of Equipment

Solar Panels - PV Modules		
1	Type of Module	JAM72D40-580/GB
2	Type of Cell	Monocrystalline N-Type (16BB)
3	Dimensions of each Module	2278 x 1134 x 30
4	Weight	31.8 kg
7	Module frame anodized	Anodized Aluminum Alloy
8	Nominal Max. Power (P Max)	580 W
9	Opt. Operating Voltage (Vmp)	43.03 V

10	Opt. Operating Current (Imp)	13.48 A
11	Open Circuit Voltage (Voc)	51.30 V
12	Short Circuit Current (ISC)	15.51 A
13	Module Efficiency	22.5 %
14	Operating Temperature	-40 °C ~ + 85 °C
15	Max. System Voltage	1500 V DC
16	Module Fire Performance	UL Type 29
PV Capacity		
17	Total Site	3.5 MWp
18	Net Capacity Factor	3.5 MW
Inverters		
1	Manufactures	Huawei Technologies
2	Capacity of each unit	300 kW Ac
3	No. of inverters	12
4	MPPT Operating Voltage Range	500 V ~ 1,500 V
5	Start Voltage	550 V
6	Max Input Voltage	1500 V
7	Total Power	330 kW
8	Max input current for each MPPT	65 A
9	Max Output Current	238.2 A
10	Adjustable P.F Range	0.8 LG 0.8 LD
11	Nominal Input Voltage	1,080 V
12	Rated Power Frequency	50 Hz / 60 Hz
13	Efficiency	≥99.0%
14	Relative Humidity (Non-Condensing)	0 ~ 100%
15	Weight	≤112 kg
16	Degree of Protection	IP 66
Structure		
17	Structure	Concrete Pile Structure | 150km/hr
18	Tilt / Azimuth	26 / 0°
Data Collection System		
19	System Data	Huawei smart logger
20	Weather Station	Seven Sensors Solutions
Other Details		
21	COD of Project (tentative)	30th June 2025
22	Expected Life from COD	25 Years

3.3 Energy Yield Estimation and Simulations

The aim of yield estimation is to predict the average annual energy output of the site. PvSyst software is used for simulation and near shading analysis. The energy yield prediction provides the basis for calculating project revenues. The aim is to predict the average annual energy output for the lifetime of the proposed power plant. To estimate accurately the energy produced from a PV power plant information is needed on the solar resource and temperature conditions of the site. Also required are the layout and technical specifications of the plant components. A number of solar energy yield prediction software packages are available in the market. These packages use time step simulation to model the performance of a project over the course of a year.

PVSyst software has been used for energy yield prediction for each site of MES Pakistan and results are in Annexure A to E.

3.4 Working Conditions

The solar system will have export control device to make sure that PV power generated by the inverters is on par with power consumption of the site load. A device will measure load at injection point and the limit power of inverters by changing register values. AC output is implemented in reference to energy flow at grid connection point which will reduce inverter AC output of the Inverter if site load will be less than the solar production.

3.5 Plant Characteristics

Generation Voltage	800 V three phase four wire system
Power Factor at rated power	1
Frequency	50 Hz
Generation characteristic:	Inverter has built-in features of controllable active power ramp following grid disturbance or normal connection, voltage regulation and frequency response. There are no additional control metering and instrumentations.

The seamless integration of Solar PV generation has been confirmed by detailed system studies conducted for each site of MES Pakistan (attached as Annex F-J)

3.6 Design Parameters

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

- Assessment of shading (horizon and nearby building)

- Outline layout of area suitable for PV development
- Designing row spacing to reduce inter-row shading and associated shading losses
- Designing the layout to minimize cable runs and associated electrical losses
- Creating access routes and sufficient space to allow movement for maintenance purposes
- Choosing a tilt angle that optimizes the annual energy yield according to the latitude of the site and the annual distribution of solar resource
- Module clearing strategy
- Simulating annual energy losses associated with various configurations of tilt angle, orientation – d row spacing
- PV layouts of the site in 3D and 2D view

3.7 Layout

The detailed layout (2D and 3D) of the solar panels is given in PySyst simulations attached as Annexure A to E. PV layout may change depending upon site constraints before or during installation.

3.8 Electrical Design

The electrical system comprises the following components:

- Array(s) of PV modules
- DC/AC cabling (module, string and main cable)
- DC connectors (plugs and sockets)
- Disconnects / switches
- Protection devices e.g., VCBs, fuses, surge protective devices, beakers
- Energy Meters
- Smart Loggers for Monitoring
- Earthing

3.9 Control, Metering, Instrumentation and Protection:

3.9.1 Reverse Feed in Protection:

In PV Plants with 100 % self-consumption all the generated power has to be consumed by the connected site / load. In case the load is less and more PV Power is being generated, the excess power will go to the grid. In order to avoid feed-in to the grid, a special control system is needed to be installed.

The feedback control loop to limit the active power feed-in to grid is implemented by using Huawei's smart loggers. They will actively sense the electrical parameters at interconnection points and curtail inverter's output to restrict feed-in to the grid.

3.9.2 Metering and Protection:

The distance of interconnection point to the PV plant is approximately 120 - 150 meters in case of each site. The metering of PV plant will be performed at the main MV busbar. Sensitivity class for meters will be at least 1 with bidirectional 4 quadrant calculations algorithm. Metering parameters, including total import and export units TOD Calculations, MDI, active and reactive power calculations etc. can be extracted over the period. Solar power plant is designed to have the following protections for the line and load side;

- Over and under voltage/frequency protections
- Phase Failure, Unbalance and Phase reversal protection
- Short Circuit protections
- Earth Fault detection
- Over current protection
- Surge Protection
- Transformer Protections

4. Financial Analysis

The Capital cost shall include the cost borne by the Applicant Company on completion of feasibility, planning, designing, material, construction and installation of the Generation Facilities. The cost of switchgear protection and interconnection with distribution system of utility is included in this case.

The expected cost of the installations under has been estimated to be US$ 0.513/Wp. This cost does not include the cost of land as facilities shall be installed at the premises of the Buyer.

Sr. No.	Description	US$/Wp
1	Civil Work	0.095
2	EPC	0.413
3	Others (including approvals costs)	0.005
	Total	**0.513**

Item wise break up of project cost is attached as Annexure- K

5. Safety and Emergency Plan

Detailed safety and emergency plan is attached as Annexure- L.

6. Training & Capacity Development

Trained and qualified personnel will be available at site (s) 24/7 with proper safety and firefighting training. Training program will focus on - but not limited to - Solar Resource Assessment; Site Survey, Technology, Engineering Design, Regulation, Policy, Metering & Billing, and Project Management of Rooftop Solar System.

7. Environmental Aspects

Detailed report on environmental aspects is attached as Annexure- M.

8. Socio-Economic Aspects

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

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

9. Conclusion

The techno-commercial feasibility for installation of 3.5 MWp Solar PV Systems at various site of MES Pakistan across Punjab study confirms that the proposed project is both technically viable and commercially attractive. From a technical perspective, the required infrastructure, technology, and resources are readily available and align with industry standards, ensuring reliable and efficient operations. Commercially, project is financially viable with manageable risks and favorable market conditions supporting long-term profitability. Key regulatory, environmental, and logistical considerations have also been adequately considered. Based on these findings, the project is deemed feasible and recommended for further development and implementation.

*****

Annex - A

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: MES Lahore (MM Line)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 501 kWp

Lahore MES (MM Line) - Pakistan

Author

Project summary

Geographical Site	Situation		Project settings	
Lahore MES (MM Line)	Latitude	31.51 °N	Albedo	0.20
Pakistan	Longitude	74.36 °E		
	Altitude	207 m		
	Time zone	UTC+5		

Meteo data
Lahore MES (MM Line)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation		Near Shadings	User's needs
Fixed plane		No Shadings	Unlimited load (grid)
Tilt/Azimuth	26 / 0 °		

System information

PV Array		Inverters	
Nb. of modules	864 units	Nb. of units	2 units
Pnom total	501 kWp	Pnom total	600 kWac
		Pnom ratio	0.835

Results summary

Produced Energy	593959 kWh/year	Specific production	1185 kWh/kWp/year	Perf. Ratio PR	72.74 %

Table of contents

PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:48
with v7.3.1

General parameters

Grid-Connected System | **No 3D scene defined, no shadings**

PV Field Orientation

Orientation		Sheds configuration	Models used	
Fixed plane		No 3D scene defined	Transposition	Perez
Tilt/Azimuth	28 / 0 °		Diffuse	Perez, Meteonorm
			Circumsolar	separate

Horizon	**Near Shadings**	**User's needs**
Free Horizon	No Shadings	Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	CSI Solar
Model	CS7L-580MB-AG 1500V
(Original PVsyst database)	
Unit Nom. Power	580 Wp
Number of PV modules	864 units
Nominal (STC)	501 kWp
Modules	32 Strings x 27 In series
At operating cond. (50°C)	
Pmpp	460 kWp
U mpp	823 V
I mpp	559 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H2
(Custom parameters definition)	
Unit Nom. Power	300 kWac
Number of inverters	2 units
Total power	600 kWac
Operating voltage	500-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	0.84
Power sharing within this inverter	

Total PV power

Nominal (STC)	501 kWp
Total	864 modules
Module area	2445 m²

Total inverter power

Total power	600 kWac
Number of inverters	2 units
Pnom ratio	0.84

Array losses

Array Soiling Losses
Loss Fraction 4.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 24 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

System losses

Unavailability of the system		**Auxiliaries loss**	
Time fraction	3.4 %	Proportionnal to Power	5.0 W/kW
	12.4 days,	0.0 kW from Power thresh.	
	3 periods	Night aux. cons.	500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.10 % at STC
Inverter: SUN2000-330KTL-H2	
Wire section (2 Inv.)	Alu 2 x 3 x 240 mm²
Average wires length	20 m

MV line up to Injection

MV Voltage	11 kV
Wires	Alu 3 x 95 mm²
Length	100 m
Loss Fraction	0.01 % at STC

AC losses in transformers

MV transfo

Medium voltage	11 kV
Transformer from Datasheets	
Nominal power	630 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.16 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	3.17 % at PNom
Coils equivalent resistance	3 x 32.25 mΩ

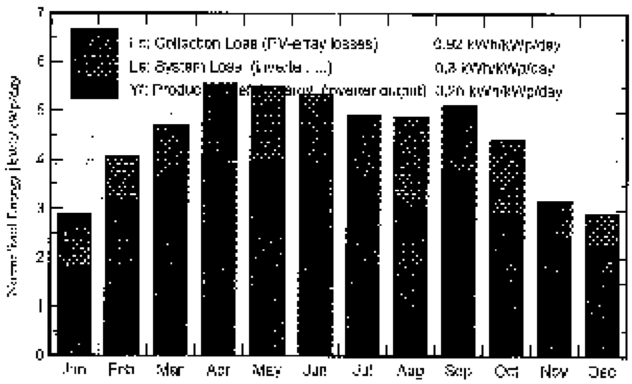
PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:48
with v7.3.1

Main results

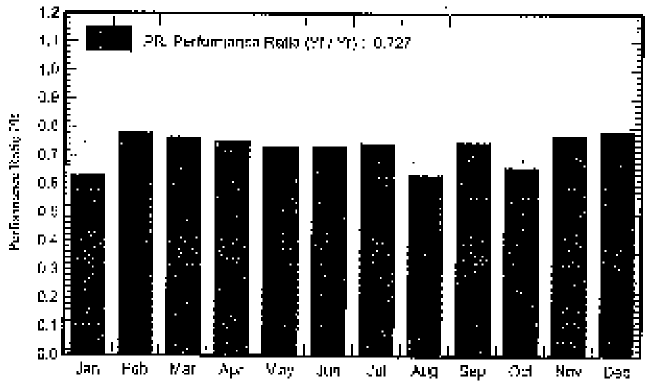
System Production

Produced Energy (P50)	593959 kWh/year	Specific production (P50)	1185 kWh/kWp/year	Performance Ratio PR	72.74 %
Produced Energy (P90)	556330 kWh/year	Produced Energy (P90)	1110 kWh/kWp/year		
Produced Energy (P99)	525662 kWh/year	Produced Energy (P99)	1049 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



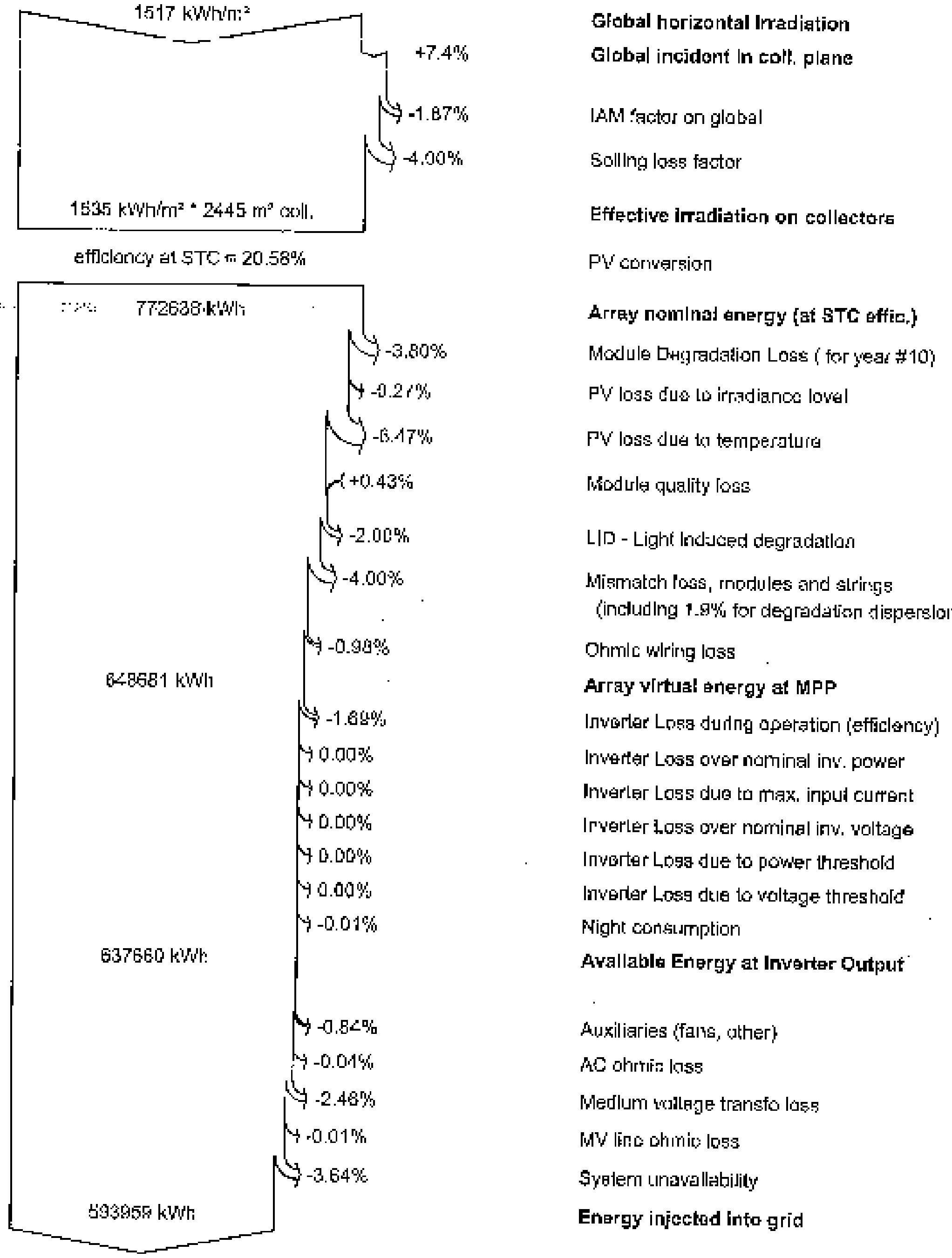
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	69.8	43.7	11.88	89.2	84.1	37531	28331	0.634
February	92.3	46.7	16.09	114.0	107.7	46962	44484	0.779
March	131.6	77.3	22.10	146.8	139.3	59265	56348	0.766
April	161.0	87.3	27.05	166.8	157.0	65711	62574	0.749
May	176.7	96.9	32.91	170.8	160.7	65704	62568	0.731
June	189.5	100.5	32.80	160.2	150.8	61926	58956	0.735
July	160.5	102.3	31.45	152.3	143.1	59594	56715	0.743
August	151.5	96.0	30.72	151.7	142.8	59496	48077	0.633
September	141.8	76.6	29.06	154.1	145.1	60591	57635	0.746
October	116.4	68.0	25.94	136.8	129.1	54502	45298	0.661
November	77.4	49.9	19.09	96.0	90.5	39361	37144	0.772
December	68.6	41.9	13.95	90.9	85.7	38037	35830	0.786
Year	1517.1	887.0	24.46	1629.4	1535.0	648681	593959	0.727

Legends

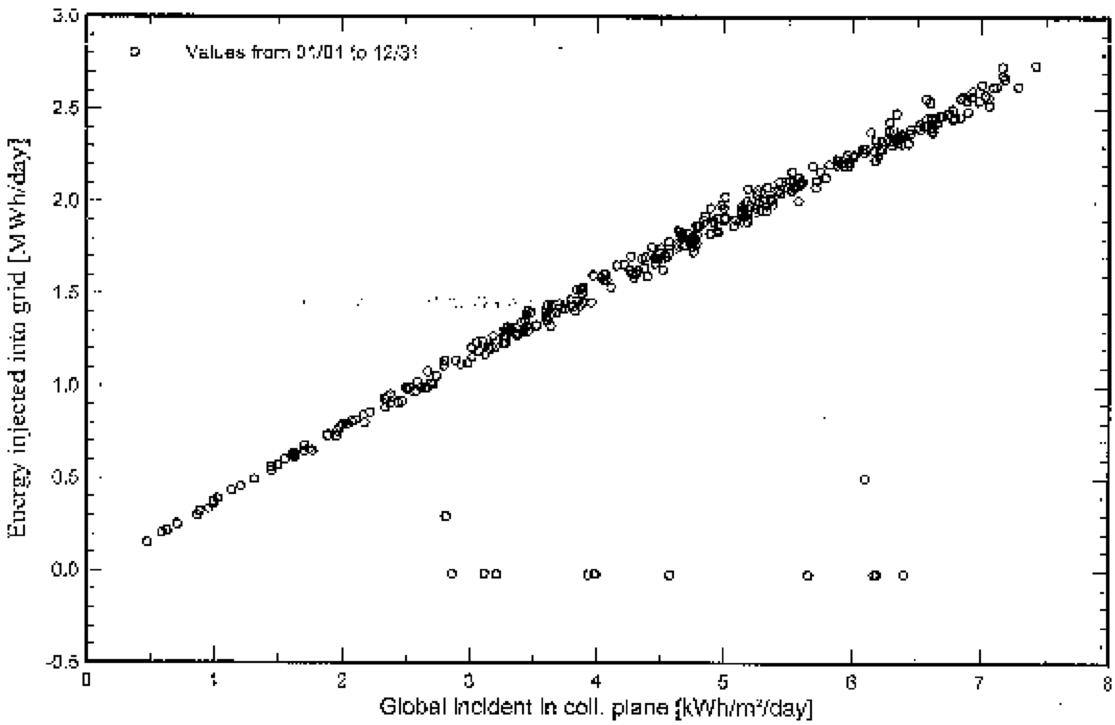
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

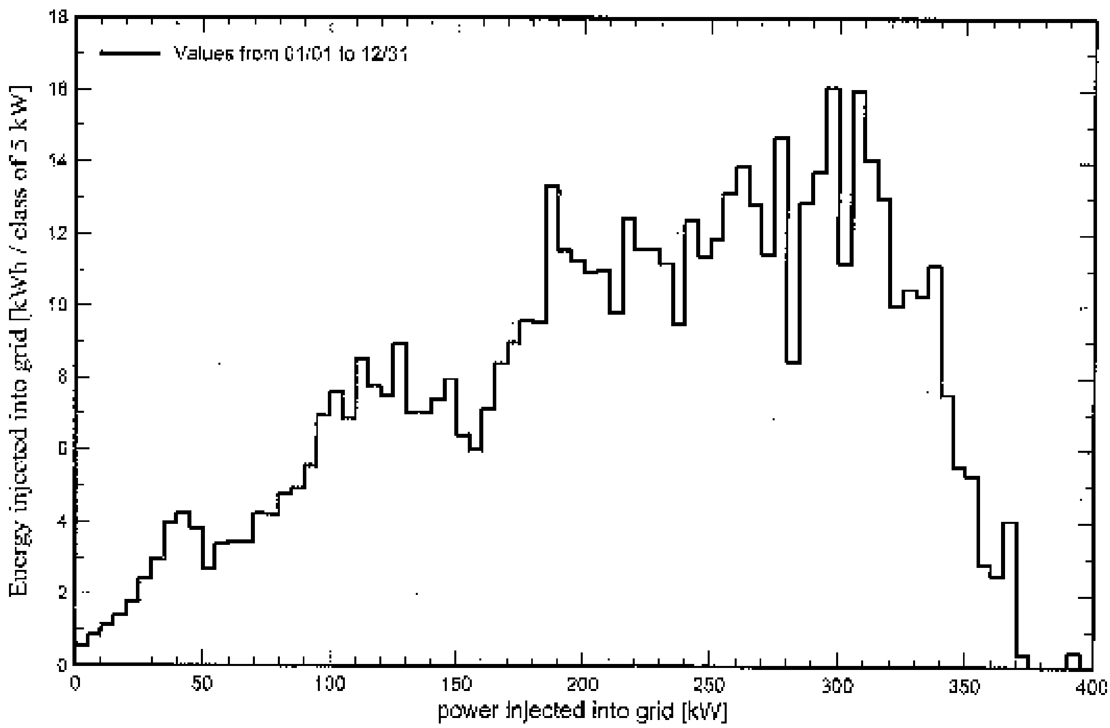


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	4.6 %
Specified Deviation	
Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.9 %

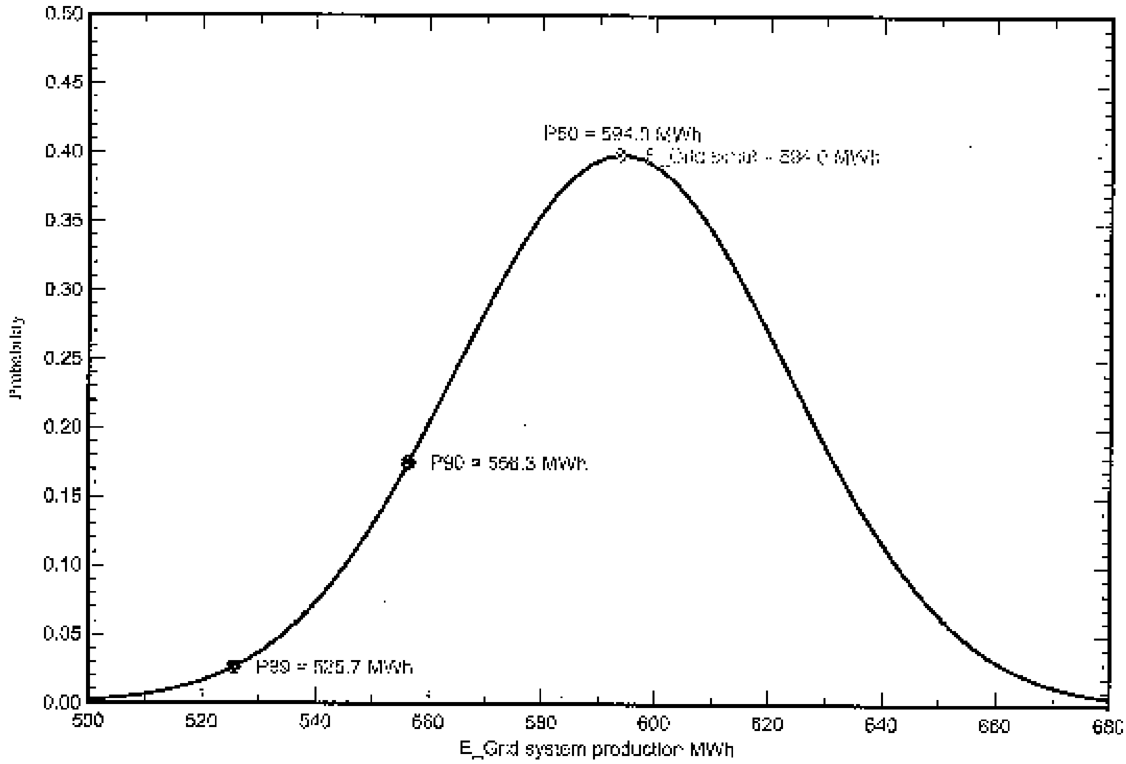
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

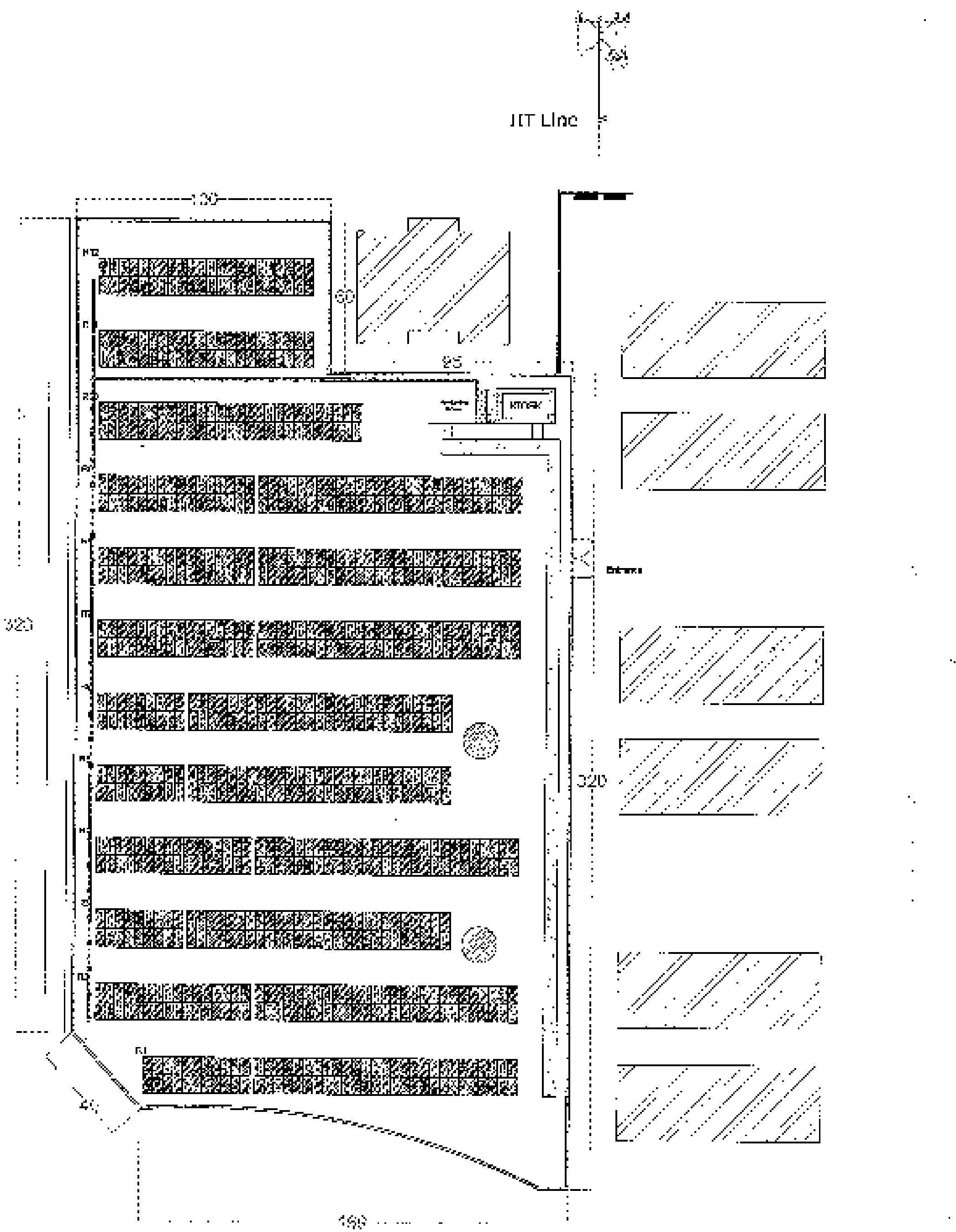
Annual production probability

Variability	28.3 MWh
P50	594.0 MWh
P90	558.3 MWh
P99	525.7 MWh

Probability distribution



PV Placement Layout
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization Ph-II
Mian Mir Lines

CLIENT:
Military Engineering Services

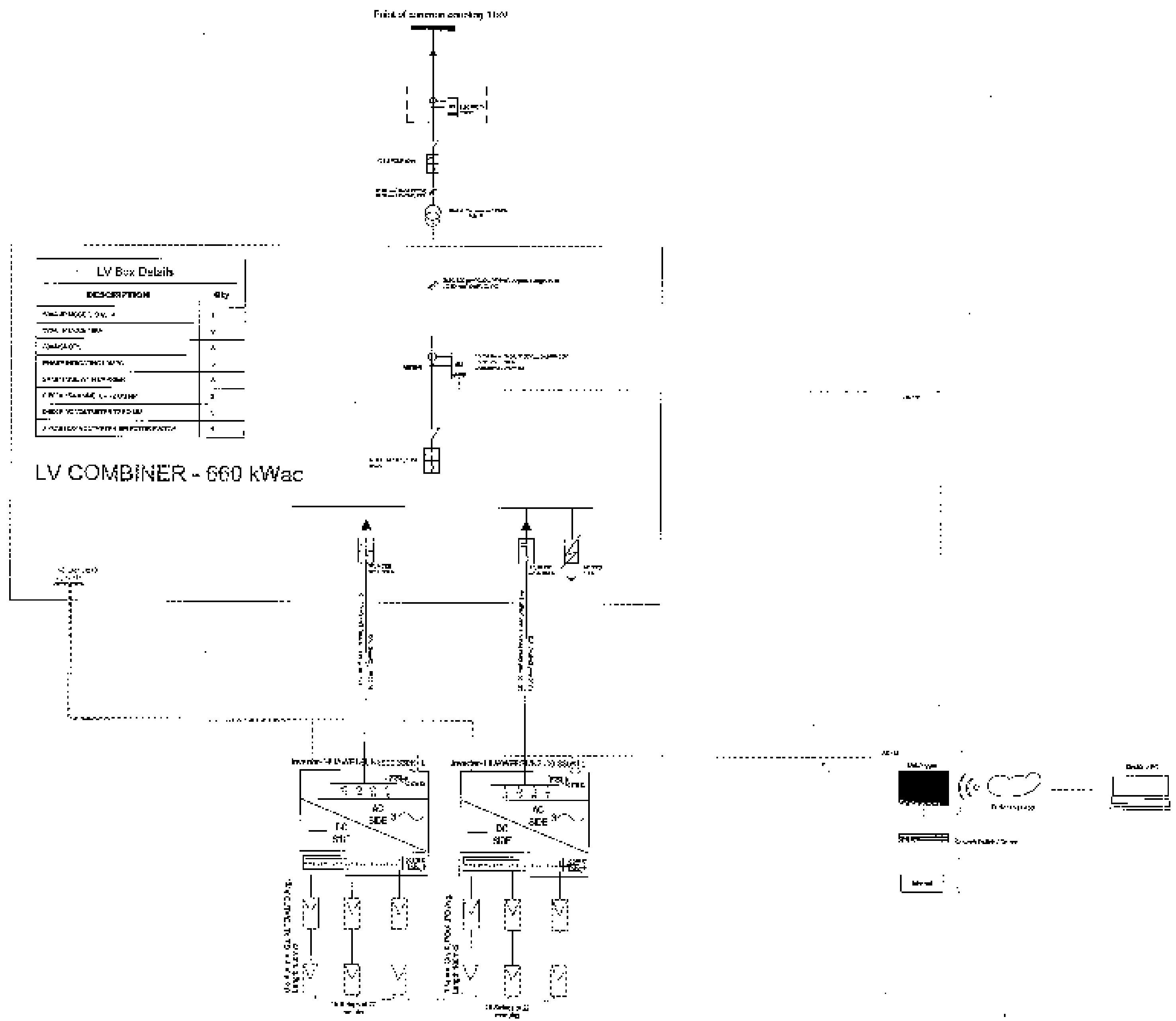
DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY
00	Preliminary Submission		

DRAWING:
SINGLE LINE DIAGRAM

SCALE: | PAPER SIZE: A3 | SHEET:
DRAWN: | CHECKED: | APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

4. Do not scale from this drawing.

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization P-III
Mian Mir Lines - Lahore

CLIENT:
Military Engineering Services

DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY

DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S
PAPER SIZE: A3
SHEET:
DRAWN:
CHECKED:
APPROVED:

Annex - B

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: Lahore MES (MSG)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 501 kWp

Lahore MES (MSG) - Pakistan

Author

Project: Lahore MES (MSG)

Variant: New simulation variant

Project summary

Geographical Site
Lahore MES (MSG)
Pakistan

Situation

Latitude	31.55 °N
Longitude	74.43 °E
Altitude	210 m
Time zone	UTC+5

Project settings

Albedo	0.20

Meteo data
Lahore MES (MSG)
Meteonorm 8.1 (2016-2021), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	864 units
Pnom total	501 kWp

Inverters

Nb. of units	2 units
Pnom total	600 kWac
Pnom ratio	0.835

Results summary

Produced Energy	589756 kWh/year	Specific production	1177 kWh/kWp/year	Perf. Ratio PR	72.60 %

Table of contents

General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Sheds configuration
No 3D scene defined

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	CSI Solar
Model	CS7L-580MB-AG 1500V
(Original PVsyst database)	
Unit Nom. Power	580 Wp
Number of PV modules	864 units
Nominal (STC)	501 kWp
Modules	32 Strings x 27 In series
At operating cond. (50°C)	
Pmpp	460 kWp
U mpp	823 V
I mpp	559 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H2
(Custom parameters definition)	
Unit Nom. Power	300 kWac
Number of inverters	2 units
Total power	600 kWac
Operating voltage	500-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	0.84
Power sharing within this inverter	

Total PV power

Nominal (STC)	501 kWp
Total	864 modules
Module area	2445 m²

Total inverter power

Total power	600 kWac
Number of inverters	2 units
Pnom ratio	0.84

Array losses

Array Soiling Losses
Loss Fraction 4.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 24 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:33
with v7.3.1

System losses

Unavailability of the system
Time fraction 3.4 %
12.4 days,
3 periods

Auxiliaries loss
Proportionnal to Power 5.0 W/kW
0.0 kW from Power thresh.
Night aux. cons. 500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.10 % at STC
Inverter: SUN2000-330KTL-H2	
Wire section (2 Inv.)	Alu 2 x 3 x 240 mm²
Average wires length	20 m

MV line up to Injection

MV Voltage	11 kV
Wires	Copper 3 x 95 mm²
Length	100 m
Loss Fraction	0.01 % at STC

AC losses in transformers

MV transfo

Medium voltage	11 kV
Transformer from Datasheets	
Nominal power	630 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.16 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	3.17 % at PNom
Coils equivalent resistance	3 x 32.25 mΩ

PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:33
with v7.3.1

Main results

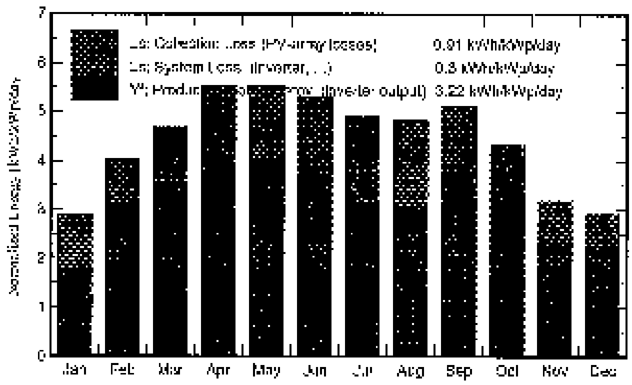
System Production

Produced Energy (P50) 589756 kWh/year
Produced Energy (P90) 541653 kWh/year
Produced Energy (P99) 502448 kWh/year

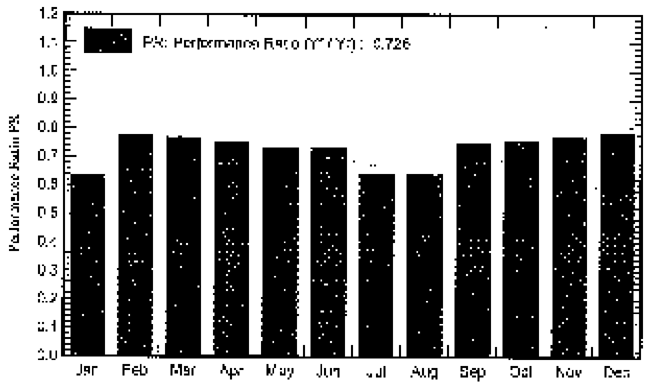
Specific production (P50) 1177 kWh/kWp/year
Produced Energy (P90) 1081 kWh/kWp/year
Produced Energy (P99) 1003 kWh/kWp/year

Performance Ratio PR 72.60 %

Normalized productions (per installed kWp)



Performance Ratio PR



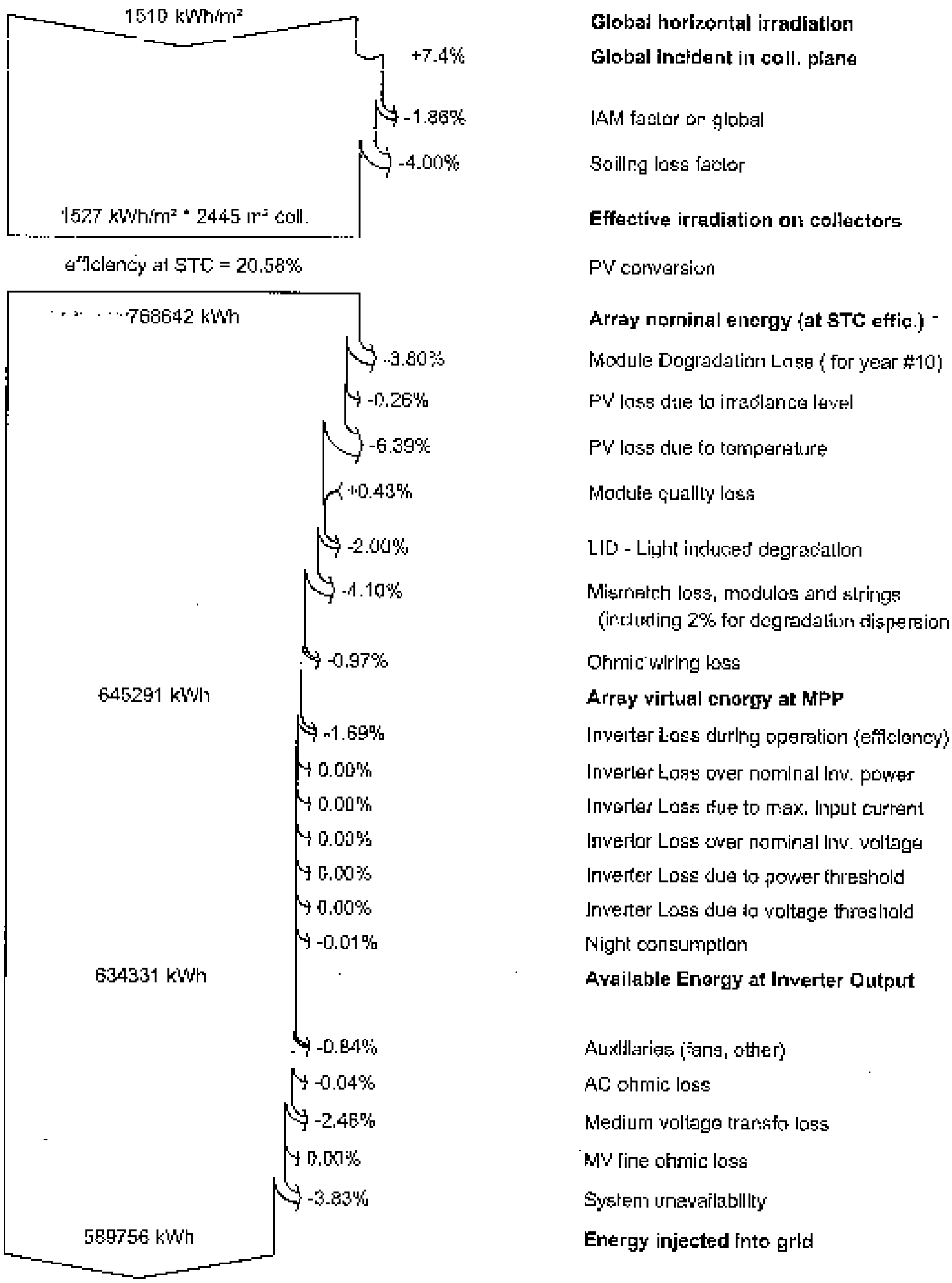
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	69.6	42.4	11.54	89.6	84.5	37686	28413	0.633
February	91.8	46.6	15.88	113.2	107.0	46619	44159	0.778
March	130.8	79.4	21.92	145.3	137.0	58713	55820	0.767
April	160.4	87.8	26.96	166.0	156.3	65390	62279	0.748
May	176.0	100.0	33.05	171.4	161.3	66009	62869	0.732
June	168.2	101.7	32.90	158.7	149.3	61304	58365	0.734
July	160.4	100.6	31.45	152.9	143.9	59650	48665	0.638
August	150.4	97.5	30.68	150.0	141.2	58865	47968	0.638
September	141.1	79.3	28.66	153.3	144.5	60336	57400	0.747
October	115.5	72.9	25.81	134.3	126.7	53619	50928	0.757
November	76.7	49.8	18.79	95.6	90.1	39211	37010	0.772
December	68.8	42.1	13.61	90.6	85.5	37888	35679	0.786
Year	1509.6	900.0	24.33	1620.9	1527.1	645291	589756	0.726

Legends

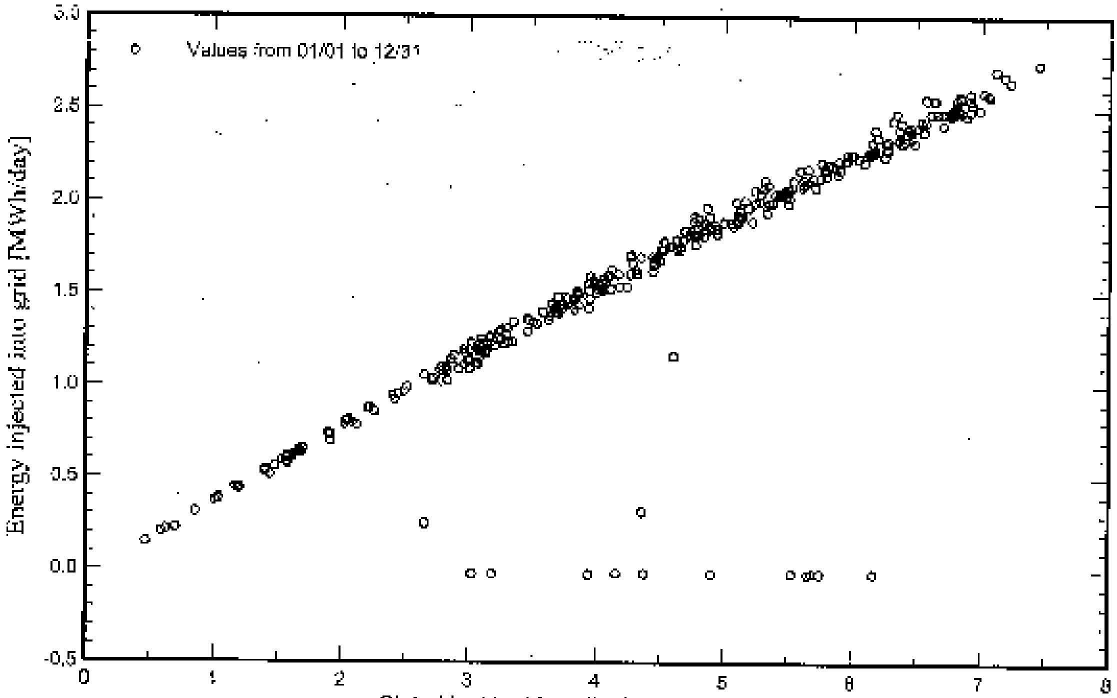
GlobHor Global horizontal irradiation
DiffHor Horizontal diffuse irradiation
T_Amb Ambient Temperature
GlobInc Global incident in coll. plane
GlobEff Effective Global, corr. for IAM and shadings
EArray Effective energy at the output of the array
E_Grid Energy injected into grid
PR Performance Ratio

Loss diagram

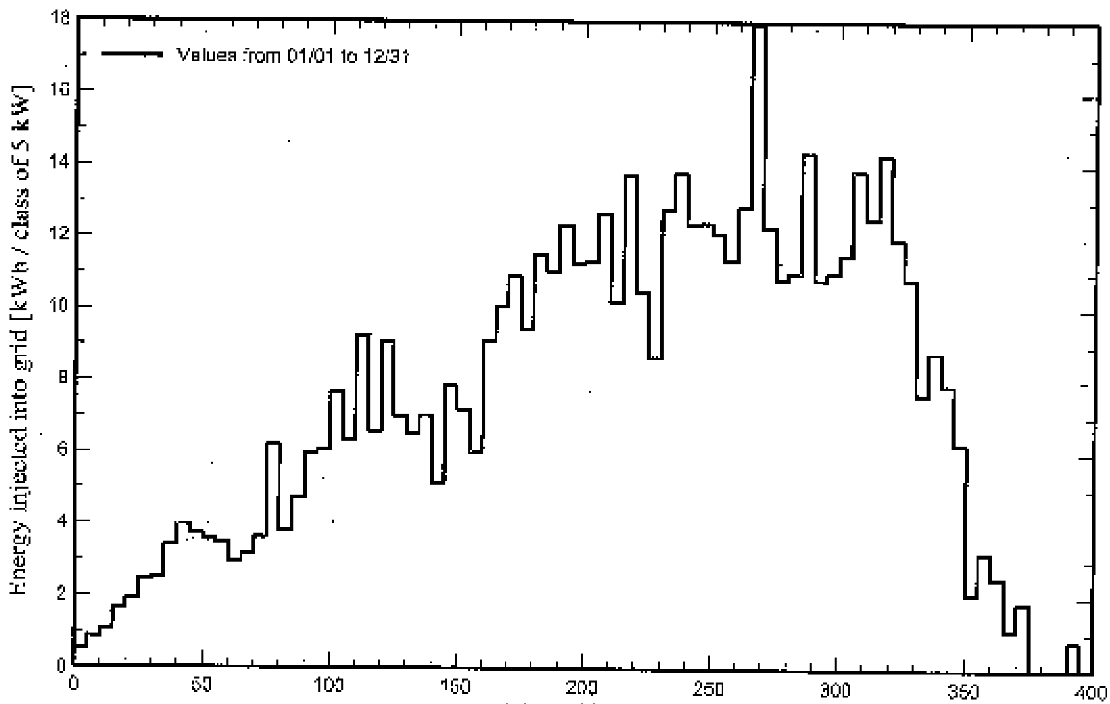


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:33
with v7.3.1

P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (2016-2021), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	6.1 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	6.4 %

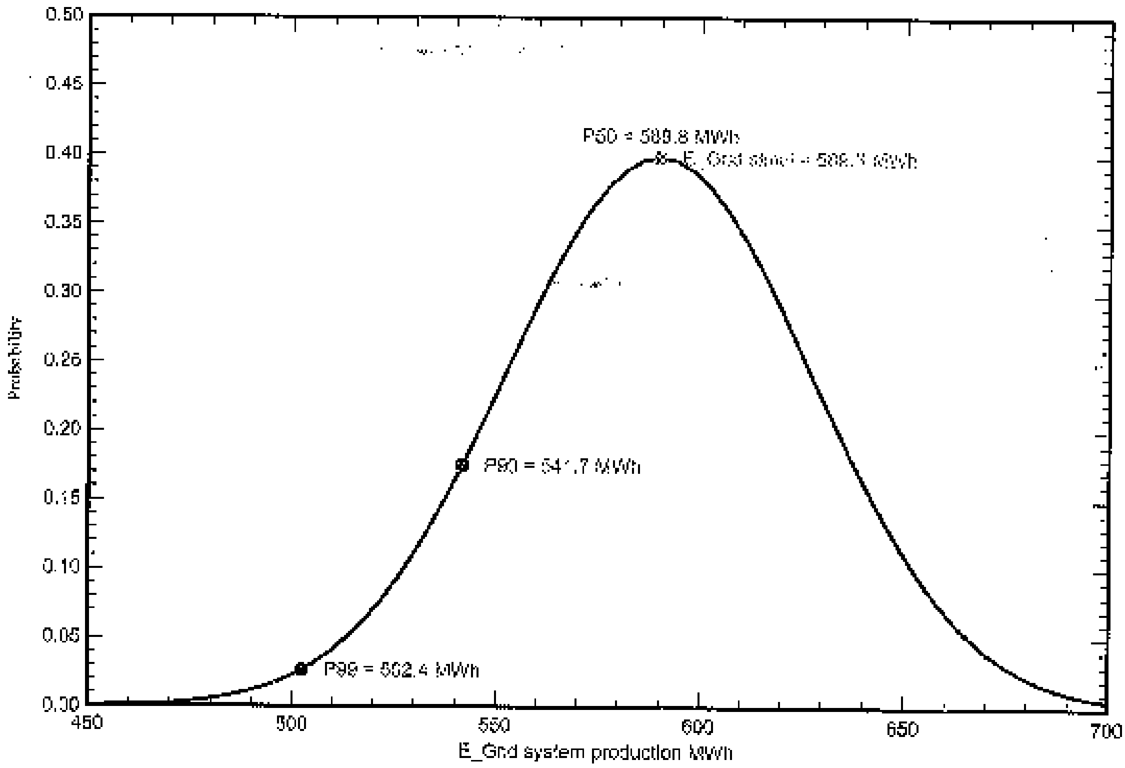
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

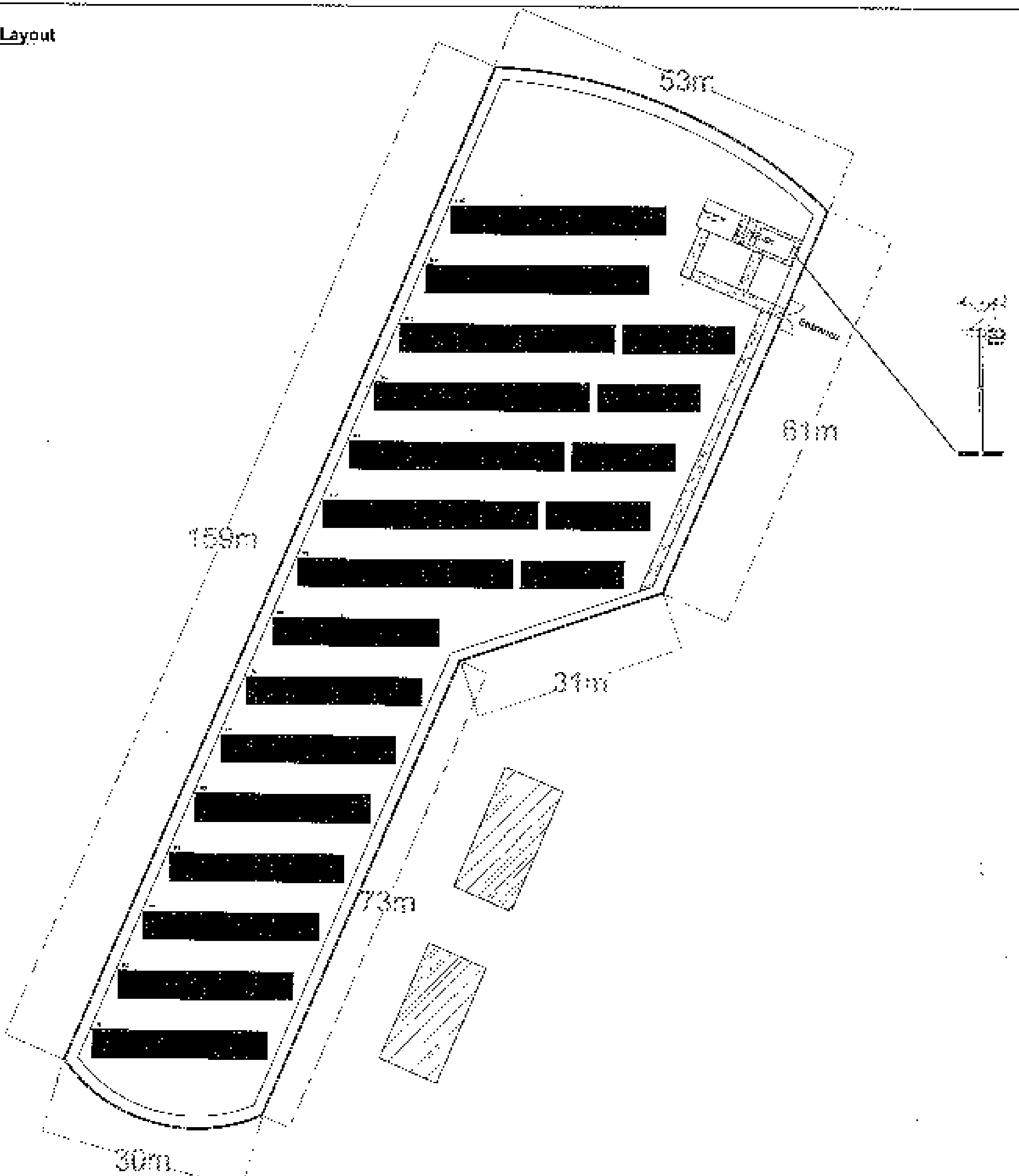
Annual production probability

Variability	37.5 MWh
P50	589.8 MWh
P90	541.7 MWh
P99	502.4 MWh

Probability distribution



PV Placement Layout
Scale N.T.S



Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-III
MSG - Lahore

CLIENT: Military Engineering Services

DEVELOPER:

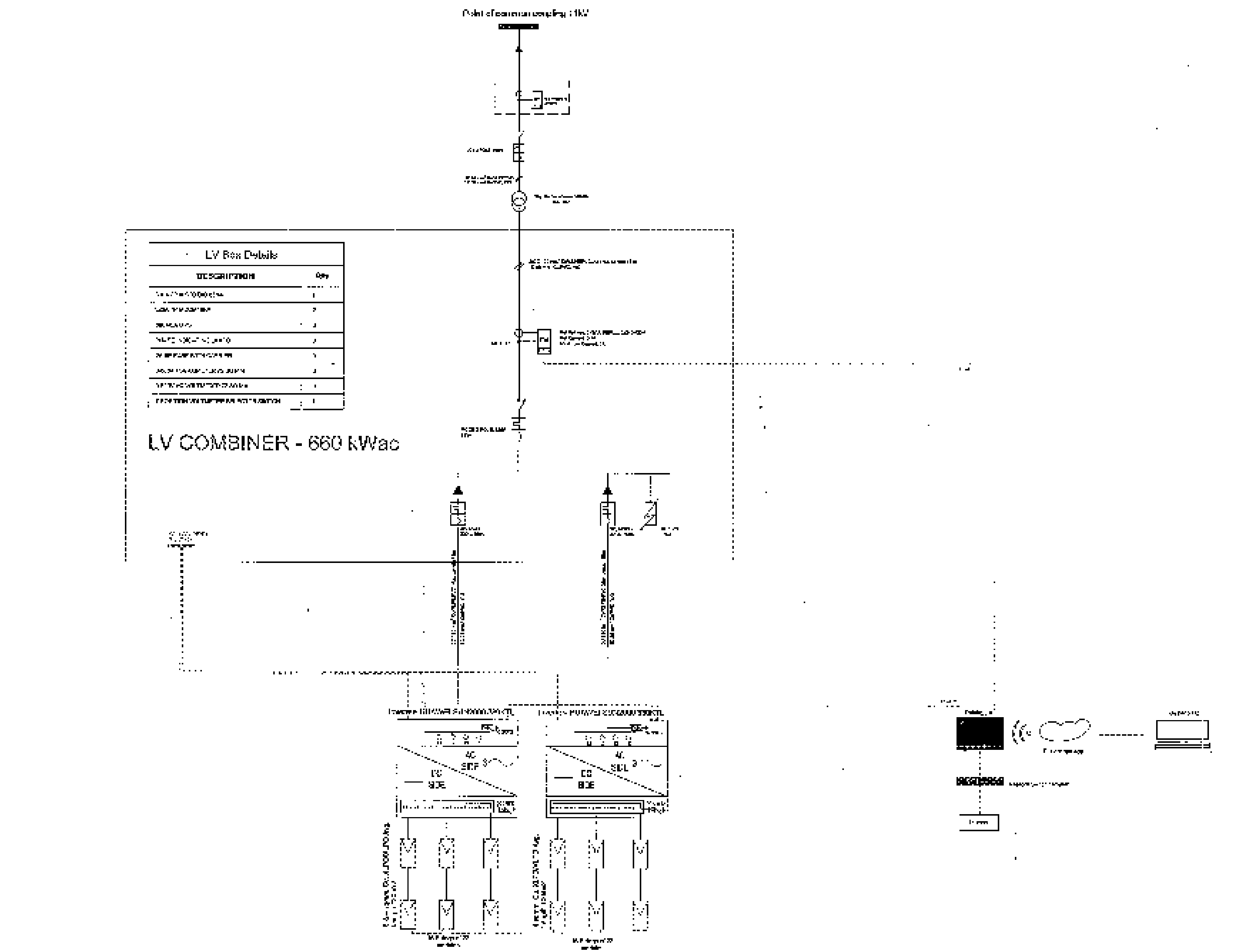
REV | DESCRIPTION

DRAWING: PV Placement

SCALE: N.T.S | PAPER SIZE: A3 | SHEET 1/1

DRAWN: | CHECKED: | APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

Inverter

ARRAY INFORMATION

PROJECT :
MES Solarization P-III
MSG - Lahore

CLIENT :
Military Engineering Services

DEVELOPER :

REV | DESCRIPTION | DATE | DRAWN BY

DRAWING :
Single Line Diagram

SCALE : N.T.S | PAPER SIZE : A3 | SHEET :
DRAWN : | CHECKED : | APPROVED :

Annex - C

PVsyst - Simulation report

Grid-Connected System

Project: Lahore Mes (CMH)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 1001 kWp

Lahore MES (CMH) - Pakistan

Author

Project summary

Geographical Site
Lahore MES (CMH)
Pakistan

Situation

Latitude	31.54 °N
Longitude	74.37 °E
Altitude	210 m
Time zone	UTC+5

Project settings

Albedo 0.20

Meteo data
Lahore MES (CMH)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	1726 units
Pnom total	1001 kWp

Inverters

Nb. of units	3 units
Pnom total	900 kWac
Pnom ratio	1.112

Results summary

Produced Energy	1201970 kWh/year	Specific production	1201 kWh/kWp/year	Perf. Ratio PR	73.94 %

Table of contents

General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation		**Sheds configuration**		**Models used**	
Fixed plane		No 3D scene defined		Transposition	Perez
Tilt/Azimuth	26 / 0 °			Diffuse	Perez, Meteonorm
				Circumsolar	separate
Horizon		**Near Shadings**		**User's needs**	
Free Horizon		No Shadings		Unlimited load (grid)	

PV Array Characteristics

PV module		**Inverter**	
Manufacturer	CSI Solar	Manufacturer	Huawei Technologies
Model	CS7L-580MB-AG 1500V	Model	SUN2000-330KTL-H2
(Original PVsyst database)		(Custom parameters definition)	
Unit Nom. Power	580 Wp	Unit Nom. Power	300 kWac
Number of PV modules	1726 units	Number of inverters	3 units
Nominal (STC)	1001 kWp	Total power	900 kWac
Array #1 - PV Array			
Number of PV modules	868 units	Number of inverters	8 * MPPT 17% 1.3 unit
Nominal (STC)	503 kWp	Total power	400 kWac
Modules	31 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	463 kWp	Max. power (=>30°C)	330 kWac
U mpp	854 V	Pnom ratio (DC:AC)	1.26
I mpp	542 A	No Power sharing between MPPTs	
Array #2 - Sub-array #2			
Number of PV modules	858 units	Number of inverters	10 * MPPT 17% 1.7 units
Nominal (STC)	498 kWp	Total power	500 kWac
Modules	33 Strings x 26 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	457 kWp	Max. power (=>30°C)	330 kWac
U mpp	793 V	Pnom ratio (DC:AC)	1.00
I mpp	577 A	No Power sharing between MPPTs	
Total PV power		**Total inverter power**	
Nominal (STC)	1001 kWp	Total power	900 kWac
Total	1726 modules	Number of inverters	3 units
Module area	4885 m²	Pnom ratio	1.11
		No Power sharing	

Array losses

Array Soiling Losses		**Thermal Loss factor**		**Serie Diode Loss**	
Loss Fraction	4.0 %	Module temperature according to irradiance		Voltage drop	0.7 V
		Uc (const)	29.0 W/m²K	Loss Fraction	0.1 % at STC
		Uv (wind)	0.0 W/m²K/m/s		
LID - Light Induced Degradation		**Module Quality Loss**		**Module mismatch losses**	
Loss Fraction	2.0 %	Loss Fraction	-0.4 %	Loss Fraction	2.0 % at MPP

Array losses

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year

Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

DC wiring losses

Global wiring resistance 10 mΩ
Loss Fraction 1.5 % at STC

Array #1 - PV Array
Global array res. 26 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2
Global array res. 23 mΩ
Loss Fraction 1.5 % at STC

System losses

Unavailability of the system
Time fraction 3.4 %
12.4 days,
3 periods

Auxiliaries loss
Proportionnal to Power 5.0 W/kW
0.0 kW from Power thresh.
Night aux. cons. 500 W

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 800 Vac tri
Loss Fraction 0.08 % at STC

Inverter: SUN2000-330KTL-H2
Wire section (1 Inv.) Alu 1 x 3 x 240 mm²
Wires length 20 m

Inverter: SUN2000-330KTL-H2
Wire section (2 Inv.) Alu 2 x 3 x 150 mm²
Average wires length 0 m

MV line up to Injection
MV Voltage 11 kV
Wires Alu 3 x 120 mm²
Length 100 m
Loss Fraction 0.02 % at STC

AC losses in transformers

MV transfo
Medium voltage 11 kV

Transformer from Datasheets
Nominal power 1250 kVA
Iron Loss (24/24 Connexion) 1.00 kVA
Iron loss fraction 0.08 % of PNom
Copper loss 20.00 kVA
Copper loss fraction 1.60 % at PNom
Coils equivalent resistance 3 x 8.19 mΩ

Main results

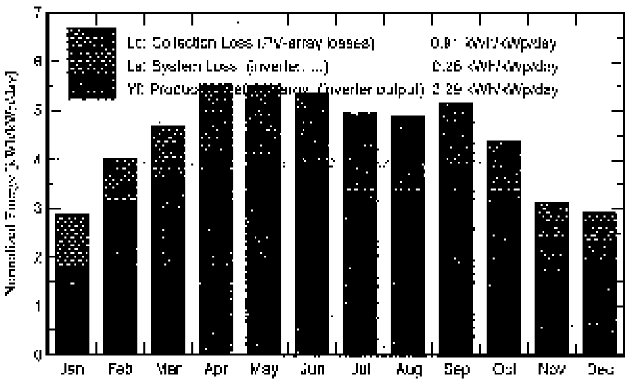
System Production

Produced Energy (P50) 1201970 kWh/year — Specific production (P50) 1201 kWh/kWp/year — Performance Ratio PR 73.94 %

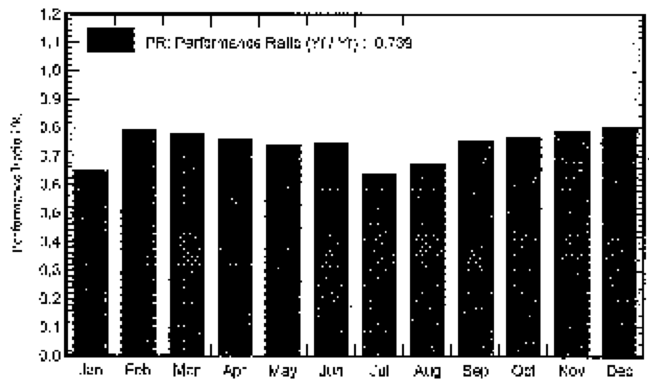
Produced Energy (P90) 1103932 kWh/year — Produced Energy (P90) 1103 kWh/kWp/year

Produced Energy (P99) 1024030 kWh/year — Produced Energy (P99) 1023 kWh/kWp/year

Normalized productions (per installed kWp)



Performance Ratio PR



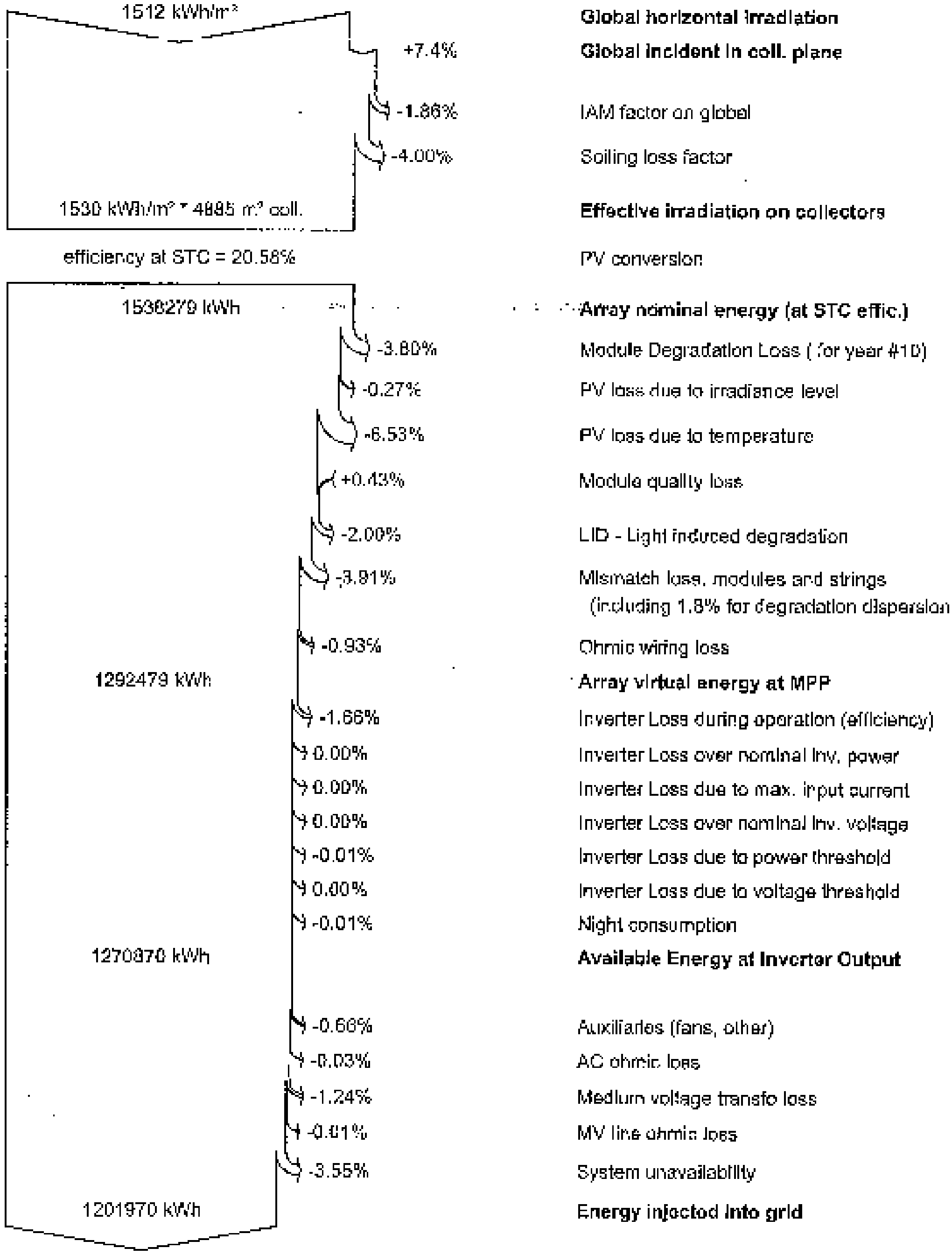
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	PR ratio
January	69.8	43.8	11.97	89.2	84.1	75051	0.648
February	91.5	47.0	16.08	112.8	106.6	93022	0.793
March	130.8	77.5	22.10	145.7	137.2	117704	0.779
April	160.2	87.6	27.05	165.9	156.2	130724	0.760
May	176.0	99.4	33.10	171.5	161.5	132068	0.742
June	169.5	102.6	33.05	160.2	150.7	124093	0.747
July	160.6	102.3	31.57	153.2	144.1	119855	0.641
August	151.4	95.3	30.79	151.6	142.7	118810	0.675
September	141.5	71.5	29.07	154.5	145.6	121017	0.755
October	115.7	69.5	26.00	135.2	127.6	107744	0.768
November	76.5	52.0	19.67	93.4	88.0	76644	0.788
December	68.5	41.9	13.92	90.7	85.5	75726	0.801
Year	1511.9	890.5	24.52	1623.8	1529.9	1292479	0.739

Legends

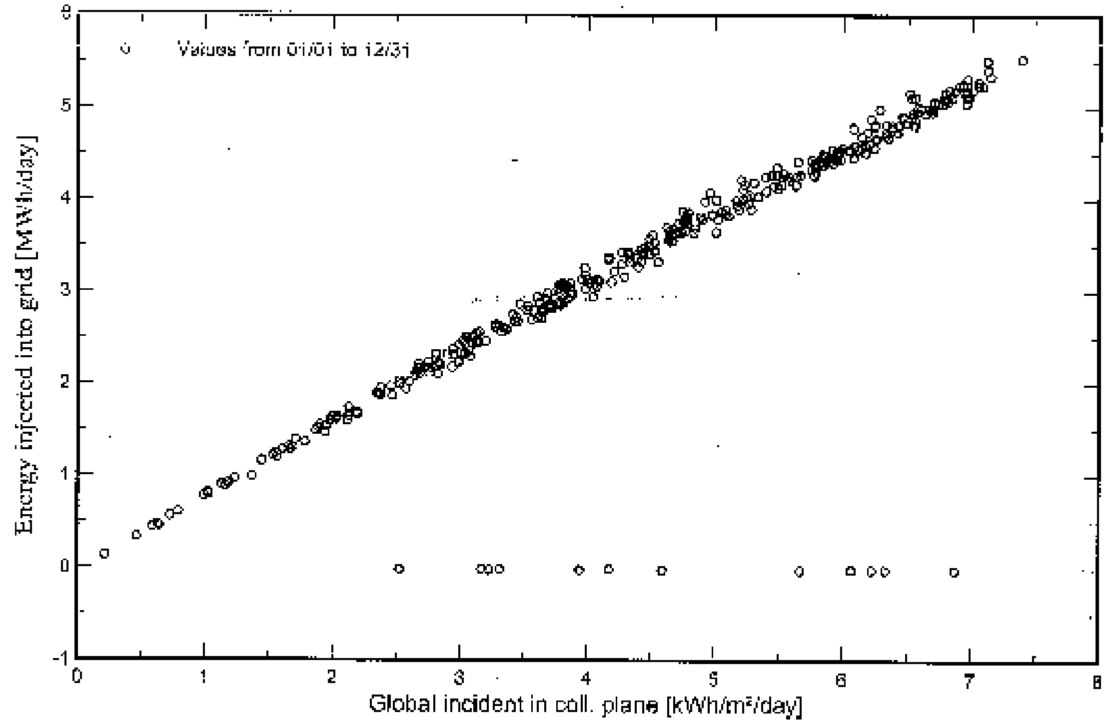
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	PR	Performance Ratio
T_Amb	Ambient Temperature		
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

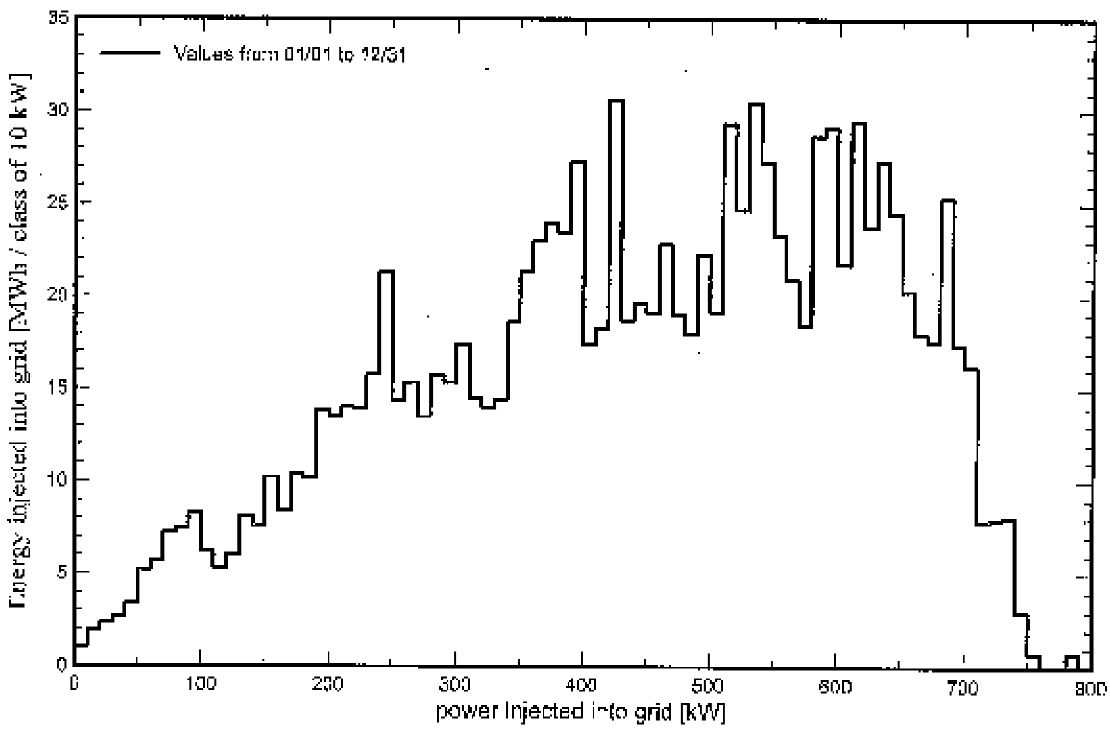


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	6.1 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	6.4 %

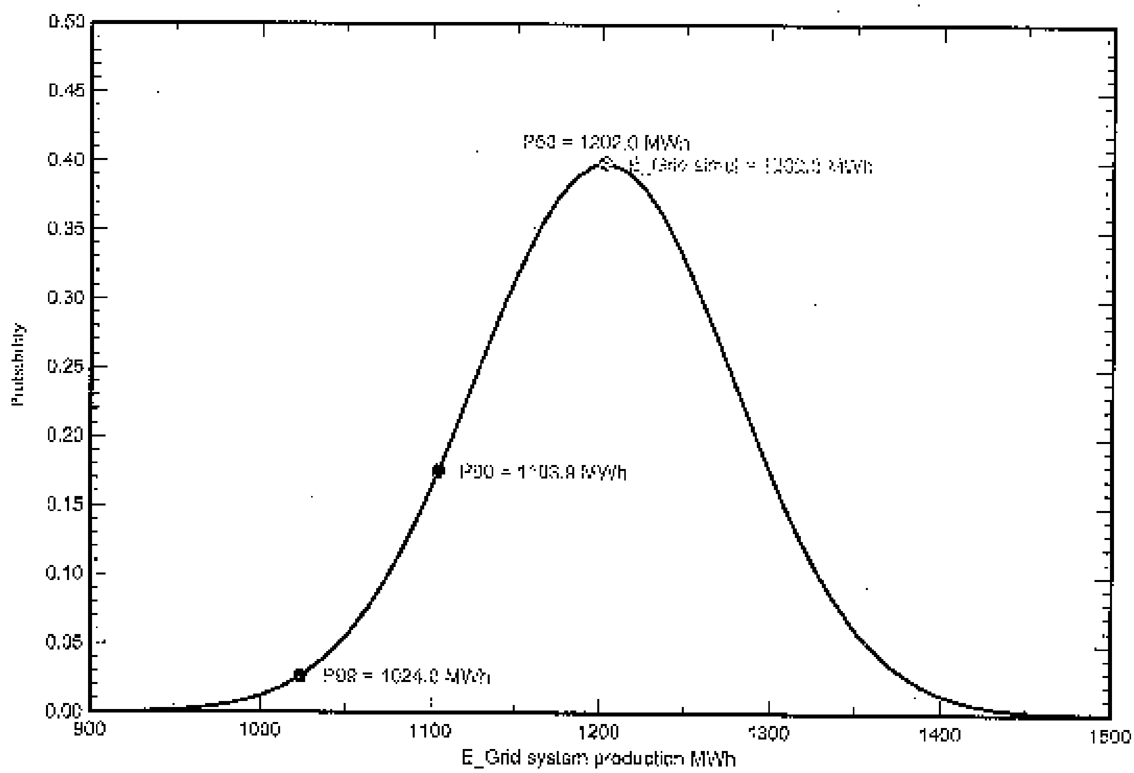
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

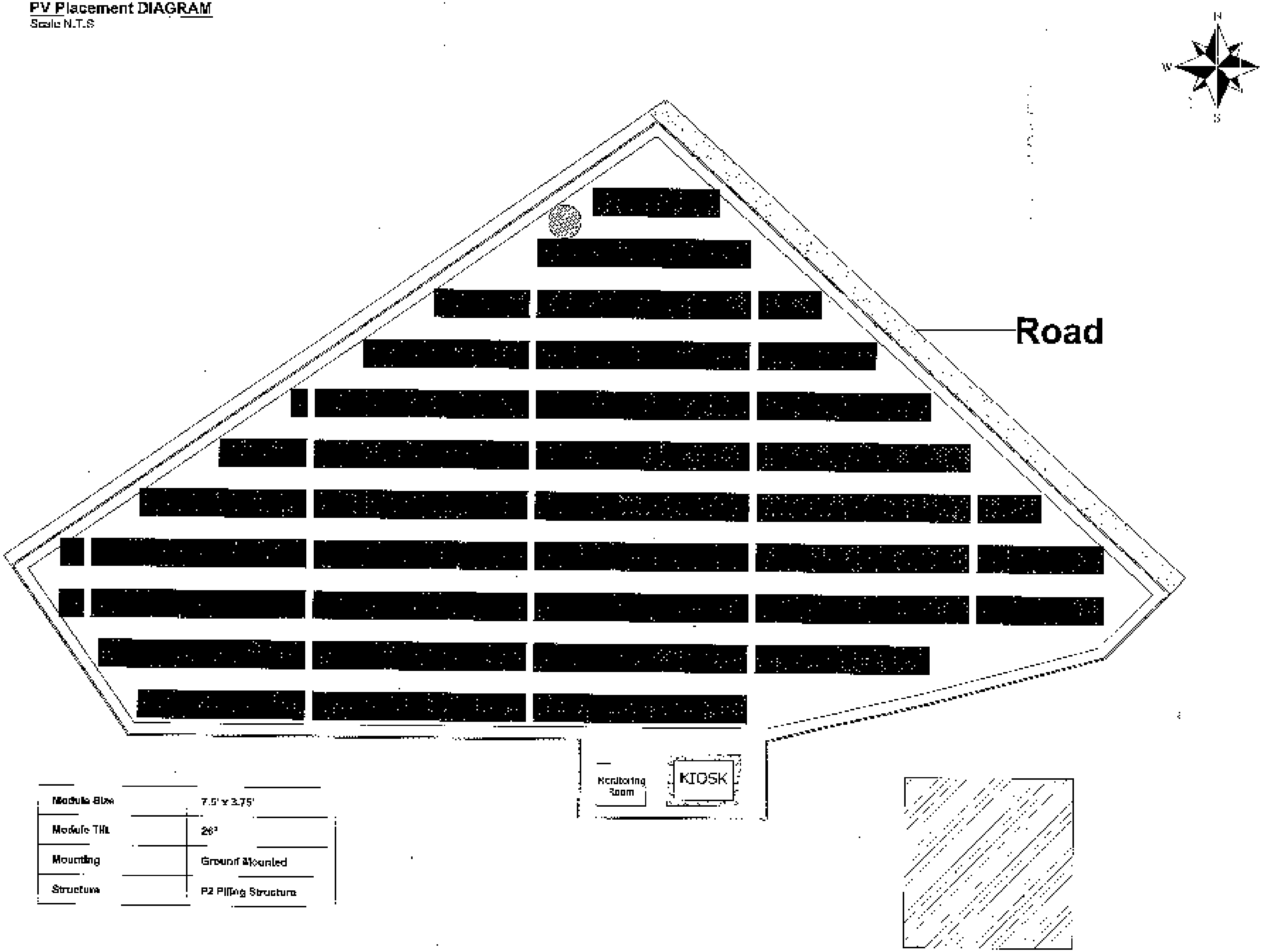
Annual production probability

Variability	76.5 MWh
P50	1202.0 MWh
P90	1103.9 MWh
P99	1024.0 MWh

Probability distribution



PV Placement DIAGRAM
Scale N.T.S



Module Size	7.5' x 3.75'
Module Tilt	26°
Mounting	Ground Mounted
Structure	P2 Pilling Structure

SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization P-III
CMH - Lahore

CLIENT:
Military Engineering Services

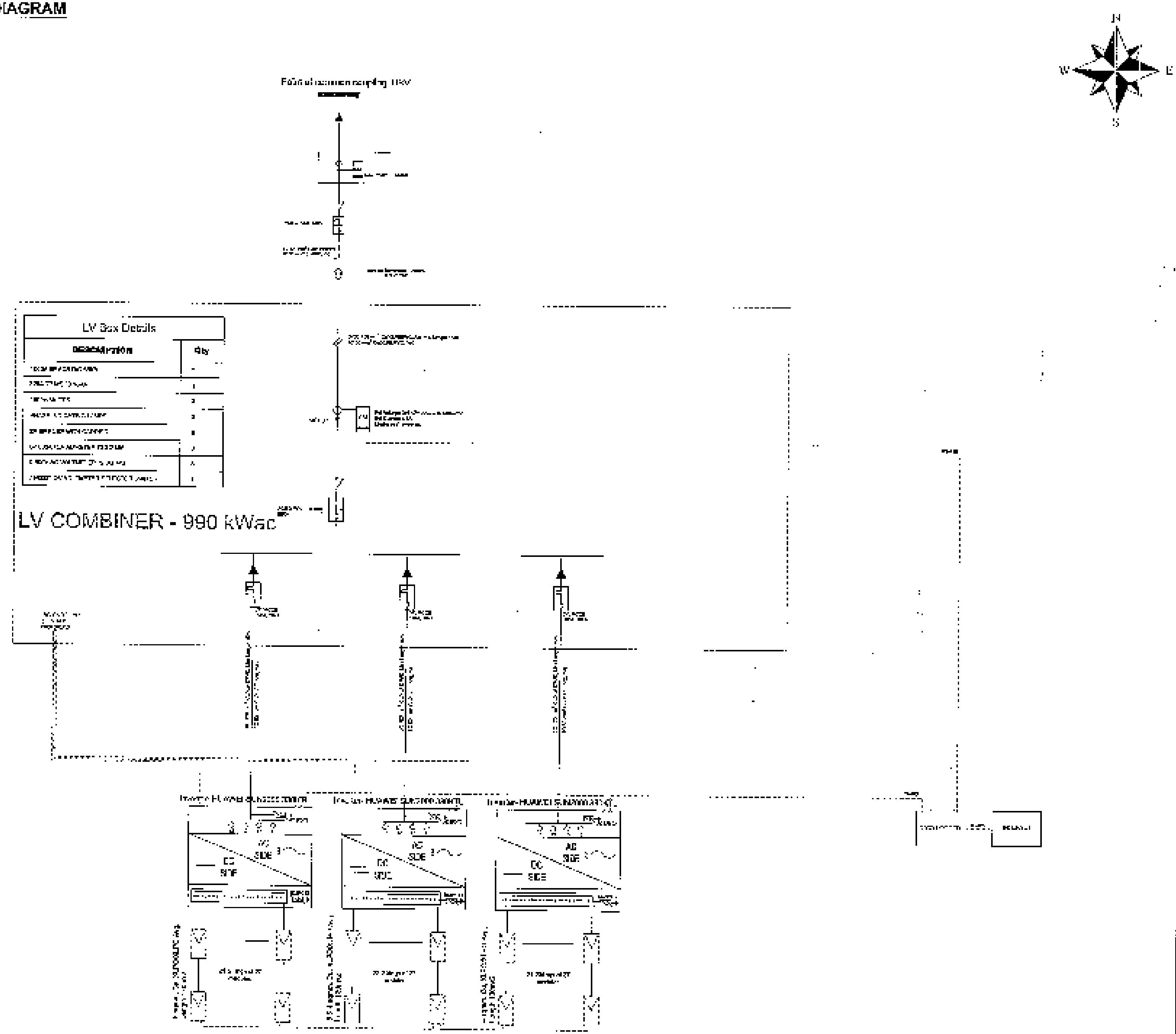
DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY

DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S	PAPER SIZE: A3	SHEET 1/3
DRAWN:	CHECKED:	APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization F-III
CMH - Lahore

CLIENT:
Military Engineering Services

DEVELOPER:
D:\images.png

REV | DESCRIPTION | DATE | DRAWN BY

DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S | PAPER SIZE: | SHEET:
DRAWN: | CHECKED: | APPROVED:

Annex - D

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: Lahore MES (Akram Line)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 501 kWp

Lahore Mes (Akram Line) - Pakistan

Author

Project summary

Geographical Site
Lahore Mes (Akram Line)
Pakistan

Situation

Latitude	31.53 °N
Longitude	74.39 °E
Altitude	217 m
Time zone	UTC+5

Project settings
Albedo 0.20

Meteo data
Lahore Mes (Akram Line)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array		**Inverters**	
Nb. of modules	864 units	Nb. of units	2 units
Pnom total	501 kWp	Pnom total	600 kWac
		Pnom ratio	0.835

Results summary

Produced Energy	595529 kWh/year	Specific production	1188 kWh/kWp/year	Perf. Ratio PR	72.86 %

Table of contents

PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:40
with v7.3.1

General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation		Sheds configuration		Models used	
Fixed plane		No 3D scene defined		Transposition	Perez
Tilt/Azimuth	26 / 0 °			Diffuse	Perez, Meteonorm
				Circumsolar	separate

Horizon	**Near Shadings**	**User's needs**
Free Horizon	No Shadings	Unlimited load (grid)

PV Array Characteristics

PV module		**Inverter**	
Manufacturer	CSI Solar	Manufacturer	Huawei Technologies
Model	CS7L-580MB-AG 1500V	Model	SUN2000-330KTL-H2
(Original PVsyst database)		(Custom parameters definition)	
Unit Nom. Power	580 Wp	Unit Nom. Power	300 kWac
Number of PV modules	864 units	Number of inverters	2 units
Nominal (STC)	501 kWp	Total power	600 kWac
Modules	27 Strings x 32 In series	Operating voltage	500-1500 V
At operating cond. (50°C)		Max. power (=>30°C)	330 kWac
Pmpp	460 kWp	Pnom ratio (DC:AC)	0.84
U mpp	976 V	Power sharing within this inverter	
I mpp	472 A		
Total PV power		**Total inverter power**	
Nominal (STC)	501 kWp	Total power	600 kWac
Total	864 modules	Number of inverters	2 units
Module area	2445 m²	Pnom ratio	0.84

Array losses

Array Soiling Losses		**Thermal Loss factor**		**DC wiring losses**	
Loss Fraction	4.0 %	Module temperature according to irradiance		Global array res.	34 mΩ
		Uc (const)	29.0 W/m²K	Loss Fraction	1.5 % at STC
		Uv (wind)	0.0 W/m²K/m/s		
Serie Diode Loss		**LID - Light Induced Degradation**		**Module Quality Loss**	
Voltage drop	0.7 V	Loss Fraction	2.0 %	Loss Fraction	-0.4 %
Loss Fraction	0.1 % at STC				
Module mismatch losses		**Strings Mismatch loss**		**Module average degradation**	
Loss Fraction	2.0 % at MPP	Loss Fraction	0.1 %	Year no	10
				Loss factor	0.4 %/year
				Mismatch due to degradation	
				Imp RMS dispersion	0.4 %/year
				Vmp RMS dispersion	0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

System losses

Unavailability of the system		Auxiliaries loss	
Time fraction	3.4 %	Proportionnal to Power	5.0 W/kW
	12.4 days,	0.0 kW from Power thresh.	
	3 periods	Night aux. cons.	500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.10 % at STC
Inverter: SUN2000-330KTL-H2	
Wire section (2 Inv.)	Alu 2 x 3 x 240 mm²
Average wires length	20 m

MV line up to Injection

MV Voltage	11 kV
Wires	Alu 3 x 95 mm²
Length	100 m
Loss Fraction	0.01 % at STC

AC losses in transformers

MV transfo

Medium voltage	11 kV
Transformer from Datasheets	
Nominal power	630 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.16 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	3.17 % at PNom
Coils equivalent resistance	3 x 32.25 mΩ

Main results

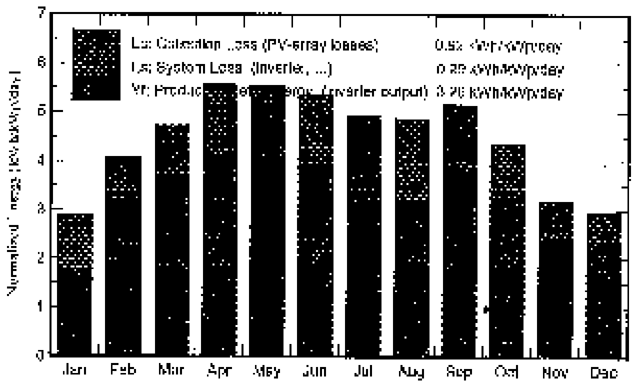
System Production

Produced Energy (P50) 595529 kWh/year
Produced Energy (P90) 546955 kWh/year
Produced Energy (P99) 507367 kWh/year

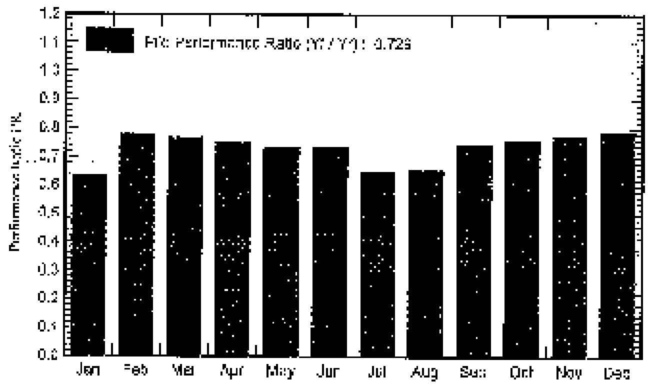
Specific production (P50) 1188 kWh/kWp/year
Produced Energy (P90) 1091 kWh/kWp/year
Produced Energy (P99) 1012 kWh/kWp/year

Performance Ratio PR 72.88 %

Normalized productions (per installed kWp)



Performance Ratio PR



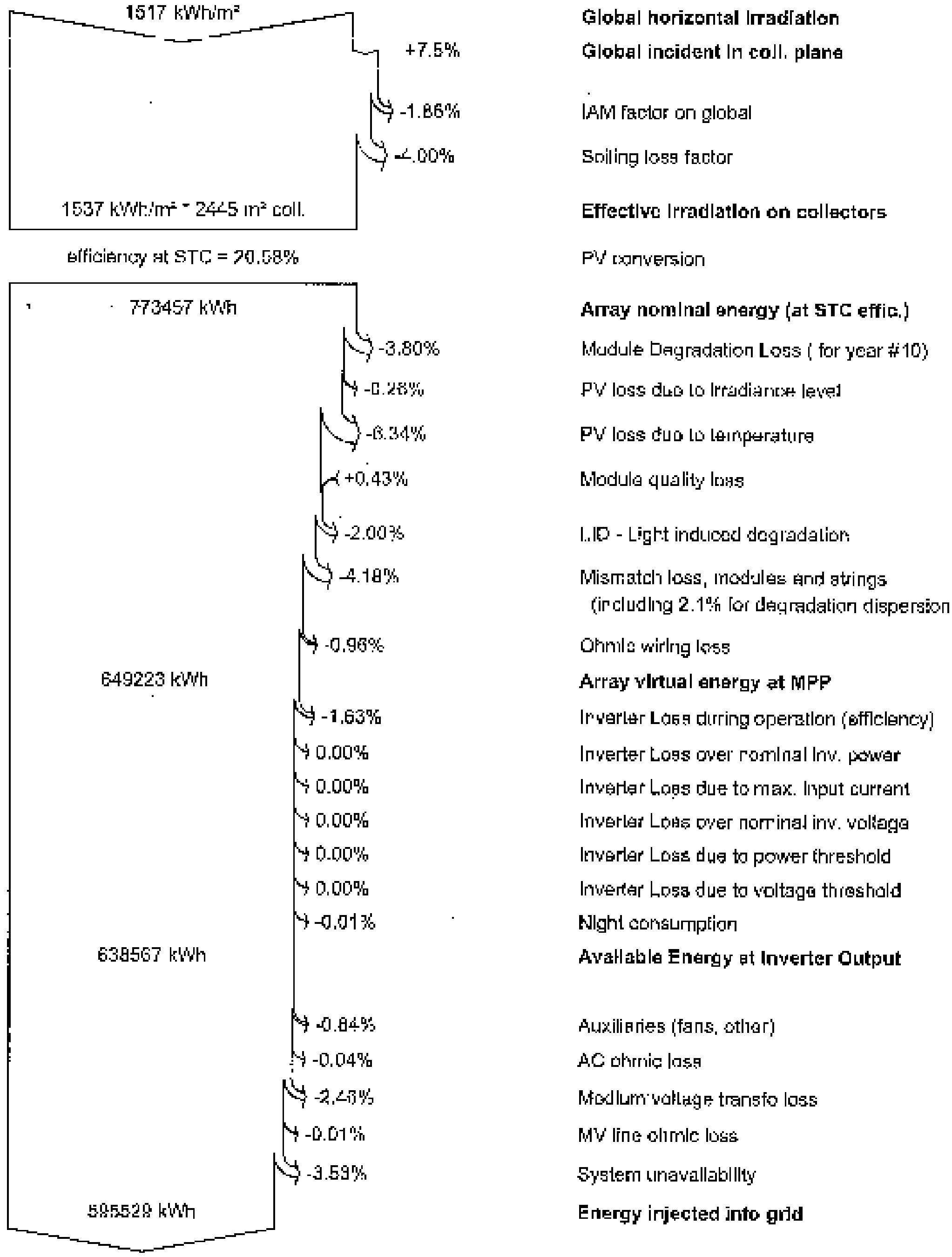
Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	kWh	kWh	ratio
January	69.8	43.8	11.37	89.2	84.1	37528	28371	0.635
February	92.5	46.5	15.69	114.4	108.1	47087	44653	0.779
March	131.6	77.3	21.71	146.8	138.3	59241	56368	0.766
April	161.0	87.2	26.85	166.8	157.1	65640	62526	0.748
May	176.7	99.0	32.94	172.2	162.2	66243	63090	0.731
June	169.5	105.7	32.79	160.3	150.8	62018	59076	0.736
July	160.5	105.1	31.24	153.2	144.0	59925	49693	0.647
August	151.1	95.5	30.47	150.9	142.0	59213	49407	0.653
September	141.8	74.6	28.75	154.3	145.4	60574	57618	0.745
October	118.2	71.3	25.59	135.5	127.9	54007	51303	0.756
November	77.2	50.6	18.59	95.9	90.4	39371	37208	0.774
December	69.1	42.5	13.44	91.7	86.5	38375	36218	0.788
Year	1517.3	899.2	24.16	1631.1	1536.7	649223	595529	0.729

Legends

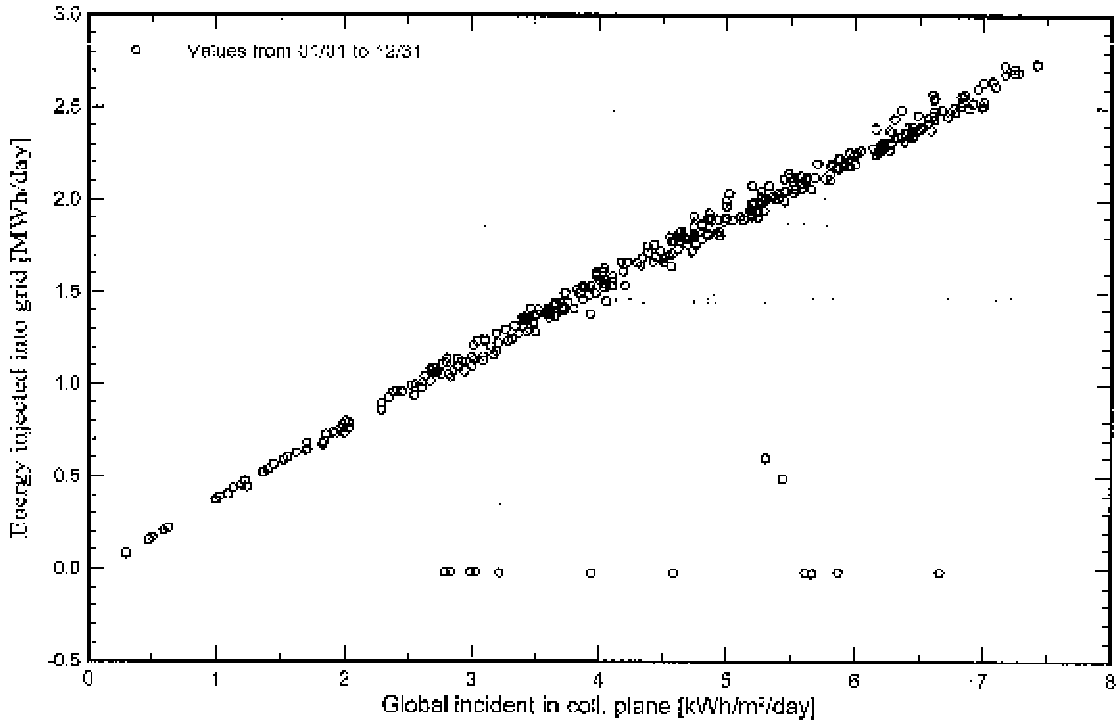
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

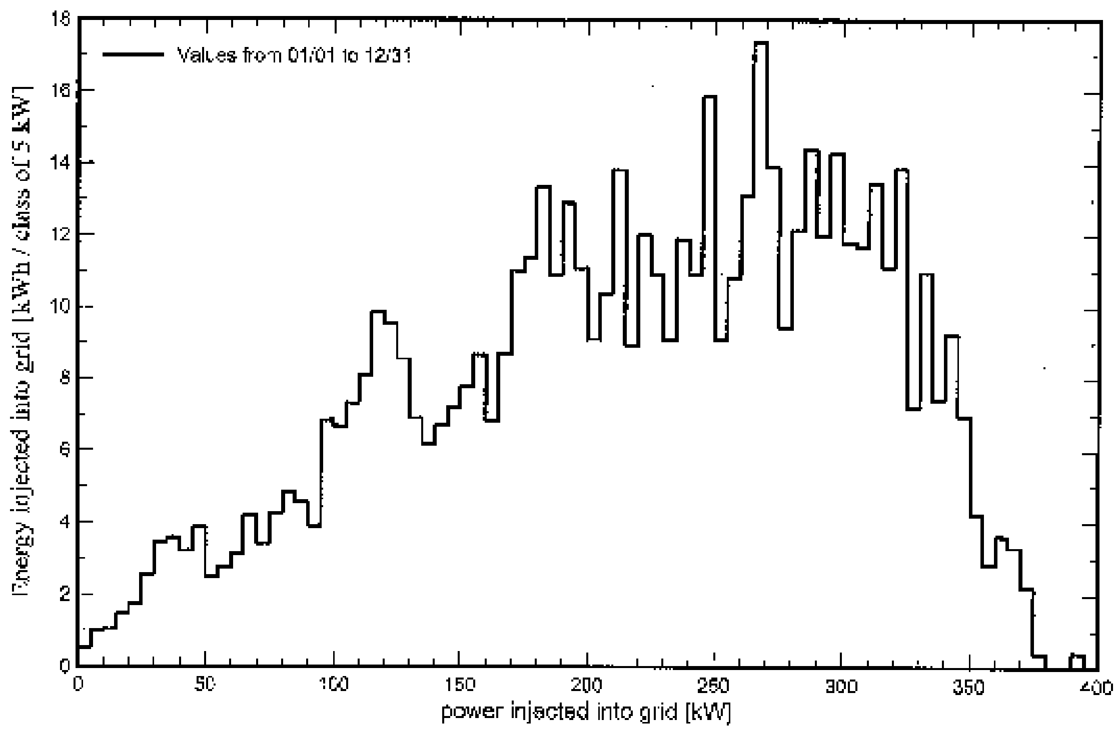


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	6.1 %
Specified Deviation	
Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	6.4 %

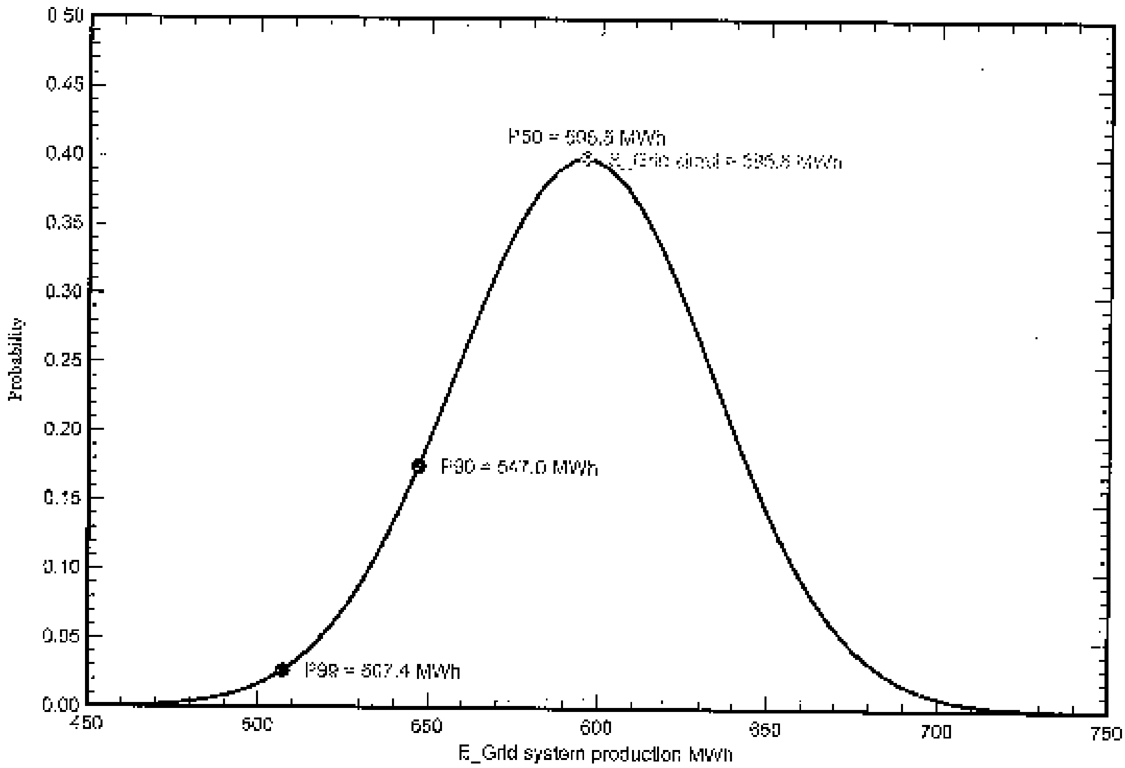
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

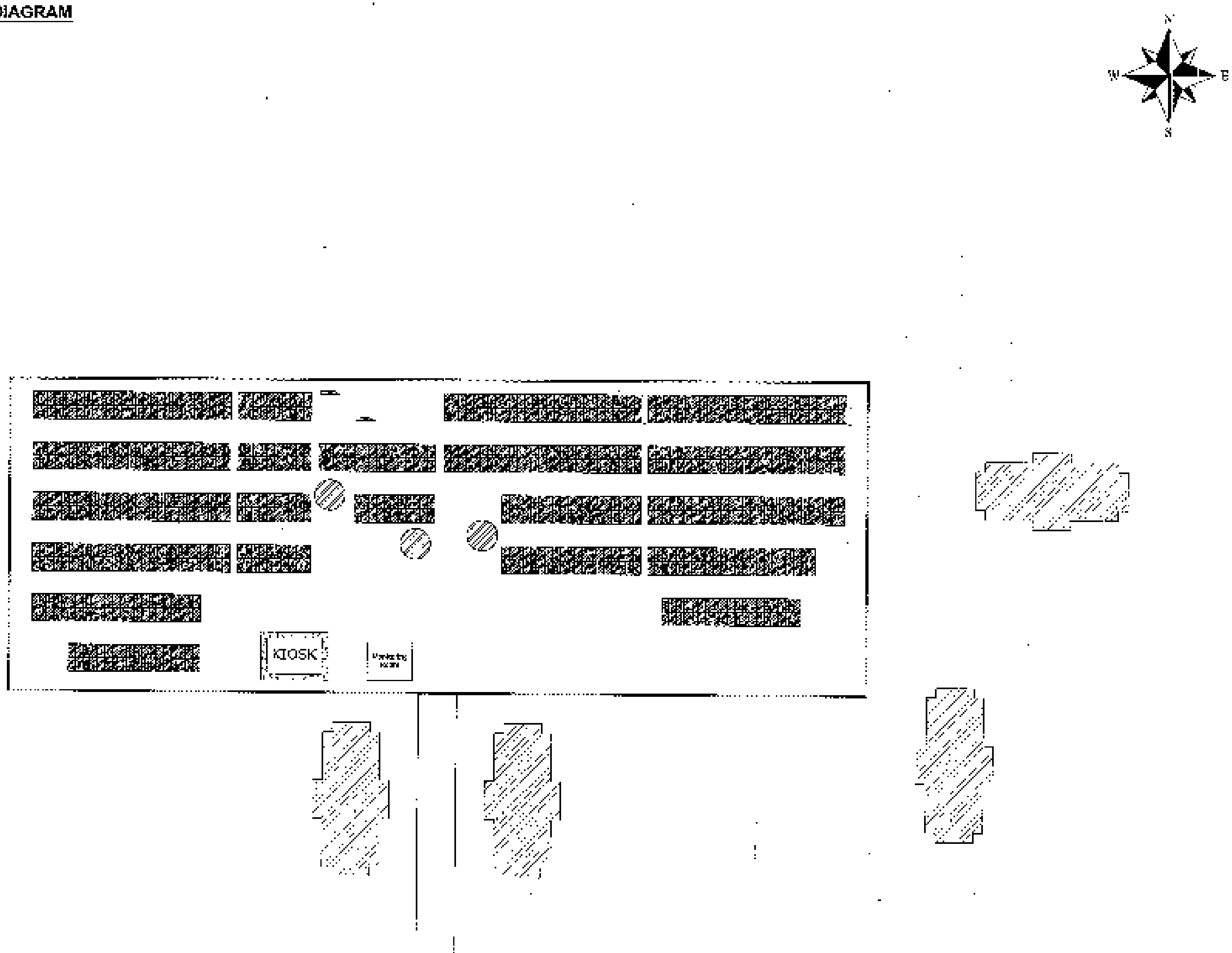
Annual production probability

Variability	37.9 MWh
P50	595.5 MWh
P90	547.0 MWh
P99	507.4 MWh

Probability distribution



PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization P-III
New Akram Lines - Lahore

CLIENT:
Military Engineering Services

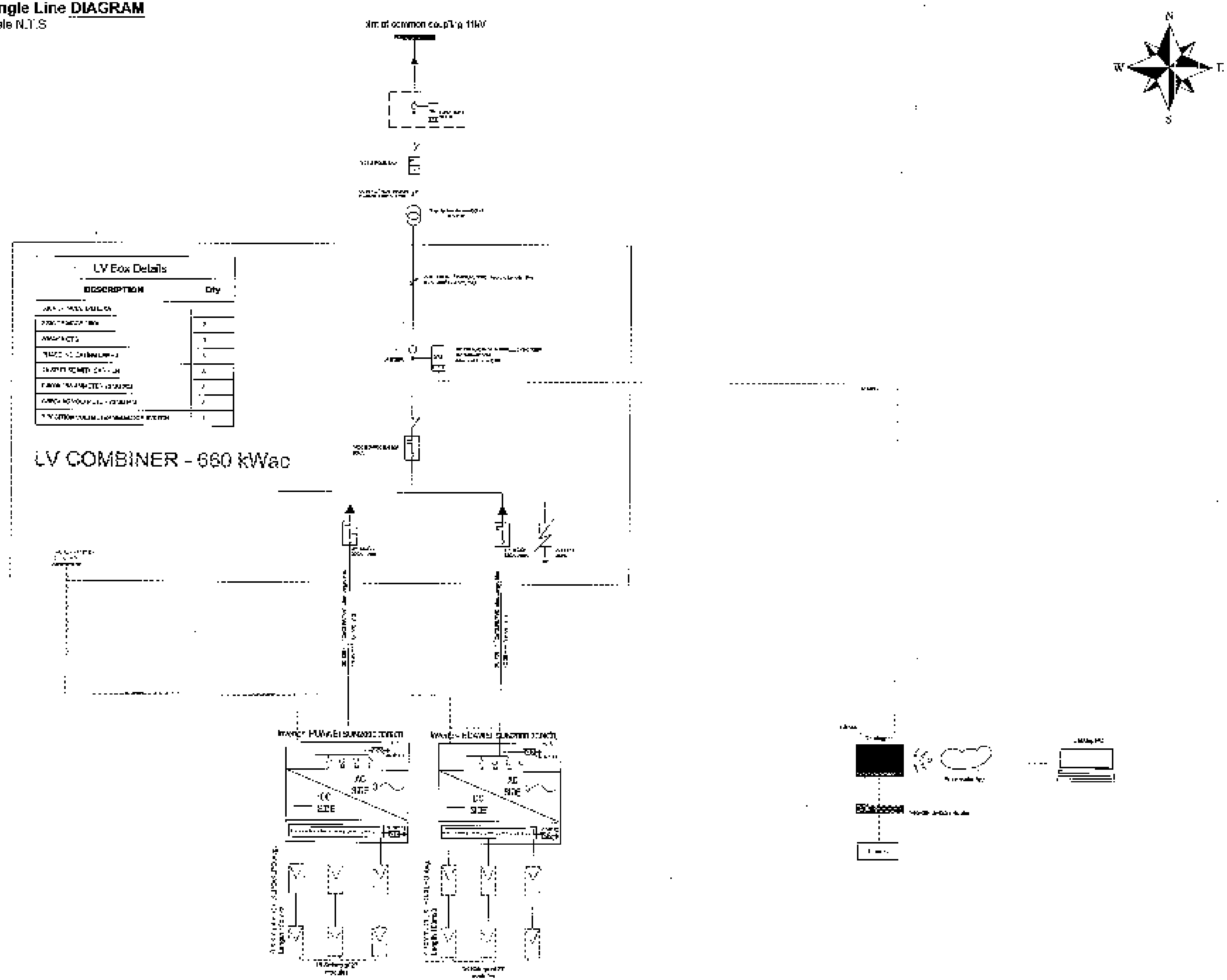
DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY

DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S
SHEET:
DRAWN:
CHECKED:
APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization P-III
New Aksari Lines - Lahore

CLIENT:
Military Engineering Services

DEVELOPER:

REV | DESCRIPTION | DATE | DRAWN BY

DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S

DRAWN:

CHECKED:

SHEET:

APPROVED:

Annex - E

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: Okara MES

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 1001 kWp

Okara MES - Pakistan

Author

Project summary

Geographical Site		**Situation**		**Project settings**	
Okara MES		Latitude	30.75 °N	Albedo	0.20
Pakistan		Longitude	73.35 °E		
		Altitude	170 m		
		Time zone	UTC+5		

Meteo data
Okara MES
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation		**Near Shadings**		**User's needs**	
Fixed plane		No Shadings		Unlimited load (grid)	
Tilt/Azimuth	26 / 0 °				

System information

PV Array		**Inverters**	
Nb. of modules	1726 units	Nb. of units	3 units
Pnom total	1001 kWp	Pnom total	900 kWac
		Pnom ratio	1.112

Results summary

Produced Energy	1353019 kWh/year	Specific production	1352 kWh/kWp/year	Perf. Ratio PR	78.68 %

Table of contents

General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation		**Sheds configuration**		**Models used**	
Fixed plane		No 3D scene defined		Transposition	Perez
Tilt/Azimuth	26 / 0 °			Diffuse	Perez, Meteonorm
				Circumsolar	separate
Horizon		**Near Shadings**		**User's needs**	
Free Horizon		No Shadings		Unlimited load (grid)	

PV Array Characteristics

PV module		**Inverter**	
Manufacturer	CSI Solar	Manufacturer	Huawei Technologies
Model	CS7L-580MB-AG 1500V	Model	SUN2000-330KTL-H2
(Original PVsyst database)		(Custom parameters definition)	
Unit Nom. Power	580 Wp	Unit Nom. Power	300 kWac
Number of PV modules	1726 units	Number of inverters	3 units
Nominal (STC)	1001 kWp	Total power	900 kWac
Array #1 - PV Array			
Number of PV modules	868 units	Number of inverters	9 * MPPT 17% 1.5 units
Nominal (STC)	503 kWp	Total power	450 kWac
Modules	31 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	463 kWp	Max. power (=>30°C)	330 kWac
U mpp	854 V	Pnom ratio (DC:AC)	1.12
I mpp	542 A	No Power sharing between MPPTs	
Array #2 - Sub-array #2			
Number of PV modules	858 units	Number of inverters	9 * MPPT 17% 1.5 units
Nominal (STC)	498 kWp	Total power	450 kWac
Modules	33 Strings x 26 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	457 kWp	Max. power (=>30°C)	330 kWac
U mpp	793 V	Pnom ratio (DC:AC)	1.11
I mpp	577 A	No Power sharing between MPPTs	
Total PV power		**Total inverter power**	
Nominal (STC)	1001 kWp	Total power	900 kWac
Total	1726 modules	Number of inverters	3 units
Module area	4885 m²	Pnom ratio	1.11
		No Power sharing	

Array losses

Array Soiling Losses		**Thermal Loss factor**		**Serie Diode Loss**	
Loss Fraction	2.0 %	Module temperature according to irradiance		Voltage drop	0.7 V
		Uc (const)	29.0 W/m²K	Loss Fraction	0.1 % at STC
		Uv (wind)	0.0 W/m²K/m/s		
LID - Light Induced Degradation		**Module Quality Loss**		**Module mismatch losses**	
Loss Fraction	2.0 %	Loss Fraction	-0.4 %	Loss Fraction	2.0 % at MPP

Array losses

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year

Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

DC wiring losses

Global wiring resistance 10 mΩ
Loss Fraction 1.5 % at STC

Array #1 - PV Array
Global array res. 26 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2
Global array res. 23 mΩ
Loss Fraction 1.5 % at STC

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 800 Vac tri
Loss Fraction 0.03 % at STC

Inverter: SUN2000-330KTL-H2
Wire section (2 Inv.) Alu 2 x 3 x 240 mm²
Average wires length 10 m

Inverter: SUN2000-330KTL-H2
Wire section (2 Inv.) Alu 2 x 3 x 150 mm²
Average wires length 0 m

MV line up to injection
MV Voltage 11 kV
Wires Alu 3 x 120 mm²
Length 392 m
Loss Fraction 0.08 % at STC

AC losses in transformers

MV transfo
Medium voltage 11 kV

Transformer from Datasheets
Nominal power 1250 kVA
Iron Loss (24/24 Connexion) 1.00 kVA
Iron loss fraction 0.08 % of PNom
Copper loss 2.00 kVA
Copper loss fraction 0.16 % at PNom
Coils equivalent resistance 3 x 0.82 mΩ

PVsyst V7.3.1
VC0, Simulation date:
01/08/24 17:58
with v7.3.1

Main results

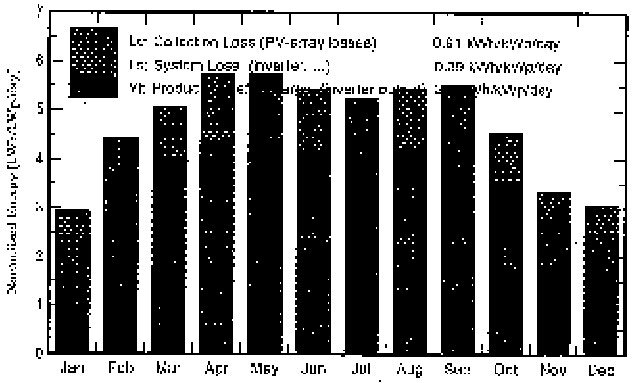
System Production

Produced Energy (P50) 1353019 kWh/year
Produced Energy (P90) 1267301 kWh/year
Produced Energy (P99) 1197439 kWh/year

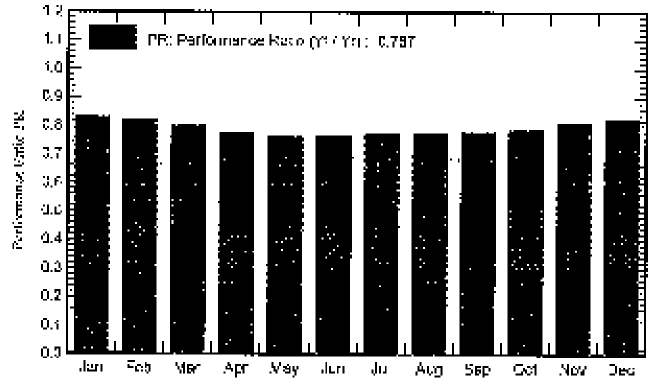
Specific production (P50) 1352 kWh/kWp/year
Produced Energy (P90) 1266 kWh/kWp/year
Produced Energy (P99) 1196 kWh/kWp/year

Performance Ratio PR 78.68 %

Normalized productions (per installed kWp)



Performance Ratio PR



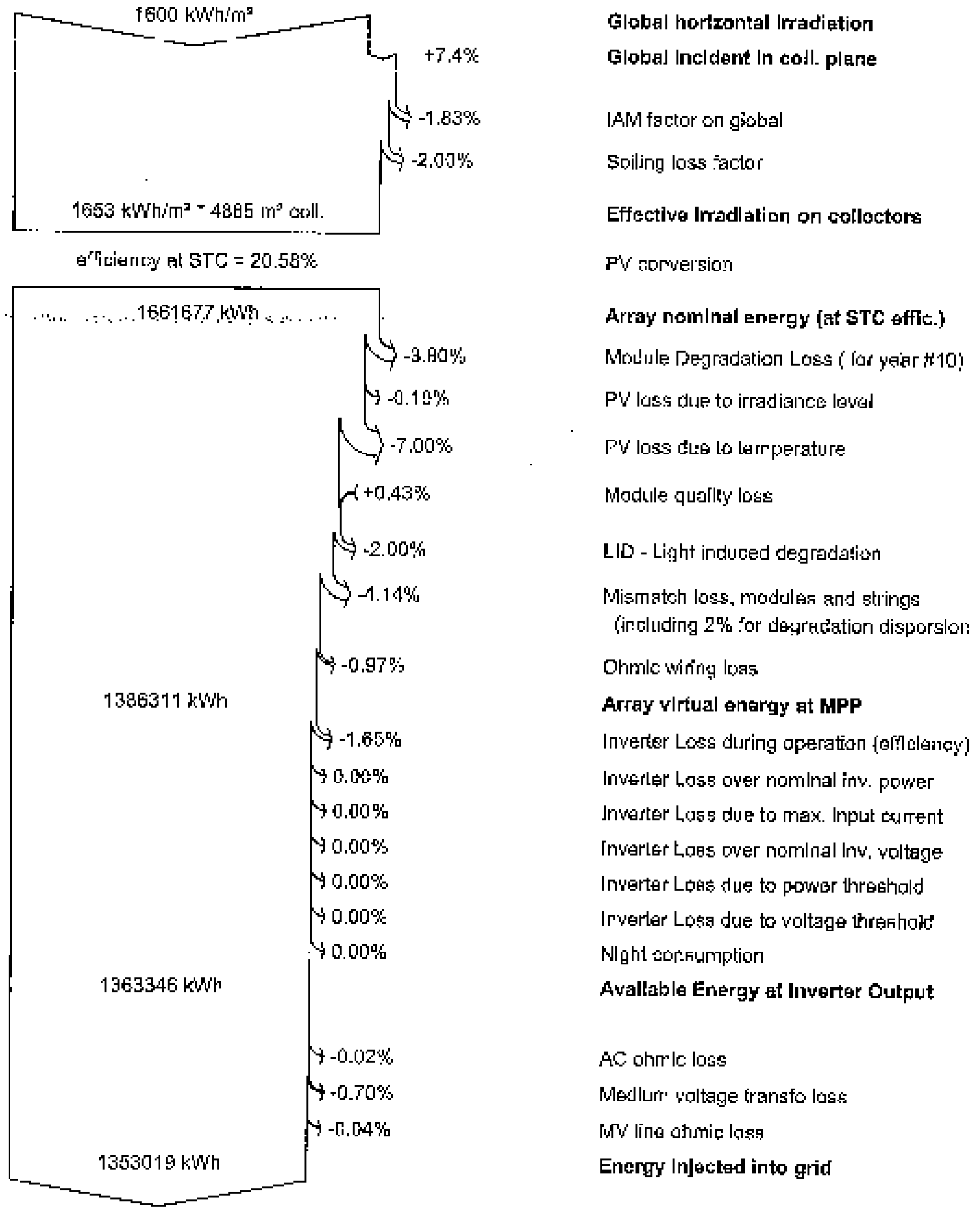
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	72.0	44.1	12.67	90.8	87.4	77537	75362	0.830
February	100.5	52.8	16.58	123.9	119.5	104112	101593	0.819
March	139.6	78.4	22.74	156.9	151.2	128386	125384	0.798
April	166.7	89.5	28.19	172.4	165.8	137437	134293	0.778
May	183.4	101.2	33.85	177.8	170.9	138844	135639	0.762
June	173.7	107.9	34.21	163.3	156.8	128068	125087	0.765
July	170.9	104.8	33.08	162.4	156.0	128382	125359	0.771
August	168.5	99.0	31.92	168.6	162.1	133754	130648	0.774
September	152.3	78.4	29.90	166.1	159.8	132403	129346	0.778
October	120.0	66.2	26.94	141.0	135.9	113872	111127	0.788
November	80.9	52.4	20.30	100.1	96.3	83176	80993	0.809
December	71.7	44.1	14.94	94.6	91.1	80339	78167	0.825
Year	1600.1	919.0	25.49	1717.7	1652.6	1386311	1353019	0.787

Legends

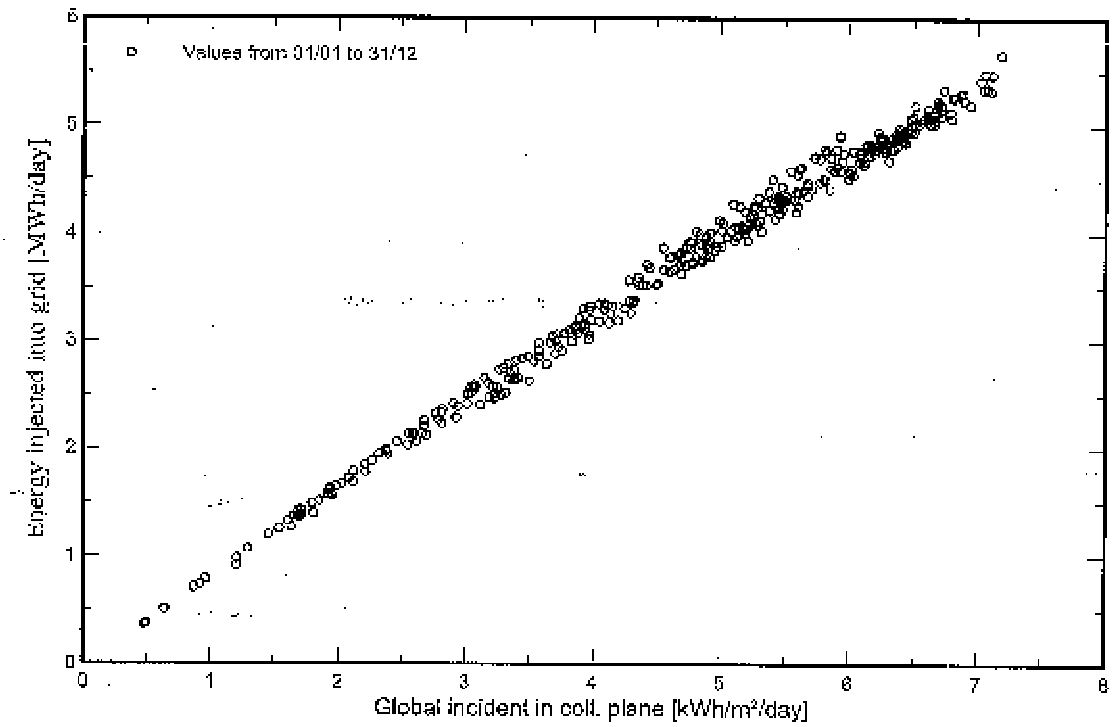
GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse irradiation
T_Amb	Ambient Temperature
GlobInc	Global incident in coll. plane
GlobEff	Effective Global, corr. for IAM and shadings
EArray	Effective energy at the output of the array
E_Grid	Energy injected into grid
PR	Performance Ratio

Loss diagram

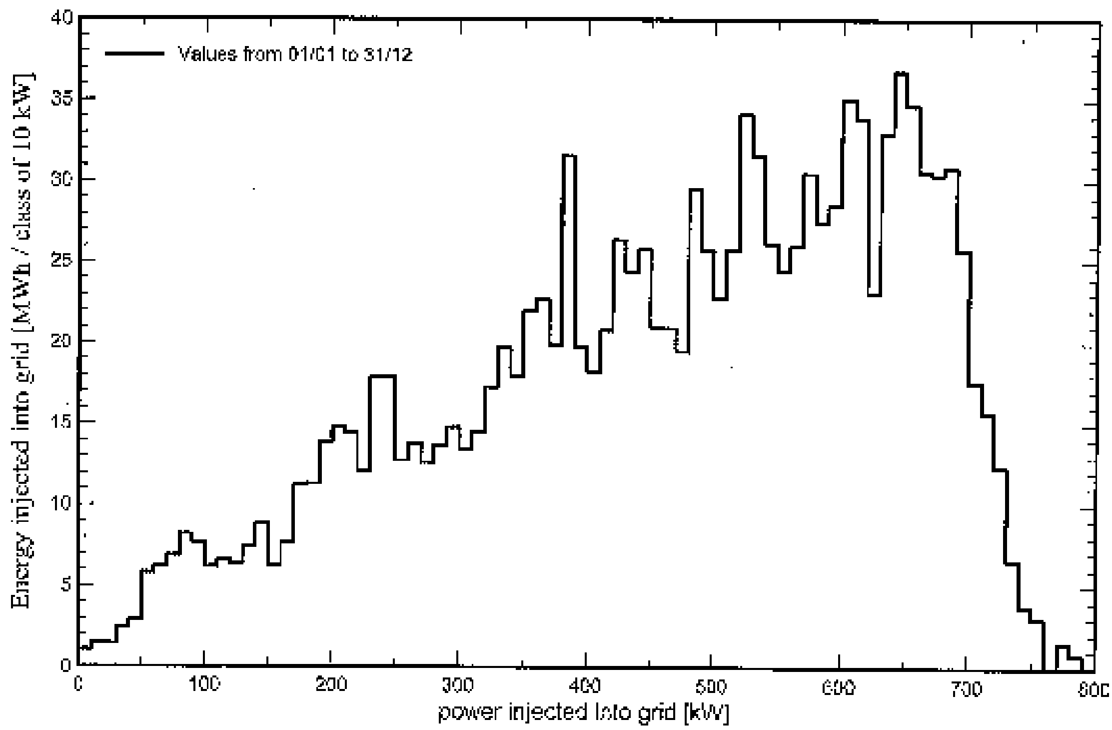


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%	
Kind	Monthly averages	
Synthetic - Multi-year average		
Year-to-year variability(Variance)		4.6 %
Specified Deviation		
Climate change		0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.9 %

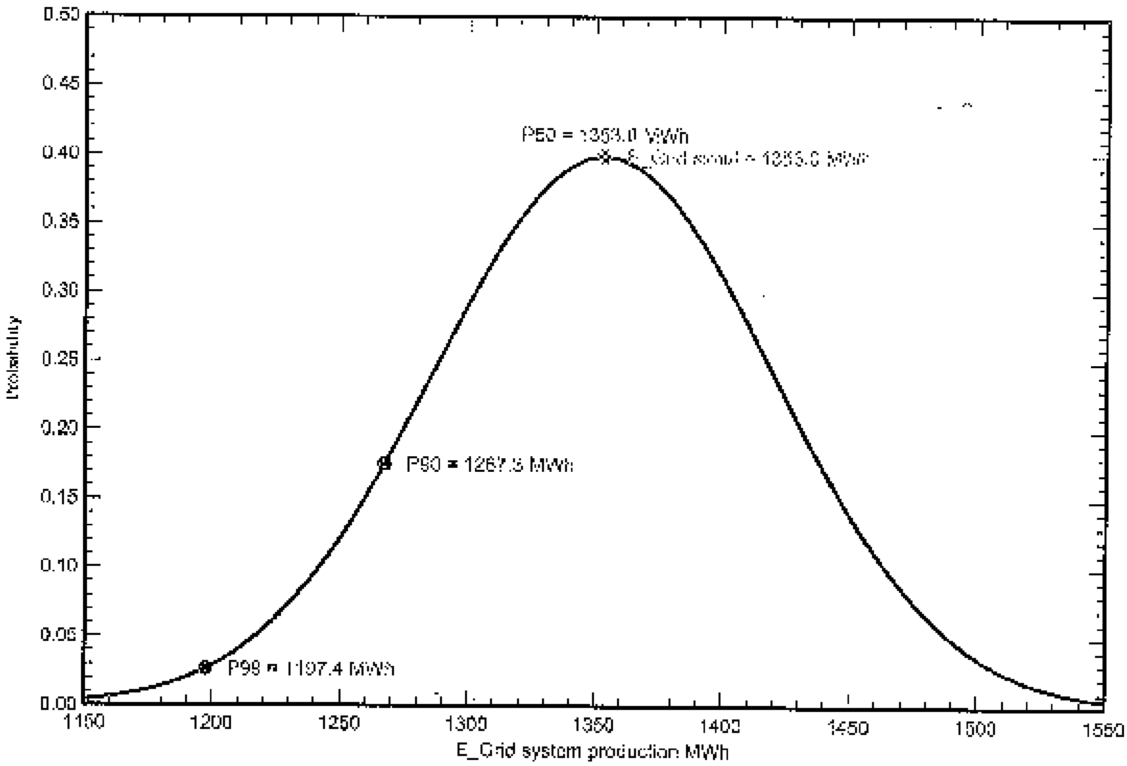
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

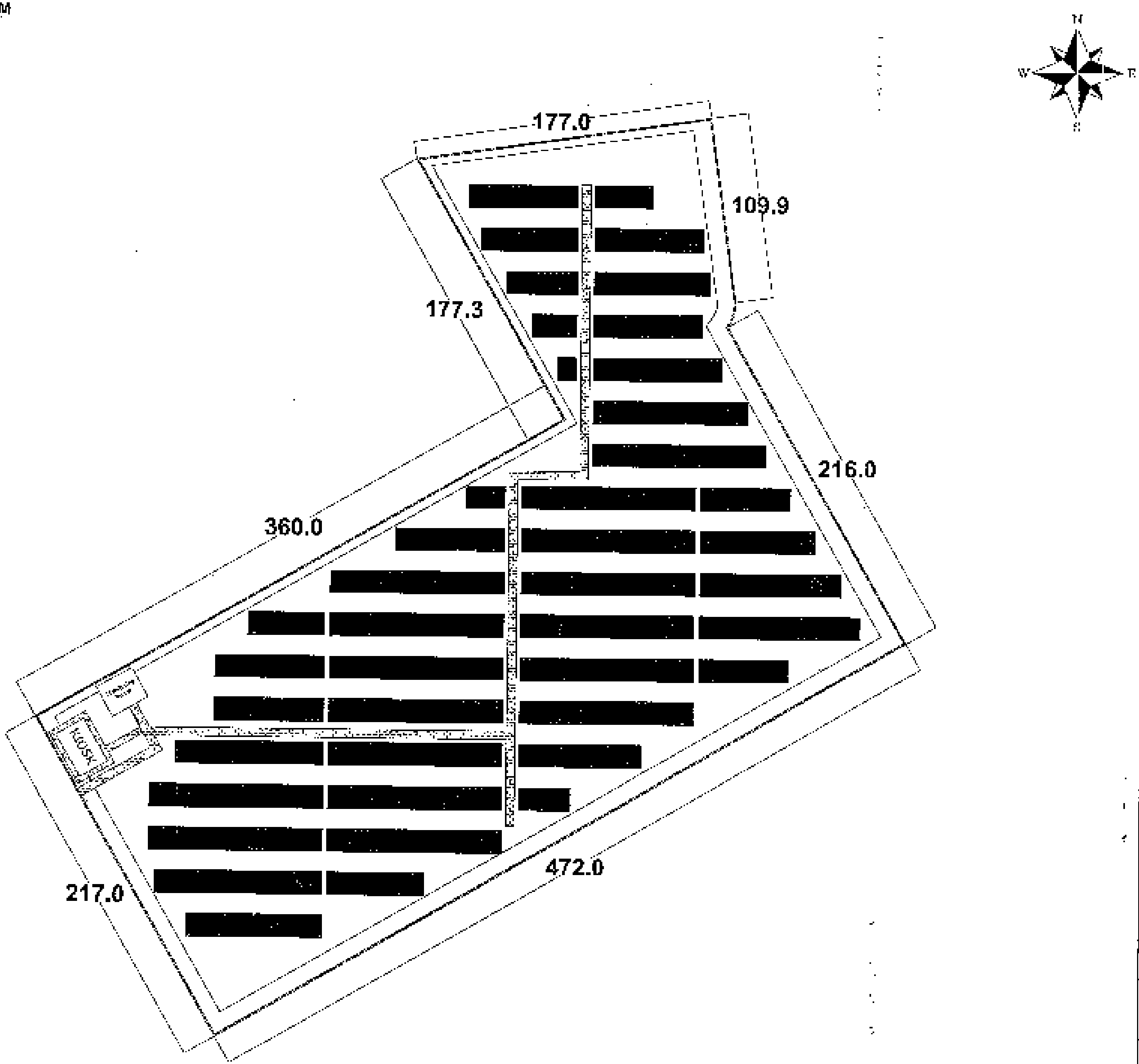
Annual production probability

Variability	66.8 MWh
P50	1353.0 MWh
P90	1267.3 MWh
P99	1197.4 MWh

Probability distribution



PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-III
Dinara Cantt

CLIENT: Military Engineering Services

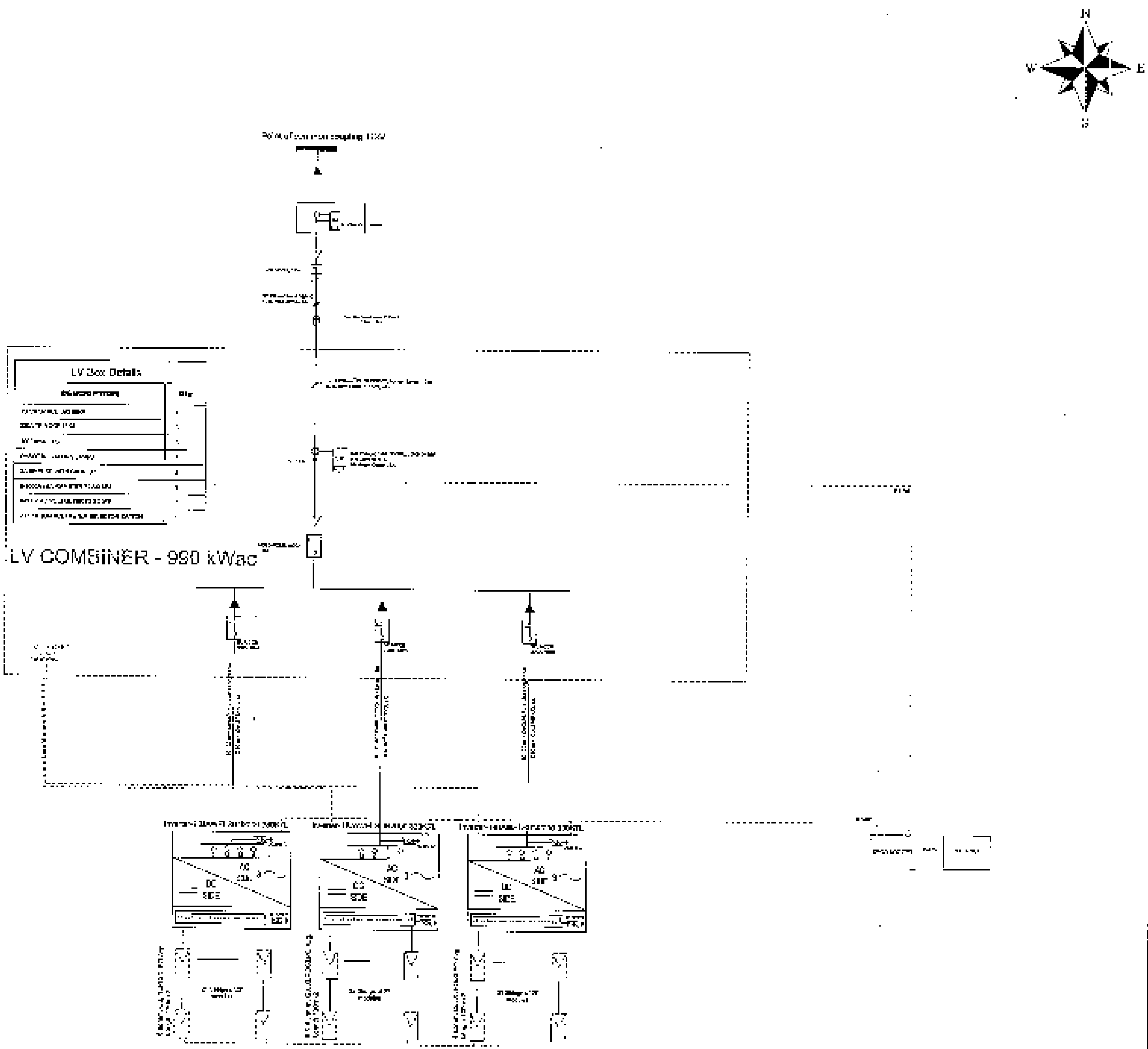
DEVELOPER:

REV | DESCRIPTION | DATE

DRAWING: SINGLE LINE DIAGRAM

SCALE: N.T.S | PAPER SIZE: A3 | SHEET: 1/3
DRAWN: | CHECKED: | APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT : MES Solarization P-[redacted]
Okara Cantt

CLIENT : Military Engineering Services

DEVELOPER : D:\Images\.png

DRAWING : SINGLE LINE DIAGRAM

SCALE : N.T.S | PAPER SIZE : A3 | SHEET :

DRAWN : | CHECKED : | APPROVED :

Annex - K (Project Cost)

Regulatory Complaince

#	Item	Vendor/Brand	Description	Quantity	Unit	Unit Cost (PKR)	Cost without Tax (PKR)	Tax Imposed	Final Cost (PKR)
1	Generation Licensing	NEPRA	3.5 MW - (5 Sites | 2 Cities)	1	Job	4,[illegible]	4,601,428	[illegible],220	[illegible]
2	Design & Engineering	NE	3.5 MW - (5 Sites | 2 Cities)						
3	Environmental Approval	[illegible]EPA	IEE | As per Regional Environmental Protection Agency						
						[illegible] Cost (PKR)	[illegible]	[illegible]	[illegible]

Civil Works

#	Item	Vendor/Brand	Description	Quantity	Unit	Unit Cost (PKR)	Cost without Tax (PKR)	Tax Imposed	Final Cost (PKR)
1	Geo Technical Studies	NE	Unit cost considered for each site mentioned in the zone.	5	Job	1,[illegible]	8,425,000.00	1,[illegible]	9,773,000.00
2	Land preparation	NE	Size 3.5 MW	5	Job	2,215,909.09	11,079,545.45	1,772,727.27	[illegible]
3	Roof Civil Works	NE	Size 0 MW	-	Job	2,260,000.00		-	
4	Fencing	NE	Unit cost considered for each site mentioned in the zone.	5	Job	2,[illegible]	13,000,000.00	2,[illegible]	15,080,000.00
5	Drainage	NE	Cumulative 1050 meters estimated length is considered for [illegible]	5	Job	2,[illegible]	13,125,000.00	2,[illegible]	15,225,000.00
6	Shed	NE	Kiosk Platform & Monitoring room at each site	5	Job	3,[illegible]	15,000,000	2,400,000	17,[illegible]
7	Living room	NE	Living room with basic accessories.	5	Job	2,[illegible]	12,500,000	2,000,000	14,500,000
8	Water Network	NE	Unit cost considered for each site mentioned in the zone	5	Job	1,420,000	7,[illegible]	1,278,000	8,[illegible]
						Civil Works Cost (PKR)	[illegible]	[illegible]	[illegible]

PV Plant

#	Item	Vendor/Brand	Description	Quantity	Unit	Unit Cost (PKR)	Cost without Tax (PKR)	Tax Imposed	Final Cost (PKR)
1	PV Panels	JA/JINKO/CANADIAN/LONGI/TRINA/[illegible]	Tier 1	3300	KWatt	23,430.20	[illegible]	-	80,026,875
2	PV Inverters	Huawei/Sungrow	Smart String Inverter - [illegible] Series	3300	KWatt	12,000.00	35,000,000.00	6,300,000.00	41,300,000
3	PV Structure	NE	HDG | P1b - P2	3300	KWatt	22,500.00	78,750,000.00	14,175,000.00	92,925,000
4	Cables	[illegible]	DC XLPO | AC XLPE [illegible]	1	Job	12,250,000.00	[illegible]	2,205,000.00	14,455,000
5	LV Switchgear	NE	LV switchgear for [illegible] systems	0	Job	1,200,000.00	-	-	-
6	Kiosk	NE	LV/MV Switchgear for ground mount systems	1	Job	77,[illegible]	77,[illegible]	13,[illegible]	91,273,[illegible]
7	Services	NE	Electrical | Mechanical | Civil	1	Job	65,000,000.00	65,000,000.00	10,[illegible]	75,[illegible]
						PV Plant Cost (PKR)	[illegible]	[illegible]	[illegible]

Total	442,207,848	60,717,956	502,925,804

Annex - L (Health and Safety Plan)

Contents

1.0. PURPOSE:

The purpose of this HSE Plan for Project of **Procurement of Grid Connected Solar PV Plants Aggregate up to 33MW at Various locations in Pakistan** is to identify the strategy and devise mechanism which is directed towards the better management of occupational Health, Safety, Environment (hereinafter referred to as HSE) for the Solar power project and demonstrates the NRTC Energies' overall approach in relation to health and safety to meet its health and safety obligations under both the Contract and Health and Safety Legislation

2.0. SCOPE:

The HSE Plan details the procedures and Standard Operating Procedures that shall apply to all activities coming under project scope of work at the project including the subcontractors employed by the contractor under the EPC contract. The scope of work shall be executed by supplying the designated materials, baseline manpower, temporary facilities, baseline equipment / tools, consumables, testing and inspection facilities and other services necessary to complete the scope of work.

3.0. NRTC's HSE POLICY:

Every employee, no matter from or sub-contractors shall recognize that health, safety, environment and community responsibilities are an integral part of his work.
We shall prevent harm to people, environment and community around us by:

- Developing management structure and procedures for implementations at all our workplaces and continuous improvement through regular monitoring.
- Fully abiding by applicable government legislation and regulations.
- Creating awareness amongst all the employees, through a comprehensive program, facilitated by HSE department and implemented by respective site and office management.
- Ensuring that every leader of an operation, whether in the field or office, is directly responsible for the judicious enforcement of an organized program upholding this HSE Policy.
- Making line managers, all personnel accountable for HSE management effort towards elimination of causes that might lead to harm people, environment and community.
- Ensuring that the management systems of our subcontractor and vendors are compatible with our own commitment to HSE.
- Participating in hazard identification, risk assessment and eliminating potential threats to HSE.
- Providing training and encourages behavior that upholds this policy.

- Every employee and subcontractors work shall endeavor to conserve the environmental resources and work in an environment friendly atmosphere.
- Developing environmental management standards in compliance with EPA & SEPA and their maintenance through application of inspection and audit system.
- Fully abiding by government legislations and regulations related to environmental preservation and pollution control.
- Communicating environmental Issues all across the company and investigation of incidents and violations thereof, to prevent recurrence.
- Ensuring commitment from our subcontractors and vendors to comply with environmental standards.
- Striving for continuous improvement in environmental matters.

4.0. OBJECTIVES:

Pursuant to the Policy Statement above, the following objectives are identified in order to create a positive approach to health, safety, and protection of the environment during all activities for project:

- To avoid all personal injuries during the execution of the Project, 'Target Zero LTI (lost time injury)'. ('Target Zero LTI' can be achieved by conducting risk assessments, safety trainings to employees and employers of the project, permit to work (PTW) system and implementation of HSE plan at site.)
- To ensure that all personnel employed on the project either employee or subcontractor employee are competent to carry out their designated tasks safely.
- To create positive health, safety and environment attitudes and perceptions at all levels of the project organization, and to raise health safety and environmental awareness in general.
- To implement a training program that supports the achievement of personnel competency in relation to Health, Safety, and the Environment.
- To complete the Project without Incurring any significant property damage to permanent equipment, or temporary facilities.
- To complete the Project with minimum avoidable impact upon the surrounding environment.
- To implement a hierarchy of communication forums that ensure that HSE concerns can be raised and addressed at all levels of the organization.
- To introduce a method of motivating good safety and environmental performance, which shall include the usage of commendation, as well as corrective techniques.
- To continually monitor and improve HSE performance.
- Ensure availability of resources to fully implement health and safety policy of the company.

5.0. SITE HSE RULES:

- All new workers of the contractor and subcontractors must go through the HSE Orientation before starting work, understand HSE Policy of **NRTC ENERGIES** and adhere to HSE rules.
- Personal Protective Equipment will be provided and must be worn when required. Safety shoes, overalls and hard hats in all site areas, masks, gloves and earplugs as required, etc.
- Follow the messages and instructions displayed on HSE boards installed on site. Be aware of emergency assembly points and escape routes. In the event of an emergency do not panic, follow the site emergency response procedures.

- Report promptly all accidents to your supervisor and HSE officer at site. Immediately provide first aid for the injured and call for the medic.
- While working in a confined space make sure that your nearby colleague and supervisor are well informed.
- Ensure adequate lighting is in place for work on night shifts or for emergency response.
- All scraps, waste materials and garbage must be disposed of in accordance with the construction waste management plan.
- Always clean work site after completing the job or shift. Maintain appropriate barricades as required. Never tamper with electric cables and appliances. Never insert direct cables into sockets, rather use proper plugs.
- Work at height is strictly prohibited without appropriate fall arrest systems in place. Ensure presence of strong side railings; there should be no gaps and ensure that all planks are secured appropriately.
- Do not enter scaffold that is not tagged safe for access.
- Tools or materials must not be carried while climbing up or down scaffolding or ladders. Use pouches or ropes for this purpose.
- Do not smoke or produce naked flame in NO SMOKING area. Use of open fire is prohibited.
- Keep all gangways and aisles clear and clean at work sites.
- Vehicles must be driven at a safe speed, observing speed limits. Drivers must have a valid driving license. Vehicles shall only be parked in designated parking areas.

6.0. MANAGEMENT SYSTEM AND RESPONSIBILITY:

Project Management is committed to a HSE Plan requiring that accountability will begin at the highest level of management. Each level of Project Management, Subcontractor Management, supervision and employees will claim ownership in, and take personal responsibility for their roles in the safety program and will act as a change agent to modify each employee's behavior positively towards working safely. Each level of management shall take on the responsibility for the safety of employees and comply with the project safety standards and requirements. Contractor and The Project Company will perform inspections and audits and continuous field monitoring jointly and/or separately to determine compliance to safety. Accountability is a critical part of the HSE Plan and will be implemented with positive reinforcement that will challenge everyone involved, irrespective of his level of responsibility, to achieve our mutual goal of "No Accidents." All activities will be governed by the assumption that, "all accidents can be prevented" and that the "behavior of all employees can be modified to work safely". In order to achieve a No Accident and No Injury culture all levels of management are required to subscribe to the following:

- A bold aligned commitment to the elimination of worker injury.
- Establishing a sense of urgency for the elimination of incidents and injury.
- Forming a powerful coalition with parties that can make a difference to lead the initiative.
- Creating a vision of No Accident that emphasizes the impact on people and the possibilities it creates.
- Communicating the vision to everyone many times and in many ways.
- Focusing on leadership, behavior and the environment for safety.
- Empowering everyone to act on the vision.
- Institutionalizing new approaches by articulating the connection between incident and No Accident and the project's business objectives.

6.1. Common Requirements

The management of HSE issues for contractor and subcontractors shall be based on the following:

- Performance Standards on Social and Environmental Sustainability
- Environmental, Health, and Safety General Guidelines.
- Ensuring the requirements of the contract.
- Contractor's HSE Policy.
- HSE issues must be integrated in all business areas and every subcontractor.
- All incidents can be prevented. Everyone responsible for safety, if anyone witness unsafe acts or conditions must act. Safe behavior must be promoted & rewarded in order to continuously improve working conditions.
- Establishing performance standards to eliminate or minimize risks to the HSE resulting from the work to be done.
- Establishing means for management of subcontractors and coordination of subcontractor's activities.
- The Project's HSE Policy, Objectives and Plan must be communicated to everyone.
- HSE risks associated to construction and commissioning activities must be understood and managed effectively.
- Workers must be competent to carry out their designated work.
- Corrective and preventive actions must be implemented.
- HSE shall not be compromised in order to achieve any objective.
- HSE Management Plan update as necessary.
- Performance must be openly reported.
- Consequences for non-compliance:
- HSE violations are not condoned, tolerated and accepted as the norm, but strict disciplinary action shall be taken against violators as per the disciplinary procedures.

6.1.1. Legal and Other Requirements:

The EPC Contractor shall comply with its obligations (with respect to the EPC Contractor, its subcontractors and otherwise) under and in accordance with the HSE Audit Requirements. The EPC Contractor shall additionally grant or ensure the grant to the Project Company and the Client of all the rights accorded to the Project Company and the Client under and in accordance with the HSE Audit Requirements.

HSE-related laws and regulations of Pakistan.

- Environment Protection Rules of Pakistan, 2054(1997)
- Environment Protection Act of Pakistan, 2053 (1997)
- National Ambient Air Quality Standard (NAAQS; issued in 2003)
- Environmental Impact Assessment (EIA; issued in 1993)
- Labor Protection Act of Pakistan (2010)

6.2. ORIENTATION AND TRAINING:

6.2.1. HSE orientation:

Every person will undergo an HSE orientation program. On completion of orientation he/she will be issued an ID card and permitted to enter the site. HSE orientation shall be performed by Safety Manager, based on but not limited to the following:

- introduce and explain HSE Policy and Project organization.
- General HSE rules and regulations for working at the project, including use of PPE, electrical equipment, Working at the height, accident Reporting, First Aid, Emergency Response, HSE Inspection, Housekeeping, etc.
- Risk Identification, Risk Assessment and Control at construction site, works, offices, etc. Specific hazards like work at height, electrical, fire, crane, scaffold and vehicle safety etc. Environmental hazard.

6.2.2. HSE Training:

This training is to improve all kinds of engineers as civil engineers, electrical engineers, quality engineers, especially HSE engineers, for the safety management level and quality to better reflect pairs of responsibilities system, people-oriented principle, and be conducted by the Safety Manager and HSE engineers.

- HSE rules and regulations
- HSE theoretical knowledge
- Risk Identification, Risk Assessment, Risk Controls.
- Typical accident case.
- HSE induction training for new personal
- HSE training for management and supervision
- Emergency evacuation training
- HSE Training Weekly
- Occupational Health and safety
- Fire Safety & prevention
- Emergency Response Preparation
- Onsite Waste Management
- PPE Training
- Driver Safety
- Implementation of environmental and social management plan

6.2.3. HSE Induction Training for New Personal:

All employees must attend a site-specific orientation presented by Contractor/Subcontractor prior to the start of work or as required when site conditions change such as when there is a change in the construction phase and/or during recommissioning and start-up. The goals set for the project, the project safety rules and regulations and the No Accident philosophy will be communicated to all employees, supervisors and managers. The course will also emphasize the importance of human life and promote employee ownership and accountability by utilizing behavior based safety techniques. The subcontractor should give the new hire internal orientation and submit the copy of attendance list to HSE department before the start of the site work.

The orientation should include but not limited to following:

- Safety and environment policy,
- Basic PPE,
- Emergency preparedness and response plan,
- evacuation plan,
- Disciplinary procedure,
- Site safety and environment rules,
- Security procedure,
- Applicable HSE legalization and regulations.

6.2.4. Tool Box Talk:

- All supervisors will be trained to deliver daily tool box talk in their respective areas.
- Subjects for "tool box talks" would be selected to reflect the specific hazards of a particular site, feedback from first line supervisors/ HSE inspectors and observation / input from any other employee.
- Incidents, which may occur in the site, shall also be discussed in "tool box talks". Annexure:018

6.2.5. First Aid Training:

- First AID training will be conducted by safety Manager.
- Although all employees will be trained in basic first aid, having got training in advance first aid will be posted at selected points to impart first aid, when required.

7.0. HSE INSPECTION:

7.1. Check List:

Safety Check List is an effective management procedure for the discovery of potential hazards and the implementation of various laws and regulations. Safety Check Lists comprise of and will be used as per site requirements:

Annexures	Description
Annexure:001	Minutes OF Meeting
Annexure:002	Safety Signs
Annexure:003	Environmental Inspection
Annexure:004	Hazardous Waste inspection
Annexure:005	Ladder Inspection
Annexure:006	Permit to Work
Annexure:007	Confined Space
Annexure:008	Chemical Inventory
Annexure:009	Fall Protection
Annexure:010	Job Safety Analysis
Annexure:011	DG Inspection
Annexure:012	Electrical Safety
Annexure:013	Monthly Fire Extinguisher
Annexure:014	Hazard Identification
Annexure:015	Scaffold Inspection

Annexure:016	Housekeeping
Annexure:017	Daily TBT
Annexure:018	HSE Rules
Annexure:019	Daily EHS Report
Annexure:020	Lifting Activities
Annexure:021	Accident Report
Annexure:022	Risk Assessment Format
Annexure:023	EHS Orientation
Annexure:24	Training plan/Record

- Others, if necessary

7.2. Periodic Inspection:

HSE periodic inspection include weekly, monthly, quarterly HSE inspection that will be respectively conducted by engineers, Safety. After completion, HSE inspection reports must be delivered to relevant company, department, personnel, so that they can correct unsafe behaviors, conditions and circumstances. HSE monitoring will be conducted all time until unsafe behaviors, conditions and circumstances are corrected thoroughly.

8.0. HSE MEETING:

8.1. Weekly HSE Meeting:

Weekly HSE Meetings chaired by the Safety Head, will be held each week with all sub-contractors and nominated Engineers, Supervisors etc. All-important HSE matters of the site as well as the results of the HSE inspect and corrective action will be discussed in weekly HSE meeting. The meeting will promote the Implementation of the HSE management and rectification.

9.0. Risk Management:

Hazard Analysis and Risk management techniques shall be carried out on all life critical and asset damaging activities, so that all the potential hazards are identified and evaluated prior to execution, thereby enabling either substitution or adoption of control techniques. All method statements, hazard analysis & control sheets will be reviewed.

9.1. Risk Identification:

Hazard Analysis and Risk management techniques shall be carried out on all life critical and asset damaging activities, so that all the potential hazards are identified and evaluated prior to execution, thereby enabling either substitution or adoption of control techniques. All method statements, hazard analysis & control sheets will be reviewed.

9.2. Hazards Type:

Following are examples of typical hazards that can be encountered:

- Fire (Fire extinguishers will be set on any location based on the risk assessment)
- Falling objects

- Falls from heights
- Grinding
- Erection of steel work
- Installation of equipment
- Electric shock.

9.3. Interface Potential Hazards:

- Existing emergency evacuation procedures
- Emergency communication system
- Protective equipment requirements
- Waste disposal

9.4. Risk Assessment:

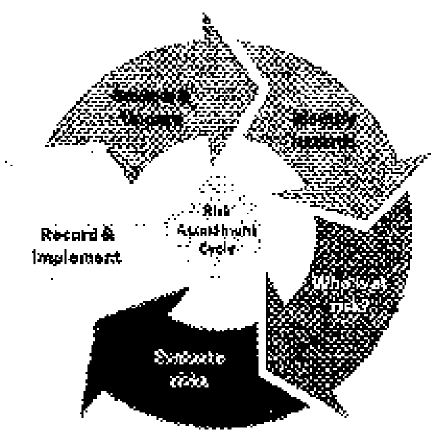
The responsibility for ensuring that risk assessments are carried out lies with Health & Safety Head.

The Head of HSE must ensure that all operations likely to give rise to risk are fully assessed and that control measures are put in place to reduce any significant risks.

Basic Five Steps for a Risk Assessment:

Five steps to risk assessment can be followed to ensure that your risk assessment is carried out correctly, these five steps are:

- Identify the hazards
- Decide who might be harmed and how
- Evaluate the risks and decide on control measures
- Record your findings and implement them
- Review your assessment and update if necessary



Procedure to calculate risk level by matrix method

The matrix works by selecting the appropriate consequences from across the top, and then cross referencing against the row containing the likelihood, to read off the estimated risk rating.

The following is a guide to the matrix's risk rating clarification.

Insignificant Risk. No action is required.

Medium Risk. Efforts should be made to mitigate the risk. Risk should only be tolerated for the short term, and then only whilst further control measures to mitigate the risk are being planned and introduced, and these within a pre-defined time period. However, the costs of prevention should be carefully measured. Where the moderate risk is associated with extremely harmful consequences, further assessment maybe necessary to establish more precisely the likelihood of harm, this as a basis for determining the need for improved control measures.

High Risk. Work activities should not be started until the risk has been mitigated. Significant resources may have to be allocated to mitigate the risk. Where the risk involves work in progress, urgent action should be taken.

Extreme Risk. Work should not be started or continued until the risk has been mitigated. If it is not possible to mitigate risk even with unlimited resources, the work should remain prohibited.

- The Safety Manager will assign duties for the preparation, review communication, coordination and Implementation, of the work method statement and risk assessment process, to the concerned individuals of execution team.
- Details on who is doing the work and the respective disciplines, numbers involved, date of preparation and reference number to be supplied by the individual responsible for managing and controlling the work - an outline definition of the work scope to be provided, and then any risks identified in terms of high potential, should be highlighted and addressed as part of the stage two procedure on risk assessment.
- It is essential for the purpose of this procedure that all tools and equipment are listed and a Performa providing a list of considerations should be reviewed against the previous sections and after undergoing the approval route of this procedure, an assurance regarding communication should be made that parties involved with the task are fully aware of the steps, procedures and considerations necessary to undertake the task.
- Following the completion of the work method statement Performa, an evaluation will be made as to any identified hazards which shall be ranked in order of magnitude against the list of hazards.
- The rankings are given as low, medium and high in terms of probability and severity, the assessment should therefore be based on what the hazards are and what potential exists for injury or property damage. In other words, risk rating i.e. low, medium and high = severity x probability.

9.5. Risk Controls:

- The hierarchy of Risk/Hazard Control is used to determine risk reduction measure in order of their effectiveness, as follows:
- Elimination or substitution of the task / job step or substance.
- Engineering Control
- Including guarding and mechanical aids such as scaffolding, extraction ventilation and alike Administrative Controls.
- Including permits, training, signage, reduction in time or personnel exposure
- Personal Protective Equipment
- Control of Ignition Sources

Factors Contributing To Fires:

To eliminate chances of fire, its causes must be identified. The most common ones are summarized below:

- Electrical Safety:**This is a leading cause of fire.** Most electrical fire starts in wiring and can be prevented by proper installation.
- **Smoking:** Smoking must be strictly prohibited in storage area. It can be permitted in clearly designated safe areas only.
-
- **Static Sparks:** Ignition of flammable processes getting out of control, chemicals reacting with other materials, and decomposition of unstable chemicals can cause fires. These can be prevented by proper operation, instrumentation and controls; and by careful handling and storage, particularly avoiding conditions of heat and shock.

10.0. Incident Accident Report and Investigation:

10.1. Incident Report:

- The objective of incident reporting, investigation & analysis is to identify the cause(s) of an incident to allow for preparation of recommendations, to avoid recurrence of such incident(s) in future.
- As soon as an incident occurs, Supervisor/Area Engineer will immediately inform the Area Supervisor, who will communicate the incident to the HSEHead.
- For a restricted work injury/lost time injury/fatal case or any serious incident involving damage or loss to property or a near-miss, email to PM, Initial Incident Report, within one hours of the incident; a copy of the report will also be provided to.
- If an injury results from an incident or causes damage to the EMPLOYER assets, HSE Engineer would classify the injury and estimate the cost of damage.
- HSE In-charge will issue a Weekly HSE Report to Head Office, with one copy to.
- In the internal Weekly Site Meetings, HSE Head shall brief the attendees about the incident(s).
- The HSE Engineer, covering each and every incident, including all the first aid cases shall also fill monthly injury record format.
- One copy of the monthly injury record shall be sent to Head HSE while one copy of each report will be kept in the office of the HSE Manager.

10.2. Incident Investigation:

- As soon as an incident occurs, the Area Supervisor and HSE Head shall go to the location and investigate the cause of the incident.
- HSE Head will involve the Site Manager and together take immediate corrective action(s), if required.
- As soon as possible the HSE Manager and Site Manager with input from the area engineer will compile an incident report. The incident report should include where appropriate, statements from the people involved, eye witnesses and technical experts.
- Based on the incident report the HSE Manager would indicate responsibility for the incident and make recommendations on the corrective actions on the Incident Report.

10.3. Accident Report:

The objective of accident report and investigation is to Identify the causes, draw lessons, avoid reoccurrence, and specify the procedure. The following accident report and investigation procedure, include near misses/incidents.

- As soon as an accident occurs, the parties or relevant personnel as supervisor, engineer, team leader, etc. at site, must immediately inform Site Manager and Safety Head.

10.4. Accident Investigation:

As soon as an accident occurs, Safety Head, Site manager shall go to the site and investigate the cause.

- Safety Manager involve the Site Manager and together take immediate corrective actions.
- As soon as possible the Safety Manager and Site Manager will compile an accident report after investigation. The accident report should Include casualty, causes, responsible personnel, witnesses and technical measures.

11.0. Permit To Work:

PTW procedure will be followed at operations. The Work Permit System incorporates procedure, commonly used to ensure that necessary communication takes place and hazards are controlled. Project areas are potentially hazardous. However, people using proper procedures can perform work tasks efficiently and safely.

12.0. Emergency Response:

12.1. Emergency Communication:

Mobile Phones will be the main communication method for emergency purposes. Location of accidents should be clearly communicated by area according to the area identification system. All emergency contact numbers should be saved on all project line management's mobile phones. All emergency contact numbers should be clearly displayed in all project site working and office areas.

Emergency Telephone Number	
Police Help line	15

12.2. Emergency Response Plan:

Relying on emergency rescue system, according to actual engineering Project will formulate and publish the following site response plan, as an emergency response guidance documents.

- Site response plan for falling accident
- Site response plan for mechanical injury

- Site response plan for electric stroke
- Site response plan for fire accident

13.0. Emergency response drill:

- Emergency response drills shall be conducted based on Risk Assessment but at least quarterly and Risk assessment will be conducted after the TSF construction. Emergency drill should be carried out on quarterly basis.
- The observations and debrief notes shall be recorded. Safety Manager shall analyze the findings and identify any remedial actions required.
- The emergency procedure shall be updated from time to time to reflect observations made.
- Training shall be conducted on regular basis for emergency response teams.
- The location of emergency facilities e.g. firefighting appliances shall be clearly identified on plans displayed at conspicuous locations.
- Shall be also very clearly marked on this plan.

13.1. Plan of Emergency Procedure:

In an emergency or on hearing the Stop Work Alarm, every employee shall ensure the following:

- All work is stopped at once.
- All equipment is shut down and put in a safe place.
- All men are evacuated to a pre-determined assembly point in an orderly manner.
- No one is permitted to return to work until notification has been received from operations or from the company representative that it is safe to do so.

13.2. Emergency Layout Plan:

To be added at site

14.0. Safety Work Practices

14.1. Electrical:

- The Electrical HV side to MV generation, prior to back energizing all HSE precautionary measurements should be taken, and confirm with concerned department. All work on electrical equipment is subject to 'Permit to Work' handled by key persons.
- All electrical work, installation, modification and wire capacities shall be in accordance with the pertinent provisions of the national electric code, and shall be approved by contractor's electrical engineer.
- All temporary power panels shall have covers installed at all times. All open or exposed breaker spaces shall be adequately covered and is subject to the approval of contractor's HSE Manager and/or electrical engineer.

14.2. Hand & Power Tools:

All hand tools shall be kept in satisfactory condition and used only for the purpose for which they are designed.

- Regularly cleaned and, where necessary, slightly oiled to prevent corrosion.

- Non-conductive and properly insulated hand tools will be used in areas where activities are exposed to electrical risks.
- Appropriate type of hand tools will be used depending upon the nature of work, as determined by the competent foreman or supervisor.
- Damaged hand tools will immediately be taken out of serviced and repaired. If the damaged tool cannot be effectively repaired, it will be removed from Client facilities.
- All applicable requirements of Hand Tools and Power Tools will be adhered. All Power tools shall be kept in satisfactory condition and used only for the purpose for which they are designed. Prior to use, power tools shall be inspected and tested to ensure safe operating conditions. Periodic inspections shall be made to assure safe operating conditions.
- A designated competent electrician to conduct a periodic and ensure proper maintenance is performed on all power tools.
- Rotating tools, such as grinders, will have to be switched off and held until rotation has completely stopped before they are set down.
- Only authorized / competent persons will be allowed to operate portable power tools.
- ONLY the designated competent maintenance personnel will perform repair of defective power tools
- .

14.3. Work At Height:

All subcontractors must take three-step systematic approach to protect the employees who work at height from falling. This approach consists of falling elimination, falling protection and falling arresting.

Falling Elimination: The first step in this approach is to assess the workplace and the work itself in the earliest design/engineering stages of the project/site and during the planning stages of all work. The objective is to eliminate all fall hazards..

Falling Protection: The second step in continuous fall protection also requires assessing the workplace and work processes. If fall hazards cannot be eliminated during the first step, management must take a proactive approach to the prevention of falls by improving the workplace. Early installation of stairs, guardrails, barriers, and travel restriction systems can ensure a safe work environment.

Falling Arresting: The third step, the last line of defense against falls, is to use fall-arresting equipment. Use fall-arresting equipment, however, ONLY after determining that potential falls cannot be eliminated by changing work procedures or the workplace. Equipment such as harnesses, lanyards, shock absorbers, fall arresters, lifelines, anchorages, and safety nets can reduce the risk of injury if a fall occurs. Carefully assess the workplace and work processes to select the most appropriate equipment and to install and use it correctly.

14.4. Ladders:

When using A-shape ladders, both side should be fix tight, no standing on the top side, no position change allowed on ladder. When operate on slippery surface, ladder foot should be fixed with cloth or other measures.

15.0. Hazardous Material:

Any substance or compound that has the ability to produce an adverse health effect in a worker

15.1. Guidelines:

Subcontractors and vendors who introduce a material onto the Project shall provide a Material Safety Data Sheet (MSDS Annexure:008), if available, shall be submitted to the Site HSE office.

15.2. Emission Control:

Air quality emissions associated with the project are to be managed during construction. These potential impacts include:

- Emissions to the atmosphere generated by combustion of fuel from construction plant Including small volumes of particulates, carbon monoxide, carbon dioxide, hydrocarbons and nitrogen oxides.
- The Contractor shall control dust and other airborne emissions from such activities as, but not limited to, vehicular and machinery movement, demolition and/or decommissioning of existing structures, stockpiling of soils or other construction materials.
- Burning of refuse or other material is prohibited, to control emissions to the atmosphere due to construction activities including small volumes of particulates, carbon monoxide, carbon dioxide, hydrocarbons, etc.
- Construction machine and equipment will be well maintained and regularly serviced so that vehicular emissions remain within relevant air quality guidelines and standards.
- Investigate and implement corrective/preventative control measures, and report corrective action.

15.3. Noise Control:

15.3.1. Hazard Identification:

The steps that must be taken in order to effectively and efficiently control the noise in the workplace are:

- Identify the sound sources: vibrating sources.
- Identify the path of the noise from the source to the worker.
- Determine the sound level of each source.
- Identify solutions by taking into consideration the degree of sound attenuation, operation, and productivity restraints and cost.

15.3.2. Control Measure:

The exposure to noise can be reduced by eliminating the source of noise (if possible), substituting the source with a quieter one, applying engineering modifications, using administrative controls, and by using protective equipment.

16.0. Housekeeping:

- Housekeeping is the act of keeping the work environment cleared of all unnecessary waste and materials thereby providing a first-line defense against accidents and injuries. Housekeeping is the responsibility of all site personnel.
- The main road in construction site should be smooth, firm, clear and keep regular watering to reduce dust, advocate beautify, hardening.
- The construction site must be standardized enclosure, make it tidy and nondestructive. The site should be neat and clean, smooth drainage, garbage should be placed at fixed-point and removed regularly.
- Machinery, equipment, materials such as woods, bricks, sand and so on must be classified and placed neatly with sign broad.
- Site area should be identified respectively with safety signs and warning signs.
- Construction site must be kept clean by three work: clear after work, clear the rest of materials, clear remaining work.
- In the duration of construction process, everyone must respect the neighbors, no disturbing.
- Mess must be cleaned up daily and kept tidy at all times. Cook should have health certificates.
- All spillages of liquids, especially oily or greasy liquids, shall be immediately cleared by absorption in inert sand or other suitable materials. All material used to mop up spills shall be immediately removed to a safe place and stored in closed containers for safe disposal.
- Tools, equipment and raw materials at the workplace should be kept to a minimum, commensurate with efficient working practice. Finished work, tools and equipment should be removed as soon as possible to the area defined storage, such that the workplace is maintained clear.
- Any instances of poor housekeeping that results in the creation of a tripping, slipping or fire hazard shall be immediately dealt with.
- Materials shall be stacked or stored in a safe manner that prevents sliding, falling or collapse.

17.0. Site Security:

The site contractor has the overall responsibility for security access control at the project.

17.1. Control Measure:

All project employees, including subcontractors and/or vendors and visitors shall use only the designated gate for entrance and exit to and from the job site and lay-down facilities. Access of project personnel, subcontractors, vendors and visitors, vehicles and equipment will only be allowed with a valid entry pass.

17.2. Identification Control:

Security will conduct random searches of vehicles, property and personal carry items of project personnel and visitors as they enter or exit the project. Bags and attach cases hand-carried by persons authorized to have access shall be voluntarily presented for inspection to the security guards on duty at the main gates.

17.3. Material Control:

All tools and materials, other than trash, that is removed from the project must be accompanied by a material gate pass. All trash that is removed from site will be checked by security to verify the content.

17.4. Incoming Material:

All packages for delivery to personnel on site shall be inspected by the security guards at the access gates. The addressee shall be informed about the arrival of the package prior to inspection. After inspection, the package may be collected by the addressee, or stored in the Security office, depending on the addressee's advice or the contents of the package.

17.5. Outgoing Material:

All supplies, materials and equipment to be taken off the site or lay-down facilities shall be presented for inspection to the security guards on duty at the gate and signed off by the supervisor. The corresponding gate pass for said items shall be presented to the security guards on duty. A designated representative(s) of Management must sign the material gate pass to authorize material exit. All signatures will be checked against a list of authorized signatories, which will be maintained at the security office. A copy (original) of the gate pass shall be retained with the Security.

18.0. Fire Prevention:

18.1. General:

Contractor shall appoint a Fire coordinator with adequate training and experience in fire prevention and firefighting to coordinate the Sub Contractor's overall fire prevention and firefighting program, fire prevention/fighting training program, and the training of Fire-watchers at the jobsite.

18.2. Fire Prevention Guide:

- Good Housekeeping shall be maintained in all work areas. (Accumulation of flammables is prohibited.
- Fire protection equipment will be provided in all areas where combustible materials are present. Regular inspections will be made by the Safety Department to assure that fire extinguishers, hydrants are in good working order.
- A clear access to all fire protection equipment will be maintained. (Including extinguishers, hydrants, etc.
- Fire protection equipment is to be used only for that purpose.
- Smoking will be permitted only in designated areas.

18.3. Requirements:

Contractor/Subcontractor shall at a minimum comply to the following requirements:

- Adequate distance for firefighting equipment shall be maintained.
- Provide portable or permanently mounted extinguishers shall be available within 10 meters of a workforce involving welding, burning or the use of an open flame.
- All fire prevention/firefighting equipment shall be inspected monthly to ensure they are in a good working order and replaced if faulty. Records of inspections shall be maintained for review, as applicable.
- Extinguishers shall be conspicuously located where they shall be readily accessible and immediately available in case of fire, and their locations shall be conspicuously marked. Extinguishers shall be installed on hangers or in the brackets provided.

19.0. Engagement of Staff and Labour:

19.1. General:

- The object of the act is to provide for health, safety and welfare of the workers and to regulate the employment in the factories.
- The law is meant for the welfare of the worker and as such the beneficial operation of the legislation should not be limited.
- The underlying sprit of act is to eliminate condition which so often renders the job in the factory hazardous, unpleasant, monotonous, and even lacking in comfort.

19.2. Labour Law:

Article 11(3) of Pakistan' constitution expressly prohibit the employment of children below the age of fourteen years in any factor, mine or other hazardous employment.

The factories act,1934 allow the employment of children between the age of 14 and 18 years provided that each adolescent obtain a certificate of fitness from a certifying surgeon

Under the employment of children rule anyone who employs a child to work in contravention of the constitution is punishable by imprisonment from a term extending up to one year or may be fined up to 20000 or subject to both.

Sub HSES Plans/Policies

Security Management Plan
Health and Safety Policy
Health and safety handbook
Emergency Response Plan
Safety Practices and Procedures
Code of Practice for hazardous equipment and materials
Traffic Management Plan
Environmental Policy
Environmental Procedures Manual
Hazardous waste management procedure
Emission and dust control procedure
Noise omission and control procedure
Water conservation procedure
Policy on sexual harassment

Adult worker manor woman maximum working time daily should not exceed more than 9 hours a day. In case seasonal factory 10 hours.

Annexure 001

MINUTES OF MEETING

Meeting Attendees:	Location:

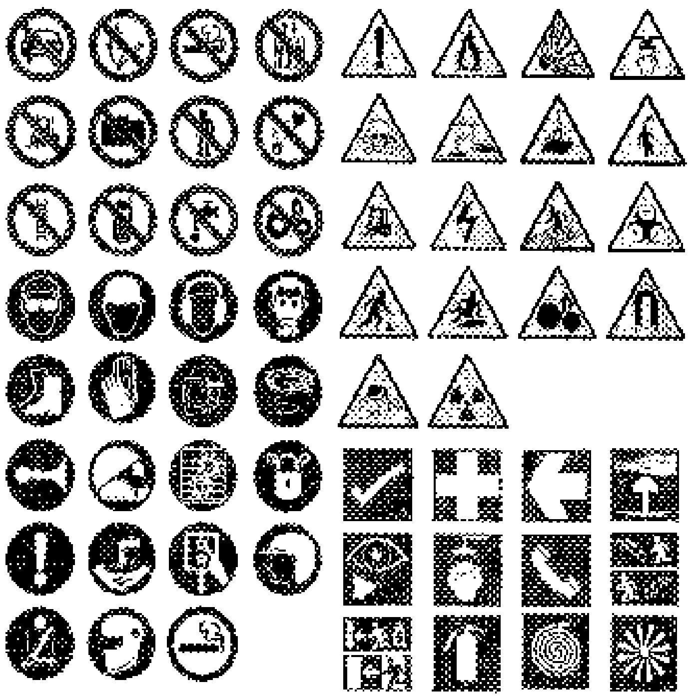
Meeting Date:_____________

Action Item Summery

Ref#	Description	Resolution Date	Current status	Responsibility

Annexure 002

Site Safety Signs List:



Annexure 003

Environmental Site Inspection Checklist

Note: This form is designed for general use and may not be exhaustive. Modifications and additions may be necessary to suit individual projects and to address specific environmental issues and associated mitigation measures.

Project : ______ Site Location : ______

Construction stage / status during inspection : ______

Inspection Date : ______ Inspection Time : ______

Inspected by : ______ Weather : ______

Inspection Items	Implemented? Yes	Implemented? No*	N/A	Remarks (i.e. specify location, good practices, problem observed, possible cause of nonconformity and/or proposed corrective/preventative actions)
1. Air Pollution Control				
1.1. Are the construction sites watered to minimize dust generated?				
1.2. Are stockpiles of dusty materials (size with more than 20 bags cement) covered or watered?				
1.3. Cement debagging process undertaken in sheltered areas				
1.4. Are all vehicles carrying dusty loads covered/watered over prior to leaving the site?				
1.5. Are demolition work areas watered? (e.g. trimming activities by using breaker)				
1.6. Are dusty roads paved and/or sprayed with water?				
1.7. Are dust controlled during percussive drilling or rock breaking?				
1.8. Are plant and equipment well maintained? (any black smoke observed, please indicate the plant/equipment and location)				
1.9. Is dark smoke controlled from plant?				
1.10. Are there enclosures around the main dust-generating activities? (e.g. grout mixing)				
1.11. Hoarding (not <2.4m) provided along boundaries and properly maintained (any damage / opening observed, please indicate the location).				
1.12. Are speed control measures applied? (e.g. speed limit sign)				
1.13. Others (please specify)				

Annexure 004

Hazardous Waste Checklist

Hazardous Waste Inspection Checklist

Inspection Information			
Container or area being inspected (number/contents/location):			
Date and time:			
Date last inspected:			
Inspection completed by:			

Hazardous Waste	Y / N	Corrective Action	Employee Responsible
Are containers properly and clearly labeled ("Hazardous Waste," the specific contents, and the collection date)?			
Are containers tightly closed?			
Are wastes stored in compatible containers?			
Is there evidence of container deterioration?			
Are spaces between containers clear of debris?			
Are incompatible wastes properly segregated?			
Are there any signs of leaks or spills?			
Is spill response equipment adequate and accessible?			
Does each container have adequate secondary containment for its volume?			
If required, is an eyewash station accessible and ready for use?			
Are "Hazardous Waste" signs in place and clearly visible?			
Is a fire extinguisher in place and clearly visible?			
Are all waste containers stored inside the waste storage area?			
Is the total volume of wastes stored below the facility's generator status?			
Are flammable wastes properly stored and grounded/bonded?			

Ladder Inspection Checklist

Inspection Date ________ Inspected by ______________ Ladder Type ____________

General	Needs Repair	Condition OK
Splinters on side rails and legs........	☐	☐
Joints tight between the side rail and steps........	☐	☐
Metal hardware is secure........	☐	☐
Splits in side rails........	☐	☐
Gouges, dents greater than 10% of thickness........	☐	☐
Worn, crushed, cracked, split, splintered, missing, rungs steps, tops or platforms........	☐	☐
Play of ¼ inch in the rails due to loose rungs or steps........	☐	☐
Broken or bent guide irons, spreader or locks........	☐	☐
Rusted or corroded spots........	☐	☐
Damaged or worn non-slip bases........	☐	☐
Rivets sheared, pulled through, uncurled, loosened........	☐	☐
Stepladders		
Loose or bent hinge spreaders........	☐	☐
Stop on hinge spreaders broken........	☐	☐
Loose hinges........	☐	☐
Damage to the pail shelf........	☐	☐
Extension ladders		
Loose, broken, missing extension locks........	☐	☐
Defective locks that do not seat properly........	☐	☐
Deterioration of rope........	☐	☐
Fixed ladders		
Loose worn or damaged rungs or side rails........	☐	☐
Damaged or corroded parts of the cage........	☐	☐
Corroded bolts and rivet heads on inside of metal stacks........	☐	☐
Damaged or corroded handrails or brackets on platforms........	☐	☐
Weakened or damaged rungs on brick or concrete slabs........	☐	☐
Base of ladder obstructed........	☐	☐

If any item needs repair tag the ladder 'Do Not Use' and remove from service.

Annexure 006

Permit No:

Permit to Work

Permit is not valid for more than 12 hours without revalidation

Request Section

1

☐ Type of Work Requested: ☐ Hot Work ☐ Cold Work ☐ Electrical

☐ JSEA completed/attached

Issue Date/Time ______

Expires Date/Time ______

Location ______

Description of Work ______

Additional Permits Required:

LOTO Permit # ______

Confined Space Permit # ______

Ground Dist. Permit # ______

☐ BP ☐ Contractor Company Name ______

Contact — Completed by Performing Authority

2

Contact Person/Supervisor	Phone Number	Radio Frequency

Equipment Condition — Completed by Performing Authority and Verified by Issuing Authority

3

☐ Out of Service
☐ In Service
☐ Deenergized/isolated
☐ Electrically Energized
☐ Depressured
☐ Pressurized
☐ Locked out
☐ [illegible] open
☐ Drained
Not Drained
Other Conditions: ______

Atmosphere checked for:
______ % Oxygen
______ [illegible]
______ CO (carbon monoxide)
______ PPM [illegible] ______

Work Hazards — Completed by Performing Authority and Verified by Issuing Authority

4

☐ SIMOPS
☐ Power tools
☐ [illegible]
☐ High pressure
☐ Severe Weather
☐ Mechanical [illegible]
☐ Stored energy
☐ Oxygen deficiency
☐ Hydrocarbon vapor
☐ Chemical exposure
☐ [illegible]
☐ Sources of ignition
☐ [illegible]
[illegible]
☐ Pinch points
☐ Working at height
☐ Electrical
☐ Overhead work
☐ Eye hazards
☐ Hot/Cold surfaces
Walking/Working surfaces
☐ Hot [illegible]
☐ Cold environment
☐ Heavy lifting
☐ Falling objects
☐ High noise
☐ Sharp objects
☐ Repetitive motion
MSDS ______
Other Hazards: ______

Controls — Completed by Issuing and Area Authority

5

☐ Barricades
☐ [illegible] required
☐ LOTO
☐ Level 2 Risk Assessment
☐ Competent person's name
Additional procedures ______
☐ Fire watch
☐ Standby fire [illegible]
☐ Blanket to contain sparks
Use tag line
☐ Additional [illegible]
☐ Additional lighting
☐ Air mover required
Continuous monitor required. Type ______
☐ Travel
☐ Travel with [illegible] device
[illegible]

[illegible]

PPE — Completed by Performing Authority and Issuing Authority

6

☐ Standard Required PPE: (safety toed boots, hardhat, safety glasses)
☐ Rubber boots
☐ Face shield/goggles
☐ Hearing protection
Supplied air
☐ Cooling vest
☐ Reflective vest
☐ Lifeline
Safety harness/lanyard/[illegible]
☐ Protective suit, Type ______
☐ Respirator, Type ______
☐ Gloves, Type ______
Electrical hot suit, Type
☐ FRC 20 cal ☐ 8 cal 40 cal
☐ Any additional PPE ______

Authorization — Permit is Not Valid Until Signed

7

	Print	Sign
Performing Authority		
Issuing Authority		
Area Authority/Facility Manager		
Affected Issuing Authority (SIMOPS)		

☐ Area Authority notified by phone and approves (for after hours work) Date/Time ______

Return Permit to Area Authority when work is finished for the shift

Permit Sign Off — Completed by BP and Contractor Representative

8

☐ Work Complete ☐ Work Incomplete (Please list reasons) ______

Performing Authority ______ Issuing Authority ______

Copy of Permit must be at Job Location

Annexure 007

CONFINED SPACE ENTRY CHECKLIST

Confined Space Location/Description/ID Number:________________Date:________________

Entry Purpose:____Supervisor: ____________________

Hazards of Confined Space	Yes	No	Special Requirements	Yes	No
Oxygen deficiency			Hot Work Permit Required		
Combustible gas/vapor			Lockout/Tagout		
Combustible dust			Lines broken, capped, or blanked		
Carbon Monoxide			Purge-flush and vent		
Hydrogen Sulfide			Secure Area-Post and Flag		
Toxic gas/vapor			Ventilation		
Toxic fumes			Other- List:		
Skin- chemical hazards			Special Equipment		
Electrical hazard			Breathing apparatus- respirator		
Mechanical hazard			Escape harness required		
Engulfment hazard			Tripod emergency escape unit		
Entrapment hazard			Lifelines		
Thermal hazard			Lighting (explosive proof/low voltage)		
Slip or fall hazard			PPE- goggles, gloves, clothing, etc.		
			Fire Extinguisher		

DO NOT ENTER IF PERMISSABLE ENTRY LEVELS ARE EXCEEDED		Test Start and Stop Time: Start	Stop
	Permissable Entry Level		
% of Oxygen	19.5 % to 23.5 %		
% of LEL	Less than 10%		
Carbon Monoxide	35 PPM (8 hr.)		
Hydrogen Sulfide	10 PPM (8 hr.)		
Other			

Name(s) of Person(s) testing: Communications Procedures:

Test Instrument(s) used- include Name, Model, Serial Number and Date Last Calibrated:

CFM-Ventilation	Size-Cubic Feet	Pre Entry Time		Time Notified:
			☐ Supervisor Notified Before	Time Notified:
			☐ Supervisor Notified After	Time Notified:

Authorized Entrants

Authorized Attendants

Confined Space Authorization and

Name:________________Initials________Date/Time________

Environmental Safety & Health Department Form

Annexure 008

Chemical Inventory			
Sr:	Material Name	Manufacturer	MSDS Available
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			

Annexure 009

Fall Protection Checklist

	Pre-Job		
1.	Does this project involve a low-slope roof (4:12 or less)?	Y	N
2.	Does this project involve a steep-slope roof (greater than 4:12)?	Y	N
3.	Is the distance from the roof to the ground or a lower level 6 feet or greater?	Y	N
4.	Is the roof a residential roof (dwelling) and constructed using residential-type methods (e.g., wood framing or trusses and sheathing)?	Y	N
5.	If a residential roof, is conventional fall protection infeasible or does its use create a greater hazard?		
6.	Is the roof area in proximity to dangerous equipment, machinery, open tanks or electrical equipment?	Y	N
7.	Will the project involve use of a debris chute?	Y	N
8.	Will the project involve a hoist?	Y	N
9.	Is material and equipment storage located at least 6 feet from the roof edge?	Y	N
10.	Are there skylights or other dangerous structural openings on the roof (HVAC openings, scuttle holes, atriums etc.)?	Y	N
11.	Are there any holes 2 inches wide or more?	Y	N
12.	Are there any permanent anchorages on the roof capable of supporting ≥ 5,000 lb. load for lifeline attachment?	Y	N
13.	Will mechanical equipment (such as roof cutters, power washers, power sweepers etc.) be used on the roof?	Y	N
14.	Does the roof have different levels?	Y	N
15.	Is the roof more than 50 feet wide?	Y	N
16.	Does the roof have a parapet at least 39 inches high?	Y	N
17.	Have all employees on the project been trained in fall protection?	Y	N
18.	Have all employees on the project been trained in the use of the fall-protection system to be used on the project?	Y	N

Annexure 010

JOB SAFETY ANALYSIS

JOB SAFETY ANALYSIS	JOB TASK:	PAGE OF JSA NO	DATE: REVIEW:	NEW REVISED
INSTRUCTIONS ON NEXT PAGE	EMPLOYEE JOB TITLE:	SUPERVISOR:	ANALYSIS BY:	
ORGANIZATION:	LOCATION:	DEPARTMENT:	REVIEWED BY:	
REQUIRED AND/OR RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT:				

SEQUENCE OF BASIC JOB STEPS	POTENTIAL HAZARDS	RECOMMENDED ACTION OR PROCEDURE

Annexure 011

Diesel Generator Inspection Check List

Inspected By____________________ Contractor Name____________________

DG Identification Code ____________________

Serial No	Subject	Observation Yes/NO/NA	Action to be taken	Remarks
1	Is the DG is freely accessible from all sides?			
2	The overall construction/condition of DG set is acceptable?			
3	Weather the area around the DG set is acceptable?			
4	Weather the DG is fitted with silencer?			
5	Weather DG operator is qualified			
6	Weather the DG operator has been provided with ear-muffs?			
7	Weather the DG is covered or provided with a shed?			
8	Weather the DG exhaust is diverted outside the shed?			
9	Weather the cables DG set are connected /covered			
10	Weather surround area of the DG set are free from flammable material			
11	Weather insulation is provided on the battery terminal.			
12	Weather entry is restricted in to the DG shed?			
13	Weather the DG shed is free from storage of personal material?			
14	Weather the rotation parts of DG are safely guarded?			
15	Weather there is any leakage of lubrication, fuel, oil etc.?			

Annexure012

Checklist for Electrical Safety

	Yes	No	Action Required
Are all plugs, sockets and electrical fittings sufficiently robust for use in the factory?			
Are all electrical fuse/junction boxes in the factory securely fixed, closed and undamaged?			
Are fuses, circuit breakers and other electrical devices correctly rated for the circuit they protect?			
Is access to fuse boxes prevented and the key held by a responsible person?			
Are main switches readily accessible and clearly identified, with all workers knowing how to use them in an emergency?			
Are all electrical installations checked periodically and repairs carried out by a competent electrician?			
Are there any cables or wires without proper casing, found in the factory?			
Are any electrical wires improperly spliced or taped?			
Is electrical equipment properly grounded to prevent electrocution or fire?			
Are any electrical wires found in damp areas or standing water?			
Are any electrical wires obstructing aisles or passageways?			
Are all visible electrical wires securely fixed?			

⚠ Electrical fittings and installations must be checked on a regular basis.

Annexure013

Monthly Fire Extinguisher Inspection

Check these details during a monthly fire extinguisher inspection.

- Confirm the extinguisher is visible, unobstructed, and in its designated location.
- Verify the locking pin is intact and the tamper seal is unbroken. Examine the extinguisher for obvious physical damage, corrosion, leakage, or clogged nozzle.
- Confirm the pressure gauge or indicator is in the green range, and lift the extinguisher to ensure it is still full.
- Make sure the operating instructions on the nameplate are legible and facing outward.
- Check the last professional service date on the tag. (A licensed fire extinguisher maintenance contractor must have inspected the extinguisher within the past 12 months.)
- Initial and date the back of the tag.

Note: An A-B-C fire extinguisher can be used on all kinds of fires.

PLEASE CALL DAMAGED AND/OR USED EXTINGUISHERS IN THE MAIN OFFICE AND SEND REPLACEMENT REQUEST TO MAINTENANCE IMMEDIATELY

MONTH	TYPE Example: ABC, Water	LOCATION Example: Main Hall, Gym, Cafeteria, Office etc ...	INSPECTION DATE	SIGNATURE
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

Principal/Director Signature .... Facility Location: .... Date: ....

Working at Height

Hazard Identification Checklist

This checklist is provided to help managers identify hazards and risks associated with working at height. IT IS NOT A RISK ASSESSMENT and it is by no means an exhaustive list.

Please answer all of the following questions. If any shaded box is ticked when answering to a question, this indicates that a risk is present and you should transfer it onto a General Risk Assessment Form for further analysis.

Workplace / WAH Location:	
Date of Assessment:	
Name of Assessor:	
Job Title:	

	Yes	No	N/A	Comments
1. Is working at heights avoidable? (consider alternatives, e.g. provision of long handled equipment)				
2. If staff have to work at height, is appropriate access equipment is available?				
3. Have you considered if staff should be working on a scaffold or platform rather than ladders or steps?				
4. Will there be any risk of asbestos dust, disturbance or settlement? (see premises asbestos register)				
5. Do any services (e.g. gas, electricity) need to be isolated before work commences?				
6. Is there any risk from overhead cables?				

Annexure015

Scaffolding Inspection Checklist

Date Inspected:	Time:	Contractor:
Location of Scaffold:		College:
Inspected by (designated competent person):		Project:

SCAFFOLD SAFETY INSPECTION CHECKLIST – Use this list to remind yourself of what to look for in order to prevent accidents. Check each item as you do them:

BEFORE USING THE SCAFFOLD-

- [ ] Has this work location been examined before the start of work operations and have all the appropriate precautions been taken? (e.g., checking for overhead objects, falling or tripping hazards, uneven ground, openings onto a floor)
- [ ] Will fall protection be required when using this scaffold?
- [ ] Has the scaffold been setup according to manufacturer's instructions?

General Rules for All Scaffolds	YES	NO	Not Applicable
Scaffold components can support at least four times their maximum intended load			
Scaffold is fully planked- No more than 1" gap between planks.			
Platform is at least 18 inches wide (12 inches on pump jacks).			
Guardrails are used or personal fall arrest system is used, if work height is >6 feet. Guardrail system: Top rail Midrail Toe board Posts			
Platform is 14" or less from face of work if workers remove front guardrails (18" for plasterers)			
Planks do not extend past the ends of the scaffold frames more than 12 inches.			
Casters are locked before work begins.			
Work platform free of clutter, mud, oil, or any tripping hazard.			
Minimum power line clearance (10 feet)			
If the scaffold is defective, has it been removed from service and tagged out?			
General Rules for Supported Scaffolds			
Height to base width ratio is: Less than 4:1 (no guying, ties, or braces required)			
Over 4:1 scaffolds are restrained from tipping by guying, tying, or bracing.			
All scaffold frames and uprights with base plates and mud sills required if on dirt			
Footings are level, sound, and rigid. No settling has occurred.			
Unstable objects such as blocks, bricks, buckets, etc. are not used as work platforms or to support scaffolds.			
Are riggers secured and installed correctly?			
General Rules for Access			
No more than 2' step up or down or a 14" step across to get on or off a platform.			
Ladder first rung is not more than 24" above the ground.			
Hook-on and attachable ladders are designed for the scaffold.			
Add-on ladders must have a rung length of at least 11 ½"			
Built in ladders (part of the scaffold frames) must have a rung length of at least 8".			
Rungs line up vertically for the entire height of the scaffold.			
Crossbraces are not used for climbing up or down from the scaffold.			

Annexure016

House Keeping Inspection Checklist

Use the checklist below to determine if there are housekeeping issues in your workplace. If you answer "no" to any of the questions below you may need to implement better housekeeping practices in your workplace.

	Yes	N/A	No	Action
HEALTH AND SAFETY POLICIES				
Are workers aware of safe operating procedures and the requirements of the law with regards to occupational housekeeping?				
Have workers been trained in general housekeeping practices and safe operating procedures?				
Are housekeeping inspections using checklists conducted regularly?				
Have the roles and responsibilities of workers been clearly outlined and communicated?				
Is there a reporting mechanism in place that covers housekeeping issues (e.g. storage problems, broken equipment, burnt-out light bulbs, clogged toilet, etc.)?				
WORK AREAS				
Are all work and storage areas kept clean and free of debris and waste throughout the workday?				
Is the access to all entrances, walkways, and emergency exits kept clear and unblocked at all times?				
Is the workplace adequately lit?				
Are ventilation systems kept clear of dust, debris and obstructions?				
EXITS/ENTRANCES				
Are exits and entrance ways kept unobstructed, clean and dry and in good condition at all times?				
Are site access and exit points well marked?				
GROUND/FLOORS/STAIRWAYS				
Are there any trip hazards – including steps or uneven surfaces – that need immediate repair?				
Are floors, stairs and access ways kept unobstructed, clean, and dry and in good condition at all times?				
Are floors, stairs and access ways free of trip hazards and [illegible]?				
Are walkways wide enough for equipment and safety accessibility?				
Have cables, cords and wires been covered or taped down so they are securely out of the way?				
Do spills get cleaned up quickly and properly?				

Annexure017

Toolbox Talks / Safety Training Template

[illegible]	Date:
[illegible]	[illegible]
[illegible]	

Name	Designation	Signature

Tool Box Talk Topics: Work At Height, Importance of PPEs, Tools Inspection, Work Stress, Sharp Edges, Pinch Points, Electrical hazard, Fire Hazard, Entanglement, Manual handling, Hot Work etc.

Annexure018

HSE RULES

ٹھیکیدار اور ذیلی ٹھیکیداروں کے تمام نئے کارکنوں کو کام شروع کرنے سے پہلے HSE اورینٹیشن سے گزرنا ہوگا، انڈکشن کریں
ڈائٹ فوجی پرائیویٹ لمیٹڈ کی HSE پالیسی کو سمجھنا اور HSE کے قواعد پر عمل کرنا چاہیے۔

ذاتی حفاظتی سامان مہیا کیا جائے گا اور جب ضرورت ہو تو برتنا چاہیے۔ حفاظتی جوتے، سائٹ کے تمام حصوں، ماسک، دستانے اور ایئر پلگس جیسے ضرورت کے مطابق سخت ٹوپیاں، وغیرہ

سائٹ پر نصب HSE بورڈز پر دکھائے گئے پیغامات اور ہدایات پر عمل کریں۔ ہنگامی اسمبلی پوائنٹس اور فرار کے راستوں سے آگاہ رہیں۔ کسی ہنگامی صورت حال میں گھبرائیں نہ، سائٹ کے ہنگامی ردعمل کے طریقہ کار پر عمل کریں۔

تمام حادثات کی اطلاع فوری طور پر سائٹ پر ٹیم سپروائزر اور ایچ ایس ای آفیسر کو دیں۔ زخمیوں کو فوری طور پر ابتدائی طبی امداد فراہم کریں اور معاونت طلب کریں۔

ایک محدود جگہ میں کام کرتے ہوئے یہ یقینی بنائیں کہ آپ کا قریبی ساتھی اور سپروائزر اچھی طرح سے باخبر ہیں۔

اس بات کو یقینی بنائیں کہ رات کی شفٹوں میں کام کے لئے یا ہنگامی ردعمل کے لئے adequate مناسب روشنی کی جگہ موجود ہے۔

تعمیراتی فضلہ کے انتظام کے منصوبے کے مطابق تمام سکریپ، فضلہ مواد اور کچرے کو ضائع کرنا ہوگا۔

لکڑی یا شٹرنگ منتقل کرنے کے بعد ہمیشہ کام کی سائٹ کو صاف کریں۔ ضرورت کے مطابق مناسب رکاوٹیں برقرار رکھیں۔ برقی کیبلز اور آلات کے ساتھ کبھی چھیڑ چھاڑ نہ کریں۔ ساکٹ میں کبھی بھی ننگے تار براہ راست داخل نہ کریں، بلکہ مناسب پلگ استعمال کریں۔

اونچائی پر کام کرنے پر مناسب طور پر گرنے کی گرفتاری کے مناسب نظام کے بغیر ممنوع ہے۔ مضبوط حفاظتی ریلنگ کی موجودگی کو یقینی بنائیں اس میں کوئی خلاء نہیں ہونا چاہیے اور یہ یقینی بنانا چاہیے کہ تمام تختے مناسب طور پر محفوظ ہیں۔

کسی ایسی کھدائی میں داخل نہ ہوں جس تک رسائی کے لئے سیڑھی نہیں ہے۔

سہاروں یا سیڑھی کو چڑھتے ہوئے یا نیچے جاتے وقت، آلے یا مواد کو نہیں لے جانا چاہیے۔ اس مقصد کے لئے بالٹی یا رسیاں استعمال کریں۔

سگریٹ نوشی نہ کریں کھلی آگ کا استعمال ممنوع ہے۔

کام کی جگہوں پر تمام کیبلز، تاروں اور نلیوں کو صاف اور صاف رکھیں۔

گاڑیوں کو ایک محفوظ رفتار سے چلانا چاہیے، رفتار کی حدود کو دیکھتے ہوئے۔ ڈرائیوروں کے پاس درست ڈرائیونگ لائسنس ہونا ضروری ہے۔ گاڑیاں صرف مخصوص پارکنگ والے علاقوں میں کھڑی کی جائیں گی۔

Annexure019

Company Name	EHS Daily Report	Form: EHS Daily Report Report no:

Project				Customer	
Equipment		Project phase		Reviewed by	
Metric		Year		Date	

EHS Statistics: It includes the head count, man-hours, near misses & no. of hazard observations	(see statistics table below)	EHS, Site Lead
EHS Issues: Site walk down	Site walk down had been done and found following concerns:	Site Team, EHS
EHS Corrective Actions: Actions taken to improve EHS		Site Team, EHS
Permits to work		Permit to work was issued by customer
LOTO	Isolation has been done by customer.	Verified by EHS
COSHH / MSDS		EHS, Supervisor
Work at height		Supervisor, Crew Team
Crane Operations		Supervisor

NO	Statistics	Today	Overall
1	Head Count		
2	Safe Manhours		
3	Near Misses		
4	Incidents		
5	Hazard Hunt / Safety Awareness Campaign		
6	Concern Reporting		

Annexure020

Major & Critical Lift Permit
Mobile Crane

Issue Date

[illegible]

1. Project Name | 2. [illegible] | 3. [illegible] | 4. [illegible] Location

5. Crane Manufacturer | 6. Model | 7. [illegible] | 8. [illegible] | 9. [illegible]

10. [illegible] | 11. [illegible] | 12. [illegible] | 13. Boom Angle

14. [illegible] | 15. [illegible]

Master Y/N Slave Y/N

16. [illegible] | 17. [illegible]

18. [illegible] | 33

19. [illegible]

20. [illegible]

21. [illegible]

If load is [illegible] or below [illegible]
If load is [illegible] proceed [illegible]
If load is above 85% DO NOT proceed [illegible]

22. [illegible]

23. [illegible] Yes

24. [illegible]

Good X

Not Required X

Not Required X

25. [illegible]

Yes X No

26. [illegible]

Overhead? Yes X No

Underground? No X

Other? No X

27. [illegible]

28. [illegible]

29. [illegible]

Section B - Signatures

Permit [illegible]

1. Operator

2. [illegible]

3. Rigger

4. [illegible]

5. Safety Reviewer

6. Supervisor

7. [illegible]

Date

Annexure021

The incident	
Reported by	Department
Email	Phone Ext
Date of occurrence	Time
Exact location	
Accident ☐ Incident ☐ Near miss ☐ Violence ☐ Ill health ☐ Safety ☐	
What happened? Report any details that may have contributed to the incident (i.e., poor lighting). Use additional paper as necessary and attach to form.	
Describe the outcome: harm/health effects/damage.	
Describe corrective measures taken to address immediate hazards related to incident.	

Annexure022

Risk Assessment Template

Prospective Risks	**Who is Affected by risk?**	**On Hand Control Measures**	**Risk Rating**	**Defensive Measures**	**Errands/ Responsibilities**

Annexure:023

Site EHS orientation

A.	General Orientation	EHS policies and procedures available to workers: - Hazcom - EHS manual - Local/Country specific Customer Site Specific EHS Rules
		Work area boundaries, off limit areas or hazardous areas
		Brief tour of facility including: - 1st aid equip - fire extinguishers - showers/eyewash - traffic areas - washrooms - eating area - smoking areas
		Safety goals for the Outage
		Inspections and safety meetings - daily pre-task meeting - weekly safety meeting - weekly inspection - responsibilities for inspection
		Disciplinary action/consequences of failure to comply
B.	Medical & Emergency Planning	Reporting injury/illness or emergency or unsafe condition - how, when, where and to whom - investigation of incidents - Security Plan/Ex-Pat Roster
		Emergency Exits - Identify access and egress locations and rally points - severe weather response - meaning of plant alarms
C.	PPE/ Dress code	Customer requirements on wearing jewelry, watches, etc.
		PPE required, and ensuring this is available
D.	Permits	Lock Out/Tag Out - walk down procedure

Annexure:024

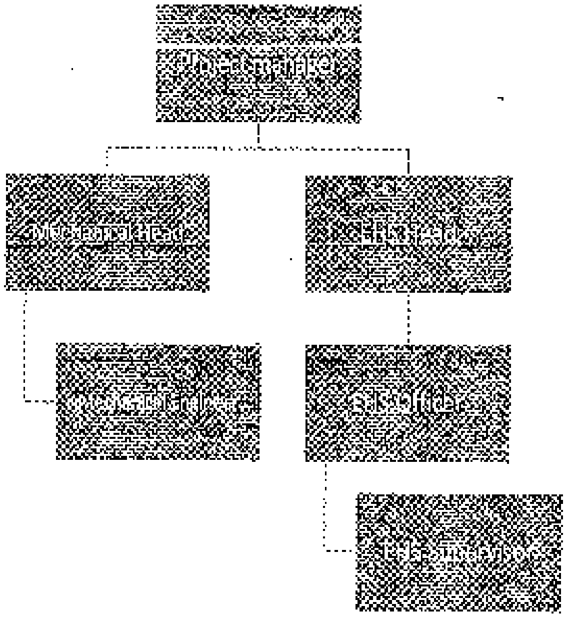
Worker health and safety training plan and record template

Project Name/Location	
Training Provider:	
Month :	

Skill/Knowledge	Planned date	Delivered by	Employee signature	Refresher	
				Planned date	Completed date
Health and safety responsibilities					
Risk identification and management					
Incident recording and reporting					
Safe work procedures					
Safe use of plant and equipment relevant to the worker's position					
Use and maintenance of any personal protective equipment					
Safe use and storage of hazardous substances					
Emergency procedures, including evacuation procedures and use of emergency equipment					
First Aid					
OOS prevention					
Stress management					
Managing extreme behaviour					
Safe handling and lifting					

Annexure:025

Site Organizational Chart



Annex - M
(Environmental Study)

ESSA (Environmental and Social Soundness Assessment)

Introduction:

Extensive fossil fuel consumption in almost all human activities has led to some undesirable phenomena such as atmospheric and environmental pollution, which have not been experienced before in known human history. Consequently, global warming, greenhouse effect, climate change, ozone layer depletion, and acid rain terminologies started to appear in the literature frequently. Since 1970, it has been understood scientifically by experiments and researches that these phenomena are closely related to fossil fuel use because they emit greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4), which hinder the long-wave terrestrial radiation escape into space, and, consequently, the earth troposphere becomes warmer. In order to avoid further impacts of these phenomena, the two concentrative alternatives are either to improve the fossil fuel quality with reductions in their harmful emissions into the atmosphere or, more significantly, to replace fossil fuel usage as much as possible with environmentally friendly, clean, and renewable energy sources. Among these sources, solar energy comes at the top of the list due to its abundance and more even distribution in nature than any other renewable energy type, such as wind, geothermal, hydro, wave, and tidal energies. Solar energy technologies are essential components of a sustainable energy future. Energy from fossil fuels may be inexpensive and assurances may have been given of the plentiful supplies of petroleum and other fossil fuels, but these fuels are finite in nature and a major source of greenhouse gas emissions.

Objective:

Pakistan is located in the Sunny Belt and can take advantage of its ideal situation for utilization of solar energy. The country's potential for solar generation is beyond doubt as it has high solar irradiation and enough space for installation of generation system those are ideal for PV and other solar energy applications. Villages and other areas which are away from grid or distribution system of utilities can also benefit from solar power generation which will also save the extra cost of laying the system and the losses. Every day, for example, the country receives an average of about 19 Mega Joules per square meter of solar energy Pakistan being in the Sun Belt is ideally located to take advantage of solarenergy technologies. This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200-250 watt per sq.m in a day. This amounts to about 2500- 3000 sun shine hours and 1.9-2.3 MWh per sq. meter in a year. It has an average daily global isolation of 19 to 20 MJ/sq. meter per day with annual mean sunshine duration of

8 to 8.5 hours (6-7hrs in cold and 10-12 hrs. in hot season) and these values are among the highest in the world.

For daily global radiation up to 23MJ/m2, 24(80%) consecutive days are available in this area for solar energy. Such conditions are ideal for solar thermal applications. Pakistan receives about 15.5x1014 kwh of solar irradiance each year with most regions receiving approximately 8 to 10 sunlight hours per day. The installed capacity of solar photovoltaic power is estimated to be 1600 GW per year, providing approximately 3.5 PWh of electricity (a figure approximately 41 times that of current power generation in the country). To summarize, the sun shines for 250-300 days per years in Pakistan with average sunshine hours of 8- 10 per day. This gives huge amount of energy to be used for electricity generation by solar photovoltaic and solar thermal power plants.

Environment Assessment:

The Lahore and Okara project will be executed on within the premises of Purchaser, and the Applicant has carried out a detailed environment assessment of the site in preparation of the Solar PV Plant. The assessment of the Project has been considered for both positive and negative effects. The proposed photovoltaic Power Project has been located as per international guidelines. Adoption of green power generation with no emission and effluent discharge with have least impact on the ambient environment and on the host community.

The importance of the sustainable development concept has increased in the whole world. As a result, some new regulations enforce that all development projects should be compatible with the environmental criterions. An environmental impact assessment should be carried out to make sure that projects are compatible with the environmental criterions. Environmental Impact Assessment (EIA) can be defined as a process of environmental management, planning, and decision-making with a purpose of keeping and improving the quality of the environment. The main goal is to develop environmentally friendly industrialization. With this kind of environmentally friendly industrialization, "sustainable development" can be a possibility in the future by keeping the usage/protection balance between economic development and the environmental protection.

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

The use of solar power has additional positive implications such as:-

- Reduction of the emissions of the greenhouse gases (mainly CO2, NOx) and prevention of toxic gas emissions (502, particulates)
- Reduction of the required transmission lines of the electricity grids.

Project Environmental Impacts & Mitigation Measure:

This Section discusses the potential environmental impacts, assesses the significance, recommends mitigation measure to minimize the adverse effect and identifies the residual impacts associated with the proposed activities of the project during the construction and operation phase of the proposed project at the proposed site and of secondary actions like potable, raw water and waste water lines. Solar energy is a lot cleaner when compared with conventional energy sources. Solar energy systems have many significant advantages, like being cheaper and not producing any pollutants during operation, and being almost an infinite energy source when compared with fossil fuels. Nevertheless, solar energy systems have some certain negative impacts on the environment just like any other energy system. Some of these impacts will be summarized in this section.

Identification of Potential Impacts:

a) Discharge of Pollutants

b) Visual Impacts

c) Impact on Natural Resources

d) Air Pollution

e) Noise Intrusion

f) Impact on Air

g) Impact on Ground Water! Surface Water

h) Impact on Solid Waste

i) Impact on Soil

j) Impact on Natural Resources

Discharge of Pollutants:

Solar cells do not emit any pollutants during their operations. But solar cell modules contain some toxic substances, and there is a potential risk of releasing these chemicals to the environment during a fire. Necessary precautions will be taken for emergency situations like fire.

Visual Impacts:

There will be some visual impacts depending on the type of the scheme and the surroundings of the solar cells. Especially for applications on the buildings, solar cells can be used as a cladding material that could be integrated into the building during the construction phase. Solar cell applications after the construction phase of the buildings might cause negative visual impacts. However, through proper planning the Applicant will minimize this impact.

Impacts on Natural Resources:

Despite being a benign energy system during operation, solar cells have some negative impacts on the environment during their production phase like many other systems. The energy needed for the production of solar energy systems is still produced in conventional methods today. Some toxic chemical substances used during the production phase are produced as a by-product. However, the solar panels to be
utilized for this project have been manufactured in China therefore, there is no direct impact on the designated vicinity.

Air Pollution:

Solar cells do not emit any substances to the air during operation. But there could be some emissions during manufacturing and transport. The emissions associated with the transport of the modules are insignificant when compared with the emissions associated with the manufacture. Transport emissions are 0.1-1% of the manufacturing emissions.

Noise Intrusion:

Solar cells do not make a noise during operation. But during the construction phase, there will be a little noise as usual in other construction activities. However, since the solar panels to be utilized for this project have been manufactured in China, this is not a risk for the designated vicinity.

Impact on Air:

There would be no hazardous emissions at site as well as during construction phase except Motor Vehicle and Crane. Moreover, there are no objectionable odors as well as alternation of air temperature.

Impact on Ground Water/ Surface Water:

There would be no use of water during design phase except curing of civil pads during construction, which have no negative impact on environment.

Impact on Solid Waste:

It may only Create litter and trash waste which is recyclable and may be cleared from site after construction. Impact on Soil: No impacts as all installed systems are roof top.

Impact on Natural Resources:

There won't be any increase in the rate of usage of any natural resource like any minerals, additional fuel other than vehicles. But there would be increase in the amount of usage of Paper for mapping, enlisting items etc. However, paper may be recycled by throwing it in ordinary dustbin, further maximum usage of electronic system e.g., emails will be done.

Environment Assessment:

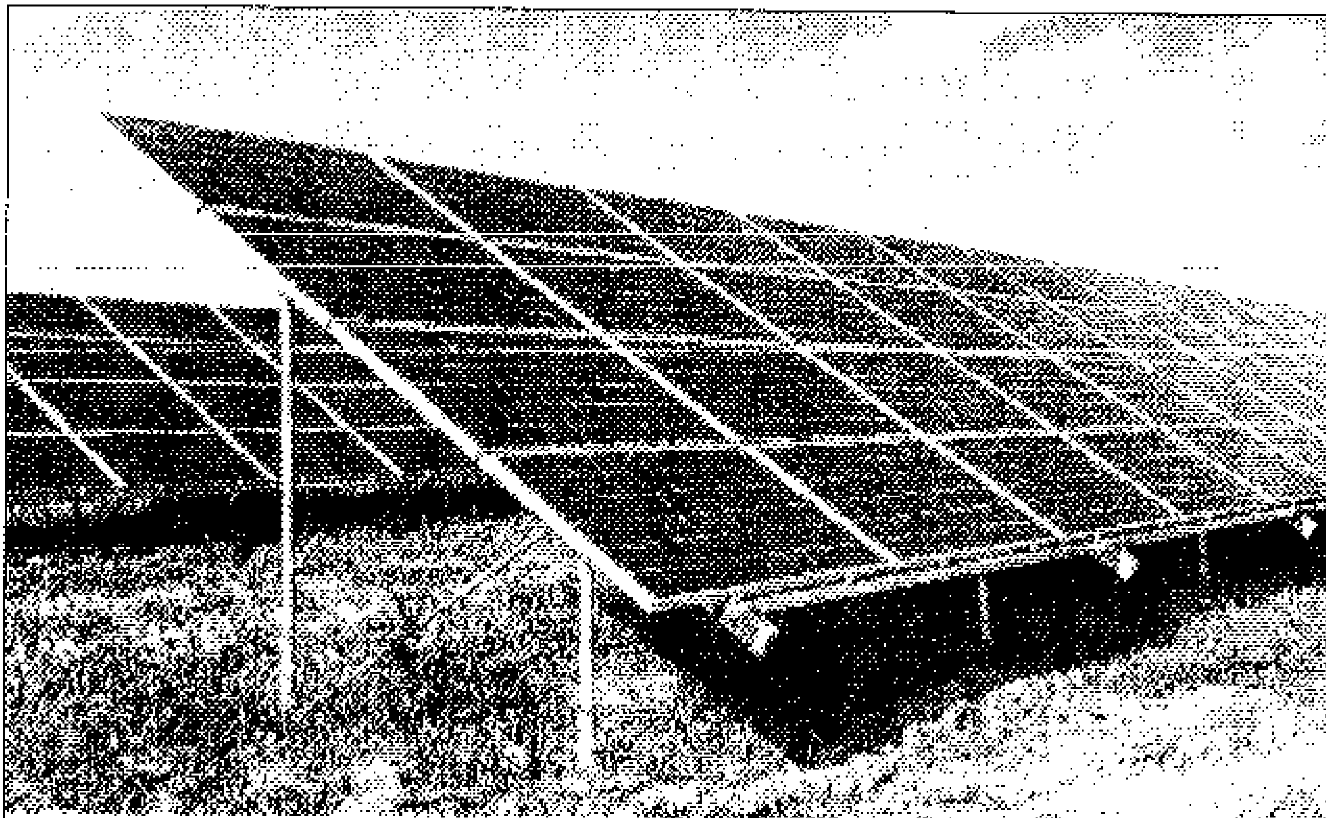
a) Almost all conventional methods of energy generation have varying degrees of adverse environmental impact. These methods have far reached detrimental effects on the climate, air, water, land and wildlife of the adjacent vicinities. However, Solar PV energy technology provides significant environmental advantages in comparison to the conventional energy sources while contributing to the sustainable development of human activities. Besides slowing down the depletion of natural resources, the main environmental advantage is zero air emissions, waste production and eventual reduction in emissions of greenhouse gases (COx, NOx) and toxic gases (SOx).

b) Solar power plants have zero fuel requirement and hence limit the depletion of natural resources, fossil fuels. Unlike conventional thermal power plants, no water consumption is required for cooling purposes. A very optimized quantity of water is occasionally used for plant maintenance / cleaning. As stated earlier, the proposed system of 5O7p DC will offset approximately 607 tons of carbon dioxide annually.

The Applicant has carried out environment assessment of the Site for installation of solar:

Environment Parameters	**Level of Impact**	**Reasons**	**Mitigation Measures**
Air Impact	Low	Solar Energy Carbon Free	No Emissions, however, during construction adequate measures to limit dust pollution will be taken.
Water	Low	Plant will require a very low quantity of water for cleaning purpose only	Specialized equipment that conserves water will be used to cleaning the PV modules.
Land	Low	No Impact on Land	The land being allocated for this facility is baren.
Ecosystem	Low	No ecologically sensitive area lies with in premises	There is no significant vegetation cover within the selected area, land is barren.

Socio EcoSystem	Low	Total area identified for said project is adjacent to the plant premises and no acquisitions needed. No displacement will occur.	Not Applicable



SYSTEM STUDY ANALYSIS OF COMBINED MILITARY HOSPITAL (CMH) 999kW SOLAR PV SYSTEM

Report

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CONTENTS

ARCO Energy

EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 999kW Solar PV Power Generation project at Combined Military Hospital (CMH) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 999kW Solar PV based system connected with the power network of CMH. The '999kW CMH solar PV Power Generation project' is located at CMH, Cantt, Lahore, Punjab, Pakistan.

The integration of solar power generation at the CMH premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. CMH currently receives a single point supply from LESCO with a sanctioned load of 4.6MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 4.6MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the CMH premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 999kW CMH solar PV system with sanctioned load in service.
- With 999kW CMH solar PV system with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of CMH. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the CMH distribution system. The power flow results for the system intact shows that the power flows on all the CMH transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for CMH. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with CMH and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 999kW CMH solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Combined Military Hospital (CMH) ("Project Owner" or "PO") for the interconnection of a 999kWp Solar PV Power Generation project ("Project") to the CMH power System at 11kV.

The '999kW CMH solar PV Power Generation project' is located at CMH, Cantt, Lahore, Punjab, Pakistan. Figure 1.1 shows Google site map of the project.

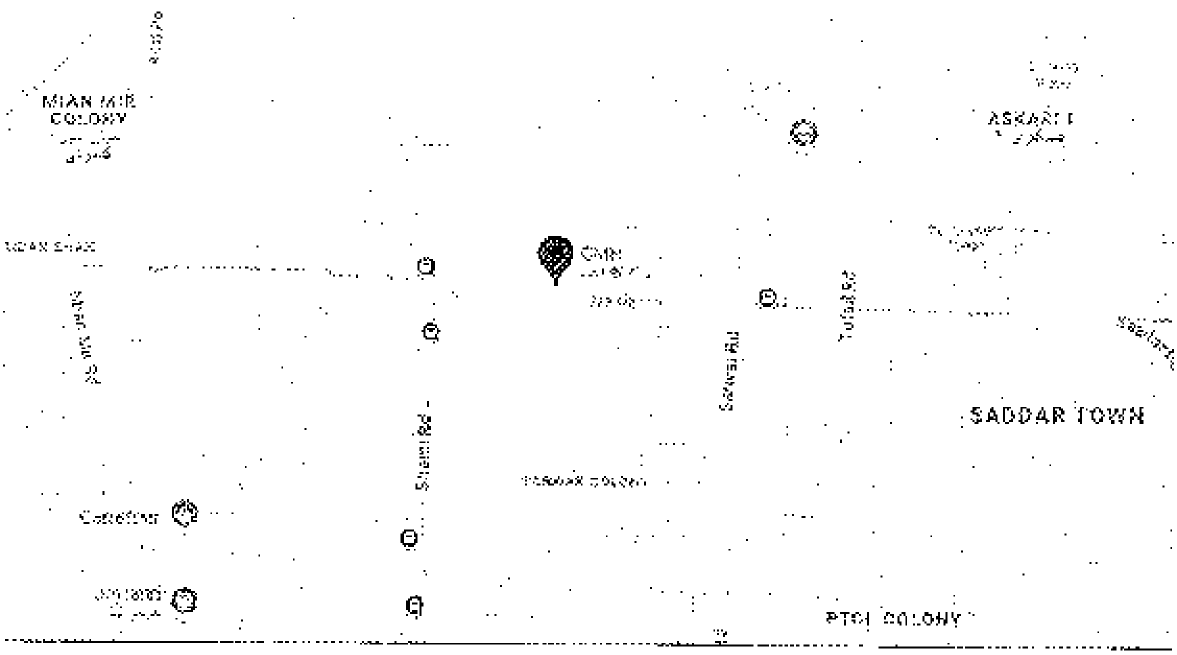


Figure 1.1: Google Site Map of the Solar PV Power Generation Project

1.2 Interconnection Arrangement

CMH aims to integrate solar power generation into its existing electrical infrastructure. CMH currently receives a single-point power supply from LESCO with a sanctioned load of 4.6MW. The entire solar generation within the CMH premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the CMH transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within CMH premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

999kW solar PV system is modelled into the CMH distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling
ii) Steady state analysis
iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 999kW CMH solar PV system with sanctioned load in service.
- With 999kW CMH solar PV system with sanctioned load in service.

This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 999kW solar PV system to the distribution system of CMH and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kV and above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within CMH.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	841
Active Power of each collector Pgen. (kW)	799
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.2626, 0.2626
Rated Frequency	50 Hz
Generation Voltage	440V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	1250
% Reactance (X)	5 %
CMH	
Sanctioned Load (LESCO)	4600 kW

Steady state power flow assessment has been performed using the network data of CMH.

3.2 Power Flow Assessment Without CMH PP and with Sanctioned Load In Service

Power flow study without CMH solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of CMH network. This base case included a detailed representation of the CMH transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the CMH distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with CMH PP

Power flow study of CMH solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 999kW CMH solar project on the CMH distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at CMH solar for peak loading summer (June) 2025 that allow us to judge the impact of CMH solar project on the CMH network.
Project power flow analysis has been performed after the connection of the project with the CMH distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at CMH solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted

with sanctioned load in service after the interconnection of the Solar project with the CMII distribution system. The power flow results for the system intact shows that the power flows on all the CMII distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without CMH solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady state conditions. Power flow analysis was also conducted with CMH solar and with sanctioned load in service with CMH distribution system. Power flow results showed that the power flows on all the CMH distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 999kW CMH solar PV system with CMH Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

LIST OF ANNEXURES

Annexure-A

Project Specific Data

Annexure-A-1

Project Site Map

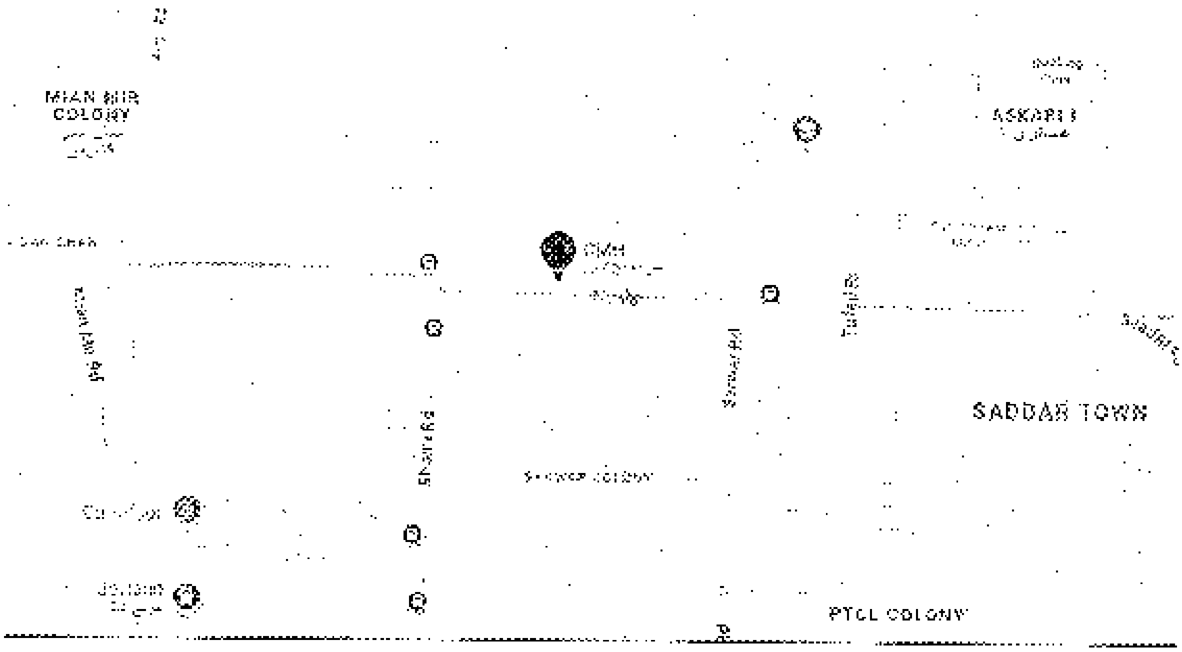
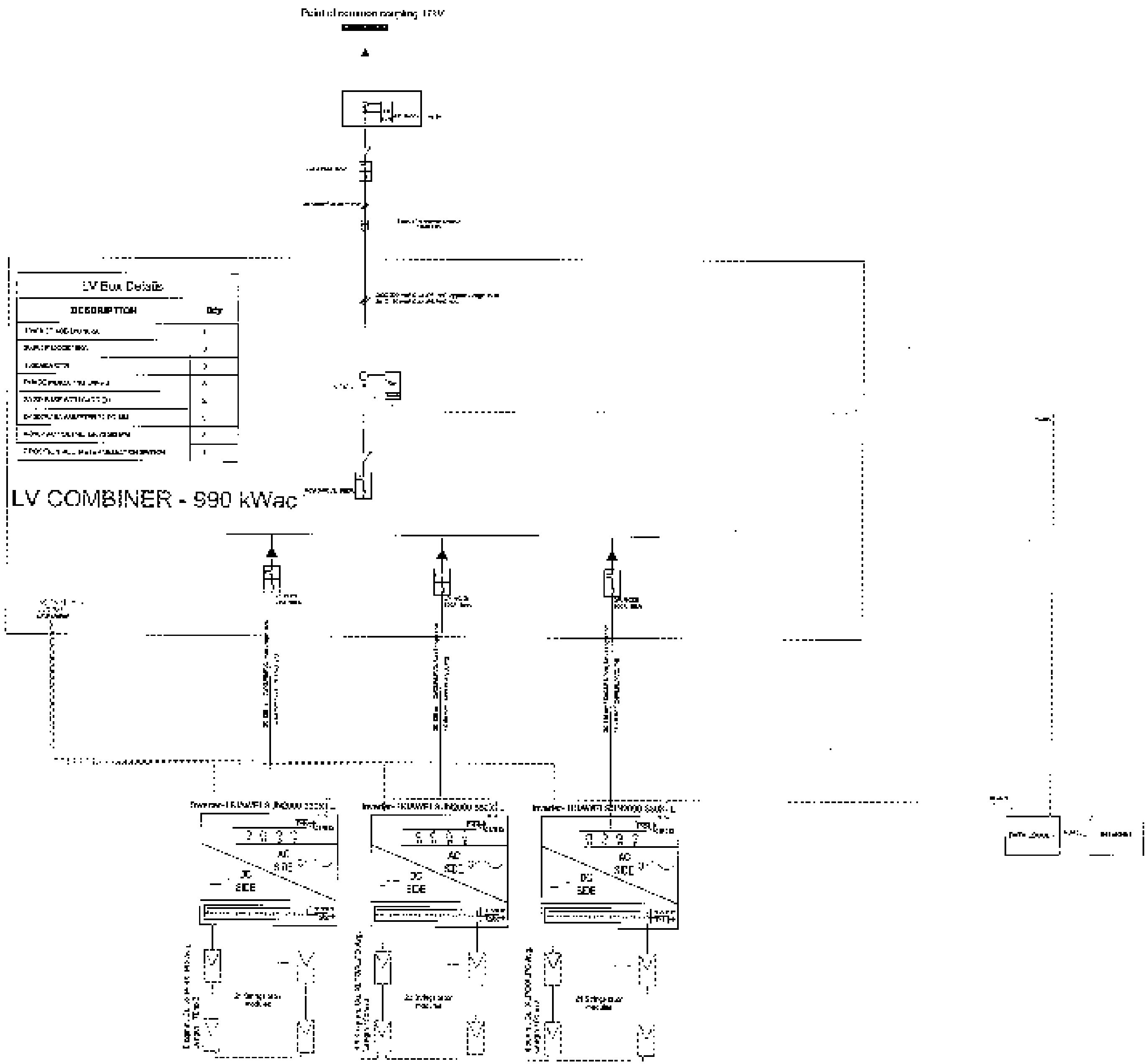


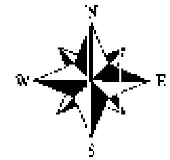
Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

Annexure-A-2

Power Plant Data

Single Line DIAGRAM
Scale N.T.S





SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:

MLS Solarization P-III

CMH - Lahore

CLIENT:

Military Engineering Services

DEVELOPER:

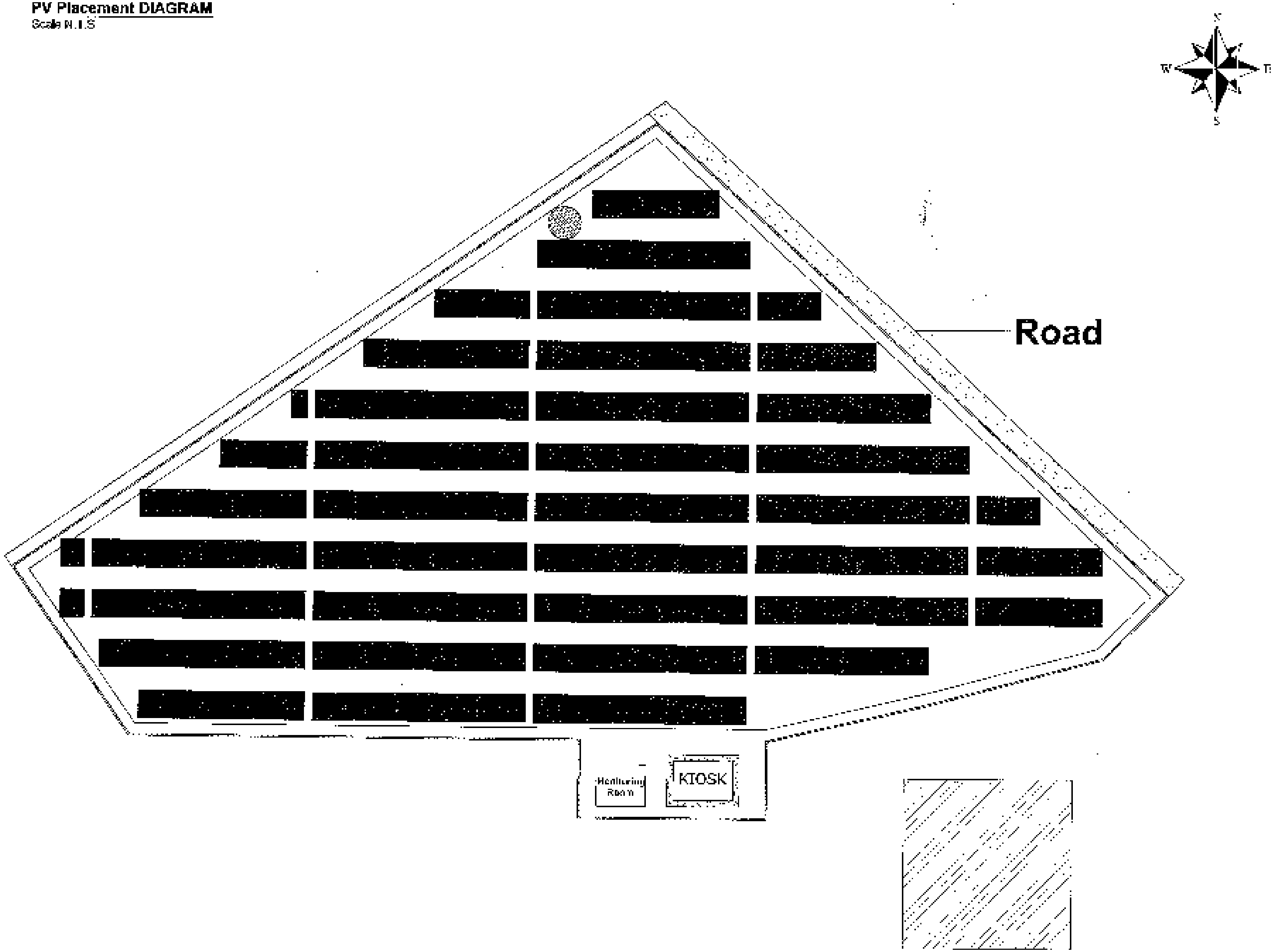
REV	DESCRIPTION	DATE	DRAWN BY

DRAWING:

SINGLE LINE DIAGRAM

SCALE: N.T.S	PAPER SIZE:	SHEET:
DRAWN:	CHECKED:	APPROVED:

PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization P-III
CMH - Lahore

CLIENT:
Military Engineering Services

DEVELOPER:

REV | DESCRIPTION | DATE | DRAWN BY

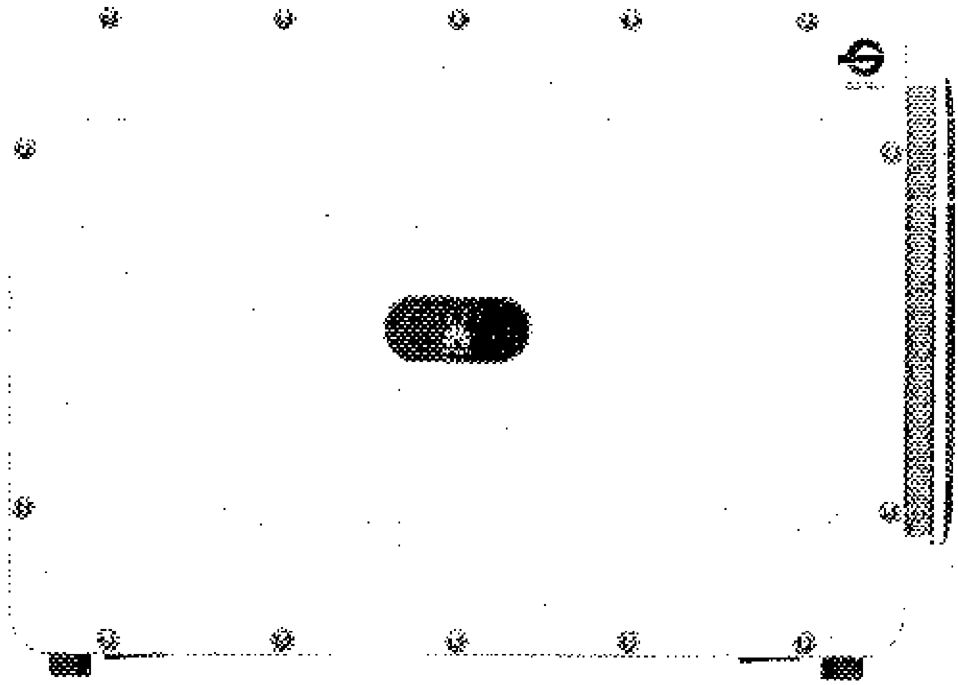
DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S
SHEET:

DRAWN: CHECKED: APPROVED:

SUN2000-330KTL-H1

Smart String Inverter



Max. Efficiency ≥99.0%

Smart Connector-level Detection (SCLD)

Smart Self-cleaning Fan (SSCF)

IP66 Protection

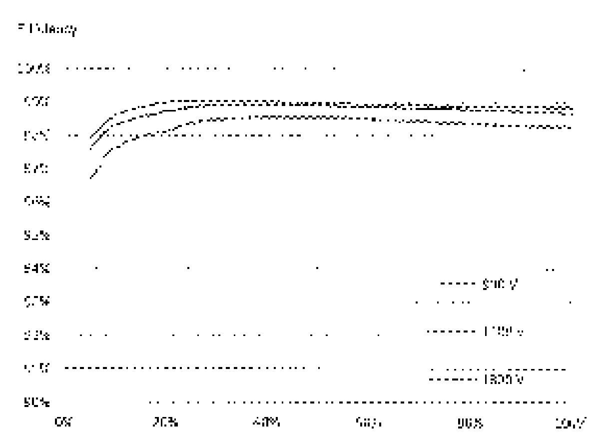
MBUS Supported

Smart String-level Disconnection (SSLD)

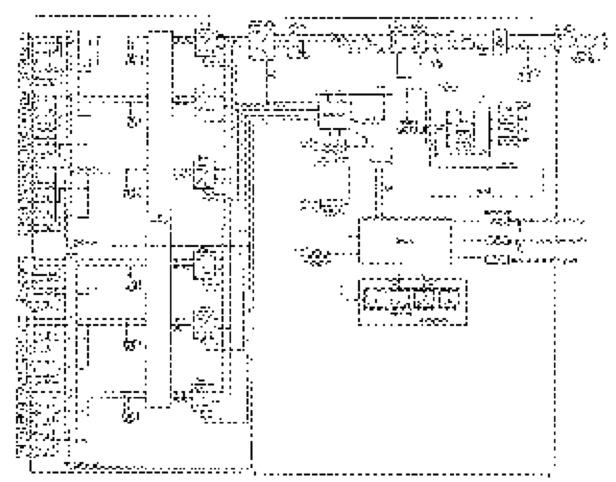
Smart IV Curve Diagnosis Supported

Surge Arresters for DC & AC

Efficiency Curve



Circuit Diagram



Technical Specifications

Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosϕ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type I
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 °C ~ 60 °C
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

Harvest the Sunshine

DEEP BLUE 4.0

Mono

580W n-type Bifacial Double Glass
High Efficiency Mono Module
JAM72D40 555-580/GB

Introduction

Power by the latest SMBB n-type solar cell, half-cell configuration and gapless ribbon connection technology, these modules have higher output power, lower LID, better weak illumination response, and better temperature coefficient.

- Higher power generation better LCOE
- n-type with very Lower LID
- Better weak illumination response
- Better Temperature Coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty

n-type Bifacial Double Glass Module Linear Performance Warranty

Standard Module Linear Performance Warranty

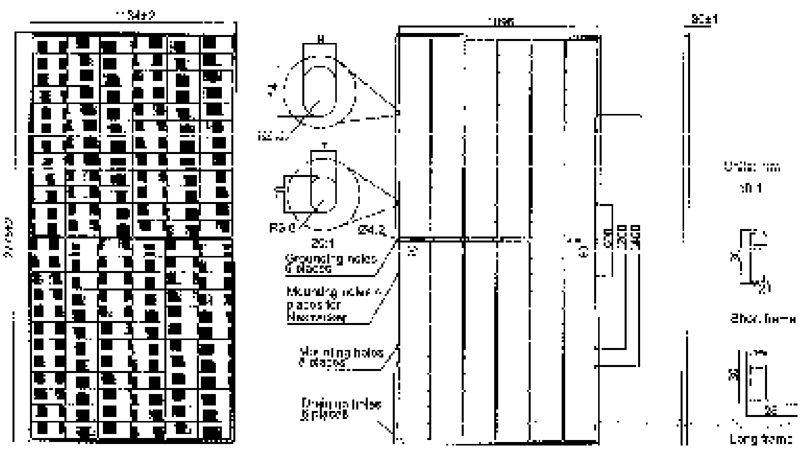
Comprehensive Certificates

- IEC 61215, IEC 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC 62941: 2019 Terrestrial photovoltaic (PV) modules - Quality system for PV module manufacturing

JA SOLAR

JAM72D40 555-580/GB

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono-166B
Weight	31.8kg
Dimensions	2278±2mm×1134±2mm×30±1mm
Cable Cross Section Size	4mm² (IEC), 12 AWG(UL)
No. of cells	144(6×24)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35)/ MC4-EVO2A
Cable Length (Including Connector)	Portrait:200mm(+)/300mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	36pcs/Pallet, 720pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Maximum Power(Pmax) [W]	555	560	565	570	575	580
Open Circuit Voltage(Voc) [V]	50.55	50.70	50.85	51.00	51.15	51.30
Maximum Power Voltage(Vmp) [V]	42.24	42.40	42.55	42.70	42.85	43.03
Short Circuit Current(Isc) [A]	14.02	14.09	14.16	14.23	14.30	14.36
Maximum Power Current(Imp) [A]	13.14	13.21	13.28	13.35	13.42	13.48
Module Efficiency [%]	21.5	21.7	21.9	22.1	22.3	22.5
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.045%/℃					
Temperature Coefficient of Voc(β_Voc)	-0.260%/℃					
Temperature Coefficient of Pmax(γ_Pmp)	-0.300%/℃					
STC	Irradiance 1000W/m², cell temperature 25°C, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Max Power(Pmax) [W]	599	605	610	616	621	626
Open Circuit Voltage(Voc) [V]	50.53	50.73	50.88	51.03	51.18	51.30
Max Power Voltage(Vmp) [V]	42.24	42.39	42.55	42.70	42.86	43.02
Short Circuit Current(Isc) [A]	15.14	15.22	15.29	15.37	15.44	15.51
Max Power Current(Imp) [A]	14.19	14.27	14.34	14.42	14.49	14.56
Irradiation Ratio (rear/front)	10%					

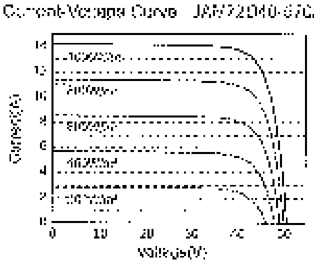
*For NextTracker installations, maximum static load please take compatibility approve letter between JA Solar and NextTracker for reference.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

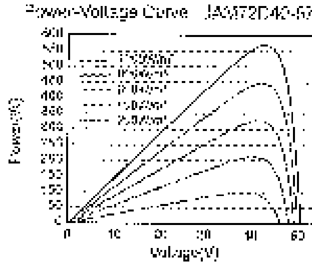
Max. System Voltage	1500V DC
Operating Temperature	-40℃~+85℃
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* / Maximum Static Load,Back*	5400Pa(112 lb/ft²) / 2400Pa(50 lb/ft²)
NOCT	45±2℃
Bifaciality**	80%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

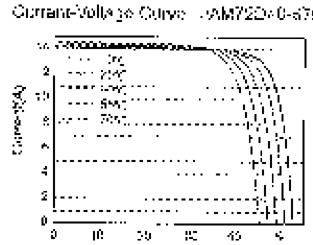
Current-Voltage Curve JAM72D40-570/GB



Power-Voltage Curve JAM72D40-570/GB



Current-Voltage Curve JAM72D40-570/GB



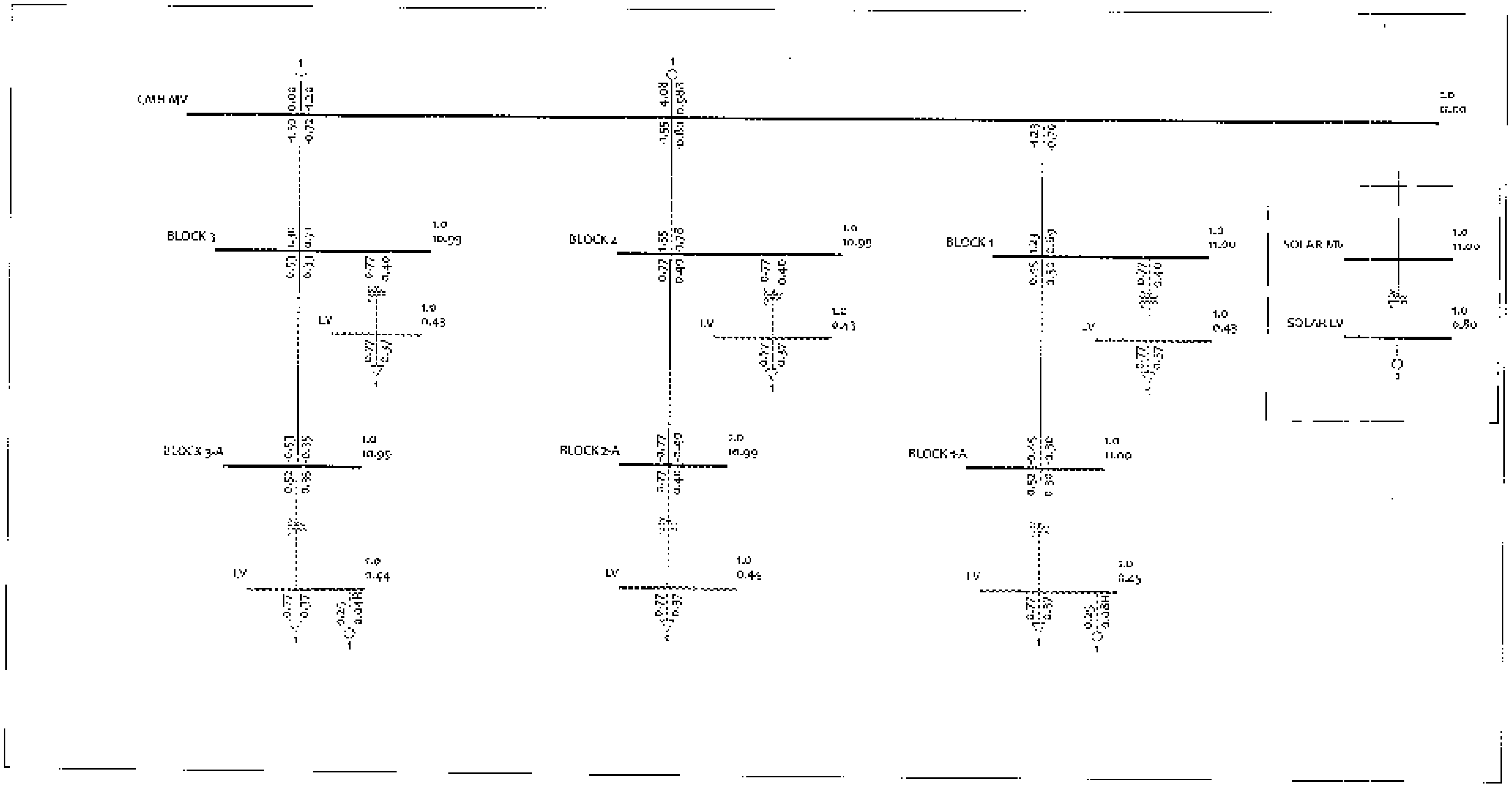
Annexure-B

Steady State Analysis Results

Load Flow Analysis of 999kW Solar PV System at Combined Military Hospital (CMH)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

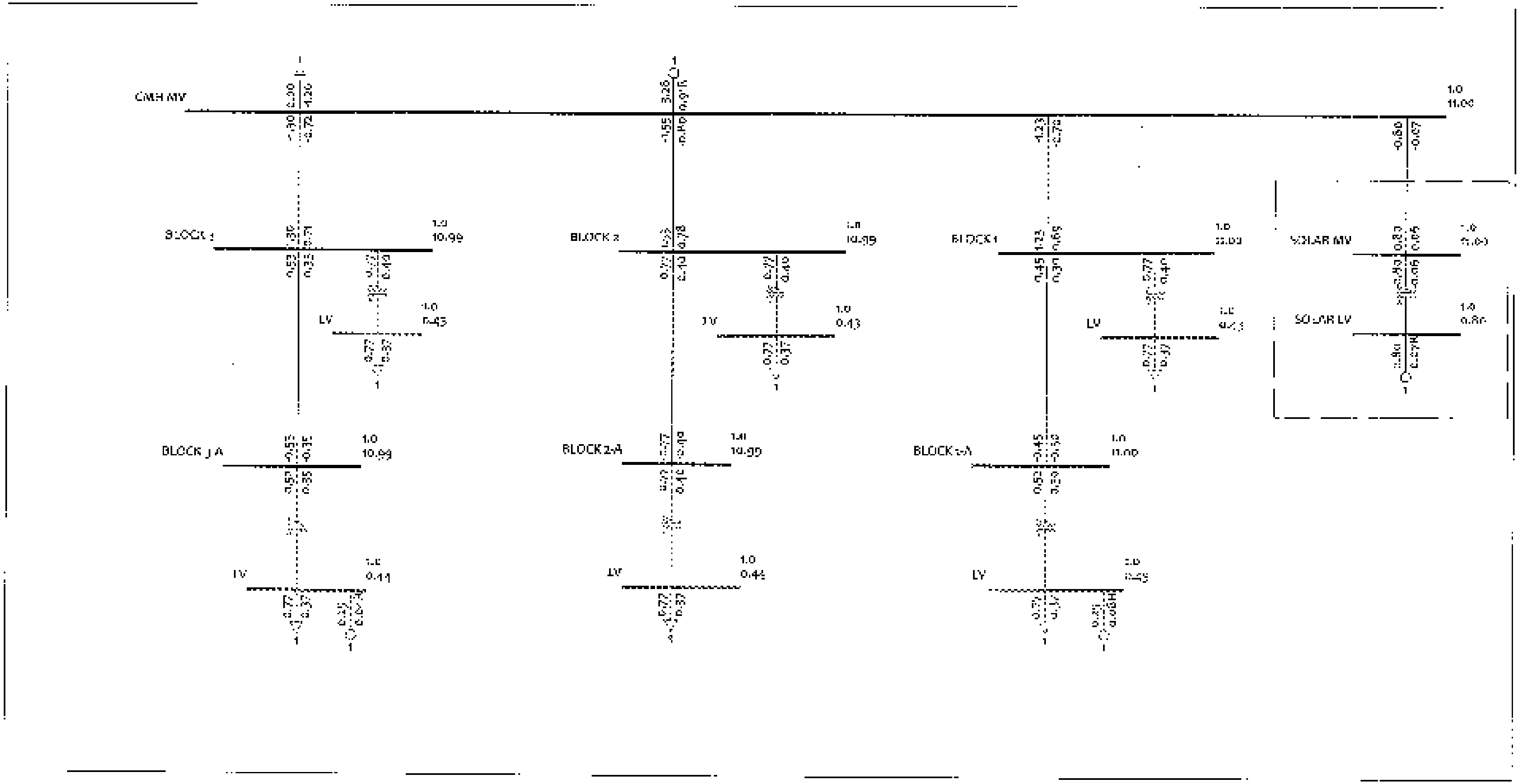
Figure: B-1



Load Flow Analysis of 990kW Solar PV System at Combined Military Hospital (CMH)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without CMH PP and With Sanctioned Load

In Service

```
                                   PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E       SAT, FEB 18 2023  17:10
                             CMB SOLAR PV SYSTEM                                           %MVA FOR TRANSFORMERS
                                                                                           % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT            GEN     LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER      RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW      MVAR
RATIO   ANGLE   %  SET A

   4100 CMB MV       11.000    4 1.0000    0.0     4.1      0.0      0.0 -----------------------------------------------------
---------------------
                               1 11.000            1.0R     0.0     -1.2  41001 BLOCK 1     11.000    4  1      1.2      0.7
14     10
                                                                          41005 BLOCK 2     11.000    4  1      1.5      0.8
17     10
                                                                          41009 BLOCK 3     11.000    4  1      1.3      0.7
15     10
  41001 BLOCK 1      11.000    4 0.9997   -0.8     0.0      0.0      0.0 -----------------------------------------------------
---------------------
                               1 10.997            0.0      0.0      0.0   4100 CMB MV      11.000    4  1     -1.2     -0.7
14     10
                                                                          41002 LV          0.4400    4  1      0.8      0.4
1.000LK          54      2
                                                                          41003 BLOCK 1-A   11.000    4  1      0.5      0.3
5     10
  41002 LV           0.4400    4 0.9875   -1.4     0.0      0.8      0.0 -----------------------------------------------------
---------------------
                               1 0.4345            0.0      0.4      0.0  41001 BLOCK 1     11.000    4  1     -0.8     -0.4
1.000UN          54      2

  41003 BLOCK 1-A    11.000    4 0.9996   -0.0     0.0      0.0      0.0 -----------------------------------------------------
---------------------
                               1 10.995            0.0      0.0      0.0  41001 BLOCK 1     11.000    4  1     -0.5     -0.3
5     10
                                                                          41004 LV          0.4400    4  1      0.5      0.3
0.975LK          38      2
  41004 LV           0.4400    4 1.0160   -0.9     0.0      0.8      0.0 -----------------------------------------------------
---------------------
                               1 0.4470            0.0H     0.4      0.0  41003 BLOCK 1-A   11.000    4  1     -0.5     -0.3
1.0000N          38      2

  41005 BLOCK 2      11.000    4 0.9993   -0.0     0.0      0.0      0.0 -----------------------------------------------------
---------------------
                               1 10.992            0.0      0.0      0.0   4100 CMB MV      11.000    4  1     -1.5     -0.8
17     10
                                                                          41006 LV          0.4400    4  1      0.8      0.4
1.000LK          54      2
```

```
                                                                             41007 BLOCK 2-A   11.000    4  1      0.8      0.4
9    10
 41006 LV            0.4400    4 0.9870   -1.4     0.0      0.8      0.0 ----------------------------------------------------------------------
---------------------
                               1 0.4349            0.0      0.4      0.0  41005 BLOCK 2     11.000    4  1     -0.8     -0.4
1.000UN          54     2

 41007 BLOCK 2-A    11.000     4 0.9993   -0.0     0.0      0.0      0.0 ----------------------------------------------------------------------
---------------------
                               1 10.992            0.0      0.0      0.0  41005 BLOCK 2     11.000    4  1     -0.8      0.4
9    10
                                                                           41008 LV          0.4400    4  1      0.8      0.4
0.988LK          54     2
 41008 LV            0.4400    4 0.9999   -1.4     0.0      0.8      0.0 ----------------------------------------------------------------------
---------------------
                               1 0.4399            0.0      0.4      0.0  41007 BLOCK 2-A   11.000    4  1     -0.8     -0.4
1.000UN          54     2

 41009 BLOCK 3      11.000     4 0.9991   -0.0     0.0      0.0      0.0 ----------------------------------------------------------------------
---------------------
                               1 10.990            0.0      0.0      0.0   4100 GMI MV      11.000    4  1     -1.3     -0.7
15    10
                                                                          410010 LV          0.4400    4  1      0.0      0.4
1.000LK          54     2
                                                                          410011 BLOCK 3-A  11.000    4  1      0.5      0.3
6    10
 410010 LV           0.4400    4 0.9968   -1.5     0.0      0.8      0.0 ----------------------------------------------------------------------
---------------------
                               1 0.4342            0.0      0.4      0.0  41009 BLOCK 3     11.000    4  1     -0.8     -0.4
1.000UN          54     2

 410011 BLOCK 3-A   11.000     4 0.9907   -0.1     0.0      0.0      0.0 ----------------------------------------------------------------------
---------------------
                               1 10.985            0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1     -0.5     -0.3
6    10
                                                                          410012 LV          0.4400    4  1      0.5      0.3
0.988LK          21     3
 410012 LV           0.4400    4 1.0045   -0.6     0.2      0.8      0.0 ----------------------------------------------------------------------
---------------------
                               1 0.4420            0.08     0.4      0.0 410011 BLOCK 3-A   11.000    4  1     -0.5     -0.3
1.000UA          21     3
```

Annexure-C-2

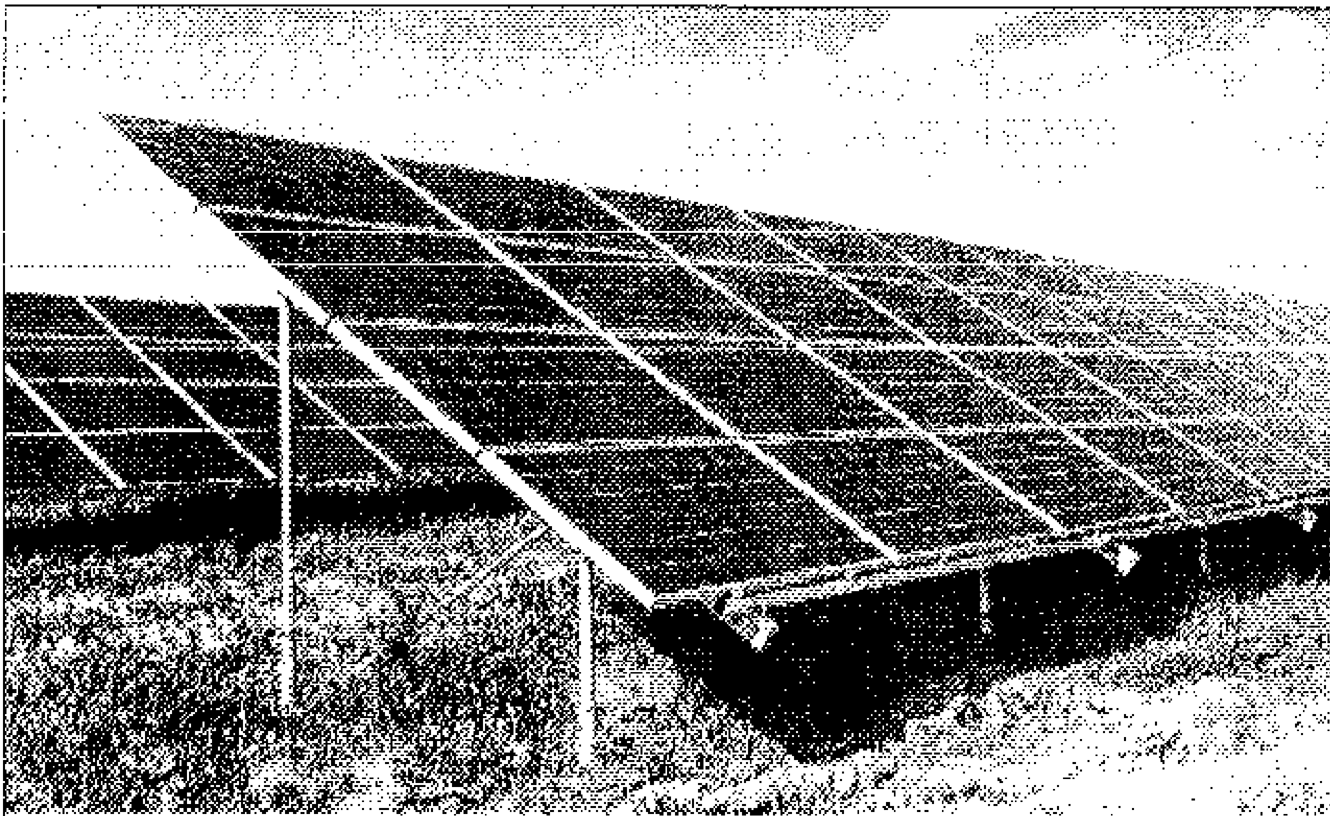
With CMH PP and With Sanctioned Load

In Service

```
                    PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)7     SAT, FEB 15 2025  17:12
          CMH SOLAR PV SYSTEM                                              %MVA FOR TRANSFORMERS
                                                                            % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT            GEN    LOAD   SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR  BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

  4100 CMH MV      11.000   4 1.0000   0.0     3.3     0.0     0.0 ----------------------------------------------------------
 --------------------
                            1 11.000           0.9R    0.0    -1.2  41001 BLOCK 1     11.000   4  1     1.2     0.7
14     10
                                                                   41005 BLOCK 2     11.000   4  1     1.5     0.8
17     10
                                                                   41009 BLOCK 3     11.000   4  1     1.3     0.7
15     10
                                                                   410013 SOLAR MV   11.000   4  1    -0.8    -0.1
8     10
  41001 BLOCK 1    11.000   4 0.9997  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
 --------------------
                            1 10.997           0.0     0.0     0.0  4100 CMH MV      11.000   4  1    -1.2    -0.7
14     10
                                                                   41002 LV           0.4400   4  1     0.8     0.4
1.000LK        54     2
                                                                   41003 BLOCK 1-A   11.000   4  1     0.5     0.3
5     10
  41002 LV          0.4400  4 0.9875  -1.4     0.0     0.8     0.0 ----------------------------------------------------------
 --------------------
                            1 0.4345           0.0     0.4     0.0  41001 BLOCK 1     11.000   4  1    -0.8    -0.4
1.000UN        54     2

  41003 BLOCK 1-A  11.000   4 0.9996  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
 --------------------
                            1 10.995           0.0     0.0     0.0  41001 BLOCK 1     11.000   4  1    -0.5    -0.3
5     10
                                                                   41004 LV           0.4400   4  1     0.5     0.3
0.975LK        38     2
  41004 LV          0.4400  4 1.0160  -0.9     0.2     0.8     0.0 ----------------------------------------------------------
 --------------------
                            1 0.4470           0.1R    0.4     0.0  41003 BLOCK 1-A   11.000   4  1    -0.5    -0.3
1.000UN        38     2

  41005 BLOCK 2    11.000   4 0.9993  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
 --------------------
                            1 10.992           0.0     0.0     0.0  4100 CMH MV      11.000   4  1    -1.5    -0.8
17     10
```

								41006 LV	0.4400	4 1	0.8	0.4
								41007 BLOCK 2-A	11.000	4 1	0.8	0.4
1.000LK	54	2										
9 10												
41006 LV		0.4400	4 0.9870	-1.4	0.0	0.8	0.0					
			1 0.4343		0.0	0.4	0.0	41005 BLOCK 2	11.000	4 1	-0.3	-0.4
1.000UN	54	2										
41007 BLOCK 2-A		11.000	4 0.9993	-0.0	0.0	0.0	0.0					
			1 10.992		0.0	0.0	0.0	41005 BLOCK 2	11.000	4 1	-0.8	-0.4
9 10								41008 LV	0.4400	4 1	0.8	0.4
0.988LK	54	2										
41008 LV		0.4400	4 0.9999	-1.4	0.0	0.8	0.0					
			1 0.4399		0.0	0.4	0.0	41007 BLOCK 2-A	11.000	4 1	-0.3	-0.4
1.000UN	54	2										
41009 BLOCK 3		11.000	4 0.9991	-0.0	0.0	0.0	0.0					
			1 10.990		0.0	0.0	0.0	4100 CMH MV	11.000	4 1	-1.3	-0.7
15 10								410010 LV	0.4400	4 1	0.8	0.4
1.000LK	54	2						410011 BLOCK 3-A	11.000	4 1	0.5	0.3
6 10												
410010 LV		0.4400	4 0.9868	-1.5	0.0	0.8	0.0					
			1 0.4342		0.0	0.4	0.0	41009 BLOCK 3	11.000	4 1	-0.8	-0.4
1.000UN	54	2										
410011 BLOCK 3-A		11.000	4 0.9987	-0.1	0.0	0.0	0.0					
			1 10.985		0.0	0.0	0.0	41009 BLOCK 3	11.000	4 1	-0.5	-0.3
6 10								410012 LV	0.4400	4 1	0.5	0.3
0.988LK	21	3										
410012 LV		0.4400	4 1.0045	-0.6	0.2	0.8	0.0					
			1 0.4420		0.08	0.4	0.0	410011 BLOCK 3-A	11.000	4 1	-0.5	-0.3
1.000UN	21	3										
410013 SOLAR MV		11.000	4 1.0002	0.0	0.0	0.0	0.0					
			1 11.002		0.0	0.0	0.0	4100 CMH MV	11.000	4 1	0.8	0.1
8 10												

```
                                                                                 410014 SOLAR LV    0.8000    4  1      -0.8    -0.1
1.000LK            64      1
 410014 SOLAR LV     0.8000     4 1.0015    0.9     0.8       0.0       0.0 ------------------------------------------------------------
---------------------
                                1 0.8012            0.1R      0.0       0.0 410013 SOLAR MV    11.000    4  1       0.8     0.1
1.000ON            64      1
```



Akram Line

SYSTEM STUDY ANALYSIS OF NEW AKRAM LINE (NAL) 500kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
Tel: +92-300-8827101

CONTENTS

EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 500kW Solar PV Power Generation project at New Akram Line (NAL) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 500kW Solar PV based system connected with the power network of NAL. The '500kW NAL solar PV Power Generation project' is located at G9FV+RF5, Abid Majeed Rd, Cantt, Lahore, Punjab, Pakistan.

The integration of solar power generation at the NAL premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. NAL currently receives a single point supply from LESCO with a sanctioned load of 0.5MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 0.5MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the NAL premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios:

- Without 500kW NAL solar PV with sanctioned load in service.
- With 500kW NAL solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of NAL. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the NAL distribution system. The power flow results for the system intact shows that the power flows on all the NAL transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for NAL. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with NAL and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 500kW NAL solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by New Akram Line (NAL) ("Project Owner" or "PO") for the interconnection of a 500kWp Solar PV Power Generation project ("Project") to the NAL power System at 11kV.

The '500kW NAL solar PV Power Generation project' is located at G9FV+RP5, Abid Majeed Rd, Cantt, Lahore, Punjab, Pakistan. Figure 1.1 shows Google site map of the project.

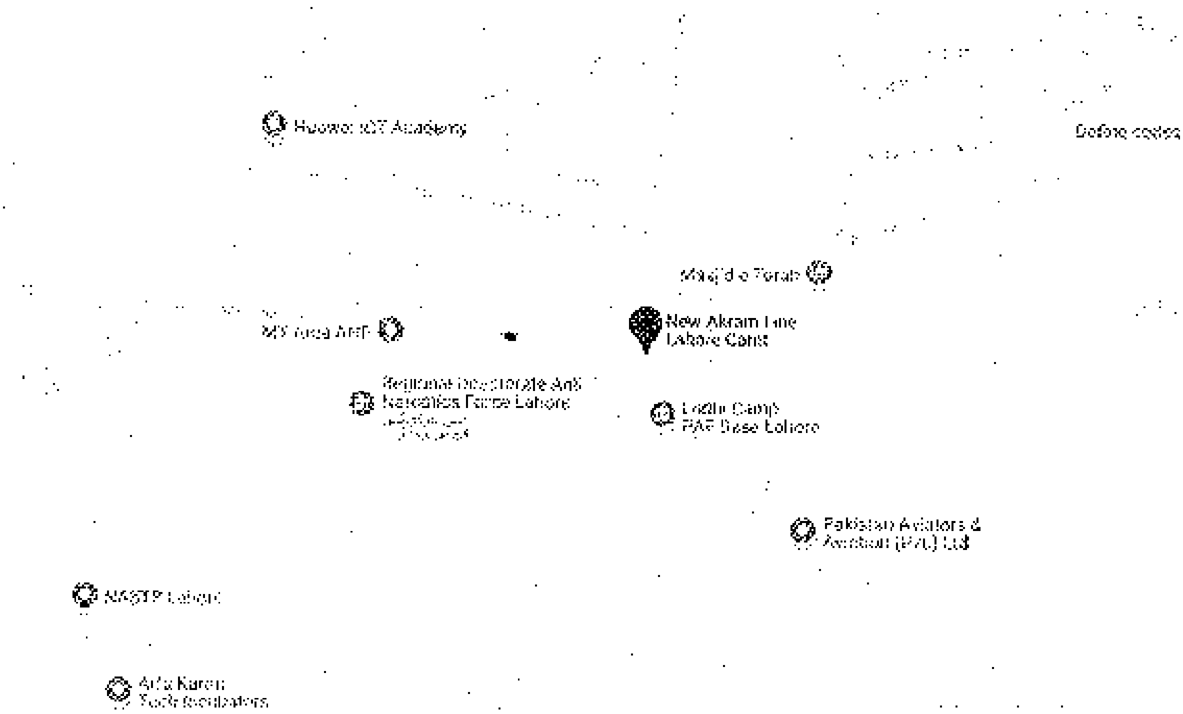


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

NAL aims to integrate solar power generation into its existing electrical infrastructure. NAL currently receives a single-point power supply from LESCO with a sanctioned load of 0.5MW. The entire solar generation within the NAL premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the NAL transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within NAL premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

500kW solar PV system is modelled into the NAL distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling
ii) Steady state analysis
iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 500kW NAL solar PV with sanctioned load in service.
- With 500kW NAL solar PV with sanctioned load in service.

This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 500kW solar PV system to the distribution system of NAL and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kVand above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within NAL.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	421
Active Power of each collector Pgen. (kW)	400
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.1315, 0.1315
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	630
% Reactance (X)	5 %
New Akram Line	
Sanctioned Load (LESCO)	500 kW

Steady state power flow assessment has been performed using the network data of NAL.

3.2 Power Flow Assessment Without NAL PP and with Sanctioned Load In Service

Power flow study without NAL solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of NAL network. This base case included a detailed representation of the NAL transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the NAL distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with NAL PP

Power flow study of NAL solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 500kW NAL solar project on the NAL distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at NAL solar for peak loading summer (June) 2025 that allow us to judge the impact of NAL solar project on the NAL network.
Project power flow analysis has been performed after the connection of the project with the NAL distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at NAL solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted

with sanctioned load in service after the interconnection of the Solar project with the NAL distribution system. The power flow results for the system intact shows that the power flows on all the NAL distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without NAL solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with NAL solar and with sanctioned load in service with NAL distribution system. Power flow results showed that the power flows on all the NAL distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 500kW New Akram Line solar PV system with NAL Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

LIST OF ANNEXURES

Annexure-A

Project Specific Data

Annexure-A-1

Project Site Map

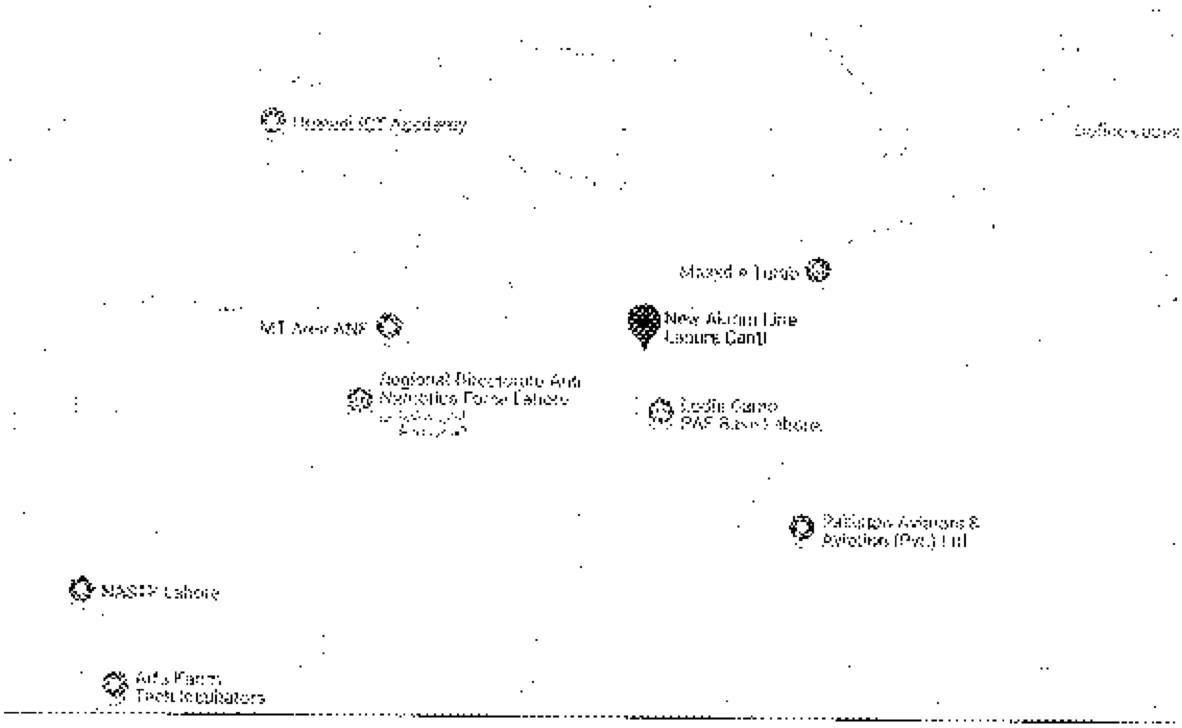
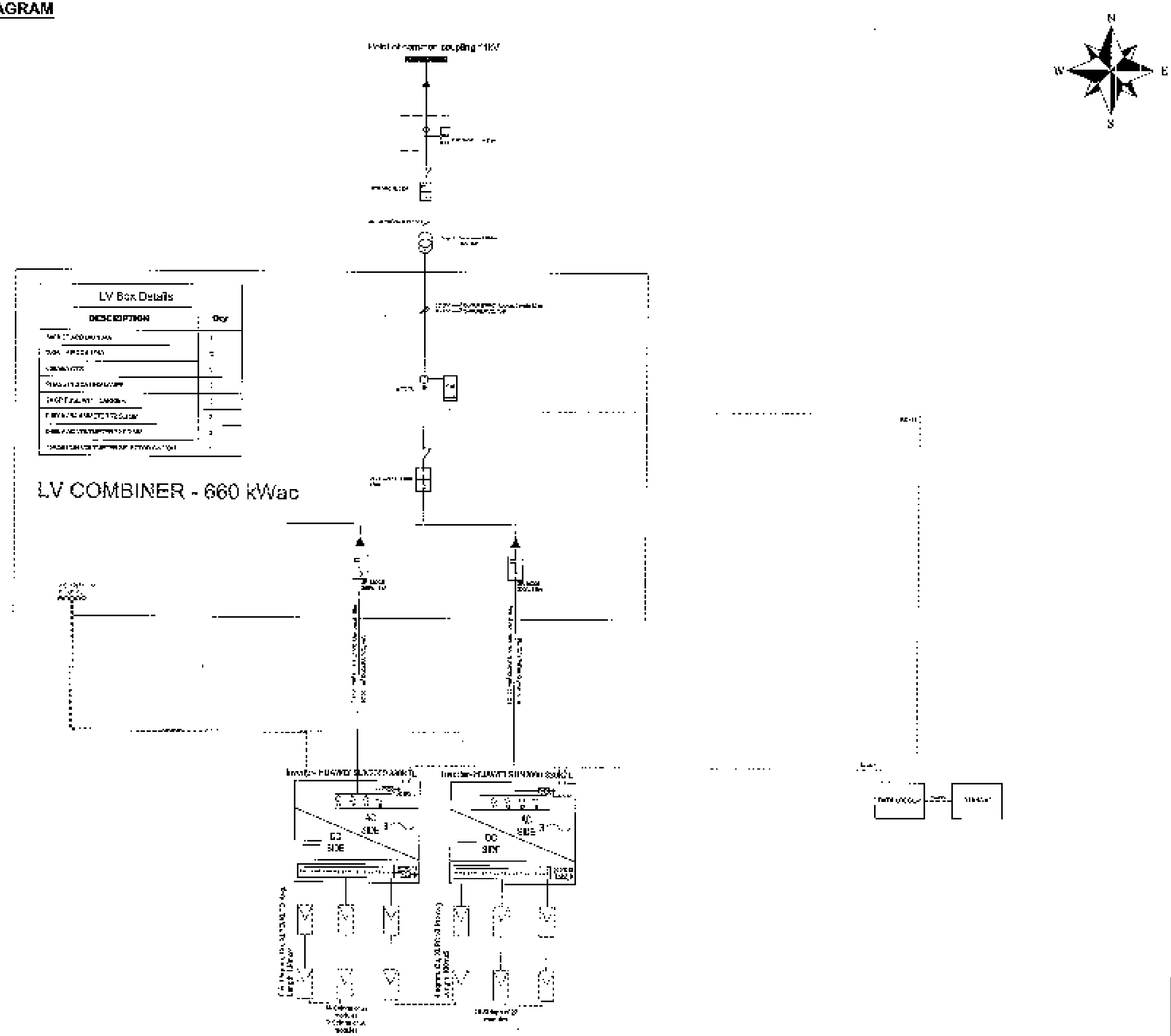


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

Annexure-A-2

Power Plant Data

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:

MES Solarization P-III

New Akram Lines - Lahore

CLIENT:

Military Engineering Services

DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY

DRAWING:

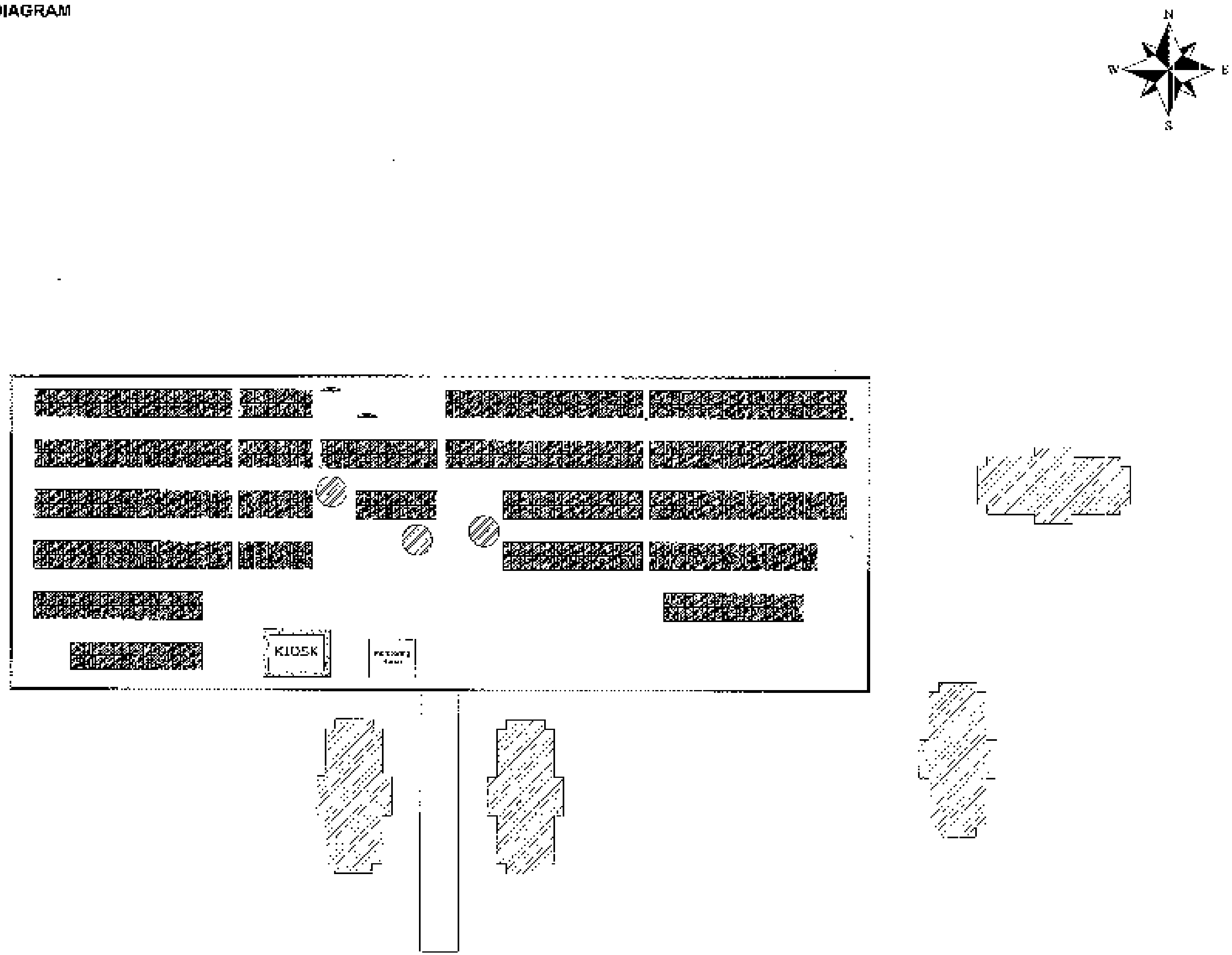
SINGLE LINE DIAGRAM

SCALE: N.T.S | PAPER SIZE: A3 | SHEET: 1/2

DRAWN: | CHECKED: | APPROVED:

PV Placement DIAGRAM

Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:

MES Solarization P-II

New Akram Ulmar - Lahore

CLIENT:

Military Engineering Services

DEVELOPER:

REV. DESCRIPTION	DATE	DRAWN BY

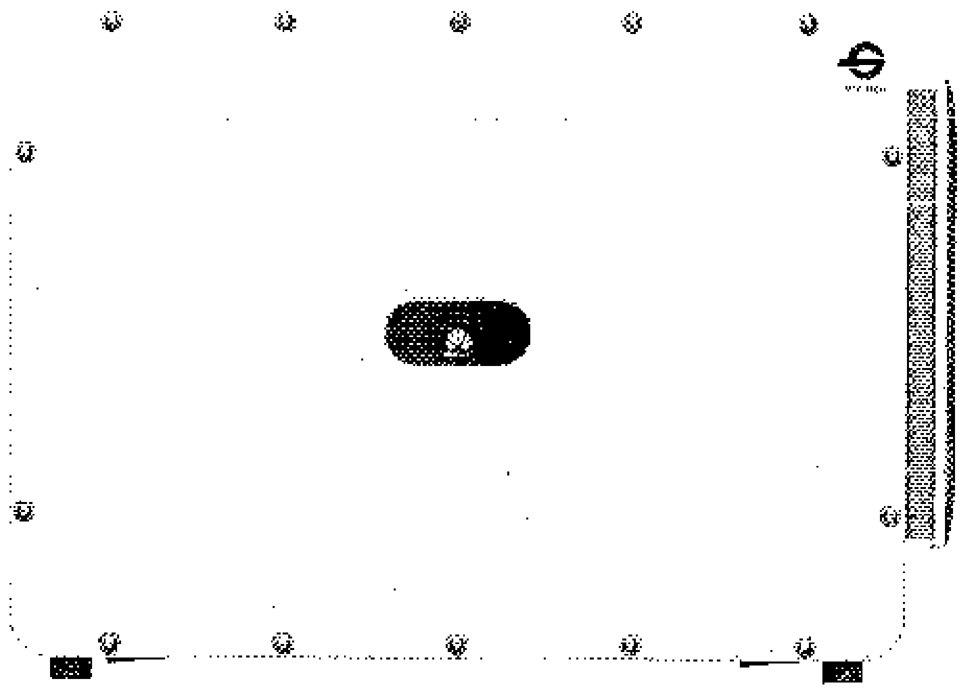
DRAWING:

SINGLE LINE DIAGRAM

SCALE: N.T.S	PAPER SIZE: A4	SHEET
DRAWN:	CHECKED:	APPROVED:

SUN2000-330KTL-H1

Smart String Inverter



Max. Efficiency ≥99.0%

Smart Connector-level Detection (SCLD)

Smart Self-cleaning Fan (SSCF)

IP66 Protection

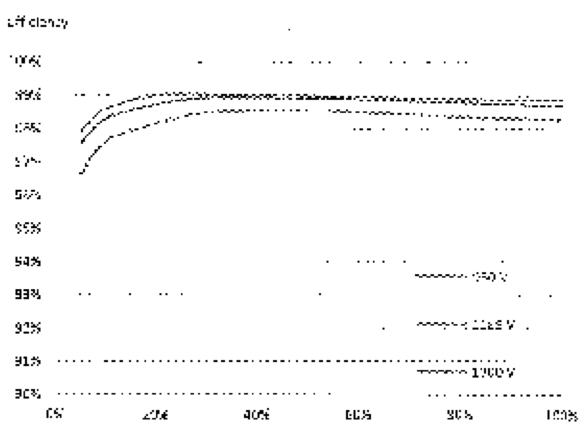
MBUS Supported

Smart String-level Disconnection (SSLD)

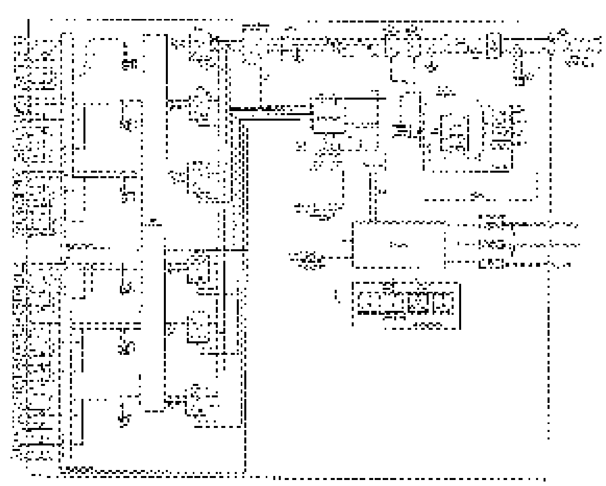
Smart IV Curve Diagnosis Supported

Surge Arresters for DC & AC

Efficiency Curve



Circuit Diagram



SUN2000-330KTL-H1

Technical Specifications

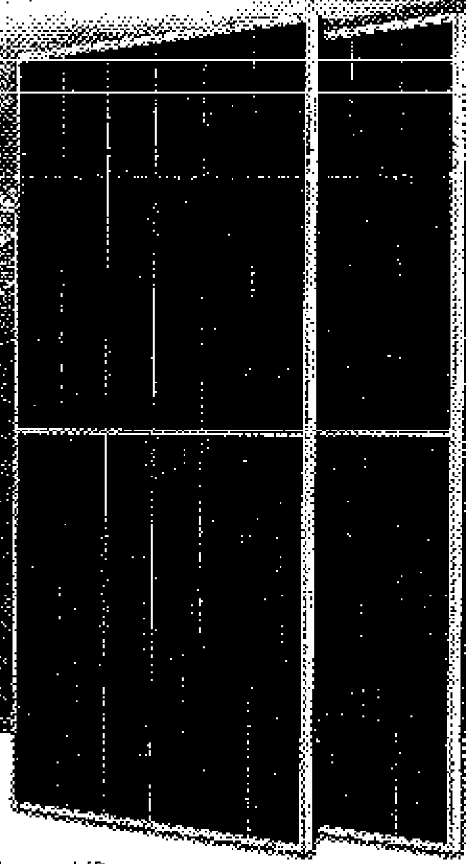
Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/3
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosφ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	215.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type I
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 ℃ ~ 60 ℃
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + CT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

Harvest the Sunshine

DEEP BLUE 4.0

Mono

580W n-type Bifacial Double Glass
High Efficiency Mono Module
JAM72D40 555-580/GB Series



Introduction

Power by the fastest SMBB n-type solar cell, half-cell configuration and gapless ribbon connection technology, these modules have higher output power, lower LID, better weak illumination response, and better temperature coefficient.

- Higher power generation better LCOE
- n-type with very Lower LID
- Better weak illumination response
- Better Temperature Coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty

n-type Bifacial Double Glass Module Linear Performance Warranty

Standard Module Linear Performance Warranty

Comprehensive Certificates

- IEC 61215, IEC 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC 62941: 2019 Terrestrial photovoltaic (PV) modules - Quality system for PV module manufacturing

CE

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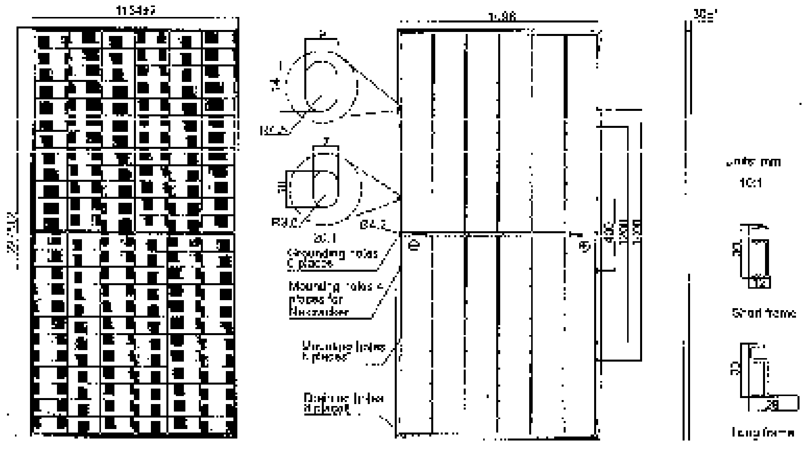
JAM72D40 555-580/GB

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono-16BB
Weight	31.8kg
Dimensions	2278±2mm×1134±2mm×30±1mm
Cable Cross Section Size	4mm² (IEC), 12 AWG(UL)
No. of cells	144(6×24)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35 / MC4-EVO2A
Cable Length (Including Connector)	Portrait:200mm(+)/300mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	36pcs/Pallet, 720pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Maximum Power(Pmax) [W]	555	560	565	570	575	580
Open Circuit Voltage(Voc) [V]	50.55	50.70	50.85	51.00	51.15	51.30
Maximum Power Voltage(Vmp) [V]	42.24	42.40	42.55	42.70	42.85	43.03
Short Circuit Current(Isc) [A]	14.02	14.09	14.16	14.23	14.30	14.36
Maximum Power Current(Imp) [A]	13.14	13.21	13.28	13.35	13.42	13.48
Module Efficiency [%]	21.5	21.7	21.9	22.1	22.3	22.5
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.046%/℃					
Temperature Coefficient of Voc(β_Voc)	-0.260%/℃					
Temperature Coefficient of Pmax(γ_Pmp)	-0.300%/℃					
STC	Irradiance 1000W/m², cell temperature 25℃, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Max Power(Pmax) [W]	590	605	610	616	621	626
Open Circuit Voltage(Voc) [V]	50.58	50.73	50.88	51.03	51.18	51.30
Max Power Voltage(Vmp) [V]	42.24	42.39	42.55	42.70	42.86	43.02
Short Circuit Current(Isc) [A]	15.14	15.22	15.29	15.37	15.44	15.51
Max Power Current(Imp) [A]	14.19	14.27	14.34	14.42	14.49	14.56
Irradiation Ratio (rear/front)	10%					

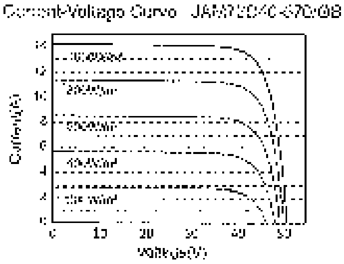
*For Nextracker installations, maximum static load please take compatibility approval letter between JA Solar and Nextracker for reference.
**Bifaciality=Pmax,rear/Rated Pmax,front.

OPERATING CONDITIONS

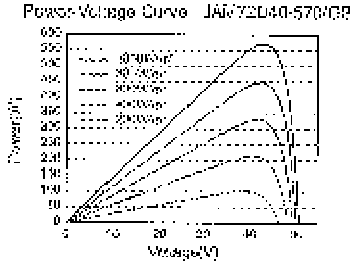
Maximum System Voltage	1500V DC
Operating Temperature	-40℃~+85℃
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* / Maximum Static Load,Back*	5400Pa(112 lb/ft²) / 2400Pa(50 lb/ft²)
NOCT	45±2℃
Bifaciality**	80%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

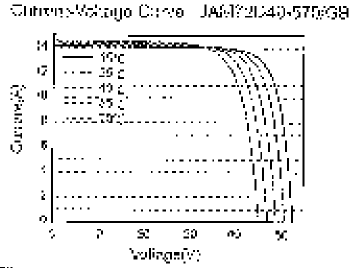
Current-Voltage Curve JAM72D40-570/GB



Power-Voltage Curve JAM72D40-570/GB



Current-Voltage Curve JAM72D40-570/GB



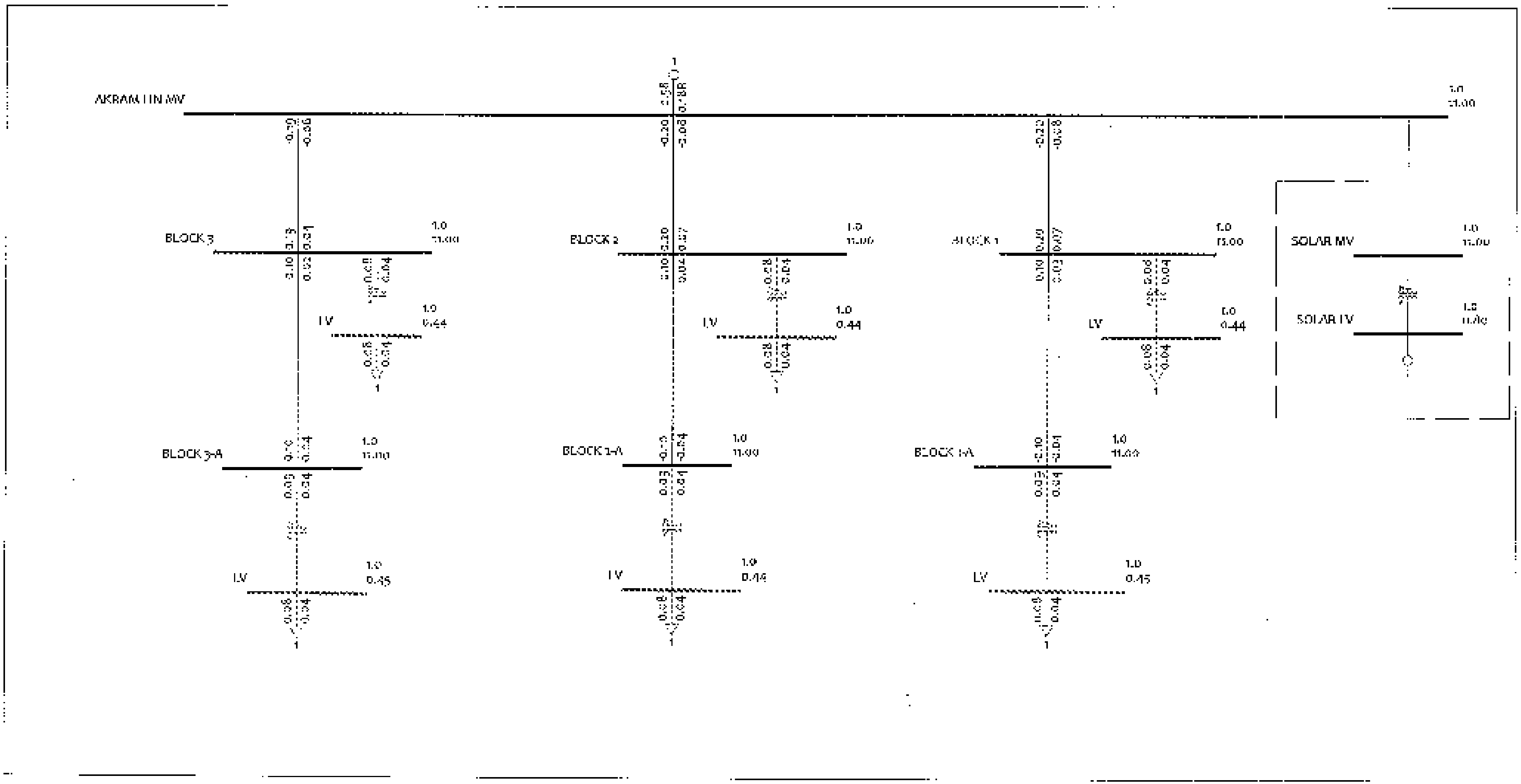
Annexure-B

Steady State Analysis Results

Load Flow Analysis of 500kWp Solar PV System at New Akram Line (NAL)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

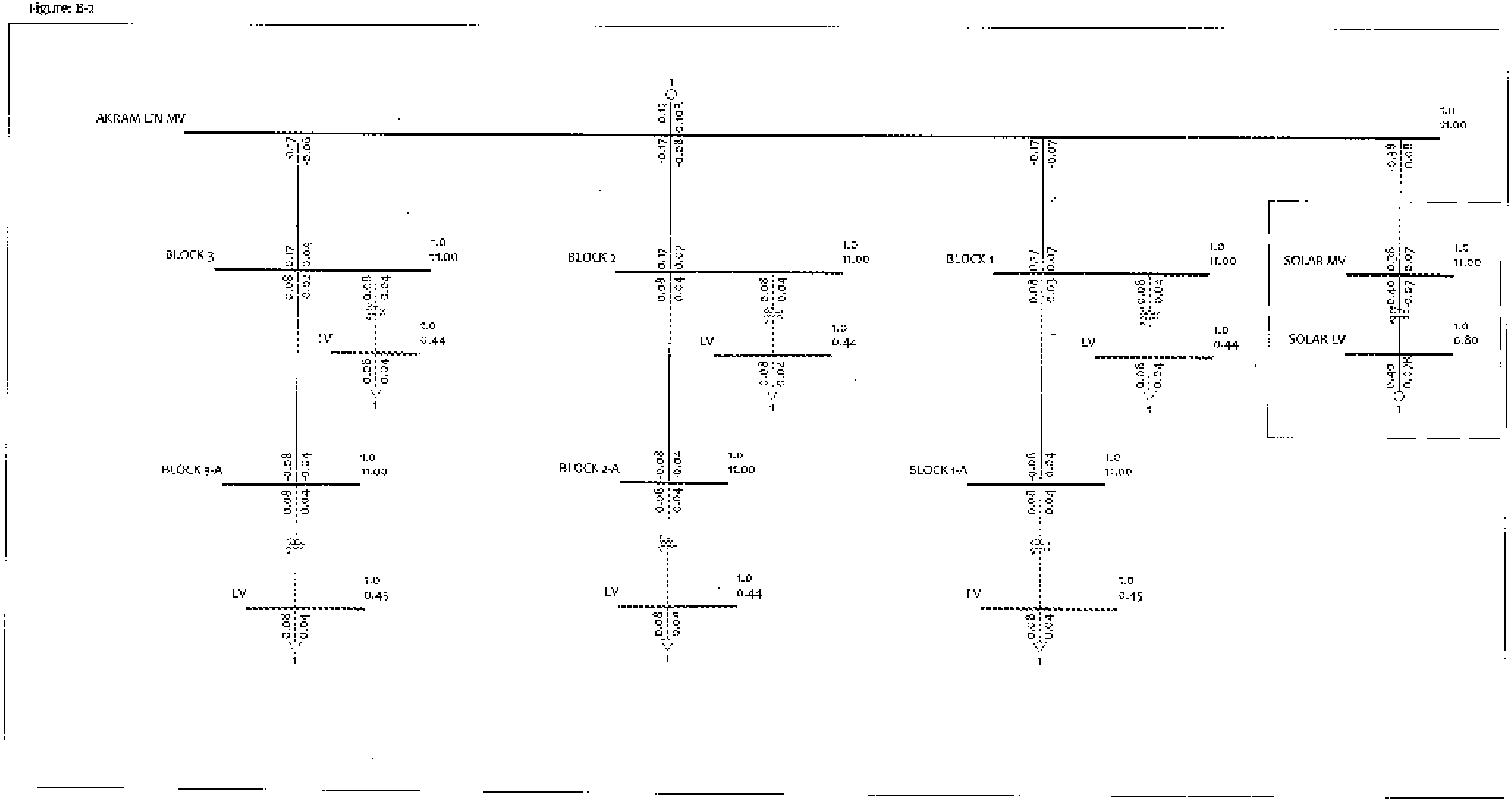
Figure: B-1



Load Flow Analysis of 500kWp Solar PV System at New Akram Line (NAL)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without NAL PP and With Sanctioned Load

In Service

```
                 PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:14
           AKRAM LINE SOLAR PV SYSTEM                                   %MVA FOR TRANSFORMERS
                                                                        % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER      RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   A  SET A

   4100 AKRAM LIN MV11.000    4 1.0000   0.0     0.6     0.0     0.0 -----------------------------------------------------
--------------------
                            1 11.000            0.2R    0.0     0.0  41001 BLOCK 1      11.000   4  1      0.2     0.1
2    10
                                                                     41005 BLOCK 2      11.000   4  1      0.2     0.1
2    10
                                                                     41009 BLOCK 3      11.000   4  1      0.2     0.0
2    10
  41001 BLOCK 1       11.000  4 1.0000  -0.0     0.0     0.0     0.0 -----------------------------------------------------
--------------------
                            1 11.000            0.0     0.0     0.0   4100 AKRAM LIN MV11.000   4  1     -0.2    -0.1
2    10
                                                                     41002 LV            0.4400   4  1      0.1     0.0
1.0000LK           6     2
                                                                     41003 BLOCK 1-A    11.000   4  1      0.1     0.0
1    10
  41002 LV            0.4400  4 0.9987  -0.2     0.0     0.1     0.0 -----------------------------------------------------
--------------------
                            1 0.4394            0.0     0.0     0.0  41001 BLOCK 1      11.000   4  1     -0.1    -0.0
1.0000UK           6     2

  41003 BLOCK 1-A     11.000  4 0.9999  -0.0     0.0     0.0     0.0 -----------------------------------------------------
--------------------
                            1 10.999            0.0     0.0     0.0  41001 BLOCK 1      11.000   4  1     -0.1    -0.0
1    10
                                                                     41004 LV            0.4400   4  1      0.1     0.0
0.9751LK           6     2
  41004 LV            0.4400  4 1.0243  -0.2     0.0     0.1     0.0 -----------------------------------------------------
--------------------
                            1 0.4307            0.0     0.0     0.0  41003 BLOCK 1-A    11.000   4  1     -0.1    -0.0
1.0000UK           6     2

  41005 BLOCK 2       11.000  4 0.9999  -0.0     0.0     0.0     0.0 -----------------------------------------------------
--------------------
                            1 10.999            0.0     0.0     0.0   4100 AKRAM LIN MV11.000   4  1     -0.2    -0.1
2    10
                                                                     41006 LV            0.4400   4  1      0.1     0.0
1.0000LK           6     2
```

```
                                                                    41007 BLOCK 2-A   11.000    4  1      0.1     0.0
1     10
  41008 LV          0.4400   4 0.9986  -0.2     0.0      0.1      0.0 -----------------------------------------------------------
---------------------
                             1 0.4334           0.0      0.0      0.0  41033 BLOCK 2     11.000    4  1     -0.1    -0.0
1.000UN            6     2

  41007 BLOCK 2-A   11.000   4 0.9999  -0.0     0.0      0.0      0.0 -----------------------------------------------------------
---------------------
                             1 10.999           0.0      0.0      0.0  41033 BLOCK 2     11.000    4  1     -0.1    -0.0
1     10
                                                                       41008 LV           0.4400    4  1      0.1     0.0
0.988LK            6     2
  41008 LV          0.4400   4 1.0013  -0.2     0.0      0.1      0.0 -----------------------------------------------------------
---------------------
                             1 0.4450           0.0      0.0      0.0  41007 BLOCK 2-A   11.000    4  1     -0.1    -0.0
1.000UN            6     2

  41039 BLOCK 3     11.000   4 0.9999  -0.0     0.0      0.0      0.0 -----------------------------------------------------------
---------------------
                             1 10.999           0.0      0.0      0.0   4100 AKRAM DIN MV11.000    4  1     -0.2    -0.1
2      0
                                                                      410010 LV           0.4400    4  1      0.1     0.0
1.000LK            6     2
                                                                      410011 BLOCK 3-A   11.000    4  1      0.1     0.0
1     10
 410010 LV          0.4400   4 0.9986  -0.2     0.0      0.1      0.0 -----------------------------------------------------------
---------------------
                             1 0.4394           0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1     -0.1    -0.0
1.000UN            6     2

 410011 BLOCK 3-A   11.000   4 0.9999  -0.0     0.0      0.0      0.0 -----------------------------------------------------------
---------------------
                             1 10.998           0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1     -0.1    -0.0
1     10
                                                                      410012 LV           0.4400    4  1      0.1     0.0
0.988LK            3     3
 410012 LV          0.4400   4 1.0017  -0.1     0.0      0.1      0.0 -----------------------------------------------------------
---------------------
                             1 0.4451           0.0      0.0      0.0 410011 BLOCK 3-A   11.000    4  1     -0.1    -0.0
1.000UN            3     3
```

Annexure-C-2

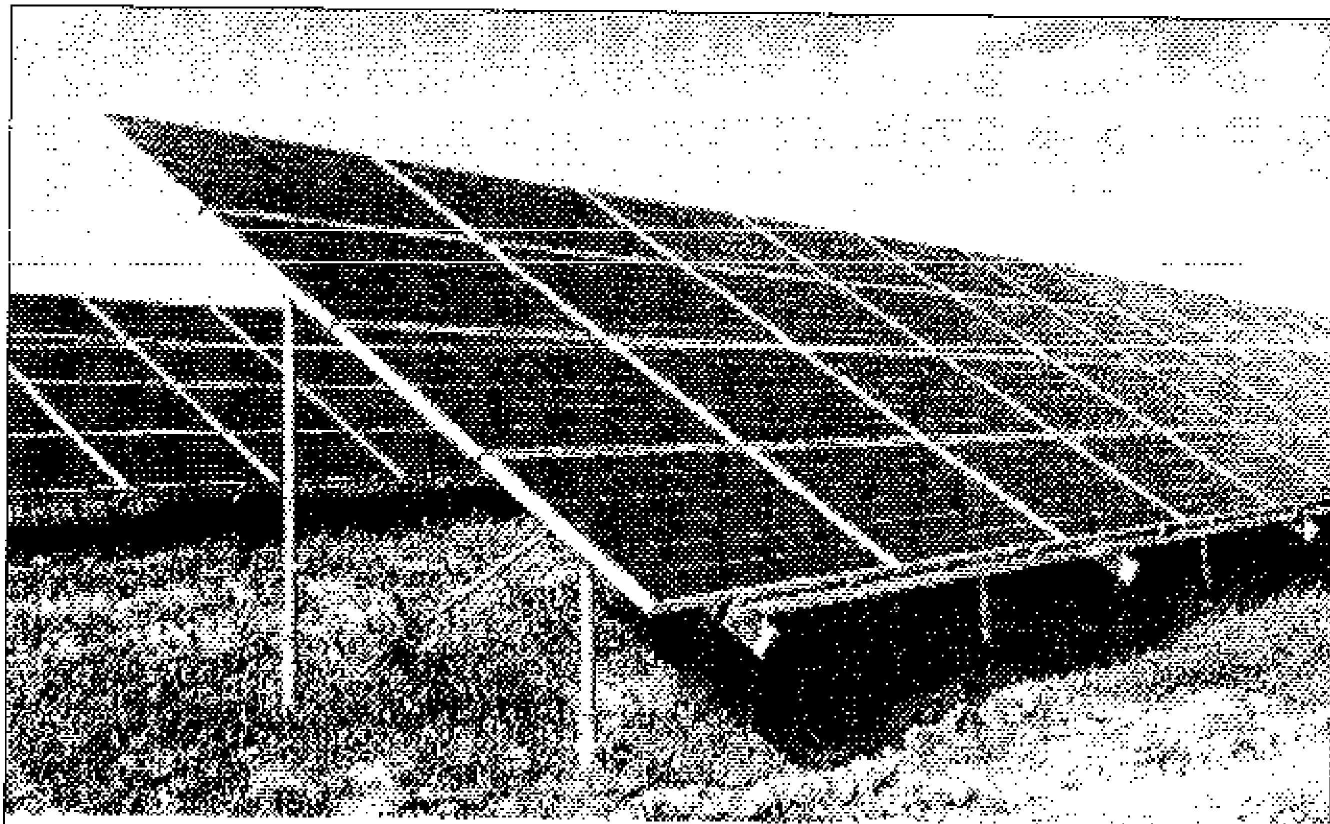
With NAL PP and With Sanctioned Load

In Service

```
                 PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:15
             AKRAM LINE SOLAR PV SYSTEM                                 %MVA FOR TRANSFORMERS
                                                                        % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN     LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER       RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 AKRAM LIN MV11.000     4 1.0000   0.0     0.1      0.0     0.0 ----------------------------------------------------------
----------------------
                               1 11.000           0.1R     0.0     0.0  41001 BLOCK 1     11.000    4  1     0.2     0.1
2     10
                                                                        41005 BLOCK 2     11.000    4  1     0.2     0.1
2     10
                                                                        41009 BLOCK 3     11.000    4  1     0.2     0.0
2     10
                                                                       410013 SOLAR MV    11.000    4  1    -0.4    -0.1
4     10
  41001 BLOCK 1      11.000    4 1.0000  -0.0     0.0      0.0     0.0 ----------------------------------------------------------
----------------------
                               1 11.000           0.0      0.0     0.0   4100 AKRAM LIN MV11.000    4  1    -0.2    -0.1
2     10
                                                                        41002 LV           0.4400   4  1     0.1     0.0
1.000LK          6     2
                                                                        41003 BLOCK 1-A   11.000    4  1     0.1     0.0
1     10
  41002 LV            0.4400   4 0.9987  -0.2     0.0      0.1     0.0 ----------------------------------------------------------
----------------------
                               1 0.4394           0.0      0.0     0.0  41001 BLOCK 1     11.000    4  1    -0.1    -0.0
1.0000N          6     2

  41003 BLOCK 1-A    11.000    4 0.9999  -0.0     0.0      0.0     0.0 ----------------------------------------------------------
----------------------
                               1 10.999           0.0      0.0     0.0  41001 BLOCK 1     11.000    4  1    -0.1    -0.0
1     10
                                                                        41004 LV           0.4400   4  1     0.1     0.0
0.9751LK         6     2
  41004 LV            0.4400   4 1.0243  -0.1     0.0      0.1     0.0 ----------------------------------------------------------
----------------------
                               1 0.4507           0.0      0.0     0.0  41003 BLOCK 1-A   11.000    4  1    -0.1    -0.0
1.0300UN         6     2

  41005 BLOCK 2      11.000    4 0.9999  -0.0     0.0      0.0     0.0 ----------------------------------------------------------
----------------------
                               1 10.999           0.0      0.0     0.0   4100 AKRAM LIN MV11.000    4  1    -0.2    -0.1
2     10
```

```
                                                                   41006 LV          0.4400   4  1    0.1    0.0
1.000LK        6    2
                                                                   41007 BLOCK 2-A   11.000   4  1    0.1    0.0
1    10
 41006 LV        0.4400   4 0.9987  -0.2   0.0   0.1   0.0 ---------------------------------------------------------
---------------------
                          1 0.4394         0.0   0.0   0.0  41005 BLOCK 2      11.000   4  1   -0.1   -0.0
1.000LN        6    2

 41007 BLOCK 2-A  11.000  4 0.9999  -0.0   0.0   0.0   0.0 ---------------------------------------------------------
---------------------
                          1 10.999         0.0   0.0   0.0  41005 BLOCK 2      11.000   4  1   -0.1   -0.0
1    10
                                                            41008 LV          0.4400   4  1    0.1    0.0
0.988LK        6    2
 41008 LV        0.4400   4 1.0113  -0.2   0.0   0.1   0.0 ---------------------------------------------------------
---------------------
                          1 0.4450         0.0   0.0   0.0  41007 BLOCK 2-A   11.000   4  1   -0.1   -0.0
1.000UN        6    2

 41009 BLOCK 3    11.000  4 0.9999  -0.0   0.0   0.0   0.0 ---------------------------------------------------------
---------------------
                          1 10.999         0.0   0.0   0.0   4100 AKRAM LIN MV11.000  4  1   -0.2   -0.1
2    10
                                                            410010 LV         0.4400   4  1    0.1    0.0
1.000LK        6    2
                                                            410011 BLOCK 3-A  11.000   4  1    0.1    0.0
1    10
 410010 LV       0.4400   4 0.9986  -0.2   0.0   0.1   0.0 ---------------------------------------------------------
---------------------
                          1 0.4394         0.0   0.0   0.0  41009 BLOCK 3      11.000   4  1   -0.1   -0.0
1.000UN        6    2

 410011 BLOCK 3-A 11.000  4 0.9999  -0.0   0.0   0.0   0.0 ---------------------------------------------------------
---------------------
                          1 10.998         0.0   0.0   0.0  41009 BLOCK 3      11.000   4  1   -0.1   -0.0
1    10
                                                            410012 LV         0.4400   4  1    0.1    0.0
0.980LK        3    3
 410012 LV       0.4400   4 1.0117  -0.1   0.0   0.1   0.0 ---------------------------------------------------------
---------------------
                          1 0.4452         0.0   0.0   0.0 410011 BLOCK 3-A  11.000   4  1   -0.1   -0.0
1.000UN        3    3

 410013 SOLAR MV 11.000   4 1.0001   0.0   0.0   0.0   0.0 ---------------------------------------------------------
---------------------
                          1 11.001         0.0   0.0   0.0   4100 AKRAM LIN MV11.000  4  1    0.4    0.1
4    10
```

```
                                                                                      410014 SOLAR LV    0.8000    4  1     -0.4    -0.1
1.000LX          64     1
 410014 SOLAR LV    0.8000    4 1.0015    0.5     0.4      0.0      0.0 ----------------------------------------------------------------
--------------------
                              1 0.8012            0.1R     0.0      0.0 410013 SOLAR MV   11.000    4  1      0.4     0.1
1.0000N          64     1
```



ARCO Energy

MIAN MIR LINE

SYSTEM STUDY ANALYSIS OF MIAN MIR LINE (MML) 500kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
Tel: +92-300-8827101

CONTENTS

EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 500kW Solar PV Power Generation project at Mian Mir Line (MML) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 500kW Solar PV based system connected with the power network of MML. The '500kW MML solar PV Power Generation project' is located at Ground of 17 NLI / HQ 106 Bde North Mian Mir Line, Shami Rd, Cantt, Lahore, Pakistan.

The integration of solar power generation at the MML premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. MML currently receives a single point supply from LESCO with a sanctioned load of 1.918MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 1.918MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the MML premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 500kW MML solar PV with sanctioned load in service.
- With 500kW MML solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of MML. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the MML distribution system. The power flow results for the system intact shows that

the power flows on all the MML transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for MML. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with MML and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 500kW MML solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Mian Mir Line (MML) ("Project Owner" or "PO") for the interconnection of a 500kWp Solar PV Power Generation project ("Project") to the MML power System at 11kV.

The '500kW MML solar PV Power Generation project' is located at Ground of 17 NLI / HQ 106 Bde North Mian Mir Line, Shami Rd, Cantt, Lahore, Pakistan. Figure 1.1 shows Google site map of the project.

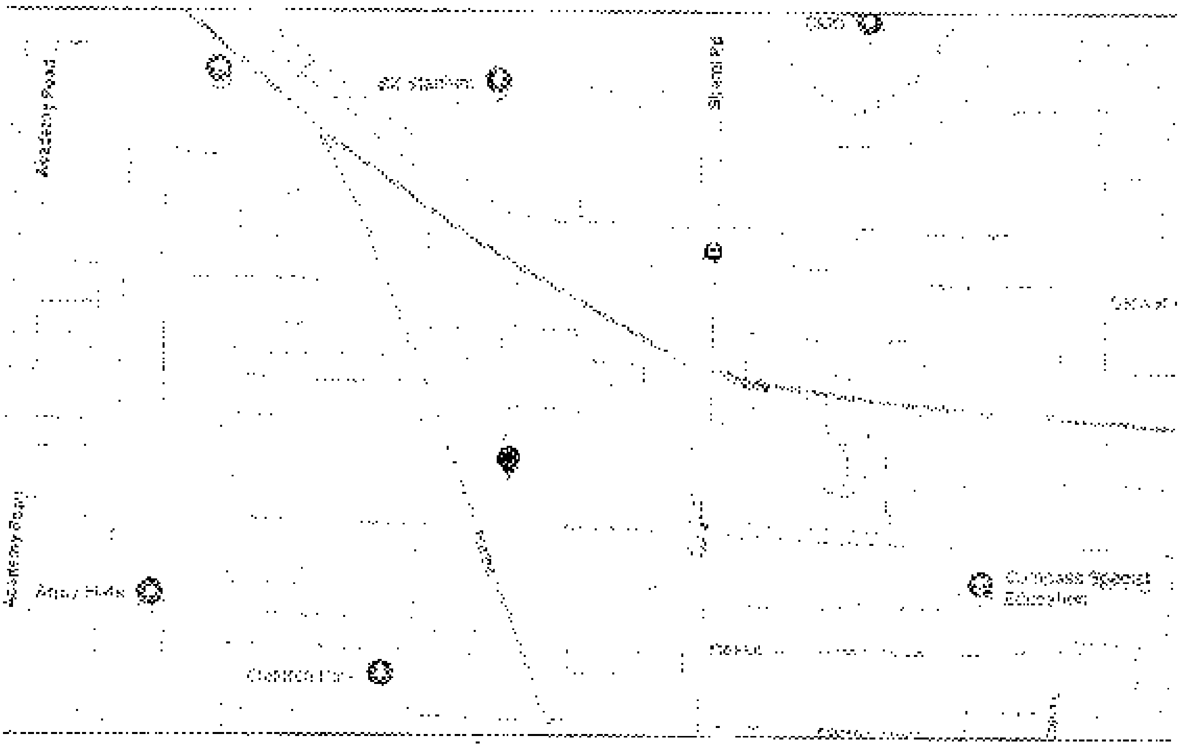


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

MML aims to integrate solar power generation into its existing electrical infrastructure. MML currently receives a single-point power supply from LESCO with a sanctioned load of 1.918MW. The entire solar generation within the MML premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the MML transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within MML premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

500kW solar PV system is modelled into the MML distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling
ii) Steady state analysis
iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios:

- Without 500kW MML solar PV with sanctioned load in service.
- With 500kW MML solar PV with sanctioned load in service.

This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 500kW solar PV system to the distribution system of MML and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kV and above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within MMT.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	421
Active Power of each collector Pgen. (kW)	400
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.1315, 0.1315
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	630
% Reactance (X)	5 %
Mian Mir Line	
Sanctioned Load (LESCO)	1918 kW

Steady state power flow assessment has been performed using the network data of MML.

3.2 Power Flow Assessment Without MML PP and with Sanctioned Load In Service

Power flow study without MML solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of MML network. This base case included a detailed representation of the MML transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the MML distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with MML PP

Power flow study of MML solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 500kW MML solar project on the MML distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at MML solar for peak loading summer (June) 2025 that allow us to judge the impact of MML solar project on the MML network.
Project power flow analysis has been performed after the connection of the project with the MML distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at MML solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted

with sanctioned load in service after the interconnection of the Solar project with the MMT distribution system. The power flow results for the system intact shows that the power flows on all the MMT distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without MML solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with MML solar and with sanctioned load in service with MML distribution system. Power flow results showed that the power flows on all the MML distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 500kW Mian Mir Line solar PV system with MML Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

LIST OF ANNEXURES

Annexure-A

Project Specific Data

Annexure-A-1

Project Site Map

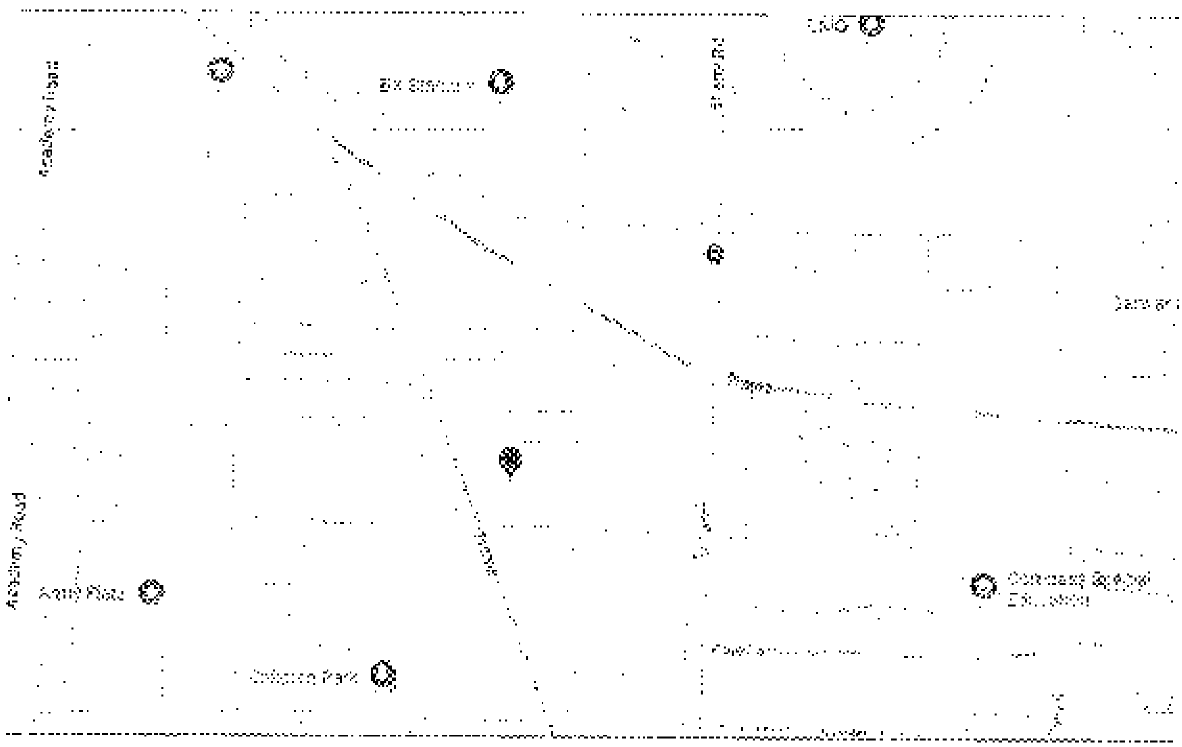
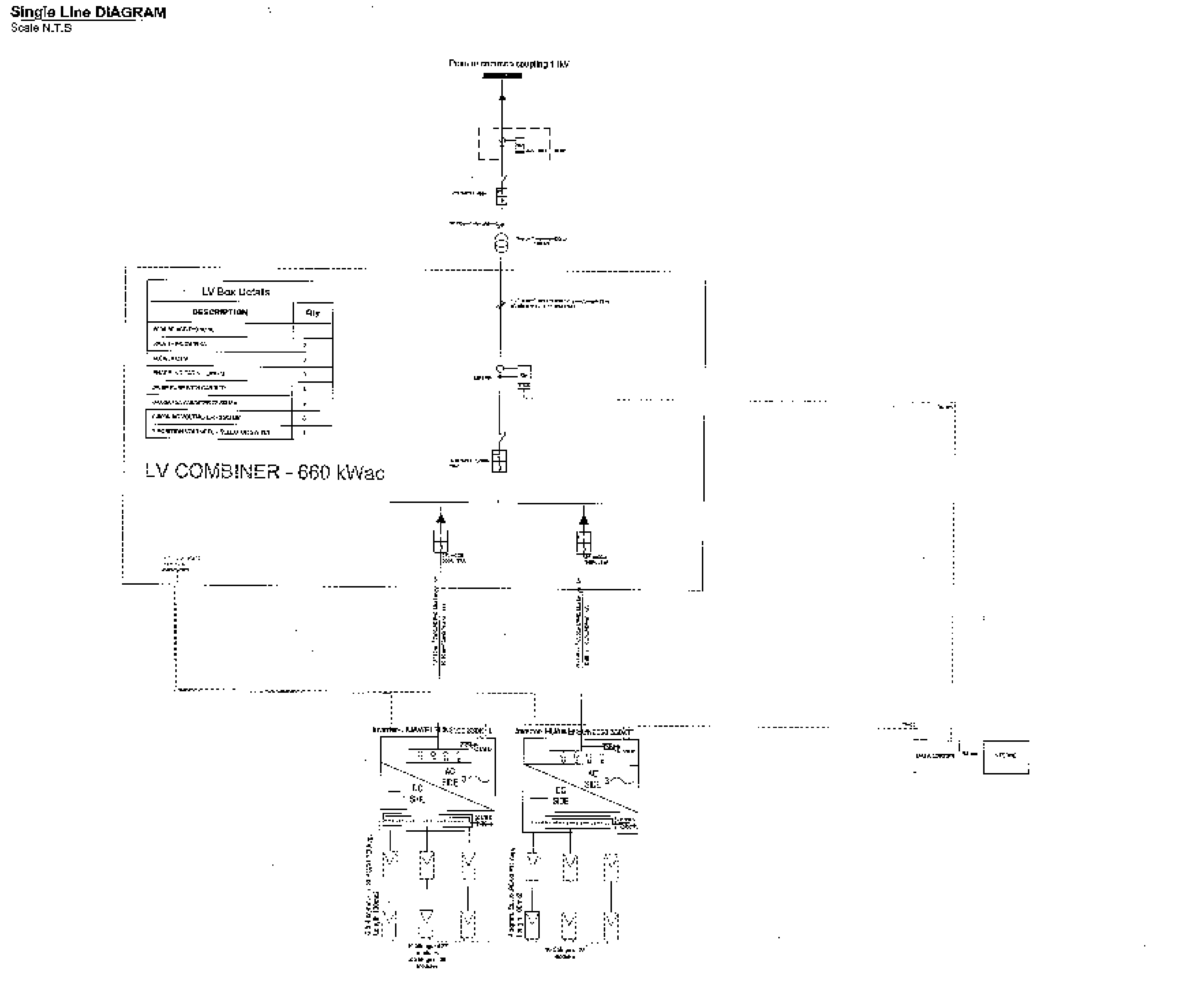


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

Annexure-A-2

Power Plant Data

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization P-III
Mian Mir Lines - Lahore

CLIENT:
Military Engineering Services

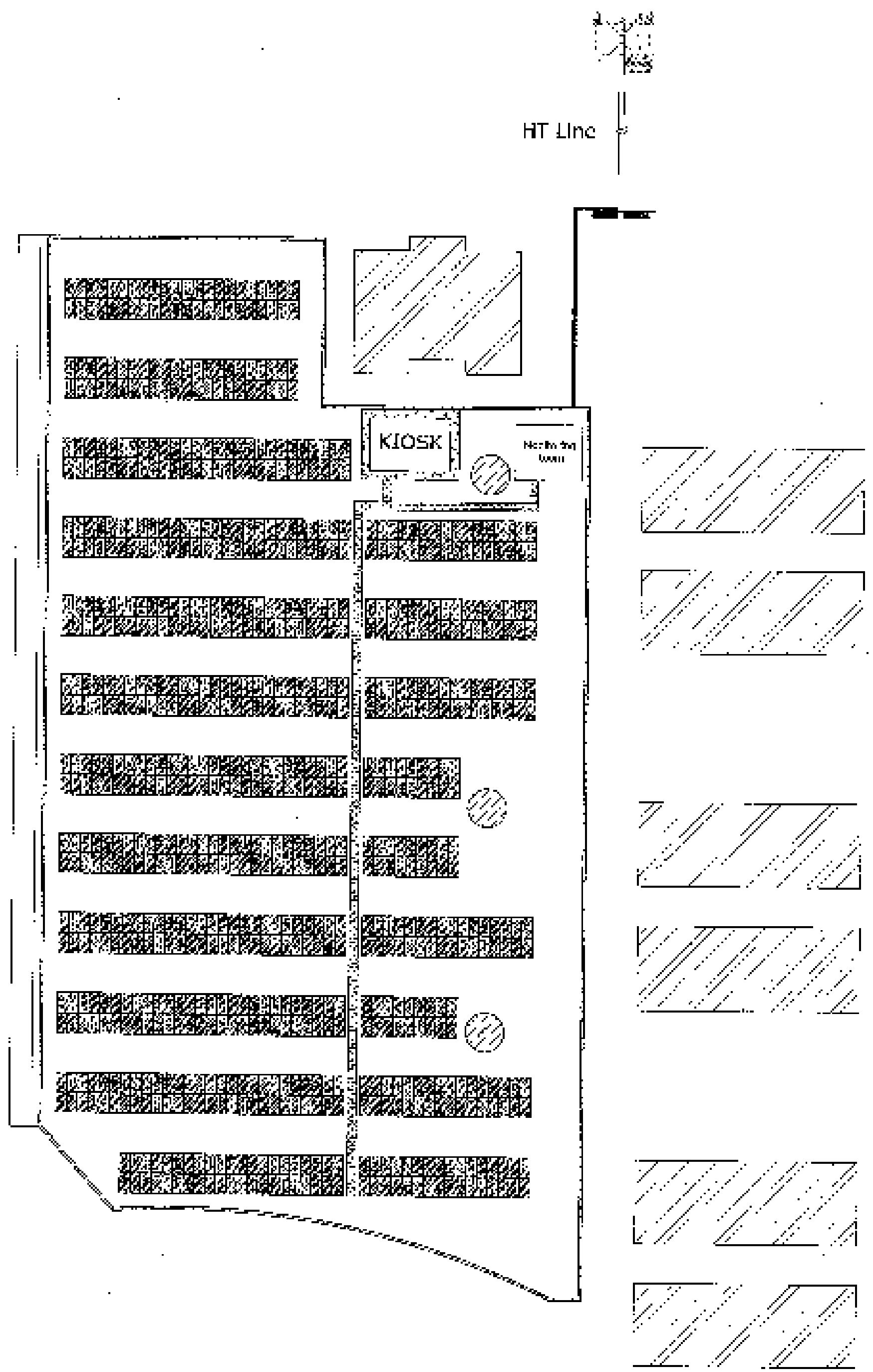
DEVELOPER:
NPTC

REV | DESCRIPTION | DATE | DRAWN BY

DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S | PAPER SIZE: A3 | SHEET:
DRAWN: | CHECKED: | APPROVED:

PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-III
Mian Mir Lines

CLIENT: Military Engineering Services

DEVELOPER:

REV | DESCRIPTION | DATE | DRAWN BY

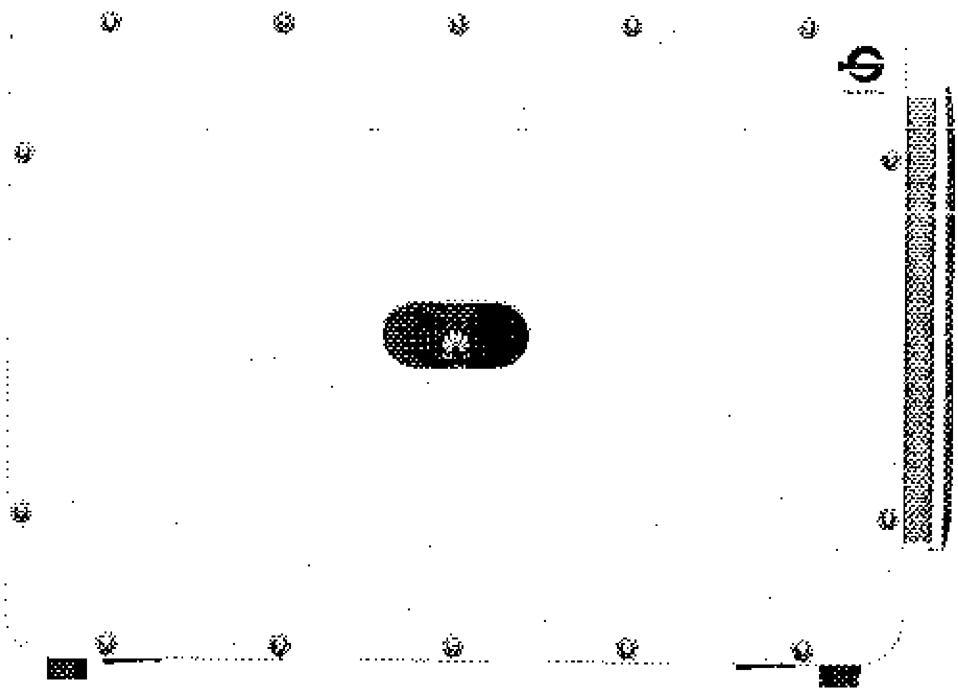
DRAWING: SINGLE LINE DIAGRAM

SCALE: N.T.S | PAPER SIZE: A3 | SHEET: 1/3

DRAWN: | CHECKED: | APPROVED:

SUN2000-330KTL-H1

Smart String Inverter



Max. Efficiency ≥99.0%

Smart Connector-Level Detection (SCLD)

Smart Self-Cleaning Fan (SSCF)

IP66 Protection

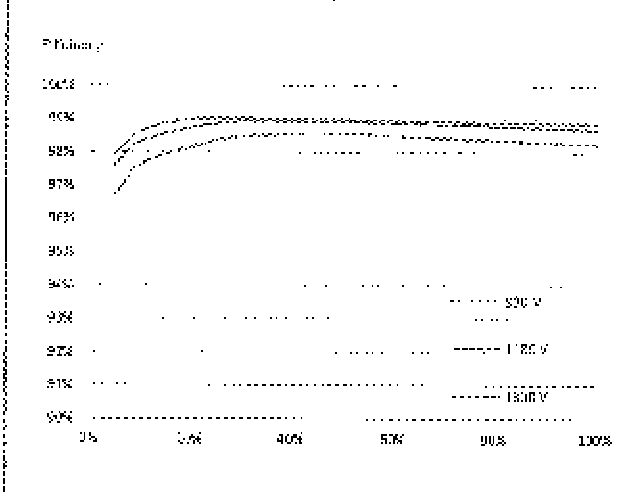
MBUS Supported

Smart String-level Disconnector (SSLD)

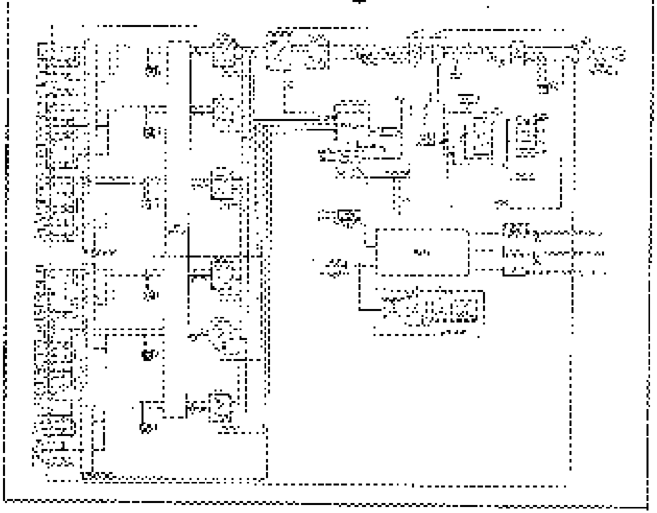
Smart IV Curve Diagnosis Supported

Surge Arresters for DC & AC

Efficiency Curve



Circuit Diagram



Technical Specifications

Efficiency

Max. Efficiency	≥99.0%
European Efficiency	≥98.8%

Input

Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V

Output

Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosϕ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%

Protection

Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes

Communication

Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes

General

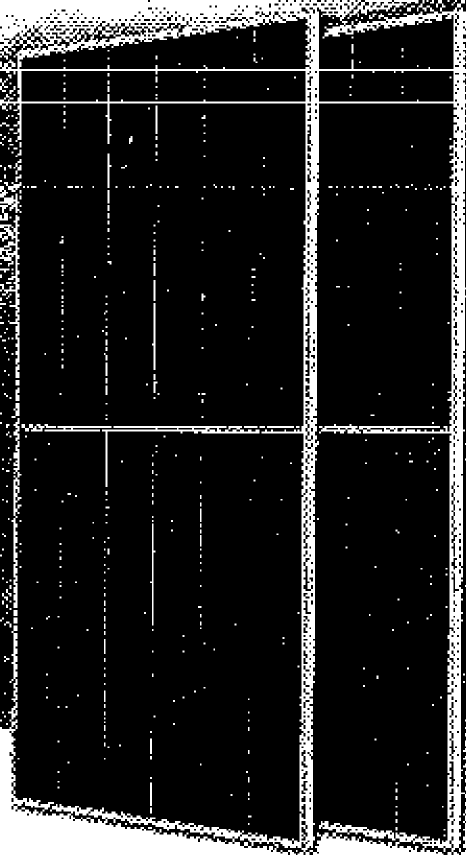
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 °C ~ 60 °C
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP66
Topology	Transformerless

Harvest the Sunshine

DEEP BLUE 4.0

Mono

580W n-type Bifacial Double Glass
High Efficiency Mono Module
JAM72D40 555-580/GB Series



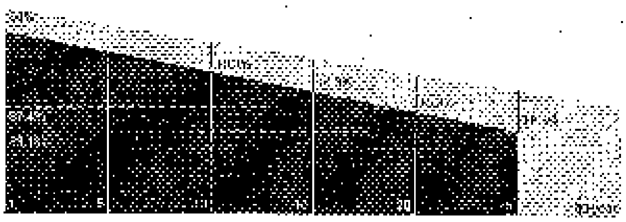
Introduction

Power by the lastest SMBB n-type solar cell, half-cell configuration and gapless ribbon connection technology, these modules have higher output power, lower LID, better weak illumination response, and better temperature coefficient.

- Higher power generation better LCOE
- n-type with very Lower LID
- Better weak illumination response
- Better Temperature Coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty



n-type Bifacial Double Glass Module Linear Performance Warranty
Standard Module Linear Performance Warranty

Comprehensive Certificates

- IEC 61215, IEC 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC 62941: 2019 Terrestrial photovoltaic (PV) modules - Quality system for PV module manufacturing

CE

JA SOLAR

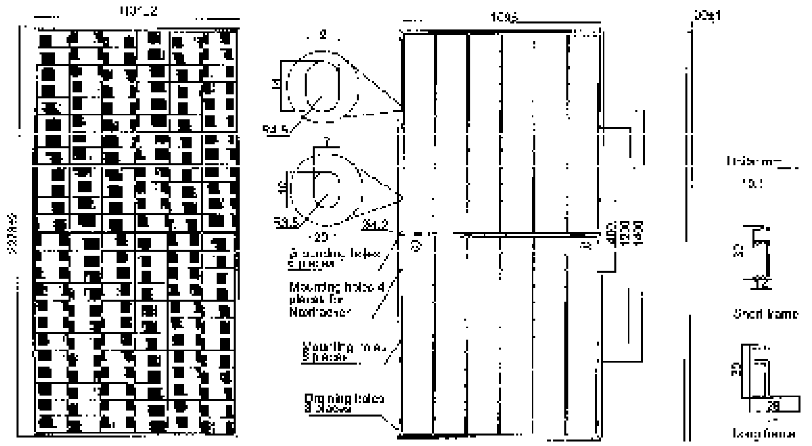
www.jasolar.com

Specifications subject to technical changes and tests. JA Solar reserves the right of final interpretation.

JA SOLAR

JAM72D40 555-580/GB

MECHANICAL DIAGRAMS



SPECIFICATIONS

Cell	Mono-166B
Weight	31.8kg
Dimensions	2278±2mm×1134±2mm×30±1mm
Cable Cross Section Size	4mm² (IEC), 12 AWG(UL)
No. of cells	144(6×24)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35 / MC4-EVO2A
Cable Length (Including Connector)	Portrait:200mm(+)/300mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	30pcs/Pallet, 720pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Maximum Power(Pmax) [W]	555	560	565	570	575	580
Open Circuit Voltage(Voc) [V]	50.55	50.70	50.85	51.00	51.15	51.30
Maximum Power Voltage(Vmp) [V]	42.24	42.40	42.55	42.70	42.85	43.03
Short Circuit Current(Isc) [A]	14.02	14.09	14.16	14.23	14.30	14.36
Maximum Power Current(Imp) [A]	13.14	13.21	13.28	13.35	13.42	13.48
Module Efficiency [%]	21.5	21.7	21.9	22.1	22.3	22.5
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.045%/°C					
Temperature Coefficient of Voc(β_Voc)	-0.275%/°C					
Temperature Coefficient of Pmax(γ_Pmp)	-0.350%/°C					
STC	Irradiance 1000W/m², cell temperature 25°C, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Max Power(Pmax) [W]	598	605	610	616	621	626
Open Circuit Voltage(Voc) [V]	50.56	50.73	50.88	51.03	51.16	51.30
Max Power Voltage(Vmp) [V]	42.24	42.39	42.55	42.70	42.85	43.02
Short Circuit Current(Isc) [A]	15.14	15.22	15.29	15.37	15.44	15.51
Max Power Current(Imp) [A]	14.16	14.27	14.34	14.42	14.49	14.56
Irradiation Ratio (rear/front)	10%					

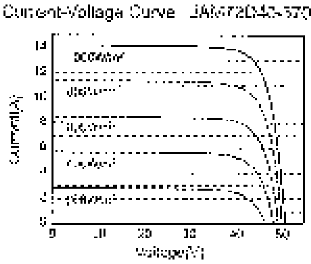
*For NexTracker installations, maximum static load please take compatibility approval letter between JA Solar and Nextracker for reference.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

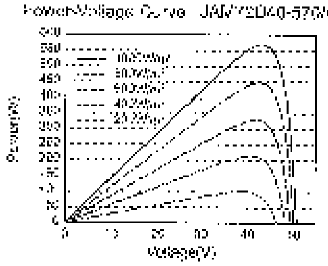
Maximum System Voltage	1500V DC
Operating Temperature	-40°C~+85°C
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* Maximum Static Load,Back*	5400Pa(112 lb/ft²) 2400Pa(50 lb/ft²)
NOCT	45±2°C
Bifaciality**	80%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

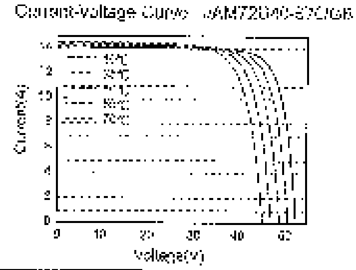
Current-Voltage Curve JAM72D40-570/GB



Power-Voltage Curve JAM72D40-570/GB



Current-Voltage Curve JAM72D40-570/GB



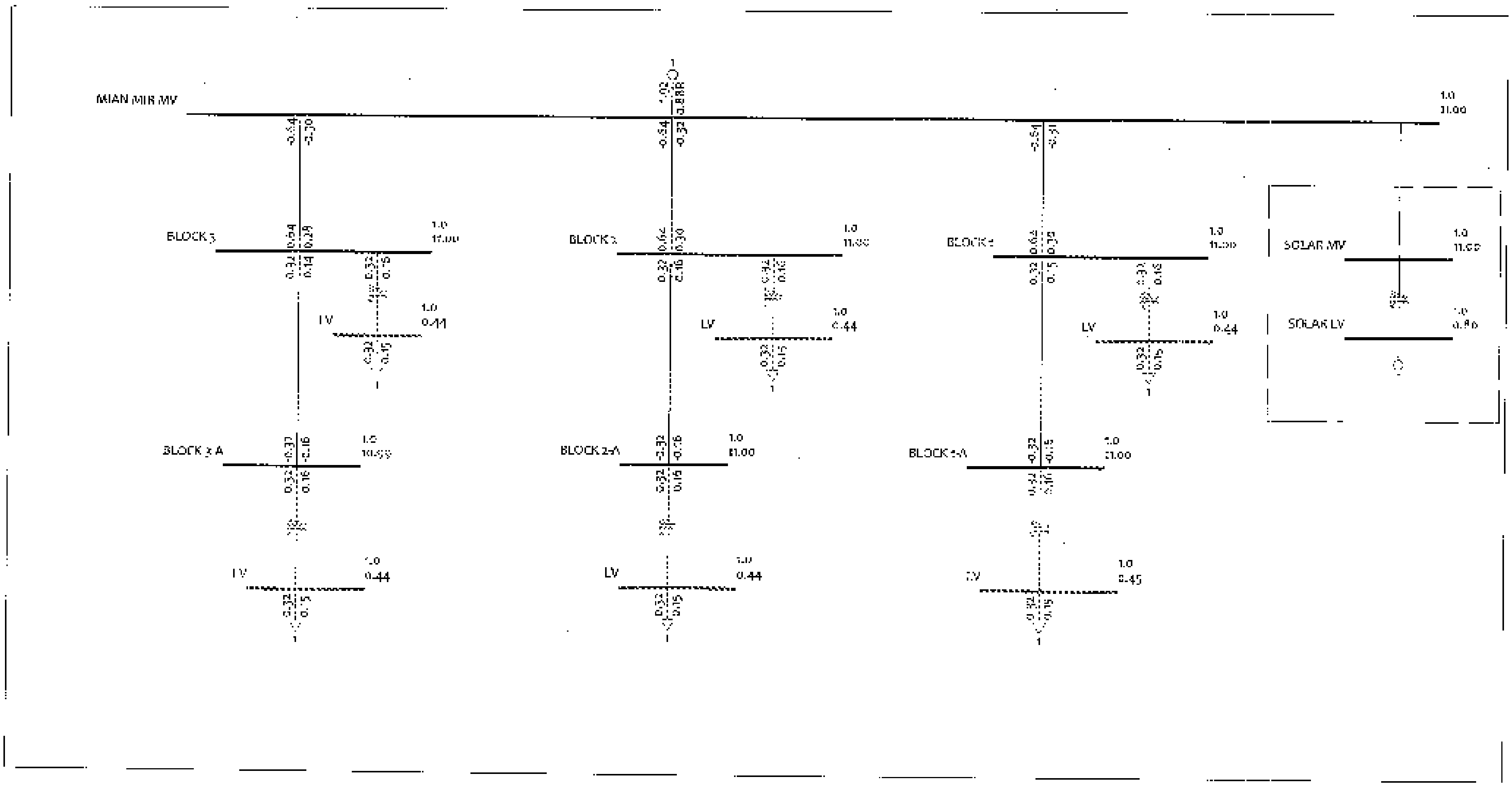
Annexure-B

Steady State Analysis Results

Load Flow Analysis of 500kW Solar PV System at Mian Mir (MM)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

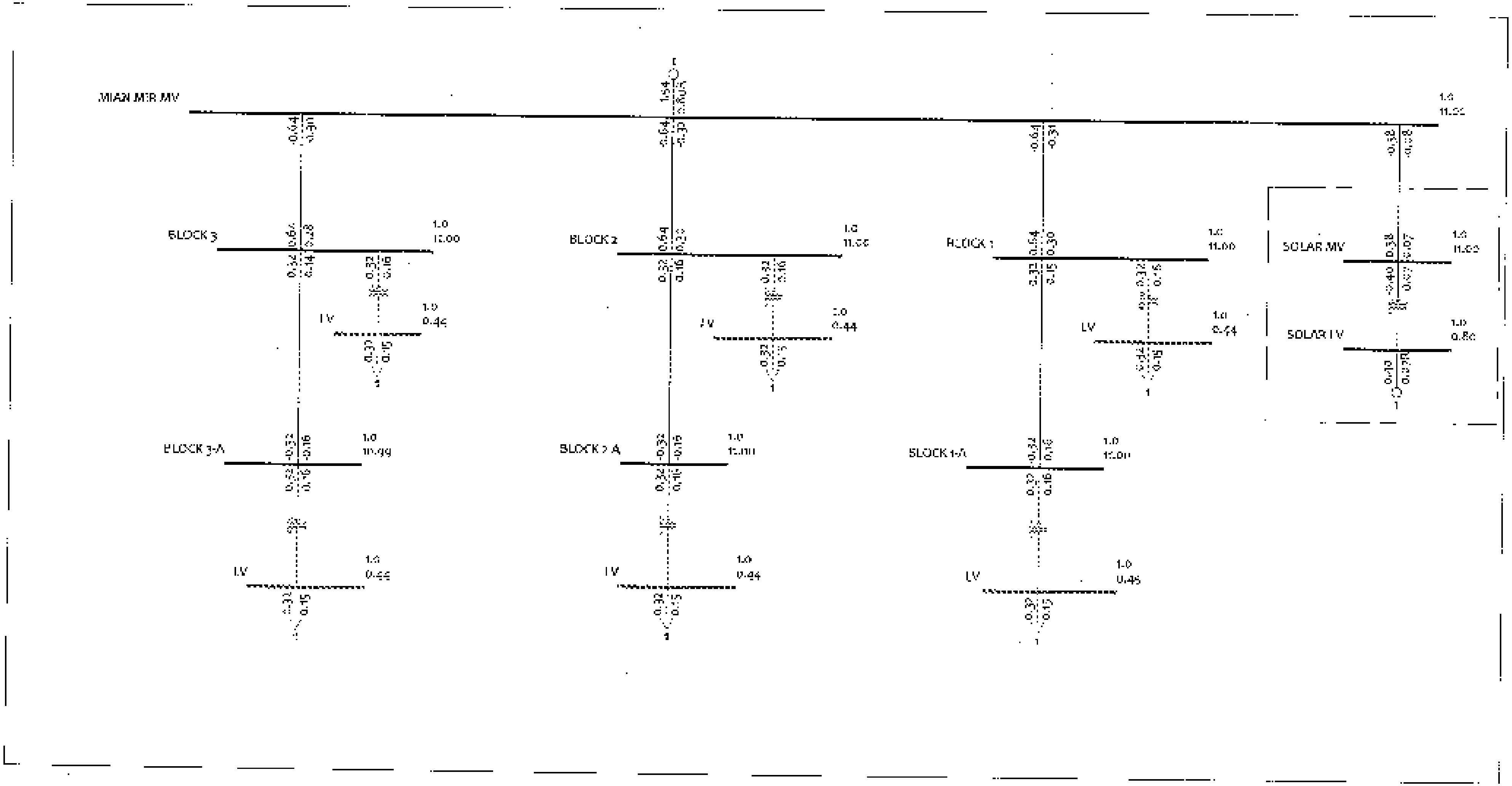
Figure: B 1



Load Flow Analysis of 500kW Solar PV System at Mian Mir (MM)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without MML PP and With Sanctioned Load

In Service

```
                              PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E      SAT, FEB 15 2025  17:17
                    MIAN MEER SOLAR PV SYSTEM                                       %MVA FOR TRANSFORMERS
                                                                                    % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT            GEN     LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER      RATING
  BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW      MVAR
RATIO   ANGLE   %  SET A

   4100 MIAN MEER MV11.000    4 1.0000   0.0     1.9     0.0     0.0 ---------------------------------------------------------
---------------------
                              1 11.000           0.9R    0.0     0.0  41001 BLOCK 1     11.000    4  1     0.6     0.3
7     10
                                                                      41005 BLOCK 2     11.000    4  1     0.6     0.3
7     10
                                                                      41009 BLOCK 3     11.000    4  1     0.6     0.3
7     10
  41001 BLOCK 1       11.000  4 0.9959  -0.0     0.0     0.0     0.0 ---------------------------------------------------------
---------------------
                              1 10.958           0.0     0.0     0.0  4100 MIAN MEER MV11.000     4  1    -0.6    -0.3
7     10
1.000LK          22     2                                             41002 LV          0.4400    4  1     0.3     0.2
                                                                      41003 BLOCK 1-A   11.000    4  1     0.3     0.2
4     10
  41002 LV            0.4400  4 0.9949  -0.6     0.0     0.3     0.0 ---------------------------------------------------------
---------------------
                              1 0.4378           0.0     0.2     0.0  41001 BLOCK 1     11.000    4  1    -0.3    -0.2
1.000UN          22     2

  41003 BLOCK 1-A     11.000  4 0.9996  -0.0     0.0     0.0     0.0 ---------------------------------------------------------
---------------------
                              1 10.993           0.0     0.0     0.0  41001 BLOCK 1     11.000    4  1    -0.3    -0.2
4     10
                                                                      41004 LV          0.4400    4  1     0.3     0.2
0.975LK          22     2
  41004 LV            0.4400  4 1.0206  -0.6     0.0     0.3     0.0 ---------------------------------------------------------
---------------------
                              1 0.4491           0.0     0.2     0.0  41003 BLOCK 1-A   11.000    4  1    -0.3    -0.2
1.000UN          22     2

  41005 BLOCK 2       11.000  4 0.9997  -0.0     0.0     0.0     0.0 ---------------------------------------------------------
---------------------
                              1 10.997           0.0     0.0     0.0  4100 MIAN MEER MV11.000     4  1    -0.6    -0.3
7     10
                                                                      41006 LV          0.4400    4  1     0.3     0.2
1.000LK          22     2
```

```
                                                                          41007 BLOCK 2-A   11.000    4  1     0.3    0.2
4     10
  41006 LV             0.4400    4 0.9948   -0.6     0.0     0.3     0.0 --------------------------------------------------------------------------
---------------------
                                 1 0.4377            0.0     0.2     0.0  41005 BLOCK 2     11.000    4  1    -0.3   -0.2
1.000UN           22      2

  41007 BLOCK 2-A      11.000    4 0.9997   -0.0     0.0     0.0     0.0 --------------------------------------------------------------------------
---------------------
                                 1 10.997            0.0     0.0     0.0  41005 BLOCK 2     11.000    4  1    -0.3   -0.2
4     10
                                                                          41008 LV          0.4400    4  1     0.3    0.2
0.998LK           22      2
  41008 LV             0.4400    4 1.0075   -0.6     0.0     0.2     0.0 --------------------------------------------------------------------------
---------------------
                                 1 0.4433            0.0     0.2     0.0  41007 BLOCK 2-A   11.000    4  1    -0.3   -0.2
1.000UN           22      2

  41009 BLOCK 3        11.000    4 0.9996   -0.0     0.0     0.0     0.0 --------------------------------------------------------------------------
---------------------
                                 1 10.996            0.0     0.0     0.0   4100 MIAN MEER MV11.000    4  1    -0.6   -0.3
7     10
                                                                          410010 LV         0.4400    4  1     0.3    0.2
1.000LK           22      2
                                                                          410011 BLOCK 3-A  11.000    4  1     0.3    0.1
3     10
 410010 LV             0.4400    4 0.9946   -0.6     0.0     0.3     0.0 --------------------------------------------------------------------------
---------------------
                                 1 0.4376            0.0     0.2     0.0  41009 BLOCK 3     11.000    4  1    -0.3   -0.2
1.000UN           22      2

 410011 BLOCK 3-A      11.000    4 0.9994   -0.0     0.0     0.0     0.0 --------------------------------------------------------------------------
---------------------
                                 1 10.993            0.0     0.0     0.0  41009 BLOCK 3     11.000    4  1    -0.3   -0.2
4     10
                                                                          410012 LV         0.4400    4  1     0.3    0.2
0.983LK           12      3
 410012 LV             0.4400    4 1.0089   -0.4     0.0     0.3     0.0 --------------------------------------------------------------------------
---------------------
                                 1 0.4439            0.0     0.2     0.0 410011 BLOCK 3-A  11.000    4  1    -0.3   -0.2
1.000UN           12      3
```

Annexure-C-2

With MML PP and With Sanctioned

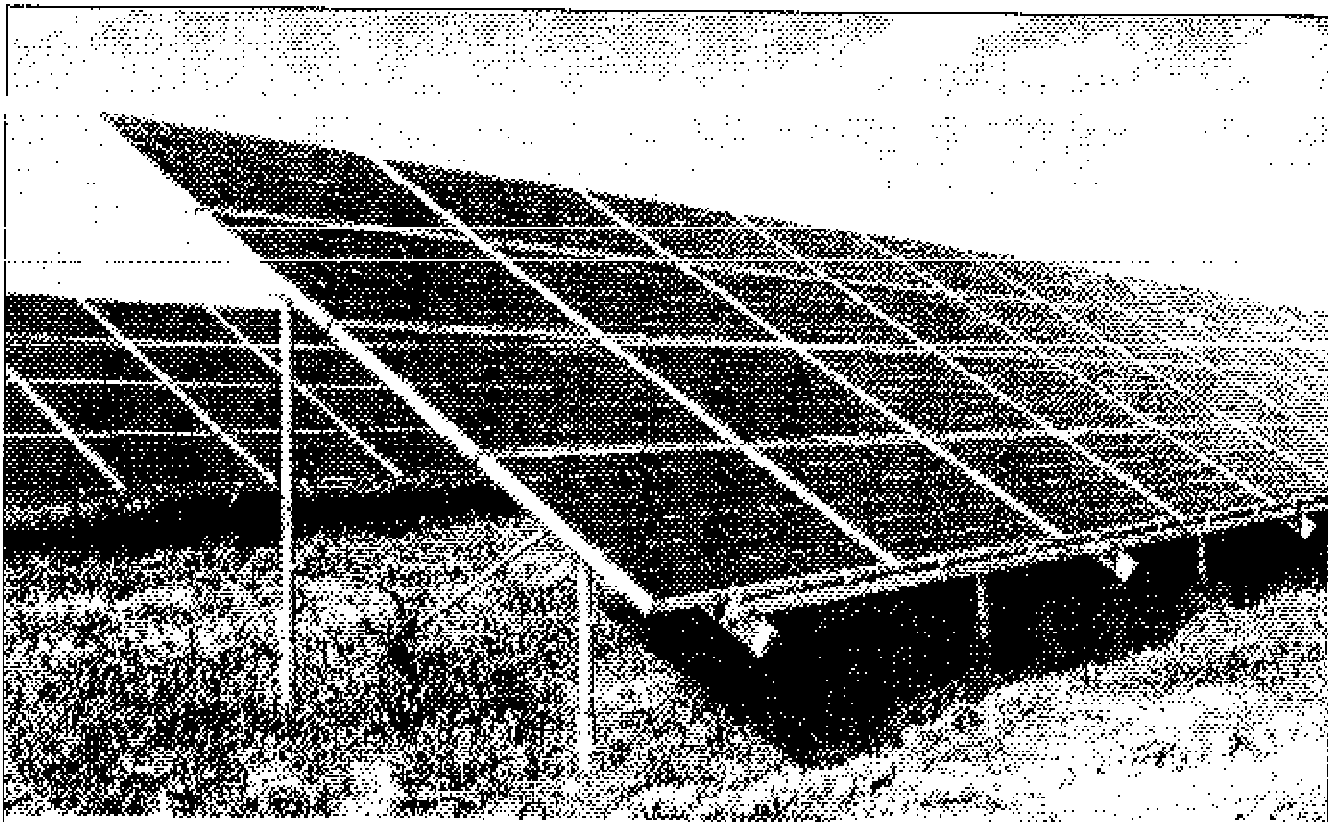
Load In Service

```
               PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:18
          MIAN MEER SOLAR PV SYSTEM                                  %MVA FOR TRANSFORMERS
                                                                     % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT          GEN    LOAD   SHUNT  X--------- TO BUS ----------X
TRANSFORMER      RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 MIAN MEER MV11.000    4 1.0000   0.0    1.5     0.0     0.0 --------------------------------------------------------
----------------------
                               1 11.000          0.8R    0.0     0.0  41001 BLOCK 1      11.000    4  1      0.6     0.3
7     10
                                                                       41005 BLOCK 2      11.000    4  1      0.6     0.3
7     10
                                                                       41009 BLOCK 3      11.000    4  1      0.6     0.3
7     10
                                                                      410013 SOLAR MV     11.000    4  1     -0.4    -0.1
4     10
  41001 BLOCK 1       11.000   4 0.9999  -0.0    0.0     0.0     0.0 --------------------------------------------------------
----------------------
                               1 10.998          0.0     0.0     0.0   4100 MIAN MEER MV11.000   4  1     -0.6    -0.3
7     10
1.000LK          22     2                                              41002 LV            0.4400    4  1      0.3     0.2

4     10                                                               41003 BLOCK 1-A    11.000    4  1      0.3     0.2
  41002 LV            0.4400   4 0.9549  -0.6    0.0     0.3     0.0 --------------------------------------------------------
----------------------
                               1 0.4378          0.0     0.2     0.0  41001 BLOCK 1      11.000    4  1     -0.3    -0.2
1.000UN          22     2

  41003 BLOCK 1-A    11.000    4 0.9998  -0.0    0.0     0.0     0.0 --------------------------------------------------------
----------------------
                               1 10.998          0.0     0.0     0.0  41001 BLOCK 1      11.000    4  1     -0.3    -0.2
4     10
0.975LK          22     2                                              41004 LV            0.4400    4  1      0.3     0.2
  41004 LV            0.4400   4 1.0208  -0.6    0.0     0.3     0.0 --------------------------------------------------------
----------------------
                               1 0.4491          0.0     0.2     0.0  41003 BLOCK 1-A    11.000    4  1     -0.3    -0.2
1.000UN          22     2

  41005 BLOCK 2      11.000    4 0.9997  -0.0    0.0     0.0     0.0 --------------------------------------------------------
----------------------
                               1 10.997          0.0     0.0     0.0   4100 MIAN MEER MV11.000   4  1     -0.6    -0.3
7     10
```

```
                                                                               41006 LV          0.4400     4  1      0.3     0.2
1.000LK          22     2
                                                                               41007 BLOCK 2-A   11.000     4  1      0.3     0.2
4     10
  41006 LV            0.4400   4 0.9948   -0.6     0.0      0.3      0.0 -------------------------------------------------------
---------------------
                               1 0.4377            0.0      0.2      0.0  41005 BLOCK 2    11.000     4  1     -0.3    -0.2
1.000UN          22     2

  41007 BLOCK 2-A     11.000   4 0.9997   -0.0     0.0      0.0      0.0 -------------------------------------------------------
---------------------
                               1 10.997            0.0      0.0      0.0  41005 BLOCK 2    11.000     4  1     -0.3    -0.2
4     10
                                                                          41008 LV          0.4400     4  1      0.3     0.2
0.988LK          22     2
  41008 LV            0.4400   4 1.0075   -0.6     0.0      0.3      0.3 -------------------------------------------------------
---------------------
                               1 0.4423            0.0      0.2      0.0  41007 BLOCK 2-A  11.000     4  1     -0.3    -0.2
1.000UN          22     2

  41009 BLOCK 3       11.000   4 0.9996   -0.0     0.0      0.0      0.0 -------------------------------------------------------
---------------------
                               1 10.996            0.0      0.0      0.0   4100 MIAN MEER MV11.000    4  1     -0.6    -0.3
7     10
                                                                         410010 LV          0.4400     4  1      0.3     0.2
1.000LK          22     2
                                                                         410011 BLOCK 3-A   11.000     4  1      0.3     0.1
3     10
 410010 LV            0.4400   4 0.9946   -0.6     0.0      0.3      0.0 -------------------------------------------------------
---------------------
                               1 0.4376            0.0      0.2      0.0  41009 BLOCK 3    11.000     4  1     -0.3    -0.2
1.000UN          22     3

 410011 BLOCK 3-A     11.000   4 0.9994   -0.0     0.0      0.0      0.0 -------------------------------------------------------
---------------------
                               1 10.993            0.0      0.0      0.0  41009 BLOCK 3    11.000     4  1     -0.3    -0.2
4     10
                                                                         410012 LV          0.4400     4  1      0.3     0.2
0.988LK          12     3
 410012 LV            0.4400   4 1.0089   -0.4     0.0      0.3      0.0 -------------------------------------------------------
---------------------
                               1 0.4439            0.0      0.2      0.0 410011 BLOCK 3-A  11.000     4  1     -0.3    -0.2
1.000UN          12     3

 410013 SOLAR MV      11.000   4 1.0001    0.0     0.0      0.0      0.0 -------------------------------------------------------
---------------------
                               1 11.001            0.0      0.0      0.0   4100 MIAN MEER MV11.000    4  1      0.4     0.1
4     10
```

410014 SOLAR LV 0.8000 4 1 -0.4 -0.1
1.000LK 64 1
410014 SOLAR LV 0.8000 4 1.0019 0.5 0.1 0.0 0.0 --

1 0.8012 0.1R 0.0 0.0 410013 SOLAR MV 11.000 4 1 0.4 0.1
1.000LN 64 1



Mehfooz Shaheed Garrison

SYSTEM STUDY ANALYSIS OF MEHFOOZ SHAHEED GARRISON (MSG) 500kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
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CONTENTS

EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 500kW Solar PV Power Generation project at Mehfooz Shaheed Garrison (MSG) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 500kW Solar PV based system connected with the power network of MSG. The '500kW MSG solar PV Power Generation project' is located at GCWM+2G5, Aziz Bhatti Town, Lahore, Pakistan.

The integration of solar power generation at the MSG premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. MSG currently receives a single point supply from LESCO with a sanctioned load of 2.690MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 2.690MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the MSG premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 500kW MSG solar PV with sanctioned load in service.
- With 500kW MSG solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of MSG. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the MSG distribution system. The power flow results for the system intact shows that the power flows on all the MSG transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for MSG. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with MSG and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 500kW MSG solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Mehfooz Shaheed Garrison (MSG) ("Project Owner" or "PO") for the interconnection of a 500kWp Solar PV Power Generation project ("Project") to the MSG power System at 11kV.

The '500kW MSG solar PV Power Generation project' is located at GCWM+2G5, Aziz Bhatti Town, Lahore, Pakistan. Figure 1.1 shows Google site map of the project.

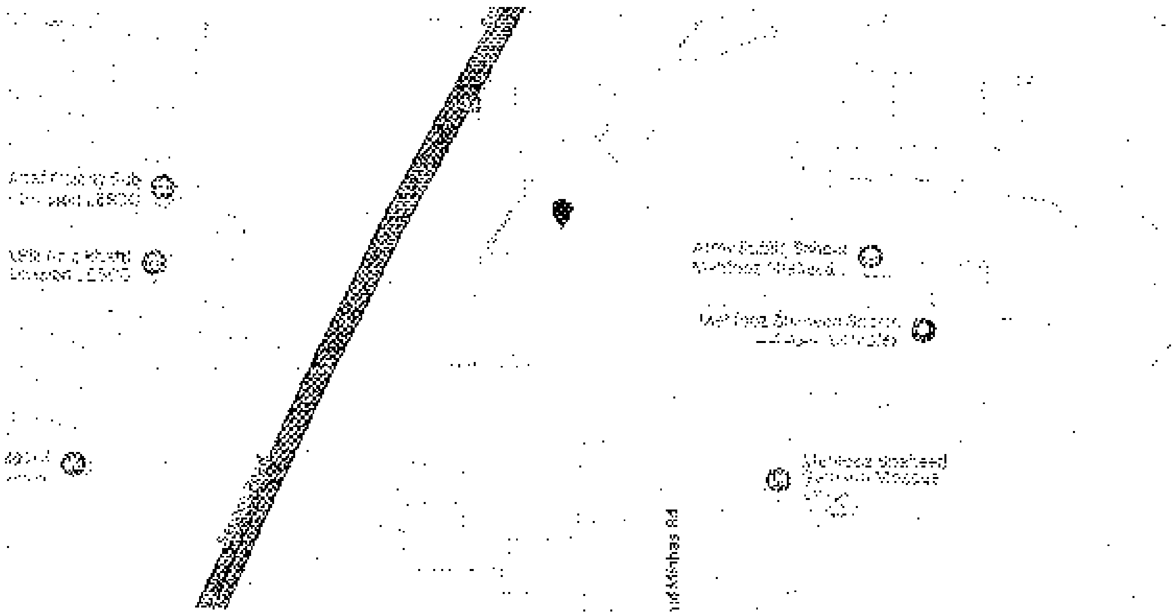


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

MSG aims to integrate solar power generation into its existing electrical infrastructure. MSG currently receives a single-point power supply from LESCO with a sanctioned load of 2.690MW. The entire solar generation within the MSG premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the MSG transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within MSG premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

500kW solar PV system is modelled into the MSG distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling

ii) Steady state analysis

iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 500kW MSG solar PV with sanctioned load in service.
- With 500kW MSG solar PV with sanctioned load in service.

This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 500kW solar PV system to the distribution system of MSG and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%, 5% p.u at 220kVand above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within MSG.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	421
Active Power of each collector Pgen. (kW)	400
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	-0.1315, 0.1315
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	630
% Reactance (X)	5 %
Mehfooz Shaheed Garrison	
Sanctioned Load (LESCO)	2690 kW

Steady state power flow assessment has been performed using the network data of MSG.

3.2 Power Flow Assessment Without MSG PP and with Sanctioned Load In Service

Power flow study without MSG solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of MSG network. This base case included a detailed representation of the MSG transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the MSG distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1.**

3.3 Power Flow Assessment with MSG PP

Power flow study of MSG solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 500kW MSG solar project on the MSG distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at MSG solar for peak loading summer (June) 2025 that allow us to judge the impact of MSG solar project on the MSG network.
Project power flow analysis has been performed after the connection of the project with the MSG distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at MSG solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the MSG distribution system. The power flow results for the system intact shows that the power flows on all the MSG distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without MSG solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with MSG solar and with sanctioned load in service with MSG distribution system. Power flow results showed that the power flows on all the MSG distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 500kW Mehfooz Shaheed Garrison solar PV system with MSG Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

LIST OF ANNEXURES

Annexure-A

Project Specific Data

Annexure-A-1

Project Site Map

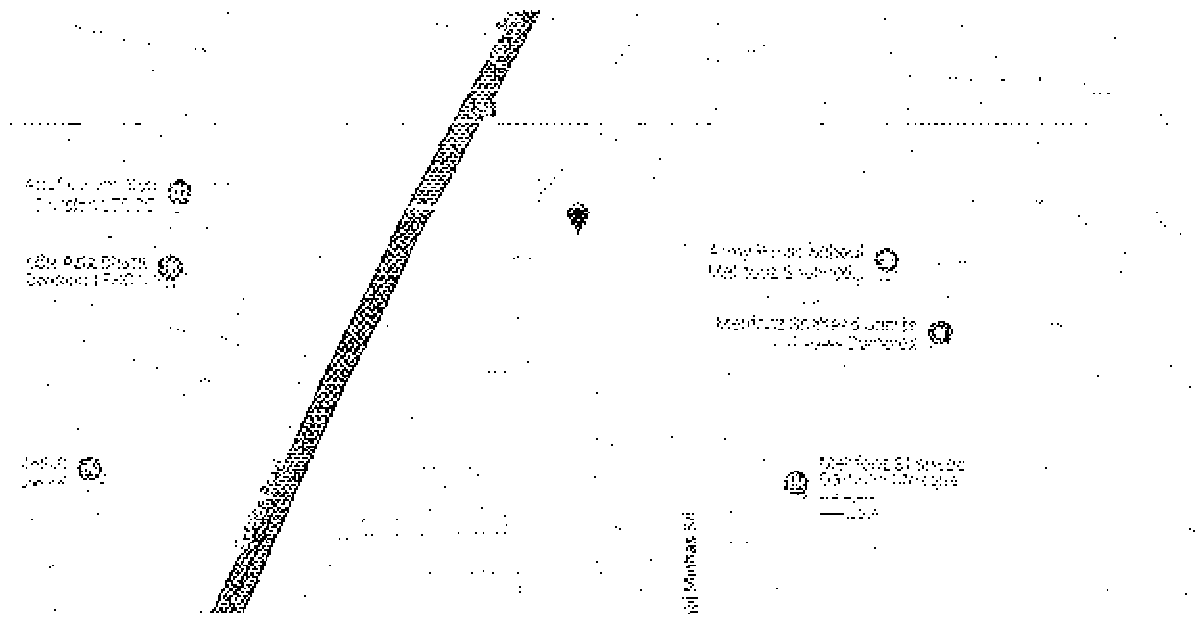
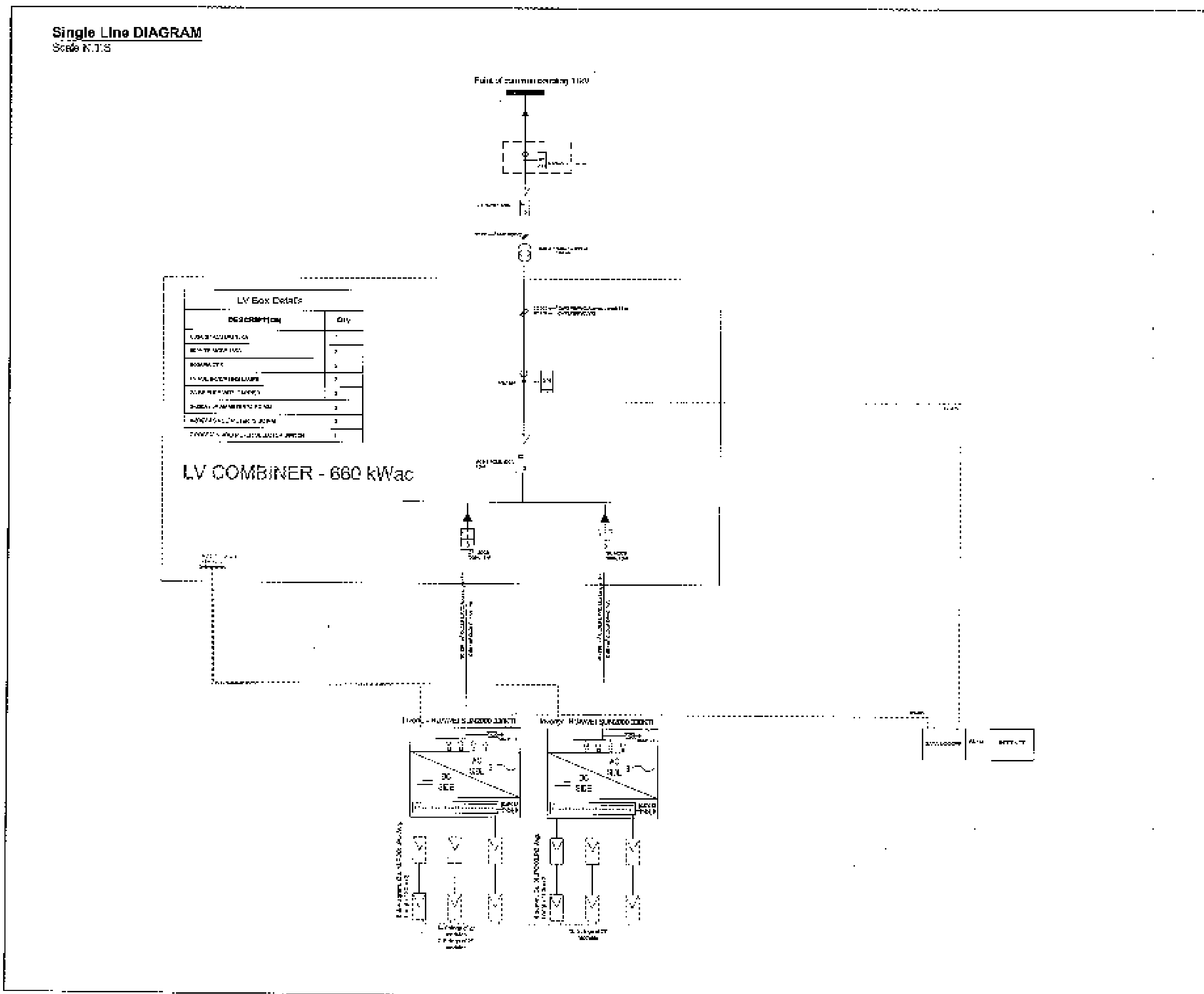


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

Annexure-A-2

Power Plant Data

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

	Solar PV Module
	Inverter
	Current Transformer
	Voltage Transformer

ARRAY INFORMATION

Tilt Angle	[illegible]
Azimuth	[illegible]

PROJECT :

MES Solarization P-III

MSG - Lahore

CLIENT :

Military Engineering Services

DEVELOPER :

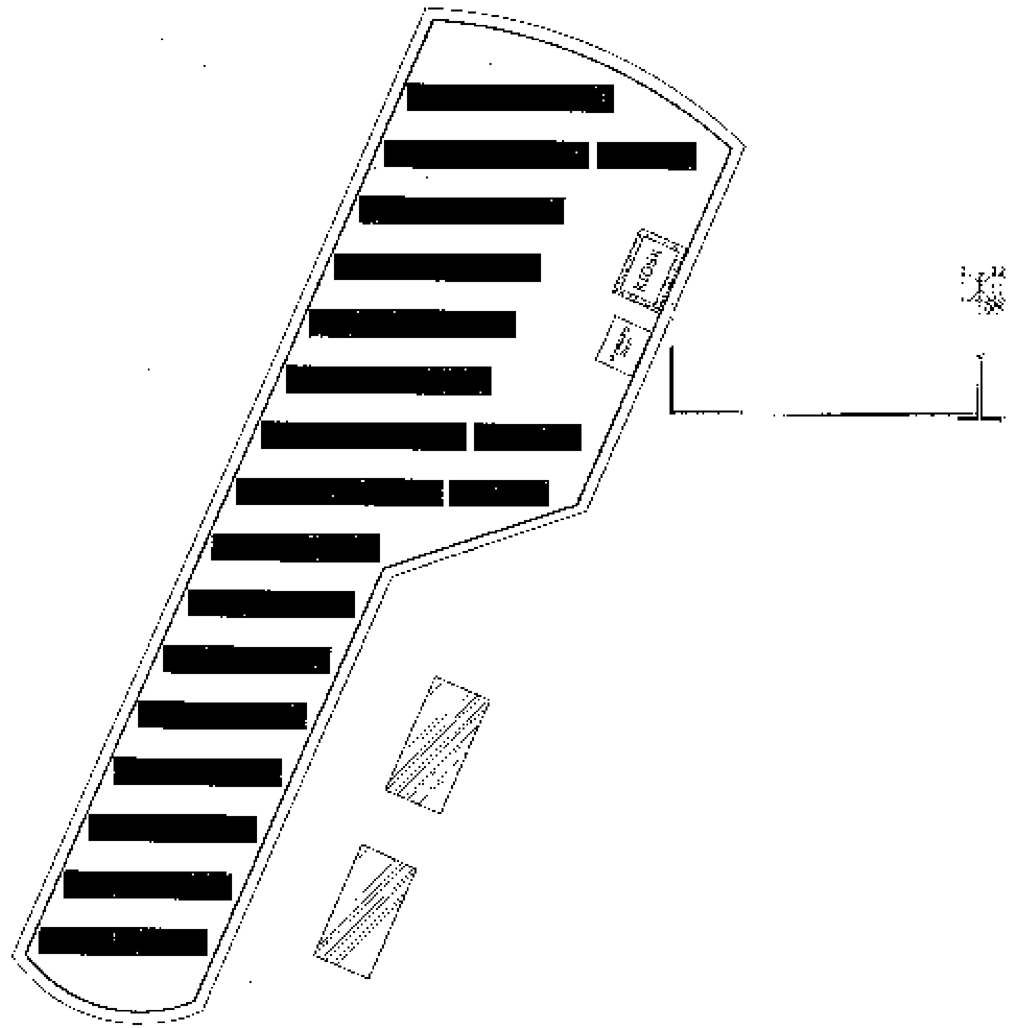
REV	DESCRIPTION	DATE	DRAWN BY
	Preliminary Submission		

DRAWING :

SINGLE LINE DIAGRAM

SCALE : N.T.S	PAPER SIZE : A3	SHEET	01
DRAWN :	CHECKED :	APPROVED :	

PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

Groundmounted

ARRAY INFORMATION

PROJECT:
MES Solarization P-80
MSG - Lahore

CLIENT:
Military Engineering Services

DEVELOPER:

REV DESCRIPTION
Preliminary

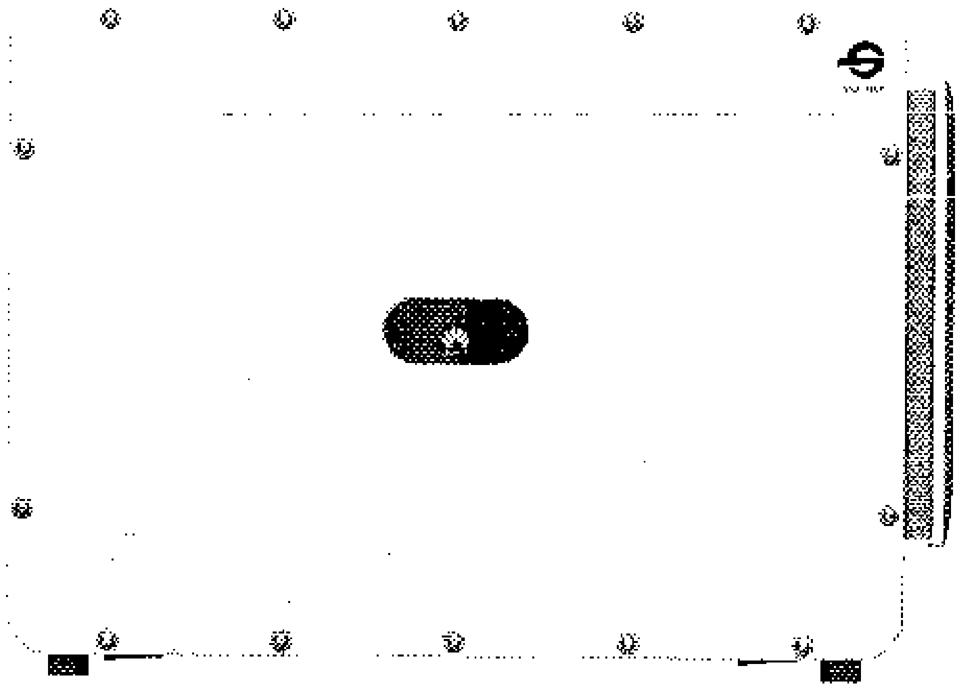
DATE DRAWN BY

DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S
PAPER SIZE: A3
SHEET: 1/1
DRAWN:
CHECKED:
APPROVED:

SUN2000-330KTL-H1

Smart String Inverter



Max. Efficiency
≥99.0%

Smart Connector-Level
Detection (SCLD)

Smart Self-cleaning
Fan (SSCF)

IP66
Protection

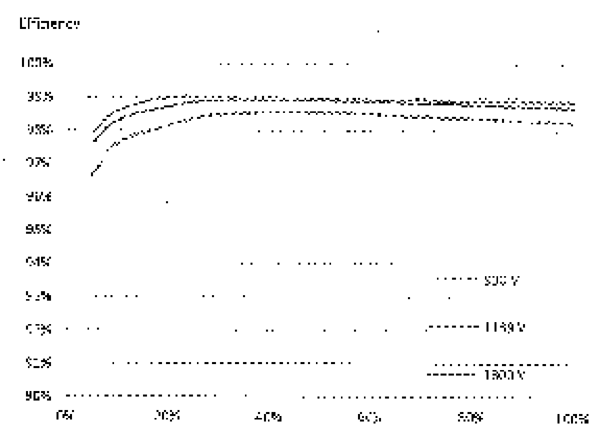
MBUS
Supported

Smart String-level
Disconnection (SSLD)

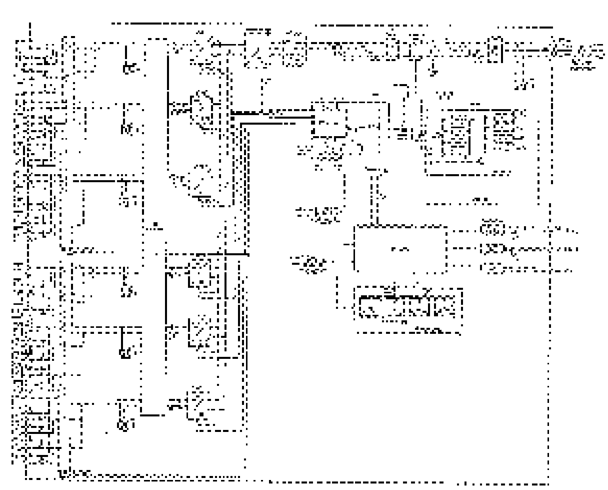
Smart IV Curve Diagnosis
Supported

Surge Arresters for
DC & AC

Efficiency Curve



Circuit Diagram



SUN2000-330KTL-H1

Technical Specifications

Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosφ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	<1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 ℃ ~ 60 ℃
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

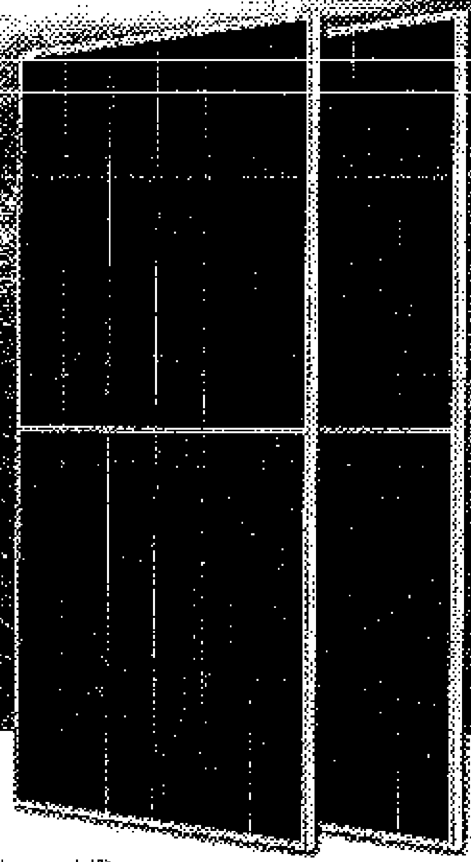
Harvest the Sunshine

DEEP BLUE 4.0

Mono

580W n-type Bifacial Double Glass High Efficiency Mono Module

JAM72D40 555-580/GB



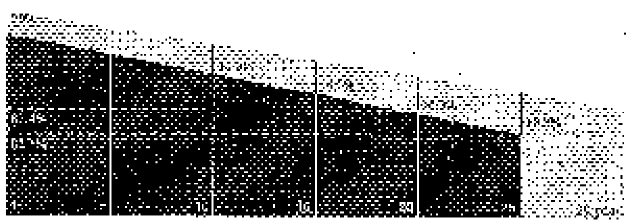
Introduction

Power by the lastest SMBB n-type solar cell, half-cell configuration and gapless ribbon connection technology, these modules have higher output power, lower LID, better weak illumination response, and better temperature coefficient.

- Higher power generation better LCOE
- n-type with very Lower LID
- Better weak illumination response
- Better Temperature Coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty



n-type Bifacial Double Glass Module Linear Performance Warranty

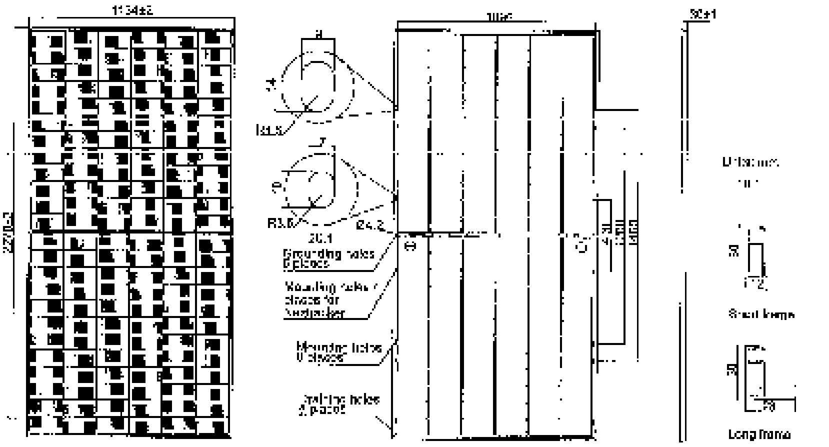
Standard Module Linear Performance Warranty

Comprehensive Certificates

- IEC 61215, IEC 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC 62941: 2019 Terrestrial photovoltaic (PV) modules - Quality system for PV module manufacturing

JA SOLAR

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono-16BB
Weight	31.8kg
Dimensions	2278±2mm×1134±2mm×30±1mm
Cable Cross Section Size	4mm² (IEC), 12 AWG(UL)
No. of cells	144(6×24)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35 / MC4-EVO2A
Cable Length (Including Connector)	Portrait:200mm(+)/300mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	36pcs/Pallet, 720pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Maximum Power(Pmax) [W]	555	560	565	570	575	580
Open Circuit Voltage(Voc) [V]	50.55	50.70	50.85	51.00	51.15	51.30
Maximum Power Voltage(Vmp) [V]	42.24	42.40	42.55	42.70	42.85	43.03
Short Circuit Current(Isc) [A]	14.02	14.09	14.16	14.23	14.30	14.36
Maximum Power Current(Imp) [A]	13.14	13.21	13.28	13.35	13.42	13.48
Module Efficiency [%]	21.5	21.7	21.9	22.1	22.3	22.5
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.045%/℃					
Temperature Coefficient of Voc(β_Voc)	-0.260%/℃					
Temperature Coefficient of Pmax(γ_Pmp)	-0.300%/℃					
STC	Irradiance 1000W/m², cell temperature 25℃, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Max Power(Pmax) [W]	599	605	610	616	621	626
Open Circuit Voltage(Voc) [V]	50.58	50.73	50.88	51.03	51.16	51.30
Max Power Voltage(Vmp) [V]	42.24	42.39	42.55	42.70	42.86	43.02
Short Circuit Current(Isc) [A]	15.14	15.22	15.29	15.37	15.44	15.51
Max Power Current(Imp) [A]	14.19	14.27	14.34	14.42	14.49	14.56
Irradiation Ratio (rear/front)	10%					

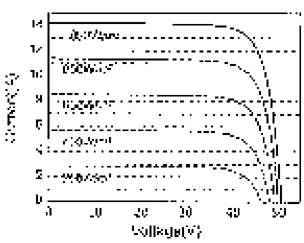
*For Nextracker installations, maximum static load please take compatibility approval letter between JA Solar and Nextracker for reference.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

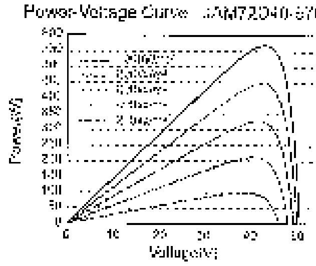
Maximum System Voltage	1500V DC
Operating Temperature	-40℃~+85℃
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* Maximum Static Load,Back*	5400Pa(112 lb/ft²) 2400Pa(50 lb/ft²)
NOCT	45±2℃
Bifaciality**	80%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

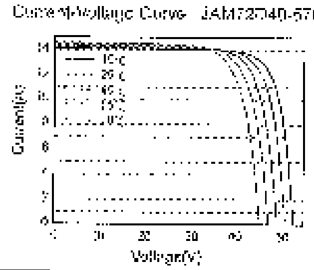
Current-Voltage Curve JAM72D40-570/GB



Power-Voltage Curve JAM72D40-570/GB



Current-Voltage Curve JAM72D40-570/GB



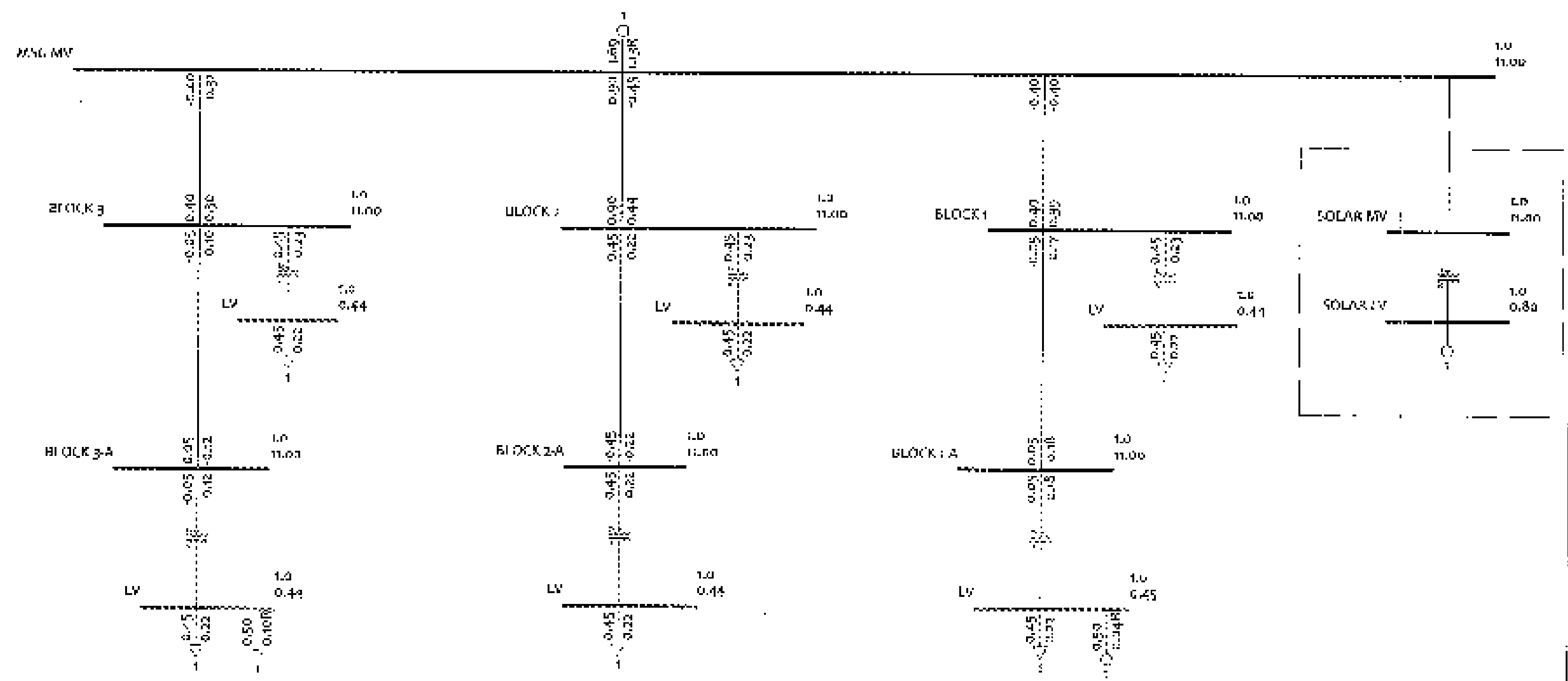
Annexure-B

Steady State Analysis Results

Load Flow Analysis of 500kW Solar PV System at Mehfooz Shaheed Garrison (MSG)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

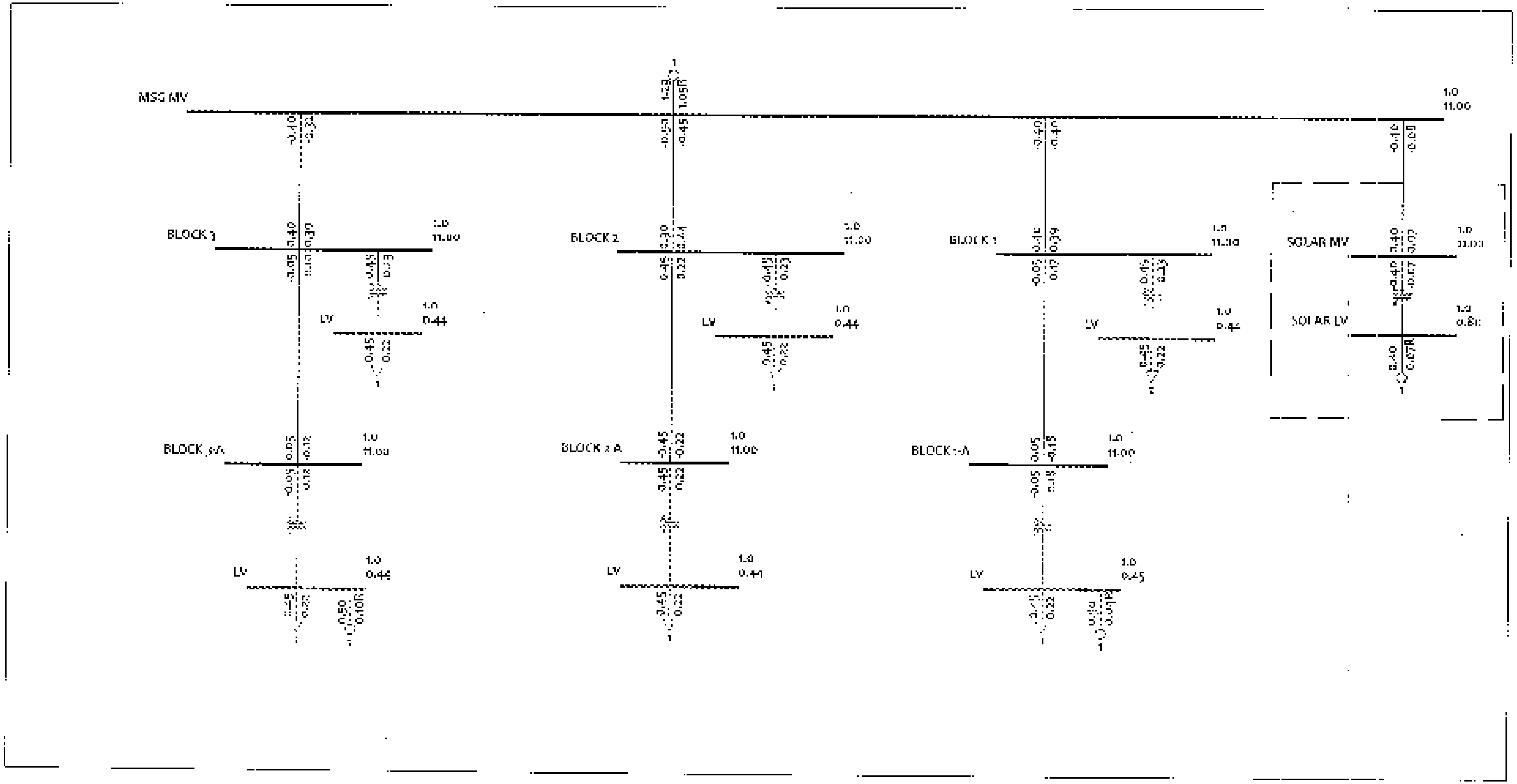
Figure: 5-1



Load Flow Analysis of 500kW Solar PV System at Mehfooz Shaheed Garison (MSG)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: 8-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without MSG PP and With Sanctioned Load

In Service

```
                         PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E      SAT, FEB 15 2025  17:20
                    MSG SOLAR PV SYSTEM                                         %MVA FOR TRANSFORMERS
                                                                                % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS -----X AREA  VOLT          GEN     LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 MSG MV       11.000   4 1.0000   0.0     1.7     0.0     0.0 ------------------------------------------------------
--------------------
                              1 11.000           1.1R    0.0     0.0  41001 BLOCK 1      11.000   4  1     0.6     0.4
6     10
                                                                      41005 BLOCK 2      11.000   4  1     0.9     0.4
10    10
                                                                      41009 BLOCK 3      11.000   4  1     0.4     0.3
5     10
  41001 BLOCK 1      11.000   4 0.9999  -0.0     0.0     0.0     0.0 ------------------------------------------------------
--------------------
                              1 10.998           0.0     0.0     0.0   4100 MSG MV       11.000   4  1    -0.4    -0.4
6     10
                                                                      41002 LV            0.4400   4        0.4     0.2
1.0000LK         31     2
                                                                      41003 BLOCK 1-A    11.000   4  1    -0.1     0.2
2     10
  41002 LV            0.4400  4 0.9929  -0.6     0.6     0.4     0.0 ------------------------------------------------------
--------------------
                              1 0.4369           0.0     0.2     0.0  41001 BLOCK 1      11.000   4  1    -0.4    -0.2
1.0000LK         31     2

  41003 BLOCK 1-A    11.000   4 0.9998  -0.0     0.0     0.0     0.0 ------------------------------------------------------
--------------------
                              1 10.998           0.0     0.0     0.0  41001 BLOCK 1      11.000   4        0.1    -0.2
2     10
                                                                      41004 LV            0.4400   4       -0.1     0.2
0.9751LK         12     2
  41004 LV            0.4400  4 1.0199   0.1     0.5     0.4     0.0 ------------------------------------------------------
--------------------
                              1 0.4488           0.5R    0.2     0.0  41003 BLOCK 1-A    11.000   4  1     0.1    -0.2
1.0000LK         12     2

  41005 BLOCK 2      11.000   4 0.9996  -0.0     0.0     0.0     0.0 ------------------------------------------------------
--------------------
                              1 10.996           0.0     0.0     0.0   4100 MSG MV       11.000   4       -0.9    -0.3
10    10
                                                                      41006 LV            0.4400   4        0.4     0.2
1.0001LK         31     2
```

```
                                                                          41007 BLOCK 2-A   11.000    4  1     0.4    0.2
5    10
  41006 LV         0.4400    4 0.9926   -0.8     0.0      0.4      0.0 ----------------------------------------------------
---------------------
                             1 0.4367            0.0      0.2      0.0  41005 BLOCK 2     11.000    4  1    -0.4   -0.2
1.000CN           31     2

  41007 BLOCK 2-A  11.000    4 0.9996   -0.0     0.0      0.0      0.0 ----------------------------------------------------
---------------------
                             1 10.996            0.0      0.0      0.0  41005 BLOCK 2     11.000    4  1    -0.4   -0.2
5    10
                                                                        41008 LV          0.4400    4  1     0.4    0.2
0.988LK           31     2
  41008 LV         0.4400    4 1.0033   -0.8     0.0      0.4      0.0 ----------------------------------------------------
---------------------
                             1 0.4424            0.0      0.2      0.0  41007 BLOCK 2-A   11.000    4  1    -0.4   -0.2
1.000UN           31     2

  41009 BLOCK 3    11.000    4 0.9996   -0.0     0.0      0.0      0.0 ----------------------------------------------------
---------------------
                             1 10.996            0.0      0.0      0.0  4108 MSS MV       11.000    4  1    -0.4   -0.3
5    10
                                                                       410010 LV          0.4400    4  1     0.4    0.2
1.000LK           31     2
                                                                       410011 BLOCK 3-A   11.000    4  1    -0.1    0.1
1    10
 410010 LV         0.4400    4 0.9927   -0.8     0.0      0.4      0.0 ----------------------------------------------------
 --------------------
                             1 0.4368            0.0      0.2      0.0  41009 BLOCK 3     11.000    4  1    -0.4   -0.2
1.000UN           31     2

 410011 BLOCK 3-A  11.000    4 0.9996   -0.0     0.0      0.0      0.0 ----------------------------------------------------
---------------------
                             1 10.995            0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1     0.1    0.1
1    10
                                                                       410012 LV          0.4400    4  1    -0.1    0.1
0.988LK            4     3
 410012 LV         0.4400    4 1.0099    0.1     0.5      0.4      0.0 ----------------------------------------------------
---------------------
                             1 0.4444            0.1R     0.2      0.0 410011 BLOCK 3-A   11.000    4  1     0.1   -0.1
1.000UN            4     3
```

Annexure-C-2

With MSG PP and With Sanctioned

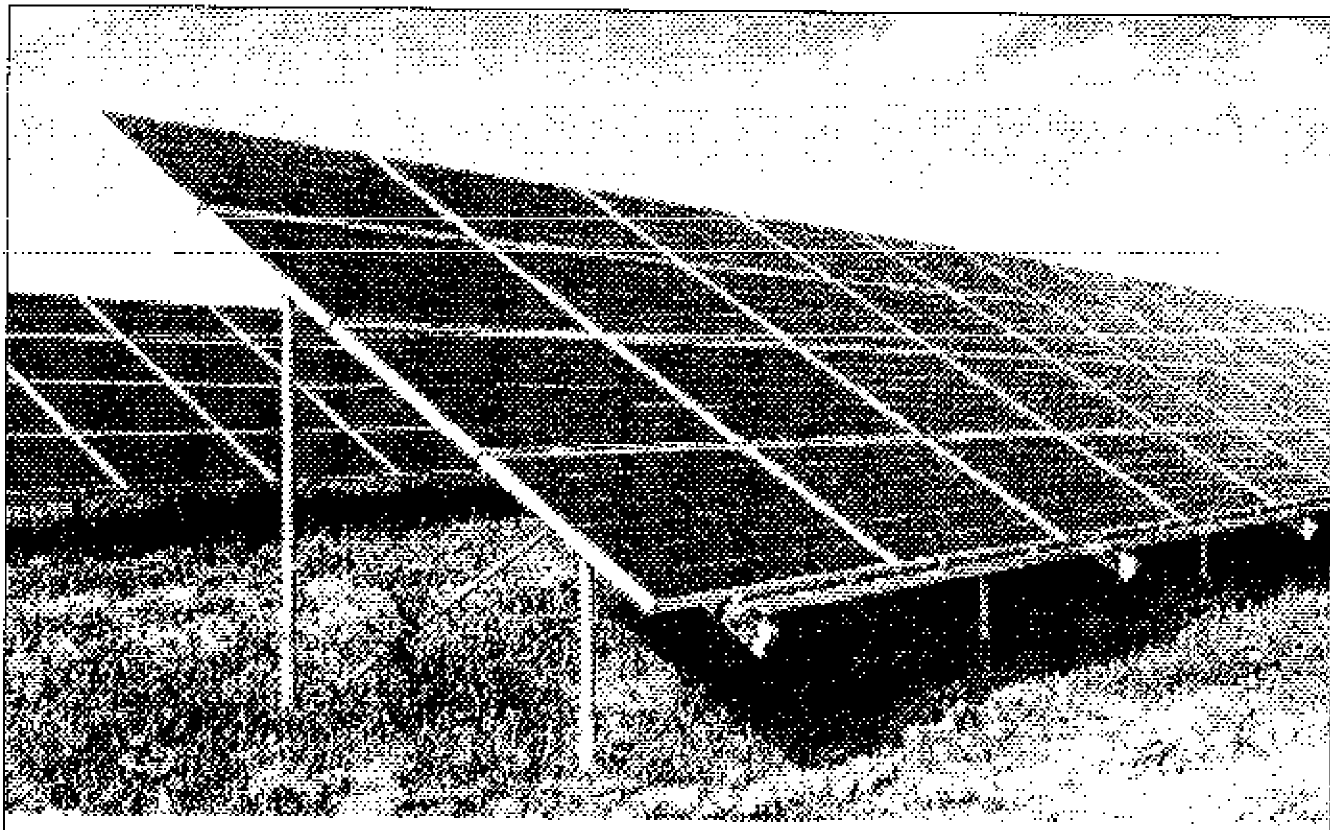
Load In Service

```
                      PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E     SAT, FEB 15 2025  17:22
                 MSG SOLAR PV SYSTEM                                       %MVA FOR TRANSFORMERS
                                                                           % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT          GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 MSG MV      11.000   4 1.0000   0.0     1.3     0.0     0.0 ------------------------------------------------------
--------------------
                             1 11.000           1.1R    0.0     0.0  41001 BLOCK 1      11.000   4  1     0.4    0.4
6    10
                                                                     41005 BLOCK 2      11.000   4  1     0.9    0.4
10    10
                                                                     41009 BLOCK 3      11.000   4  1     0.4    0.3
5    10
                                                                    410013 SOLAR MV     11.000   4  1    -0.4   -0.1
4    10
  41001 BLOCK 1     11.000   4 0.9999  -0.0     0.0     0.0     0.0 ------------------------------------------------------
--------------------
                             1 10.998           0.0     0.0     0.0   4100 MSG MV       11.000   4  1    -0.4   -0.4
6    10
                                                                     41002 LV           0.4400   4  1     0.4    0.2
1.0000K         31      2
                                                                     41003 BLOCK 1-A    11.000   4  1    -0.1    0.2
2    10
  41002 LV          0.4400   4 0.9920  -0.8     0.0     0.4     0.0 ------------------------------------------------------
--------------------
                             1 0.4360           0.0     0.2     0.0  41001 BLOCK 1      11.000   4  1    -0.4   -0.2
1.0000UN        31      2

  41003 BLOCK 1-A   11.000   4 0.9998  -0.0     0.0     0.0     0.0 ------------------------------------------------------
--------------------
                             1 10.998           0.0     0.0     0.0  41001 BLOCK 1      11.000   4  1     0.1   -0.2
2    10
                                                                     41004 LV           0.4400   4  1    -0.1    0.2
0.9751K         12      2
  41004 LV          0.4400   4 1.0199   0.1     0.5     0.4     0.0 ------------------------------------------------------
--------------------
                             1 0.4488           0.0R    0.2     0.0  41003 BLOCK 1-A    11.000   4  1     0.1   -0.2
1.0000UN        12      2

  41005 BLOCK 2     11.000   4 0.9998  -0.0     0.0     0.0     0.0 ------------------------------------------------------
--------------------
                             1 10.998           0.0     0.0     0.0   4100 MSG MV       11.000   4  1    -0.9   -0.5
10    10
```

```
                                                                               41006 LV          0.4400   4  1      0.4     0.2
1.0000LK          31     2                                                     41007 BLOCK 2-A  11.000    4  1      0.4     0.2
5     10
  41006 LV          0.4400   4 0.9926   -0.8      0.0      0.4      0.0 ------------------------------------------------------------
---------------------
                             1 0.4367             0.0      0.2      0.0  41005 BLOCK 2     11.000    4  1     -0.4    -0.2
1.0000UN          31     2

  41007 BLOCK 2-A  11.000    4 0.9996   -0.0      0.0      0.0      0.0 ------------------------------------------------------------
---------------------
                             1 10.996             0.0      0.0      0.0  41005 BLOCK 2     11.000    4  1     -0.4    -0.2
5     10
                                                                         41008 LV          0.4400    4  1      0.4     0.2
0.9881LK          31     2
  41008 LV          0.4400   4 1.0053   -0.8      0.0      0.4      0.0 ------------------------------------------------------------
---------------------
                             1 0.4424             0.0      0.2      0.0  41007 BLOCK 2-A   11.000    4  1      0.4    -0.2
1.0000UX          31     2

  41009 BLOCK 3    11.000    4 0.9996   -0.0      0.0      0.0      0.0 ------------------------------------------------------------
---------------------
                             1 10.996             0.0      0.0      0.0   4100 MSG MV      11.000    4  1     -0.4    -0.3
5     10
                                                                         410010 LV          0.4400    4  1      0.4     0.2
1.0000LK          31     2
                                                                         410011 BLOCK 3-A  11.000    4  1     -0.1     0.1
1     10
  410010 LV         0.4400   4 0.9927   -0.8      0.0      0.4      0.0 ------------------------------------------------------------
---------------------
                             1 0.4368             0.0      0.2      0.0  41009 BLOCK 3     11.000    4  1     -0.4    -0.2
1.0000UX          31     2

  410011 BLOCK 3-A 11.000    4 0.9996   -0.0      0.0      0.0      0.0 ------------------------------------------------------------
---------------------
                             1 10.995             0.0      0.0      0.0  41009 BLOCK 3     11.000    4  1      0.1    -0.1
1     10
                                                                         410012 LV          0.4400    4  1     -0.1     0.1
0.9881LK           4     3
  410012 LV         0.4400   4 1.0099    0.1      0.5      0.4      0.0 ------------------------------------------------------------
---------------------
                             1 0.4474             0.1R     0.2      0.0 410011 BLOCK 3-A   11.000    4  1      0.1     0.1
1.0000UX           4     3

  410013 SOLAR MV  11.000    4 1.0031    0.0      0.0      0.0      0.0 ------------------------------------------------------------
---------------------
                             1 11.001             0.0      0.0      0.0   4100 MSG MV      11.000    4  1      0.4     0.1
4     10
```

```
                                                                    410014 SOLAR LV    0.8000    4  1      -0.4    -0.1
1.000LK           64     1
 410014 SOLAR LV    0.8000    4 1.0013    0.5     0.4      0.0      0.0 -- ---------------------------------------------------
--------------------
                              1 0.9812             0.18     0.0      0.0 410013 SOLAR KV    11.000    4  1 .    0.4      0.1
1.000UN           64     1
```

Annex - J



ARCO Energy

Okara Cantt

SYSTEM STUDY ANALYSIS OF OKARA CANTT (OC) 999kW SOLAR PV SYSTEM

Report

ARCO Energy
PAKISTAN
Tel: +92-300-8827101

CONTENTS

EXECUTIVE SUMMARY

This report provides the documentation of an assessment that has been performed for the interconnection of a 999kW Solar PV Power Generation project at Okara Cantt (OC) distribution system at 11kV project of "Military Engineering Services" (MES). The project will be a Grid tied 999kW Solar PV based system connected with the power network of OC. The '999kW OC solar PV Power Generation project' is located at Q943+J56, Okara Cantonment, Okara, Pakistan.

The integration of solar power generation at the Okara Cantt premises necessitates a comprehensive system study analysis to ensure optimal operation of the electrical network. Okara Cantt currently receives a single point supply from LESCO with a sanctioned load of 4.5MW. The introduction of solar power generation will influence the flow of electricity within the premises, impacting both consumption and injection dynamics.

The existing setup includes transformers, switchgear, and distribution panels to distribute electricity throughout the premises. The sanctioned load of 4.5MW is the maximum load that can be drawn from LESCO's grid.

The entire solar generation within the Okara Cantt premises will be consumed internally without exporting any power to the grid. To ensure the safe and efficient integration of solar power, a load flow study is required to analyze the impact of this interconnection on the existing electrical network. This study will assist in obtaining solar generation concurrence and ensuring compliance with relevant technical and regulatory requirements.

The analyses have been carried out in following scenarios;

- Without 999kW Okara Cantt solar PV with sanctioned load in service.
- With 999kW Okara Cantt solar PV with sanctioned load in service.

Steady state power flow assessment has been performed using the network data of Okara Cantt. Power flow study was conducted without Solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the Okara Cantt distribution system. The power flow results for the system intact shows that the power flows on all the Okara Cantt transmission and distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

This systems study is a critical step in obtaining solar generation concurrence for Okara Cantt. By ensuring the stability and reliability of the electrical system, the study facilitates seamless solar power integration while maintaining compliance with Okara Cantt and regulatory requirements.

Based on the study results, it is concluded that proposed generation interconnection assessment for 999kW Okara Cantt solar PV Power Generation project meets the NEPRA grid code planning criteria.

1 INTRODUCTION

1.1 Project Description

This report provides the documentation of an assessment that has been performed by ARCO Energy in response to a request made by Okara Cantt (OC) ("Project Owner" or "PO") for the interconnection of a 999kWp Solar PV Power Generation project ("Project") to the OC power System at 11kV.

The '999kW Okara Cantt solar PV Power Generation project' is located at Q943+J56, Okara Cantonment, Okara, Pakistan. Figure 1.1 shows Google site map of the project.

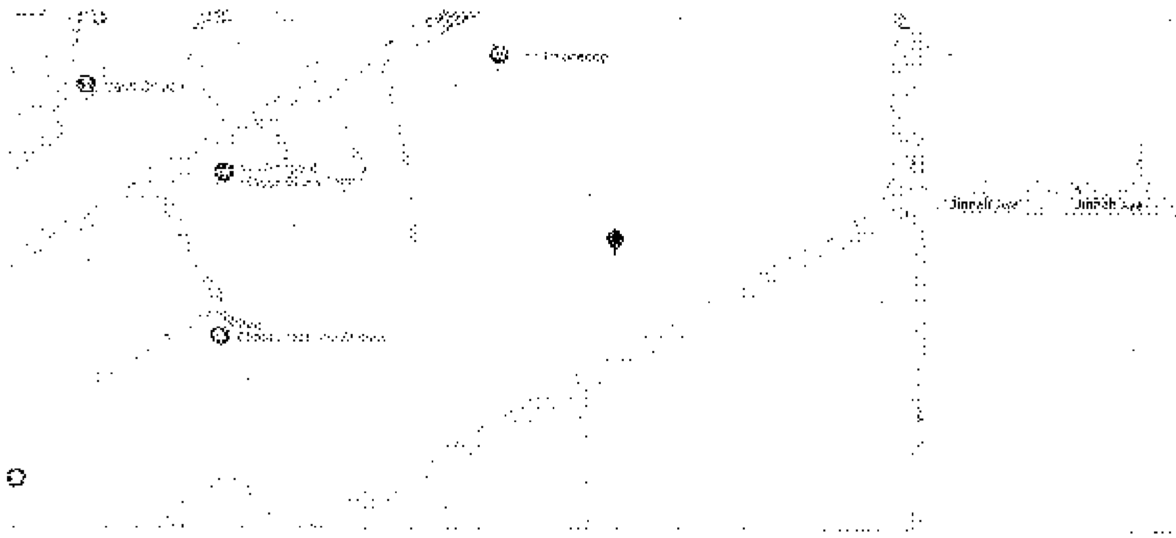


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

1.2 Interconnection Arrangement

Okara Cantt aims to integrate solar power generation into its existing electrical infrastructure. Okara Cantt currently receives a single-point power supply from LESCO with a sanctioned load of 4.5MW. The entire solar generation within the Okara Cantt premises will be consumed internally without exporting any power to the grid. The objective of the analyses is to evaluate the impact of the solar power plant on the Okara Cantt transmission and distribution system.

1.3 Objective of System Study Analysis

The primary objectives of the load flow study are:

- To evaluate the impact of solar power injection on the voltage levels and power distribution within Okara Cantt premises.
- To determine the changes in power flow patterns resulting from the integration of solar generation.
- To ensure that the existing electrical infrastructure can support the additional solar power without causing instability or operational issues.
- To verify compliance with regulatory requirements for solar power interconnection and obtain concurrence for solar generation.

1.4 Study Components

999kW solar PV system is modelled into the Okara Cantt distribution system by ARCO Energy. Technical analysis includes:

i) Data gathering and modelling
ii) Steady state analysis
iii) Conclusion

The above scope of work involved in the technical analysis has been carried to demonstrate that connection assessment of this PV system meets the National Electric Power Regulatory Authority (NEPRA) distribution code.

The analyses have been carried out in following scenarios;

- Without 999kW Okara Cantt solar PV with sanctioned load in service.
- With 999kW Okara Cantt solar PV with sanctioned load in service.

This report documents the results of the steady state analyses. The principal objective of these analyses is to evaluate the impact of 999kW solar PV system to the distribution system of Okara Cantt and vice versa.

2 STUDY METHODOLOGY

2.1 Study Criteria

The study has been carried out based on the National Electric Power Regulatory Authority (NEPRA) Grid Code planning criteria. Key parameters and their corresponding limits have been summarized in table below.

Parameter		Range
Voltage Level	Normal Condition	±5 % p.u at 132kV and below +8%,-5% p.u at 220kV and above
	Contingency	±10 % p.u
T/Line Loading Capacity	Normal Condition	100%
	Contingency	100%
Frequency	Nominal	50 Hz
	Normal Variation	49.8 Hz - 50.2 Hz
	Contingency Band	49.4 Hz - 50.5 Hz
Power Factor	Lagging	0.95
	Leading	0.95

2.2 Steady State Analysis

The purpose of steady-state analysis is to analyse the impact of the proposed solar power plant on distribution system facilities under steady-state conditions. It involves two distinct analyses: line loading analysis and voltage analysis. Power flow solutions using the PSS/E® program (Version 33.4) has been performed.

A "study area" was defined to represent the areas of interest within Okara Cantt.

2.2.1 System Intact Analysis

The incremental impact of the project on substations and transmission line loading under normal conditions was evaluated by comparing transmission and distribution system power flows through different scenarios for the project.

2.2.2 Transmission Line Loading Analysis

11kV and 0.4kV rated transmission and distribution facilities in the study area have been monitored for line loadings.

2.2.3 Voltage Analysis

Voltages at buses inside the study area have been monitored for possible for voltage violations in accordance with NEPRA Grid Code guidelines.

3 STEADY STATE ANALYSIS

3.1 Model Development

Project specific data was provided by the plant owner and it has been compiled and presented in **Annexure-A**. The steady state model of the power plant is presented in table below:

Generator	
No. of Collector Units	1
Generation size of each collector (kVA)	841
Active Power of each collector Pgen. (kW)	799
Power Factor	0.95 lagging, 0.95 leading
Qmin, Qmax (kVAR)	- 0.2626, 0.2626
Rated Frequency	50 Hz
Generation Voltage	0.8V
Xsource	∞
Generation Step Up Transformer	
No of Transformer	1
kVA Capacity of each GSU	1250
% Reactance (X)	5 %
Okara Cantt	
Sanctioned Load (LESCO)	4500 kW

Steady state power flow assessment has been performed using the network data of OC.

3.2 Power Flow Assessment Without Okara Cantt PP and with Sanctioned Load In Service

Power flow study without Okara Cantt solar and with sanctioned load in service, was conducted to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions.

The result of this power flow analysis is in **Annexure-B**.

3.2.1 Base Year 2025: Peak Loading Summer with Sanctioned Load in Service

Power flow analysis has been performed on the peak loading summer (June) 2025 case of Okara Cantt network. This base case included a detailed representation of the Okara Cantt transmission and distribution system in the study area.

The steady state results, depicts that the power flows on all the Okara Cantt distribution line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area. Result of the power flow analysis is attached in **Figure B-1**.

3.3 Power Flow Assessment with Okara Cantt PP

Power flow study of Okara Cantt solar project was conducted with sanctioned load (in service and out of service) to determine the reliability impact of the 999kW Okara Cantt solar project on the Okara Cantt distribution system. This includes the performance of load flow analysis to identify any facility overload or voltage condition that violates the NEPRA planning criteria. Any such violation that is either directly attributable to this project or for which it will have a shared responsibility is included in this report.

The results of the project power flow analysis are plotted in **Annexure-B.**

3.3.1 Base Year 2025: Peak Loading Summer with Sanctioned Load In Service

A base case has been developed with sanctioned load in service at Okara Cantt solar for peak loading summer (June) 2025 that allow us to judge the impact of Okara Cantt solar project on the Okara Cantt network.
Project power flow analysis has been performed after the connection of the project with the Okara Cantt distribution system. This includes the detailed representation of the power plant.

The steady state result, with sanctioned load in service at Okara Cantt solar depicts that the power flows on all the transmission line branches are within their normal loading limits. There is no capacity constraint in terms of load flow or voltage ratings around the study area.
Result of the power flow analysis is attached in **Figure B-2.**

The results of the project bus voltages analysis are attached in **Annexure-C.**

3.4 Conclusion

Steady state power flow assessment has been performed. Power flow study was conducted without solar Project with sanctioned load in service to analyze the magnitude and phase angles of bus voltages, line loadings and power flows under steady-state conditions. Power flow analysis was also conducted with sanctioned load in service after the interconnection of the Solar project with the Okara Cantt distribution system. The power flow results for the system intact shows that the power flows on all the Okara Cantt distribution line branches are within their normal line loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

4 CONCLUSION

4.1 Steady State Assessment

Steady state power flow assessment has been performed. Power flow study was conducted without Okara Cantt solar with sanctioned load in service, to analyze the magnitude and phase angles of bus voltages, line loadings, and power flows under steady-state conditions. Power flow analysis was also conducted with Okara Cantt solar and with sanctioned load in service with Okara Cantt distribution system. Power flow results showed that the power flows on all the Okara Cantt distribution branches are within their normal loading limit. There is no capacity constraint in terms of power flow or voltage ratings within the study area.

The steady state results found no capacity constraint in terms of power flow and voltage ranges.

Hence, it is concluded that based on the study results the Interconnection Assessment for 999kW Okara Cantt solar PV system with Okara Cantt Transmission and Distribution Network, meets the NEPRA grid code planning criteria.

LIST OF ANNEXURES

Annexure-A

Project Specific Data

Annexure-A-1

Project Site Map

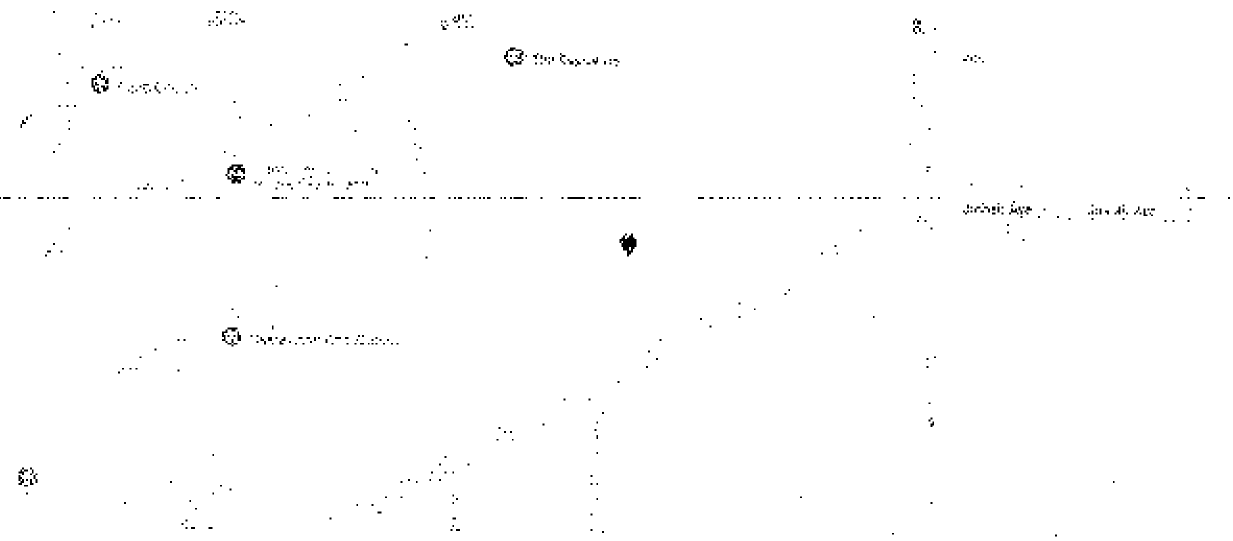
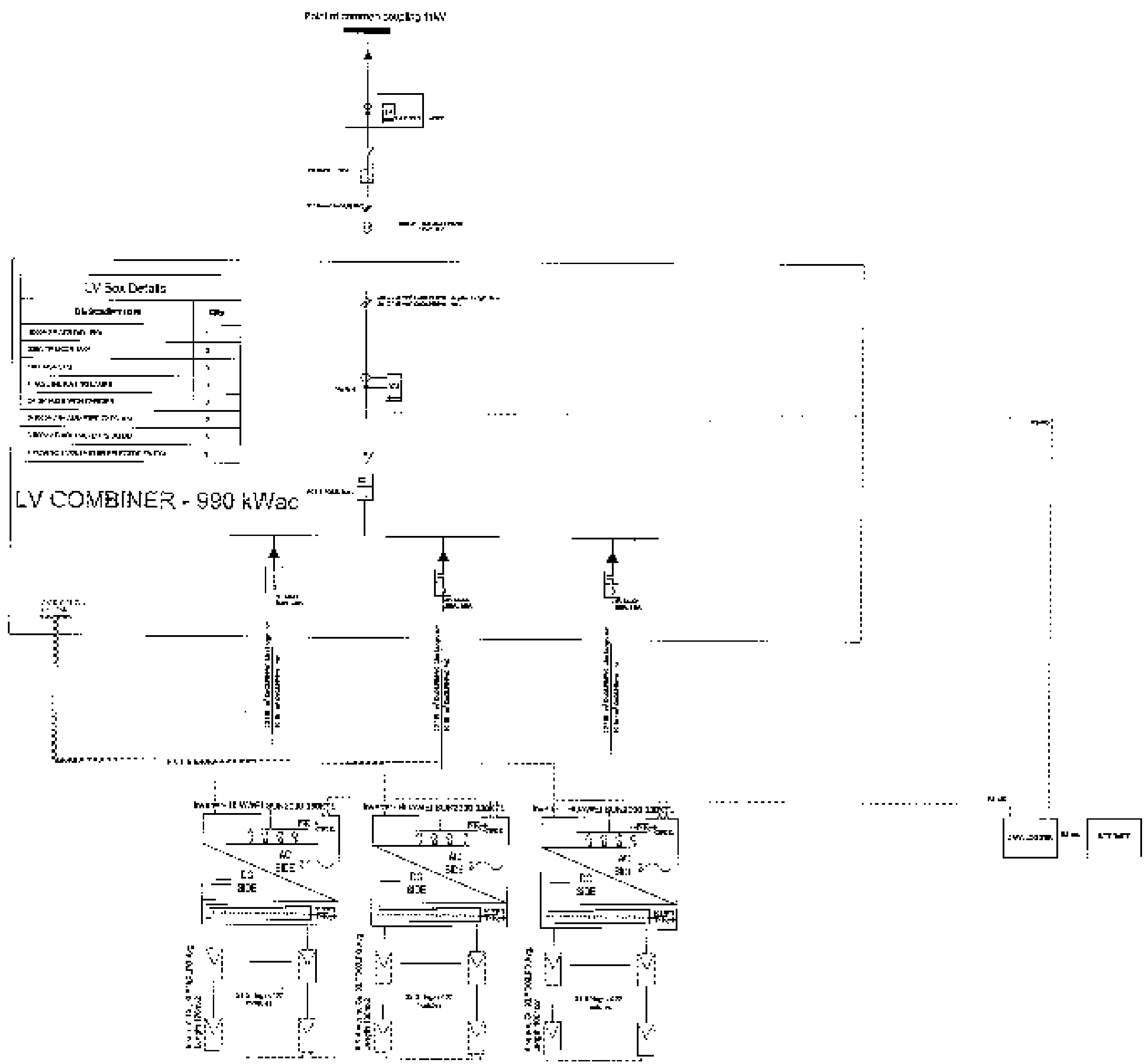


Figure 1.1: Google Site Map of the Solar PV Power Generation Project.

Annexure-A-2

Power Plant Data

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-III
Okara Cantt

CLIENT: Military Engineering Services

DEVELOPER:

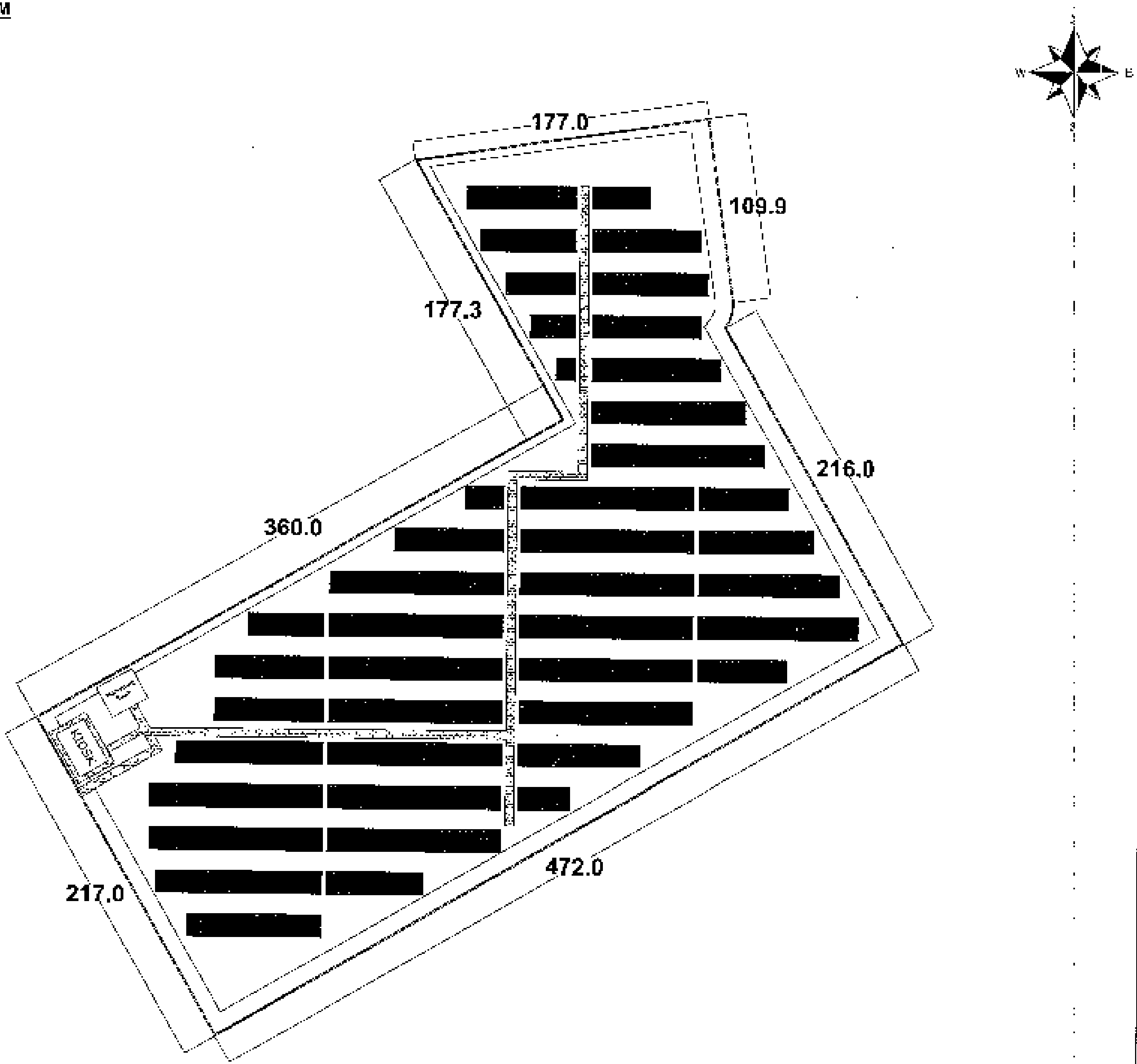
REV	DESCRIPTION	DATE	DRAWN BY

DRAWING: SINGLE LINE DIAGRAM

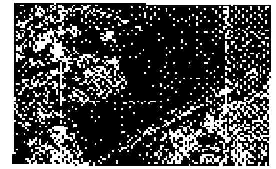
SCALE: N.T.S | PAPER SIZE: | SHEET:

DRAWN: | CHECKED: | APPROVED:

PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION



GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:

MES Solarization P-III

Okara Cantt.

CLIENT:

Military Engineering Services

DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY

DRAWING:

SINGLE LINE DIAGRAM

SCALE: N.T.S

PAPER SIZE: A4

SHEET: 1/3

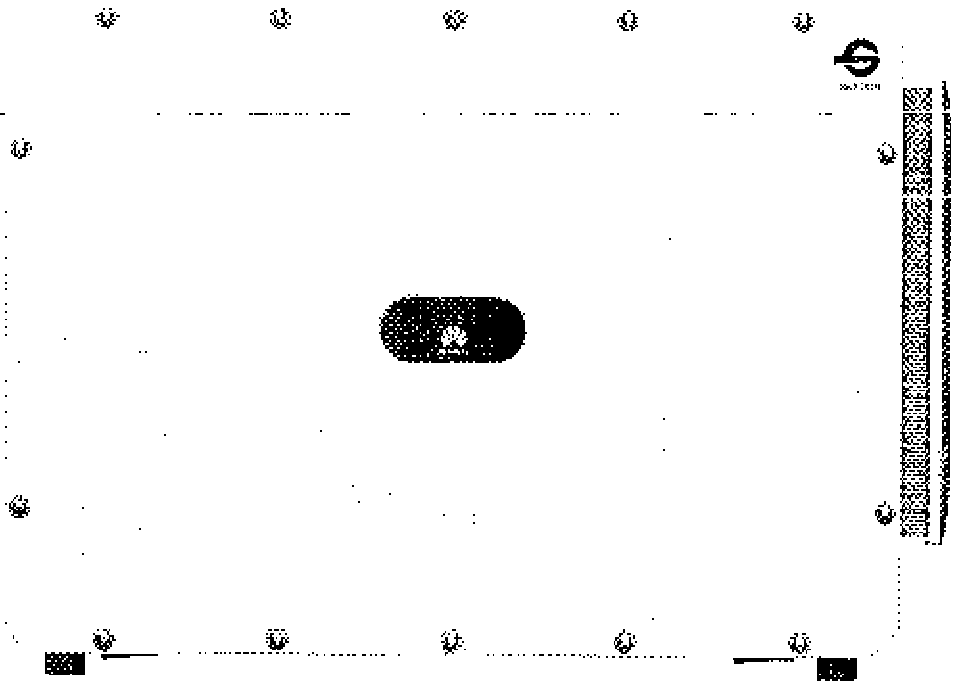
DRAWN:

CHECKED:

APPROVED:

SUN2000-330KTL-H1

Smart String Inverter



Max. Efficiency
≥99.0%

Smart Connector-level
Detection (SCLD)

Smart Self-cleaning
Fan (SSCF)

IP66
Protection

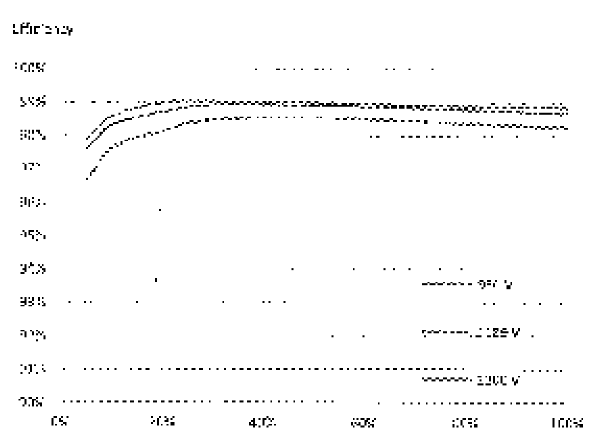
MBUS
Supported

Smart String-level
Disconnection (SSLD)

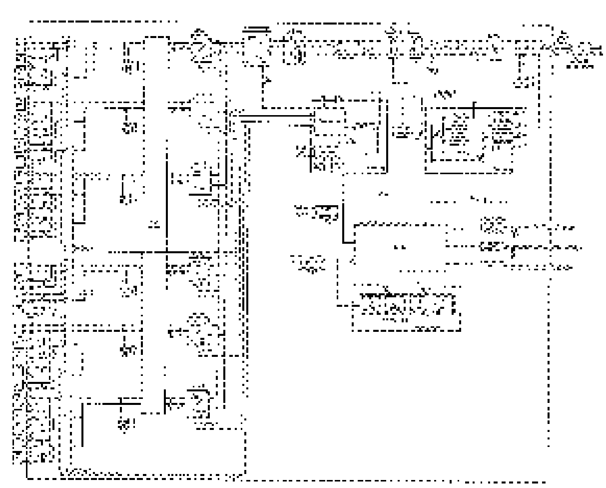
Smart IV Curve Diagnosis
Supported

Surge Arresters for
DC & AC

Efficiency Curve



Circuit Diagram



Technical Specifications

Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosφ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 °C ~ 60 °C
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

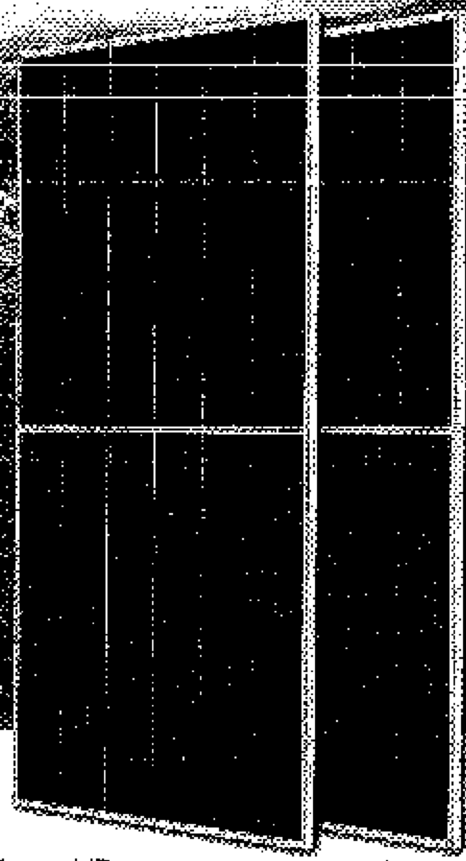
Harvest the Sunshine

DEEP BLUE 4.0

Mono

580W n-type Bifacial Double Glass High Efficiency Mono Module

JAM72D40 555-580/GB Series



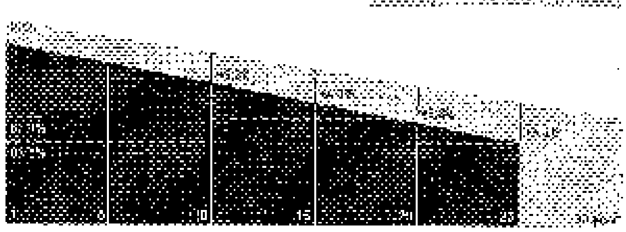
Introduction

Power by the fastest SMBB n-type solar cell, half-cell configuration and gapless ribbon connection technology, these modules have higher output power, lower LID, better weak illumination response, and better temperature coefficient.

- Higher power generation better LCOE
- n-type with very Lower LID
- Better weak illumination response
- Better Temperature Coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty



n-type Bifacial Double Glass Module Linear Performance Warranty

Standard Module Linear Performance Warranty

Comprehensive Certificates

- IEC 61215, IEC 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC 62941: 2019 Terrestrial photovoltaic (PV) modules - Quality system for PV module manufacturing

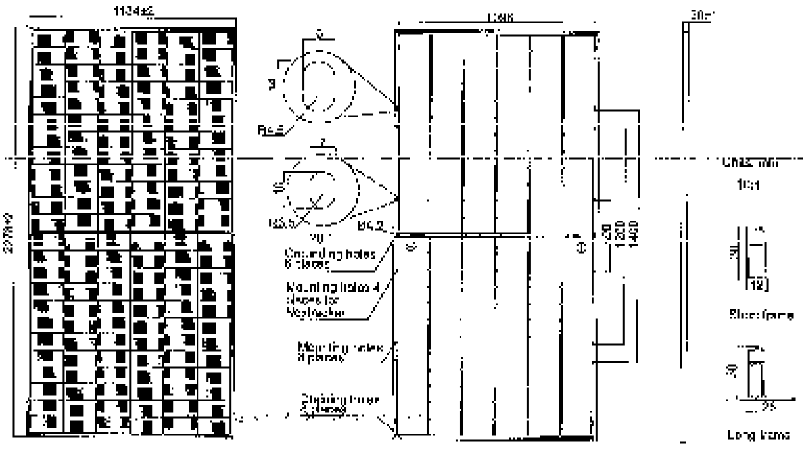
CE

JA SOLAR

JA SOLAR

JAM72D40 555-580/GB

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono-16BB
Weight	31.8kg
Dimensions	2278±2mm×1134±2mm×30±1mm
Cable Cross Section Size	4mm² (IEC), 12 AWG(UL)
No. of cells	144(6×24)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35 / MC4-EVO2A
Cable Length (Including Connector)	Portrait:200mm(+)/300mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	36pcs/Pallet, 720pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Maximum Power(Pmax) [W]	555	560	565	570	575	580
Open Circuit Voltage(Voc) [V]	50.55	50.70	50.85	51.00	51.15	51.30
Maximum Power Voltage(Vmp) [V]	42.24	42.40	42.55	42.70	42.85	43.03
Short Circuit Current(Isc) [A]	14.02	14.09	14.16	14.23	14.30	14.36
Maximum Power Current(Imp) [A]	13.14	13.21	13.28	13.35	13.42	13.48
Module Efficiency [%]	21.5	21.7	21.9	22.1	22.3	22.5
Power Tolerance	0~+5W					
Temperature Coefficient of Isc(α_Isc)	+0.045%/°C					
Temperature Coefficient of Voc(β_Voc)	-0.260%/°C					
Temperature Coefficient of Pmax(γ_Pmp)	-0.350%/°C					
STC	Irradiance 1000W/m², cell temperature 25°C, AM1.5G					

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Max Power(Pmax) [W]	599	605	610	616	621	626
Open Circuit Voltage(Voc) [V]	50.58	50.73	50.88	51.03	51.18	51.30
Max Power Voltage(Vmp) [V]	42.24	42.39	42.55	42.70	42.86	43.02
Short Circuit Current(Isc) [A]	15.14	15.22	15.29	15.37	15.44	15.51
Max Power Current(Imp) [A]	14.19	14.27	14.34	14.42	14.49	14.56
Irradiation Ratio (rear/front)	10%					

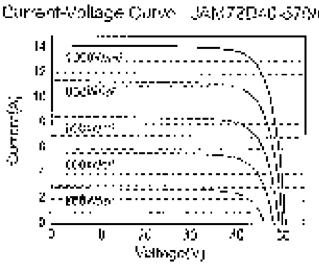
*For Nextracker installations, maximum static load please take compatibility approval letter between JA Solar and Nextracker for reference.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

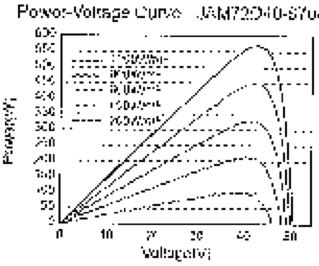
Maximum System Voltage	1500V DC
Operating Temperature	-40°C~+85°C
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* Maximum Static Load,Back*	5400Pa(112 lb/ft²) 2400Pa(50 lb/ft²)
NOCT	45±2°C
Bifaciality**	80%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

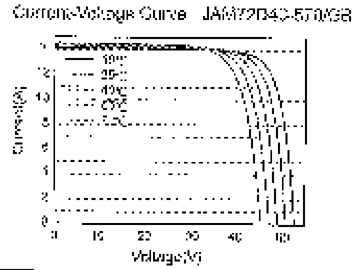
Current-Voltage Curve JAM72D40-570/GB



Power-Voltage Curve JAM72D40-570/GB



Current-Voltage Curve JAM72D40-570/GB



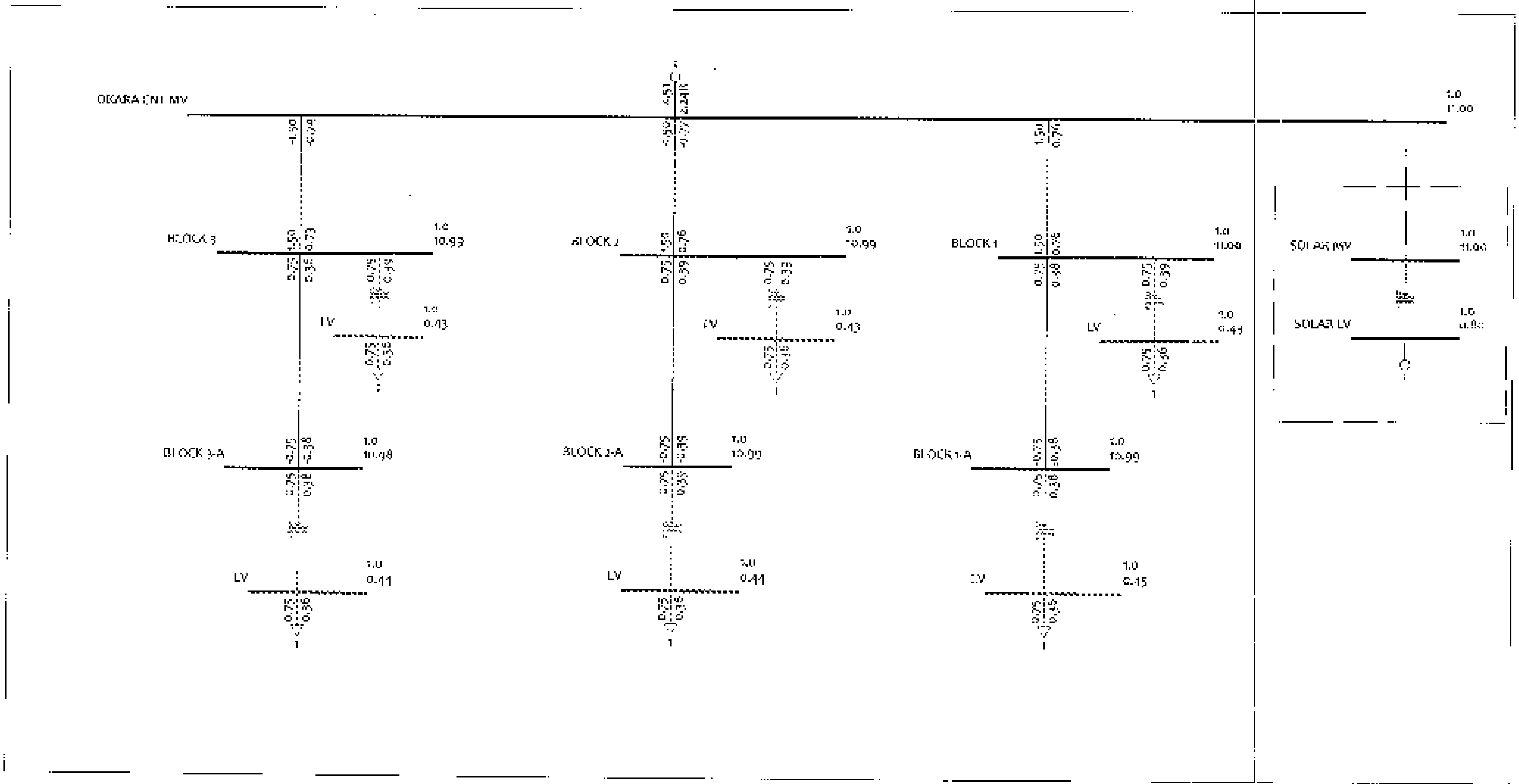
Annexure-B

Steady State Analysis Results

Load Flow Analysis of 999kW Solar PV System at Okara Cantt (OC)

Pre Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

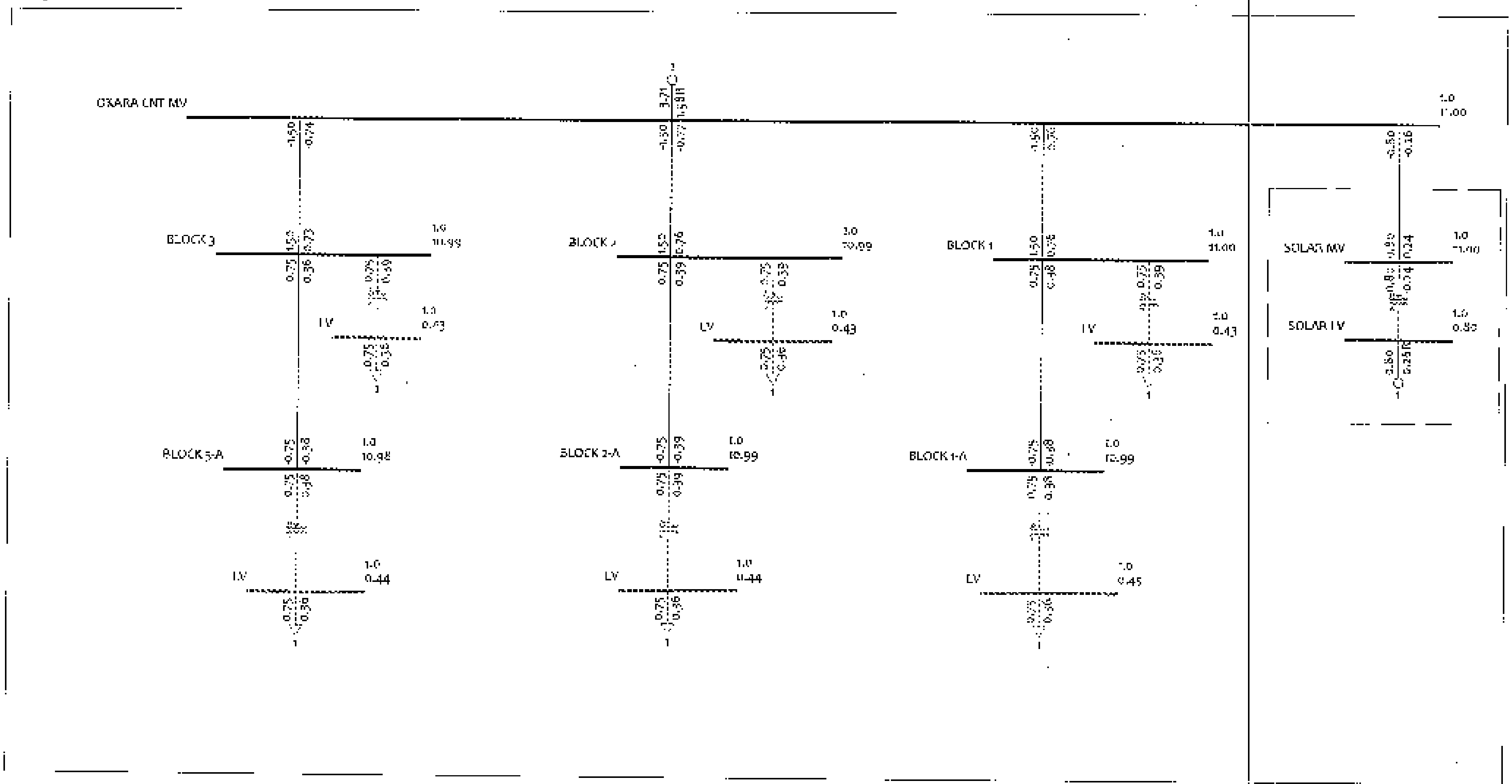
Figure: B-1



Load Flow Analysis of 999kW Solar PV System at Okara Cantt (OC)

Post Project Steady State Analysis Results: Base Year 2025 / Peak Loading 2025

Figure: B-2



Annexure-C

Assessment of bus voltages

Annexure-C-1

Without Okara Cantt PP and With Sanctioned Load In Service

```
                          PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E      SAT, FEB 15 2025  17:25
                    OKARA CANTT SOLAR PV SYSTEM                                 %MVA FOR TRANSFORMERS
                                                                                % I  FOR NON-TRANSFORMER BRANCHES

 X------- FROM BUS ------X AREA  VOLT           GEN     LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT    MW     MVAR
RATIO   ANGLE   %  SET A

   4100 OKARA CNT MV11.000    4 1.0000   0.0     4.5     0.0     0.0 ------------------------------------------------------------
--------------------
                              1 11.000           2.2R    0.0     0.0  41001 BLOCK 1      11.000    4  1      1.5     0.8
17    10
                                                                      41005 BLOCK 2      11.000    4  1      1.5     0.8
17    10
                                                                      41009 BLOCK 3      11.000    4  1      1.5     0.7
17    10
  41001 BLOCK 1      11.000   4 0.9997  -0.0     0.0     0.0     0.0 ------------------------------------------------------------
--------------------
                              1 10.996           0.0     0.0     0.0   4100 OKARA CNT MV11.000    4  1     -1.5    -0.8
17    10
                                                                      41002 LV           0.4400    4  1      0.7     0.4
1.000LK         53    2
                                                                      41003 BLOCK 1-A    11.000    4  1      0.7     0.4
8    10
  41002 LV           0.4400   4 0.9873  -1.4     0.0     0.8     0.0 ------------------------------------------------------------
--------------------
                              1 0.4348           0.0     0.4     0.0  41001 BLOCK 1      11.000    4  1     -0.7    -0.4
1.000UN         52    2

  41003 BLOCK 1-A    11.000   4 0.9995  -0.0     0.0     0.0     0.0 ------------------------------------------------------------
--------------------
                              1 10.994           0.0     0.0     0.0  41001 BLOCK 1      11.000    4  1     -0.7    -0.4
8    10
                                                                      41004 LV           0.4400    4  1      0.7     0.4
0.975LK         53    2
  41004 LV           0.4400   4 1.0136  -1.3     0.0     0.8     0.0 ------------------------------------------------------------
--------------------
                              1 0.4460           0.0     0.4     0.0  41003 BLOCK 1-A    11.000    4  1     -0.7    -0.4
1.000UN         52    2

  41005 BLOCK 2      11.000   4 0.9993  -0.0     0.0     0.0     0.0 ------------------------------------------------------------
--------------------
                              1 10.992           0.0     0.0     0.0   4100 OKARA CNT MV11.000    4  1     -1.5    -0.8
17    10
                                                                      41006 LV           0.4400    4  1      0.7     0.4
1.000LK         53    2
```

```
                                                                                 41007 BLOCK 2-A   11.000   4 1   0.8   0.4
8    10
 41006 LV        0.4400   4 0.9874  -1.4   0.0   0.8   0.0 ------------------------------------------------------------
---------------------
                          1 0.4345         0.0   0.4   0.0  41005 BLOCK 2     11.000   4 1  -0.7  -0.4
1.000UX        52    2

 41007 BLOCK 2-A 11.000   4 0.9993  -0.0   0.0   0.0   0.0 ------------------------------------------------------------
---------------------
                          1 10.992         0.0   0.0   0.0  41005 BLOCK 3     11.000   4 1  -0.8  -0.4
8    10
                                                            41008 LV          0.4400   4 1   0.7   0.4
0.989LK        53    2
 41008 LV        0.4400   4 1.0002  -1.4   0.0   0.8   0.0 ------------------------------------------------------------
---------------------
                          1 0.4401         0.0   0.4   0.0  41007 BLOCK 2-A   11.000   4 1   0.7  -0.4
1.000UN        52    2

 41009 BLOCK 3   11.000   4 0.9990  -0.1   0.0   0.0   0.0 ------------------------------------------------------------
---------------------
                          1 10.903         0.0   0.0   0.0   4100 OKARA CNV MVT11.000   4 1  -1.5  -0.7
17   10
                                                            410010 LV         0.4400   4 1   0.7   0.4
1.000LK        53    2
                                                            410011 BLOCK 3-A  11.000   4 1   0.7   0.4
8    10
 410010 LV       0.4400   4 0.9871  -1.4   0.0   0.8   0.0 ------------------------------------------------------------
---------------------
                          1 0.4343         0.0   0.4   0.0  41009 BLOCK 3     11.000   4 1  -0.7  -0.4
1.000UN        52    2

 410011 BLOCK 3-A 11.000  4 0.9985  -0.1   0.0   0.0   0.0 ------------------------------------------------------------
---------------------
                          1 10.983         0.0   0.0   0.0  41009 BLOCK 3     11.000   4 1  -0.7  -0.4
8    10
                                                            410012 LV         0.4400   4 1   0.8   0.4
0.988LK        28    3
 410012 LV       0.4400   4 1.0038  -0.9   0.0   0.8   0.0 ------------------------------------------------------------
---------------------
                          1 0.4437         0.0   0.4   0.0 410011 BLOCK 3-A   11.000   4 1  -0.8  -0.4
1.000UN        28    3
```

Annexure-C-2

With Okara Cantt PP and With Sanctioned

Load In Service

```
                                  PTI INTERACTIVE POWER SYSTEM SIMULATOR--PSS(R)E      SAT, FEB 15 2025  17:33
                           OKABAR CANTT SOLAR PV SYSTEM                                  %MVA FOR TRANSFORMERS
                                                                                         % I FOR NON-TRANSFORMER BRANCHES

 X--- --- FROM BUS -------X AREA  VOLT            GEN    LOAD    SHUNT  X---------- TO BUS ----------X
TRANSFORMER     RATING
   BUS# X-- NAME --X BASKV ZONE  PU/KV  ANGLE  MW/MVAR MW/MVAR MW/MVAR   BUS# X-- NAME --X BASKV AREA CKT   MW     MVAR
RATIO   ANGLE   %  SET A

  4100 OKARA CNT MV11.000   4 1.0000   0.0     3.7     0.0     0.0 ----------------------------------------------------------
--------------------
                            1 11.000           2.0R    0.0     0.0  41001 BLOCK 1     11.000   4  1     1.5    0.8
17    10
                                                                    41005 BLOCK 2     11.000   4  1     1.5    0.8
17    10
                                                                    41009 BLOCK 3     11.000   4  1     1.5    0.7
17    10
                                                                   410013 SOLAR PV    11.000   4  1    -0.8   -0.3
8     10
  41001 BLOCK 1      11.000   4 0.9997  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
--------------------
                            1 10.996           0.0     0.0     0.0   4100 OKARA CNT MV11.000   4  1    -1.5   -0.8
17    10
                                                                    41002 LV           0.4400  4  1     0.7    0.4
1.0900LK          53     2
                                                                    41003 BLOCK 1-A   11.000   4  1     0.7    0.4
8     10
  41002 LV            0.4400  4 0.9878  -1.4     0.0     0.8     0.0 ----------------------------------------------------------
--------------------
                            1 0.4346           0.0     0.4     0.0  41001 BLOCK 1     11.000   4  1    -0.7   -0.4
1.0000UN          52     2

  41003 BLOCK 1-A   11.000   4 0.9995  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
--------------------
                            1 10.994           0.0     0.0     0.0  41001 BLOCK 1     11.000   4  1    -0.7   -0.4
8     10
                                                                    41004 LV           0.4400  4  1     0.7    0.4
0.9750LK          53     2
  41004 LV            0.4400  4 1.0036  -1.3     0.0     0.8     0.0 ----------------------------------------------------------
--------------------
                            1 0.4460           0.0     0.4     0.0  41003 BLOCK 1-A   11.000   4  1    -0.7   -0.4
1.0000UN          52     2

  41005 BLOCK 2     11.000   4 0.9993  -0.0     0.0     0.0     0.0 ----------------------------------------------------------
--------------------
                            1 10.992           0.0     0.0     0.0   4100 OKARA CNT MV11.000   4  1    -1.5   -0.8
17    10
```

```
                                                                          41006 LV          0.4400   4  1    0.7    0.4
1.000LK        53     2
                                                                          41007 BLOCK 2-A  11.000    4  1    0.8    0.4
8    10
 41006 LV          0.4400   4 0.9874  -1.4    0.0    0.8    0.0 -------------------------------------------------------
-------------------
                            1 0.4345          0.0    0.4    0.0  41005 BLOCK 2     11.000    4  1   -0.7   -0.4
1.000UN        52     2

 41007 BLOCK 2-A  11.000    4 0.9993  -0.0    0.0    0.0    0.0 -------------------------------------------------------
-------------------
                            1 10.992          0.0    0.0    0.0  41005 BLOCK 2     11.000    4  1   -0.8   -0.4
8    10
                                                                 41008 LV          0.4400    4  1    0.7    0.4
0.988LK        53     2
 41008 LV          0.4400   4 1.0002  -1.4    0.0    0.8    0.0 -------------------------------------------------------
-------------------
                            1 0.4401          0.0    0.4    0.0  41007 BLOCK 2-A   11.000    4  1   -0.7   -0.4
1.000UN        52     2

 41009 BLOCK 3    11.000    4 0.9990  -0.1    0.0    0.0    0.0 -------------------------------------------------------
-------------------
                            1 10.989          0.0    0.0    0.0   4100 OKARA CNT MV11.000    4  1   -1.5   -0.7
17    10
                                                                 410010 LV         0.4400    4  1    0.7    0.4
1.000LK        53     2
                                                                 410011 BLOCK 3-A  11.000    4  1    0.7    0.4
8    10
 410010 LV         0.4400   4 0.9871  -1.4    0.0    0.8    0.0 -------------------------------------------------------
-------------------
                            1 0.4343          0.0    0.4    0.0  41009 BLOCK 3     11.000    4  1   -0.7   -0.4
1.000UN        52     2

 410011 BLOCK 3-A 11.000    4 0.9985  -0.1    0.0    0.0    0.0 -------------------------------------------------------
-------------------
                            1 10.983          0.0    0.0    0.0  41009 BLOCK 3     11.000    4  1   -0.7   -0.4
8    10
                                                                 410012 LV         0.4400    4  1    0.8    0.4
0.988LK        28     3
 410012 LV         0.4400   4 1.0038  -0.9    0.0    0.0    0.0 -------------------------------------------------------
-------------------
                            1 0.4417          0.0    0.4    0.0 410011 BLOCK 3-A   11.000    4  1   -0.8    0.4
1.000UN        28     3

 410013 SOLAR MV  11.000    4 1.0033   0.0    0.0    0.0    0.0 -------------------------------------------------------
-------------------
                            1 11.033          0.0    0.0    0.0   4100 OKARA CNT MV11.000    4  1    0.8    0.2
8    10
```

410014 SOLAR LV 0.8000 4 -0.8 -0.2

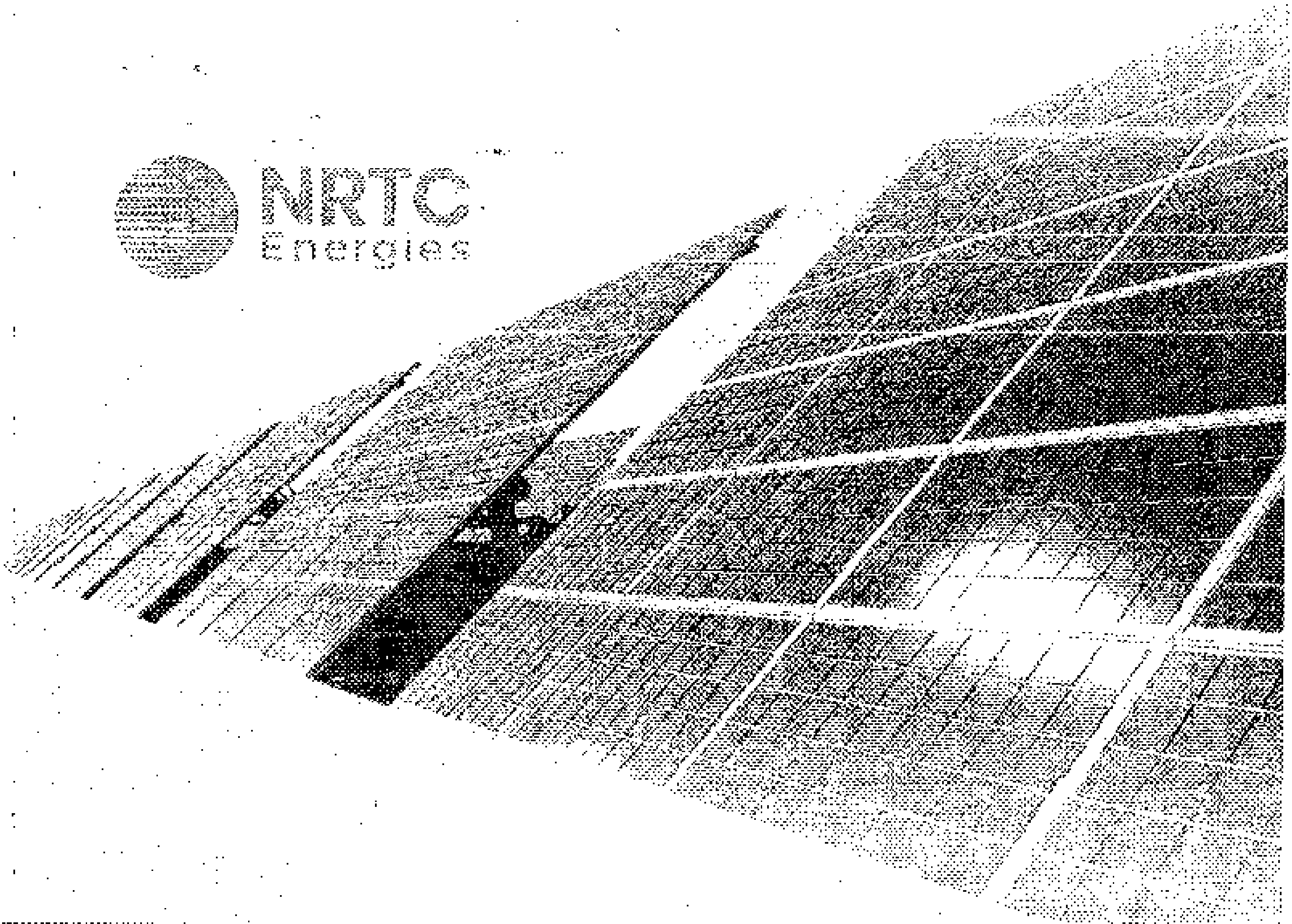
1.000LK 67 1

410014 SOLAR LV 0.8000 4 1.0053 0.9 0.8 0.0 0.0 --

1 0.8042 0.2R 0.0 0.0 410019 SOLAR MV 11.000 4 1 0.8 0.2

1.0000A 67 1

NRTC Energies



Technical and Financial Proposal of 3.5MWp

Head Office:
72 Block, PECO Road, Lahore – Pakistan
Regional Offices:
Islamabad ¦ Karachi ¦ Peshawar | Quetta | Multan

TECHNICAL PROPOSAL

Project Rationale:

The Military Engineering Services (MES) in Pakistan has a rich history dating back to the British colonial era. After the independence of Pakistan in 1947, the MES was reconstituted to serve the Pakistan Army. The MES is responsible for providing engineering support to the Pakistan Armed Forces, including construction, maintenance, and repair of military infrastructure.

Apart from the strategic importance of activities carried out by MES and their requirement of reliable electric power, MES is committed to play a notable role in reducing carbon footprints of Pakistan. To achieve the endeavor, MES is determined to meet their electric power demand through Solar energy. For aforementioned purpose, MES engaged NRTC Energies ("The Applicant Company") and their team conducted surveys to the sites of Military Engineering Services (MES) Pakistan and keeping in view their annual energy consumption, a 3.5 MWp Solar PV Solution at five sites (CMH Lahore, MM Lines Lahore, Akram Lines Lahore, Mahfooz Shaheed Garrison – MSG Lahore and Okara Cantt) in Punjab is proposed. It is anticipated that the project will serve a projected annual production of 5,110,000 kWh/year.

Business Model:

The Applicant Company intends to sell electricity to Military Engineering Services (MES) that utilizes electricity for a wide range of functions, primarily powering their operations and infrastructure. This includes tasks like construction, maintenance, and support for military installations, as well as the design and development of electrical and electronic equipment for military use. NRTC Energies ("The Applicant Company") will provide electricity to MES through its own complete on-grid solution of electricity based on solar power (Generating Facilities) under the long-term Energy Purchase Agreements (EPAs).

In this regard, the Applicant Company has conducted financial analysis and found this model to be financially workable if there are long term contracts involved. The Company will therefore, plan, design, procure material, construct, install, operate and maintain Generating Facilities at sites of the MES Pakistan ("the Buyer"). The NRTC Energies and MES shall be collectively referred as "Parties" herein after.

The Applicant Company shall provide product of the Generation Facilities to the Buyer on terms and conditions as agreed between the Parties so as to recover the cost of investment, working capital, operation and maintenance cost with reasonable rate of return on basis of actual delivery of electricity while taking the risk of shortfall in generation on account of reduction in solar irradiation at its own.

The Applicant Company will install various Generation Facilities at the sites of the Buyer and understands that the activity of generation and sale of electricity shall take place within the same premises (for each site) without crossing any other property or requiring the use of transmission or distribution lines.

The electricity generated through the Generation Facilities of the Applicant Company shall be fed directly into the distribution panel of the Buyer and in no case shall be fed or exported to the distribution system of utility company.

The electricity generated through the Generation Facilities of the Applicant Company shall be less than the total demand of the Buyer, hence, it will not be a replacement for the relevant utility company but only a partial augmentation.

Technical Overview:

Technology:

The electricity shall be generated by use of PV Panels to be installed at the premises of the Buyer and will be supplied directly to the Distribution Panel of the Buyer (s). The Solar PV system will operate in grid interactive / grid tied mode. The grid-tie inverter will be used that will convert direct current (TX electricity into alternating current (AC with built in ability to synchronize with a utility line to supplement the electricity required by the buyer from the distribution company.

Grid-tie inverters are also designed to quickly disconnect from the grid if the utility grid will go down and it will ensure that in the event of interruption of electricity from utility, the grid tie inverter will shut down to prevent the energy flow back in the distribution system of the utility. Grid interactive system will supplement utility supplied energy to building or facility. The PV System output will be designed in a manner that it will always be less than the premises load and there will be no export to the utility company's grid.

In case the Buyer subject to NEPRA's permission and agreement with the utility company, opts to export excess electricity to the distribution system through net metering arrangement, then the Applicant Company, on behalf of the Buyer, may provide requisite services.

The PV Panels shall convert the solar irradiation into DC electricity and by using inverters, DC supply will be converted into 3-Phase AC supply of 400/11,000 Volts. In the process, the Applicant will use equipment including:

- PV Modules
- DC, AC Cables

- Mounting structure
- Meters
- Invertors
- Data loggers for Monitoring;
- Surge arrestors
- Internet devices
- Junction Boxes
- Water Network
- Transformer
- Steel Structure
- LV, MV Switchgear
- Screws, Nuts/Bolts

Technical details, Single Line Diagram and flow diagram ***for each site*** is attached herewith.

Before the Distribution Panel and after the PV AC Electrical Board there shall be installed the Meter for reading of the actual energy delivered through Generation Facilities of the Applicant Company to the Buyer. DC PV Generation from Modules will be converted to both Single and three Phase AC supply (220V and 400V) by specified inverters. Single and Three phase AC supply will further be transformed to MV system (11 kV) by using specified Transformer. The whole capacity of PV plant will fully be utilized by the facility, so there is no need of Net-Metering and export of power to national grid studies and regulations. Further, standardized PV-DG operational technology along with IEC standardized protection schemes will be adopted to control the flow of power towards the national grid system.

Capacity:

The Applicant Company will deploy Solar PV facilities totaling 3.5 MWp at Buyer sites.

Site:

The Generation Facilities to be offered by the Applicant Company shall be at the site premises of the Buyer and therefore the Applicant Company does not require purchasing or acquiring a particular site / land. Moreover, since the electricity generated by the Generation Facilities of the Applicant will not be sold to any electricity utility i.e., DISCO hence it would not require any evacuation by the National Grid Company (NTDC) therefore the mentioning of a particular site is not relevant in this case. However, details of sites are as under;

CMH Lahore

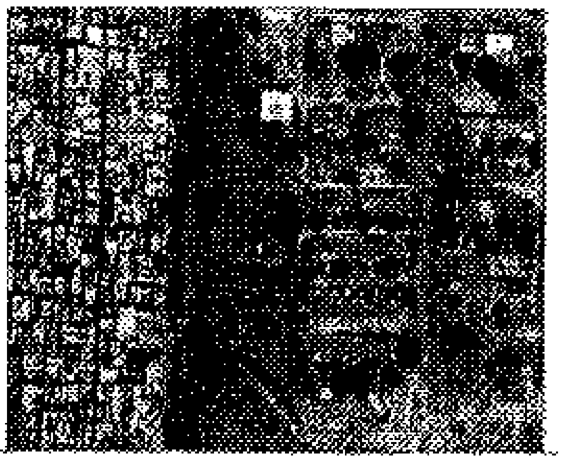
Co-ordinates: 31,5438931646, 74,37144798

Akram Line

Co-ordinates: 31,525040, 74,393176

MM Line

Co-ordinates: 31,507475, 74,381159

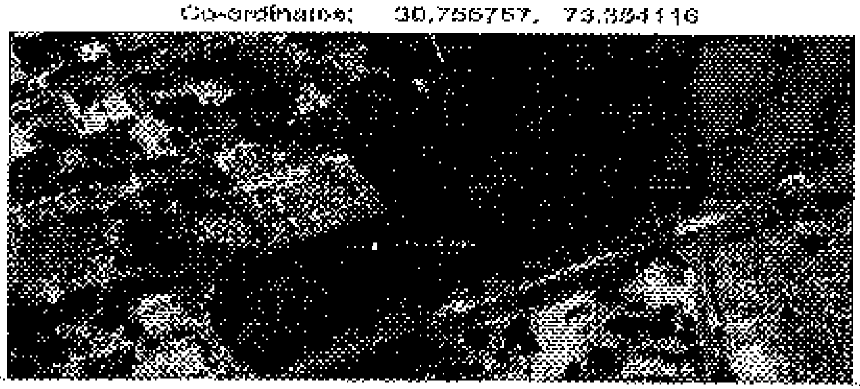


MSG

Co-ordinates: 31,548030, 74,431833

Okara Cantt

Co-ordinates: 30,756767, 73,334116



Interconnection:

Since the Generation Facilities of the Applicant Company shall be installed at the sites of the Buyer and shall provide electricity to that premises in order to supplement the electricity requirement of the Buyer therefore, the interconnection point shall also be within the premises of the Buyer at the point as identified by the Buyer. The Applicant Company shall deliver electricity to the Buyer's distribution box/panel at 11 kV level.

Commissioning & Expected Life:

The terms as to commissioning shall be as per terms of EPA. However, the average expected life of the Generation Facilities shall be 25 Years.

Operation & Maintenance:

The Applicant Company shall also provide the operation and maintenance, including periodical washing of the PV modules, of the Generation Facilities installed at the site of the Buyer. Detailed O&M Manual is attached herewith.

Monitoring Facilities:

The Applicant Company shall develop, install and maintain a remote monitoring facility at its premises for overall monitoring of the Generation Facilities to be installed at various sites of the Buyer. The Applicant will hire trained staff to carry out maintenance activities on the installed facilities at the Buyer's sites. The Applicant also has a team of qualified engineers to plan and supervise the routine / regular maintenance needs.

Eligible Site / Buyer:

The Applicant Company declares the following eligibility criteria for the site / buyer for whom Generation License is required.

i. Generation Facility to be setup should be within the site of the buyer.
ii. Electricity generated through the Generation Facility should not be provided to any premises other than the buyer's premises / site where the Generation Facility is installed.
iii. Electricity from the Generation Facility should be in addition and supplemental to the electricity being obtained from the electric utility company.
iv. Interconnection point should be within the premises / site where the Generation Facility is installed.
v. Generation Facility installed should ensure no back flow of electricity to the distribution system of the utility.
vi. The delivery of electricity from the PV Modules to the distribution Switchgears of the buyer should not require crossing of any public road / area and the distribution network

of the electric company.

vii. The buyer should not be a defaulter of dues of electricity obtained from electric utility company.

FINANCIAL PROPOSAL

Capital Cost:

The Capital cost shall include the cost borne by the Applicant Company on completion of feasibility, planning, designing, material, construction and installation of the Generation Facilities.

The cost of switchgear protection and interconnection with distribution system of utility is included in this case.

The Applicant Company aims to provide the Generation Facilities up to 3.5 MWp in a period of about 04 months, with an estimated cost on per Watt basis is worked out by the Applicant Company as below. The expected cost of the installations under has been estimated to be US$ 0.513/Wp. This cost does not include the cost of land as facilities shall be installed at the premises of the Buyer.

Sr. No.	Description	US$/Wp
1	Civil Work	0.095
2	EPC	0.413
3	Others (including approvals costs)	0.005
	Total	**0.513**

Item wise break up of project cost is attached herewith.

Source of funding:

The applicant company will install a total of 3.5 MWp at stated sites of MES Pakistan in parallel (at once) and will be equity financed with 80:20 ratio.

Details of Annexure

Sr. No.	Annexure	Description
1	**A1**	**MM Line MES 0.5MW Site**
2	A1.1	Simulation Report of 0.5MW
3	A1.2	PV Modules Layout
4	A1.3	Single Line Diagram
5	A1.4	BOQ for 0.5MW Site
6	**A2**	**MSG MES 0.5MW Site**
7	A2.1	Simulation Report of 0.5MW
8	A2.2	PV Modules Layout
9	A2.3	Single Line Diagram
10	A2.4	BOQ for 0.5MW Site
11	**A3**	**CMH MES 1MW Site**
12	A3.1	Simulation Report of 1MW
13	A3.2	PV Modules Layout
14	A3.3	Single Line Diagram
15	A3.4	BOQ for 1MW Site
16	**A4**	**New Akram Lines MES 0.5MW Site**
17	A4.1	Simulation Report of 0.5MW
18	A4.2	PV Modules Layout
19	A4.3	Single Line Diagram
20	A4.4	BOQ for 0.5MW Site
21	**A5**	**Okara MES 1MW Site**
22	A5.1	Simulation Report of 1MW
23	A5.2	PV Modules Layout
24	A5.3	Single Line Diagram
25	A5.4	BOQ for 1MW Site
26	**B1**	**Technical Data Sheets**
27	B1.1	PV modules Datasheet
28	B1.2	Inverter Datasheet
29	B1.3	DC Cable Datasheet
30	B1.4	Protection Modules Datasheet
31	B1.5	Lightening Arrestor Datasheet
32	B1.6	Weather Station Datasheet
33	B1.7	Financial Breakup
34	B1.8	O & M Manual

Annex A-1

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: MES Lahore (MM Line)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 501 kWp

Lahore MES (MM Line) - Pakistan

Author

Project: MES Lahore (MM Line)

Variant: New simulation variant

Project summary

Geographical Site	Situation		Project settings	
Lahore MES (MM Line)	Latitude	31.51 °N	Albedo	0.20
Pakistan	Longitude	74.36 °E		
	Altitude	207 m		
	Time zone	UTC+5		

Meteo data
Lahore MES (MM Line)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation		Near Shadings	User's needs
Fixed plane		No Shadings	Unlimited load (grid)
Tilt/Azimuth	26 / 0 °		

System information

PV Array		Inverters	
Nb. of modules	864 units	Nb. of units	2 units
Pnom total	501 kWp	Pnom total	600 kWac
		Pnom ratio	0.835

Results summary

Produced Energy	593959 kWh/year	Specific production	1185 kWh/kWp/year	Perf. Ratio PR	72.74 %

Table of contents

General parameters

Grid-Connected System — **No 3D scene defined, no shadings**

PV Field Orientation

Orientation		**Sheds configuration**		**Models used**	
Fixed plane		No 3D scene defined		Transposition	Perez
Tilt/Azimuth	20 / 0 °			Diffuse	Perez, Meteonorm
				Circumsolar	separate
Horizon		**Near Shadings**		**User's needs**	
Free Horizon		No Shadings		Unlimited load (grid)	

PV Array Characteristics

PV module		**Inverter**	
Manufacturer	CSI Solar	Manufacturer	Huawei Technologies
Model	CS7L-580MB-AG 1500V	Model	SUN2000-330KTL-H2
(Original PVsyst database)		(Custom parameters definition)	
Unit Nom. Power	580 Wp	Unit Nom. Power	300 kWac
Number of PV modules	864 units	Number of inverters	2 units
Nominal (STC)	501 kWp	Total power	600 kWac
Modules	32 Strings x 27 In series	Operating voltage	500-1500 V
At operating cond. (50°C)		Max. power (=>30°C)	330 kWac
Pmpp	460 kWp	Pnom ratio (DC:AC)	0.84
U mpp	823 V	Power sharing within this inverter	
I mpp	559 A		
Total PV power		**Total inverter power**	
Nominal (STC)	501 kWp	Total power	600 kWac
Total	864 modules	Number of inverters	2 units
Module area	2445 m²	Pnom ratio	0.84

Array losses

Array Soiling Losses		**Thermal Loss factor**		**DC wiring losses**	
Loss Fraction	4.0 %	Module temperature according to irradiance		Global array res.	24 mΩ
		Uc (const)	29.0 W/m²K	Loss Fraction	1.5 % at STC
		Uv (wind)	0.0 W/m²K/m/s		
Serie Diode Loss		**LID - Light Induced Degradation**		**Module Quality Loss**	
Voltage drop	0.7 V	Loss Fraction	2.0 %	Loss Fraction	-0.4 %
Loss Fraction	0.1 % at STC				
Module mismatch losses		**Strings Mismatch loss**		**Module average degradation**	
Loss Fraction	2.0 % at MPP	Loss Fraction	0.1 %	Year no	10
				Loss factor	0.4 %/year
				Mismatch due to degradation	
				Imp RMS dispersion	0.4 %/year
				Vmp RMS dispersion	0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

System losses

Unavailability of the system

Time fraction	3.4 %
	12.4 days,
	3 periods

Auxiliaries loss

Proportionnal to Power	5.0 W/kW
0.0 kW from Power thresh.	
Night aux. cons.	500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.10 % at STC
Inverter: SUN2000-330KTL-H2	
Wire section (2 Inv.)	Alu 2 x 3 x 240 mm²
Average wires length	20 m

MV line up to injection

MV Voltage	11 kV
Wires	Alu 3 x 95 mm²
Length	100 m
Loss Fraction	0.01 % at STC

AC losses in transformers

MV transfo

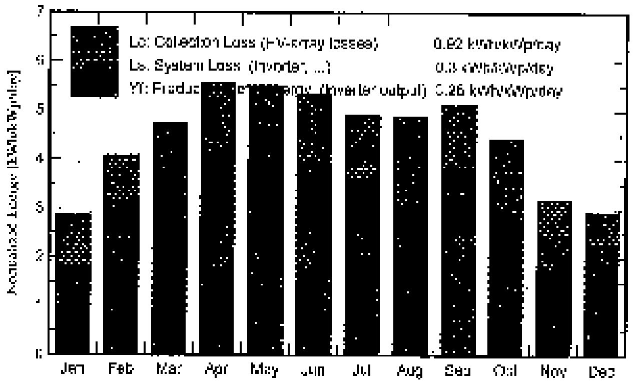
Medium voltage	11 kV
Transformer from Datasheets	
Nominal power	630 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.16 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	3.17 % at PNom
Coils equivalent resistance	3 x 32.25 mΩ

Main results

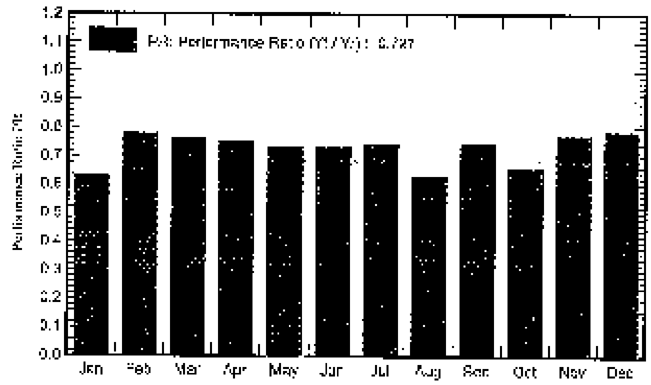
System Production

Produced Energy (P50)	593959 kWh/year	Specific production (P50)	1185 kWh/kWp/year	Performance Ratio PR	72.74 %
Produced Energy (P90)	556330 kWh/year	Produced Energy (P90)	1110 kWh/kWp/year		
Produced Energy (P99)	525662 kWh/year	Produced Energy (P99)	1049 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

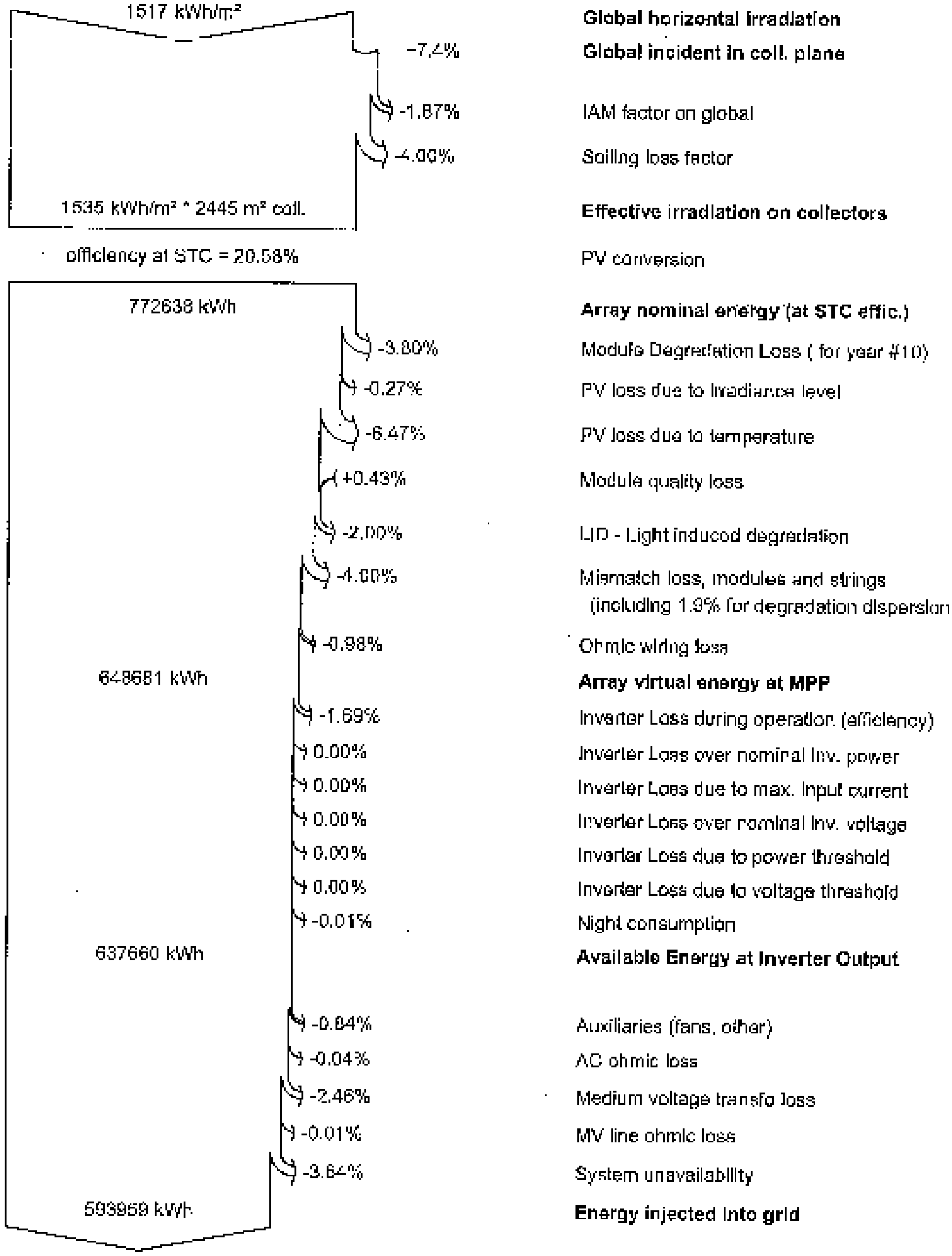
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	89.8	43.7	11.88	89.2	84.1	37531	28331	0.634
February	92.3	46.7	16.09	114.0	107.7	46962	44484	0.779
March	131.6	77.3	22.10	148.8	138.3	59265	56348	0.788
April	161.0	87.3	27.05	166.8	157.0	65711	62574	0.749
May	176.7	96.9	32.91	170.8	160.7	65704	62568	0.731
June	169.5	100.5	32.80	160.2	150.8	61926	58956	0.735
July	160.5	102.3	31.45	152.3	143.1	59594	56715	0.743
August	151.5	98.0	30.72	151.7	142.8	59498	48077	0.633
September	141.8	76.6	29.06	154.1	145.1	60591	57635	0.746
October	116.4	68.0	25.94	136.8	129.1	54502	45298	0.661
November	77.4	49.9	19.09	96.0	90.5	39361	37144	0.772
December	66.6	41.9	13.95	90.9	85.7	38037	35830	0.786
Year	1517.1	887.0	24.46	1629.4	1535.0	648681	593959	0.727

Legends

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

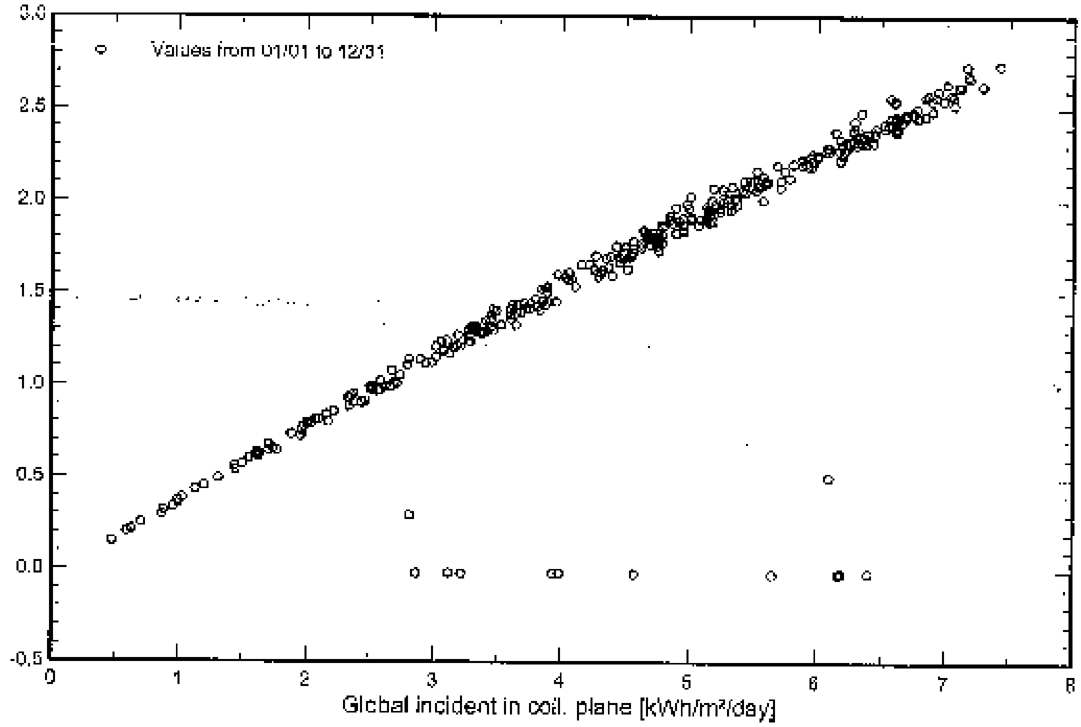
PVsyst V7.3.1
VC0, Simulation date:
08/01/24 10:48
with v7.3.1

Loss diagram

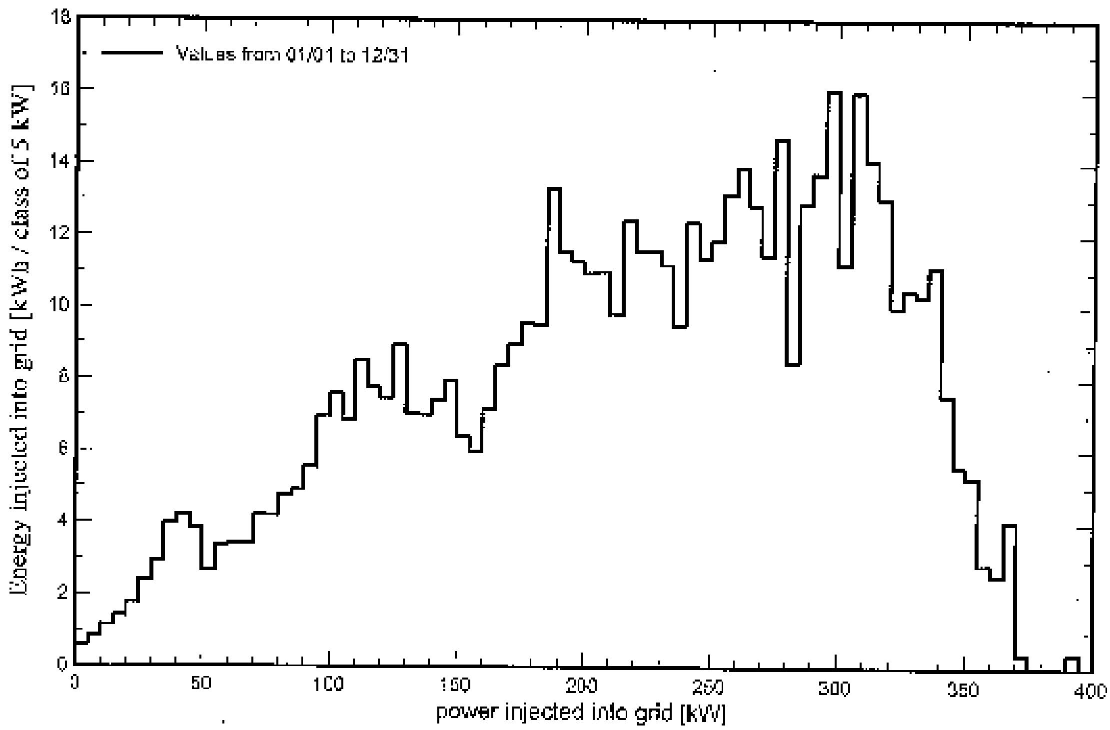


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



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08/01/24 10:48
with v7.3.1

P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	4.6 %
Specified Deviation	
Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.9 %

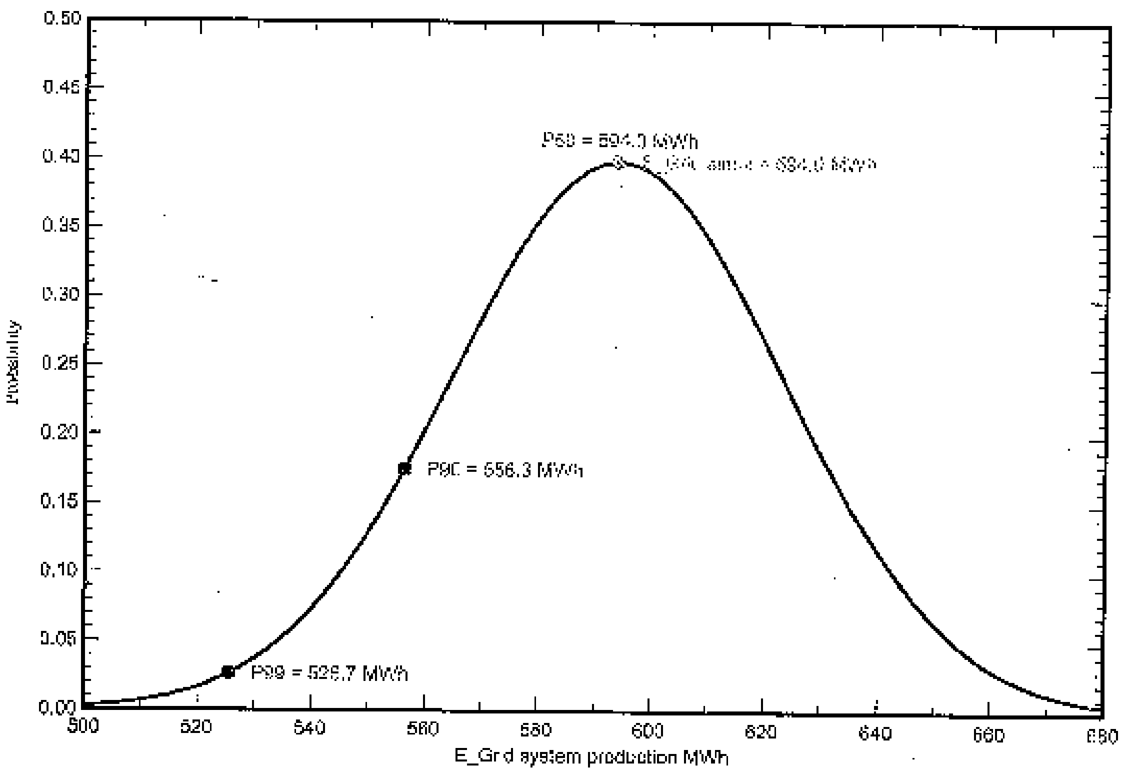
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

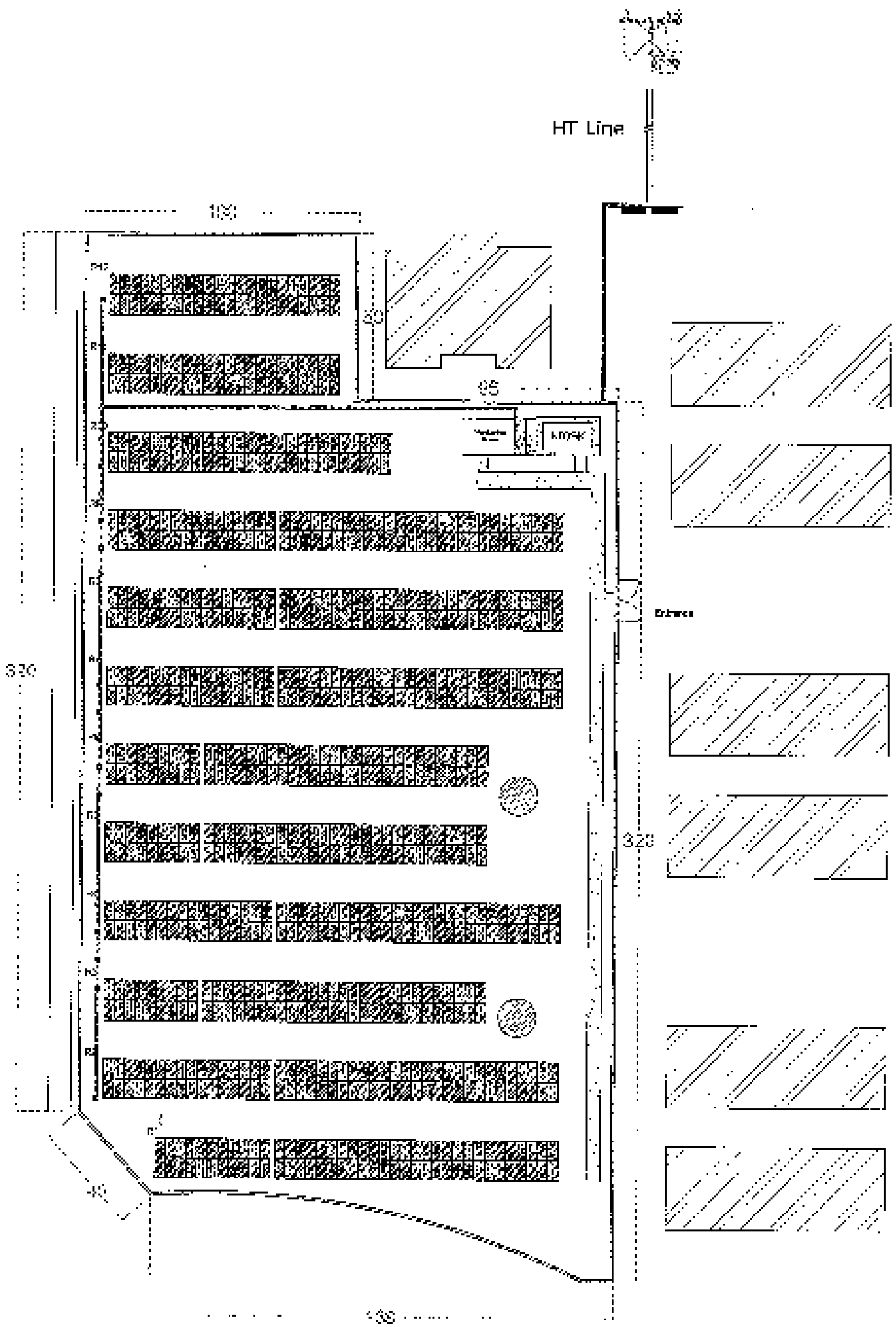
Annual production probability

Variability	29.3 MWh
P50	594.0 MWh
P90	556.3 MWh
P99	525.7 MWh

Probability distribution



PV Placement Layout
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

	Array
[illegible]	[illegible]

PROJECT:

MES Solarization P-18

Mian Mir Lines

CLIENT:

Military Engineering Services

DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY
[illegible]	[illegible]	[illegible]	[illegible]

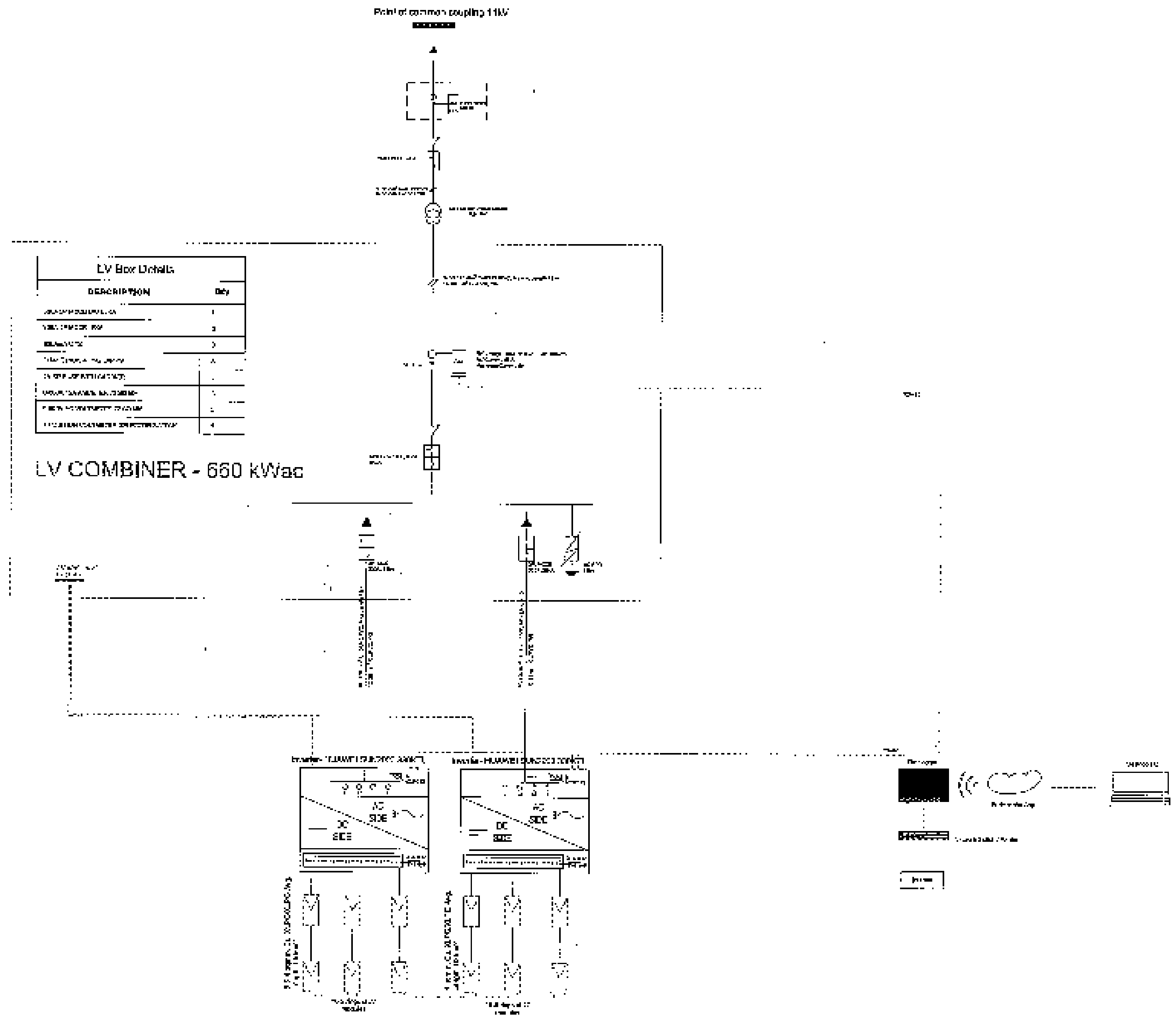
DRAWING:

SINGLE LINE DIAGRAM

SCALE: | PAPER SIZE: A3 | SHEET:

DRAWN: | CHECKED: | APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-III
Mian Mir Lines - Lahore

CLIENT: Military Engineering Services

DEVELOPER: NRTC

REV | DESCRIPTION | DATE | DRAWN BY

DRAWING: SINGLE LINE DIAGRAM

SCALE: N.T.S | PAPER SIZE: | SHEET:

DRAWN: | CHECKED: | APPROVED:

Schedule-II - BOQ FOR_0.5_MWp for SITE Name_Lahore Site-3 (MM Line)_

Sr.No	Item	Specifications	Unit	Qty	Model and make	LOCAL/IMPORTED	Country of Origin
SOLAR SYSTEM COMPONENTS							
1	Solar PV Modules (12 years product & 25 years performance warranty)	580Wp Tier-1 Bifacial mono N type Technology having efficiency_22.5%	Nr	954	N-type Bifacial 580 w - JA; China	Imported	China
2	Solar PV Inverters (5 years warranty) with Wifi Dongle	330KVA having efficiency of 99.03% with built-in SPD at DC and AC Side	Nr	2	Huawei 350 KTL; China	Imported	China
3	Data logger (Five years warranty)	Datalogger for communication	Nr	1	Huawei Smart Logger 3000A ; China	Imported	China
4	Weather sensors set	Weather sensors set (temp, wind, irradiation etc) compatible with the system as per RFP	Set	1	7 sensors ; Huawei	Imported	China
5	Solar PV mounting structure as per RFP	Solar PV mounting structure as per RFP complete with Civil and Mechanical work as per drawing approved by consultant	Job	1	Concrete Pile Structure 150x/m/r PAKISTAN - General Construction Mechanics	Local	Pakistan
6	Solar PV Cables as per IEC standard 50618 OR IEC 62930 (10 years warranty in case of Local Cable)	Single Core 4mmSq PV Cable tested at 1.5KV withstanding at 120 Degree XLPE/XLPO insulation must be compliant with IEC standard IEC 62930:2017	Job	1	Pakistan Cables	Local	Pakistan
7	AC Cables from Inverters to KIOSK and then from KIOSK to point of connectivity	Three Core 120 mmSq Cu, AC cable(Inverter to LV) Three Core MV 95 mmSq Al, AC cable (KIOSK to point of connectivity)	Job	1	Pakistan Cables	Local	Pakistan
8	KIOSK compact station	LV Side Panel 2 x 320A MCCBs 800Volts and 1 x 630A ACB.Transformer 630 KVA, HT Side Panel 630A VCB	Set	1	Tariq Electric	Local	Pakistan
9	Earthing Sytem at DC and AC side separate with material, drilling upto water level, and labour as per BOQ approved by consultant	Complete Earthing with pure copper rod, copper electrodes having less than 3 Ohm earth resistance	Job	1	NRTC ENERGIES	Local	Pakistan
10	Lightening Arrestors	ESE (Early Streamer Emission) Lightening Protection System as per RFP.	Nr	1	CONTRA50 CESE LIGHTENING TERMINAL	Imported	Turkey
11	Fencing for protection of Plant	Fencing wall for protection from animals and theft.	Job	1	NRTC ENERGIES	Local	Pakistan
12	Control Room	Well-equipped Control room with LED and Furniture	Job	1	Signature Architect	Local	Pakistan
13	SCADA	Scada system for monitoring and Control as per RFP Specifications	Job	1	ICSS	Local	Pakistan
14	Land preparation	Debris removal, clearing, leveling, paving, walkways, foundations, making land ready for SPP.	Job	1	NRTC ENERGIES	Local	Pakistan
15	Energy Meter	2020T	Job	1	MicroStar	Imported	China
16	Studies, approvals and permits	All studies approvals and permits required as per authorities in Pakistan as per law/directives/SROs.	Job	1	NRTC ENERGIES	Local	Pakistan

Annex A-2

Version 7.3.1

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: Lahore MES (MSG)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 501 kWp

Lahore MES (MSG) - Pakistan

Author

Project summary

Geographical Site
Lahore MES (MSG)
Pakistan

Situation

Latitude	31.55 °N
Longitude	74.43 °E
Altitude	210 m
Time zone	UTC+5

Project settings

Albedo	0.20

Meteo data
Lahore MES (MSG)
Meteonorm 8.1 (2016-2021), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System Information

PV Array

Nb. of modules	864 units
Pnom total	501 kWp

Inverters

Nb. of units	2 units
Pnom total	600 kWac
Pnom ratio	0.835

Results summary

Produced Energy	589756 kWh/year	Specific production	1177 kWh/kWp/year	Perf. Ratio PR	72.60 %

Table of contents

General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Sheds configuration
No 3D scene defined

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	CSI Solar
Model	CS7L-580MB-AG 1500V
(Original PVsyst database)	
Unit Nom. Power	580 Wp
Number of PV modules	864 units
Nominal (STC)	501 kWp
Modules	32 Strings x 27 In series
At operating cond. (50°C)	
Pmpp	460 kWp
U mpp	823 V
I mpp	559 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H2
(Custom parameters definition)	
Unit Nom. Power	300 kWac
Number of inverters	2 units
Total power	600 kWac
Operating voltage	500-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	0.84
Power sharing within this inverter	

Total PV power

Nominal (STC)	501 kWp
Total	864 modules
Module area	2445 m²

Total inverter power

Total power	600 kWac
Number of inverters	2 units
Pnom ratio	0.84

Array losses

Array Soiling Losses
Loss Fraction 4.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 24 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

System losses

Unavailability of the system		**Auxiliaries loss**	
Time fraction	3.4 %	Proportionnal to Power	5.0 W/kW
	12.4 days,	0.0 kW from Power thresh.	
	3 periods	Night aux. cons.	500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.10 % at STC
Inverter: SUN2000-330KTL-H2	
Wire section (2 Inv.)	Alu 2 x 3 x 240 mm²
Average wires length	20 m

MV line up to injection

MV Voltage	11 kV
Wires	Copper 3 x 95 mm²
Length	100 m
Loss Fraction	0.01 % at STC

AC losses in transformers

MV transfo

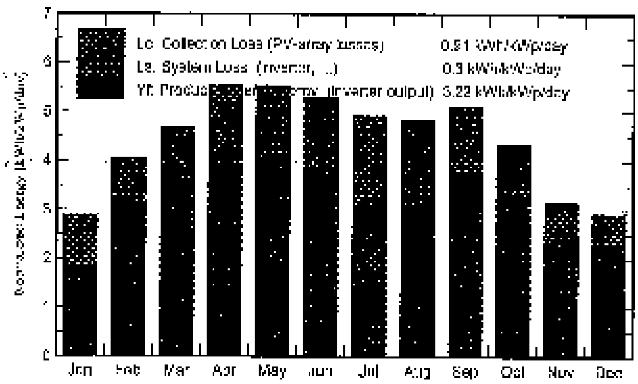
Medium voltage	11 kV
Transformer from Datasheets	
Nominal power	630 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.16 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	3.17 % at PNom
Coils equivalent resistance	3 x 32.25 mΩ

Main results

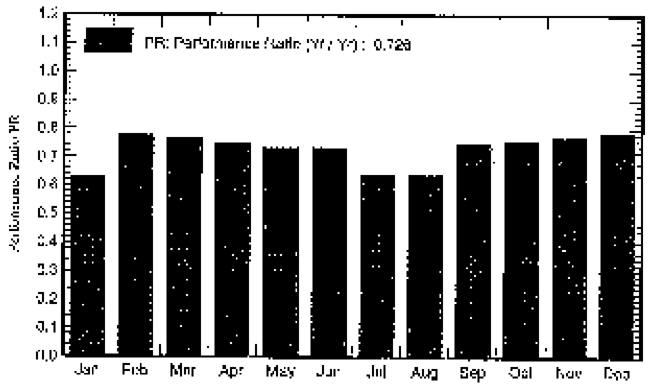
System Production

Produced Energy (P50)	589756 kWh/year	Specific production (P50)	1177 kWh/kWp/year	Performance Ratio PR	72.60 %
Produced Energy (P90)	541653 kWh/year	Produced Energy (P90)	1081 kWh/kWp/year		
Produced Energy (P99)	502448 kWh/year	Produced Energy (P99)	1003 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



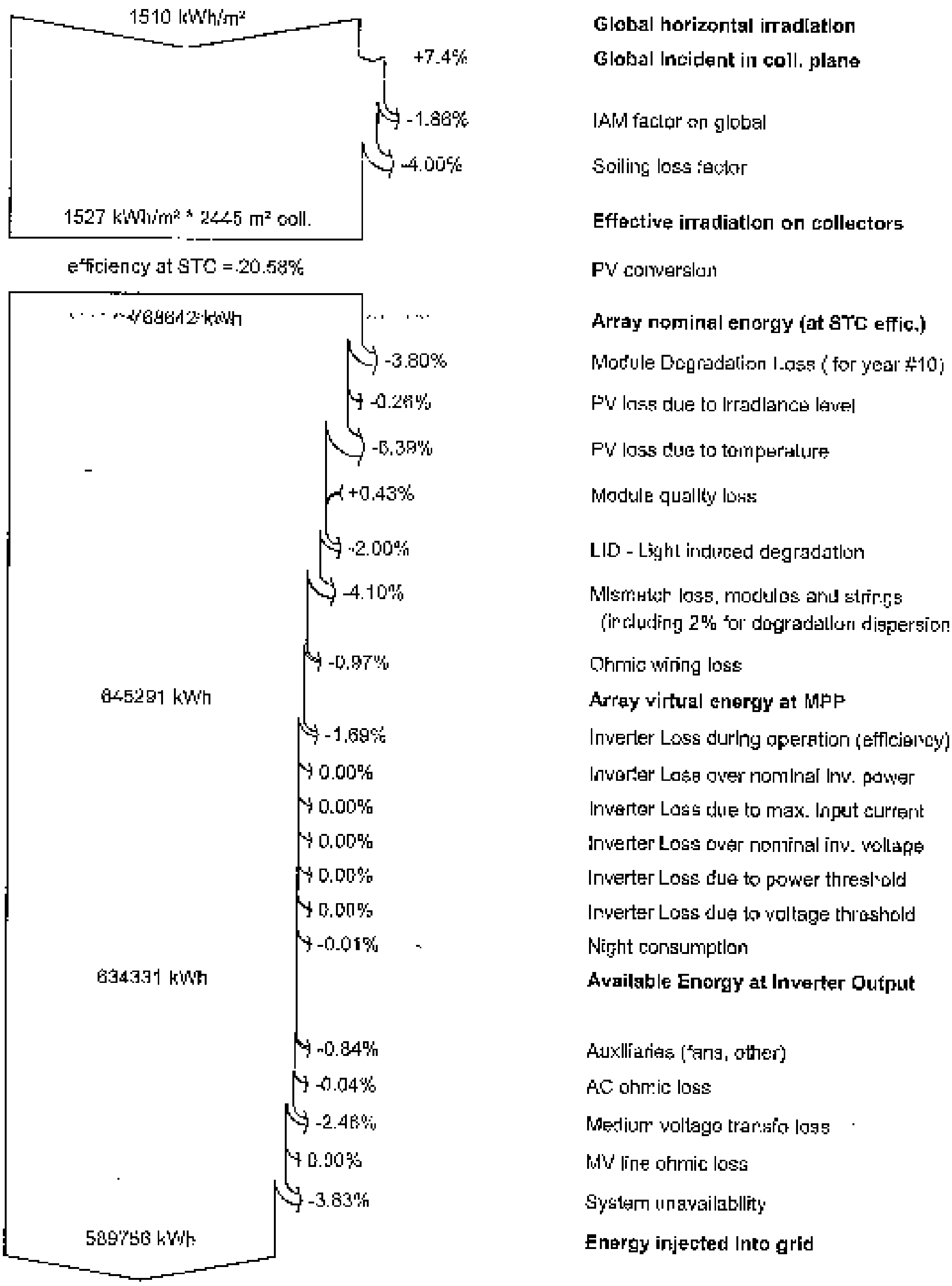
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	69.6	42.4	11.54	89.6	84.5	37686	28413	0.633
February	91.8	46.6	15.88	113.2	107.0	46619	44159	0.778
March	130.8	79.4	21.82	145.3	137.0	58713	55820	0.767
April	160.4	87.8	26.96	166.0	156.3	65390	62279	0.749
May	176.0	100.0	33.05	171.4	161.3	66009	62869	0.732
June	168.2	101.7	32.90	158.7	149.3	61304	58385	0.734
July	160.4	100.6	31.45	152.9	143.9	59650	48865	0.638
August	150.4	97.5	30.68	150.0	141.2	58865	47968	0.638
September	141.1	79.3	28.86	153.9	144.5	60336	57400	0.747
October	115.5	72.9	25.81	134.3	126.7	53619	50928	0.757
November	76.7	49.6	18.79	95.6	90.1	39211	37010	0.772
December	68.8	42.1	13.61	90.6	85.5	37888	35679	0.786
Year	1509.6	900.0	24.33	1620.9	1527.1	645291	589756	0.726

Legends

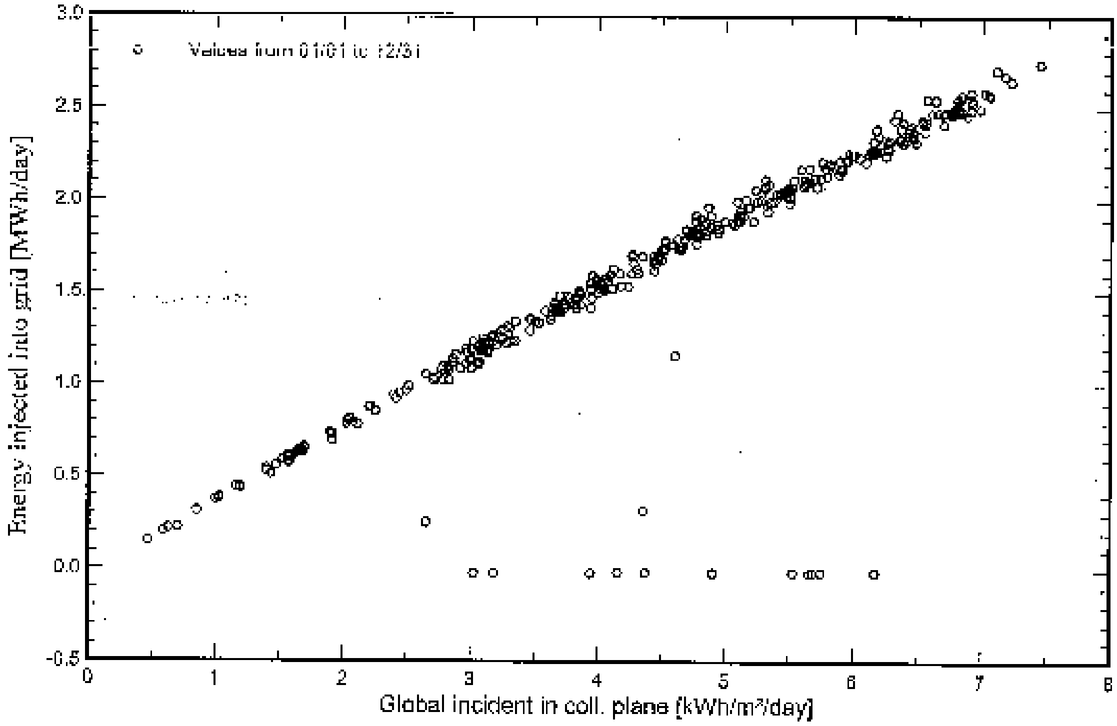
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

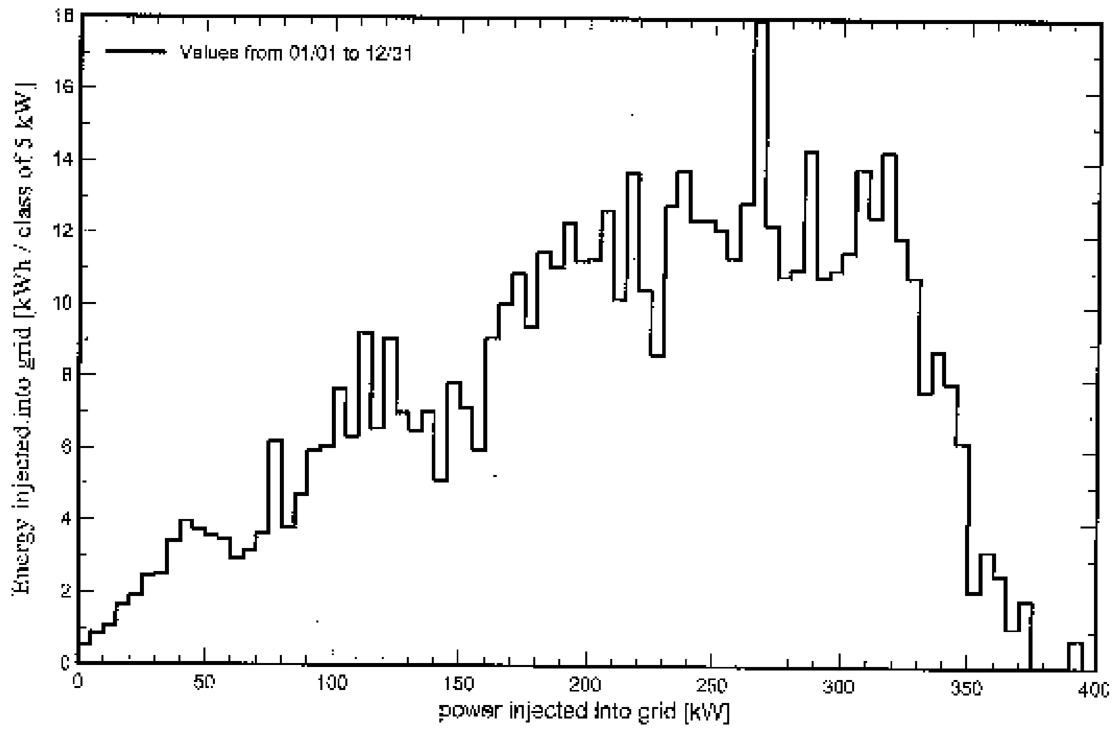


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



PVsyst V7.3.1
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08/01/24 10:33
with v7.3.1

P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (2016-2021), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	6.1 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	6.4 %

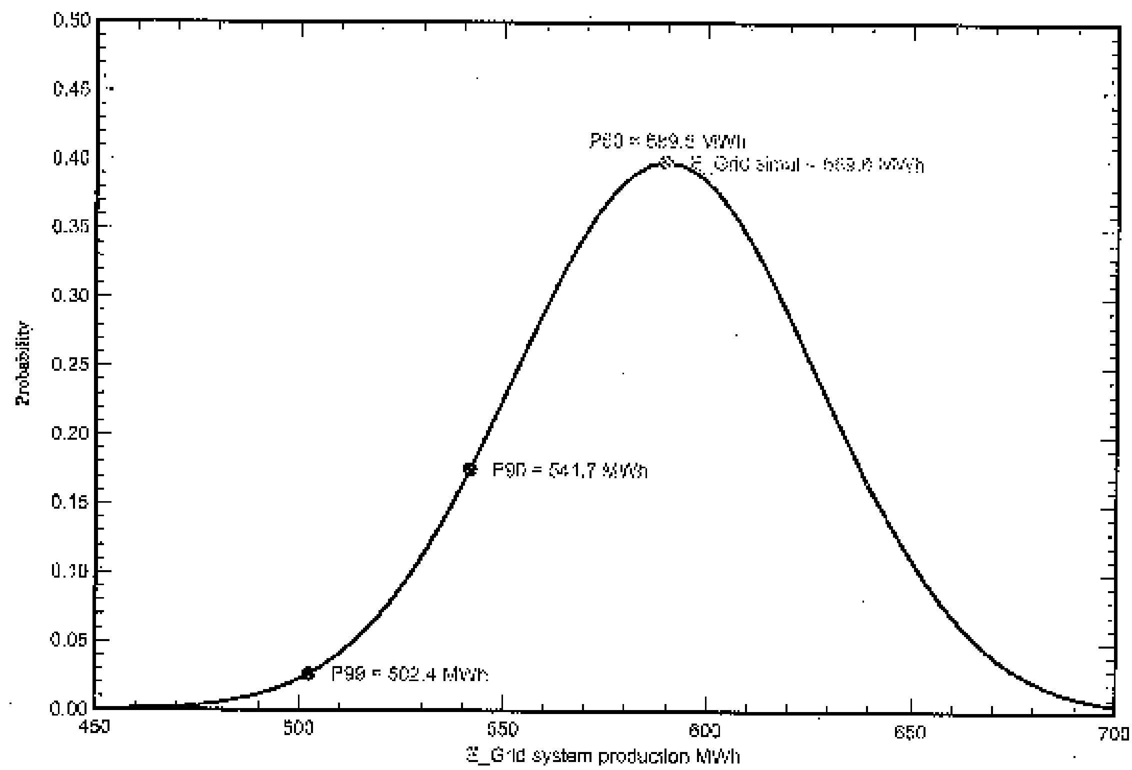
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

Annual production probability

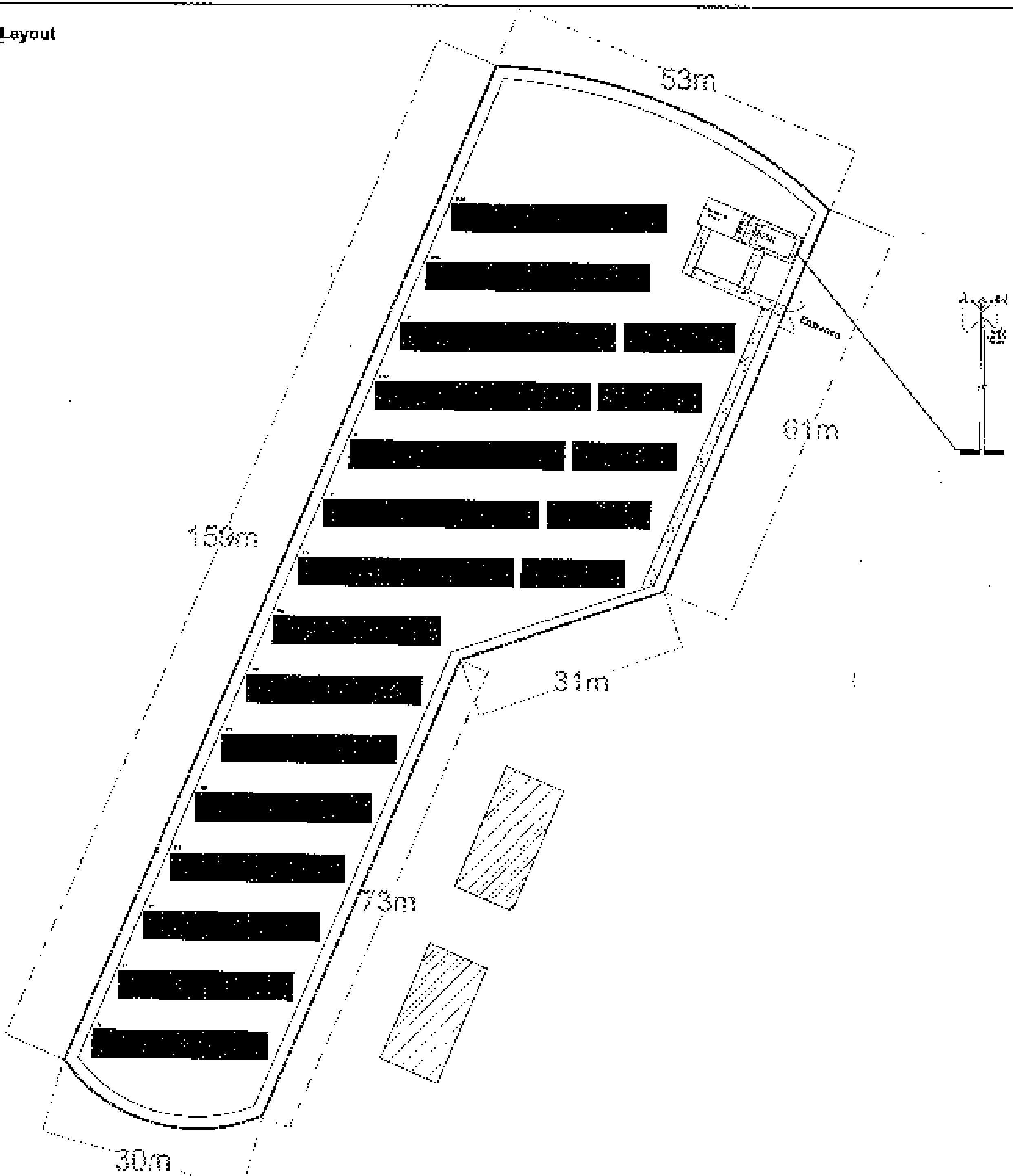
Variability	37.5 MWh
P50	589.8 MWh
P90	541.7 MWh
P99	502.4 MWh

Probability distribution



PV Placement Layout

Scale N.T.S



Notes

ARRAY INFORMATION

PROJECT:

MES Solarization Ph-II

MSG - Lahore

CLIENT:

Military Engineering Services

DEVELOPER:

REV | DESCRIPTION | DATE | DRAWN BY

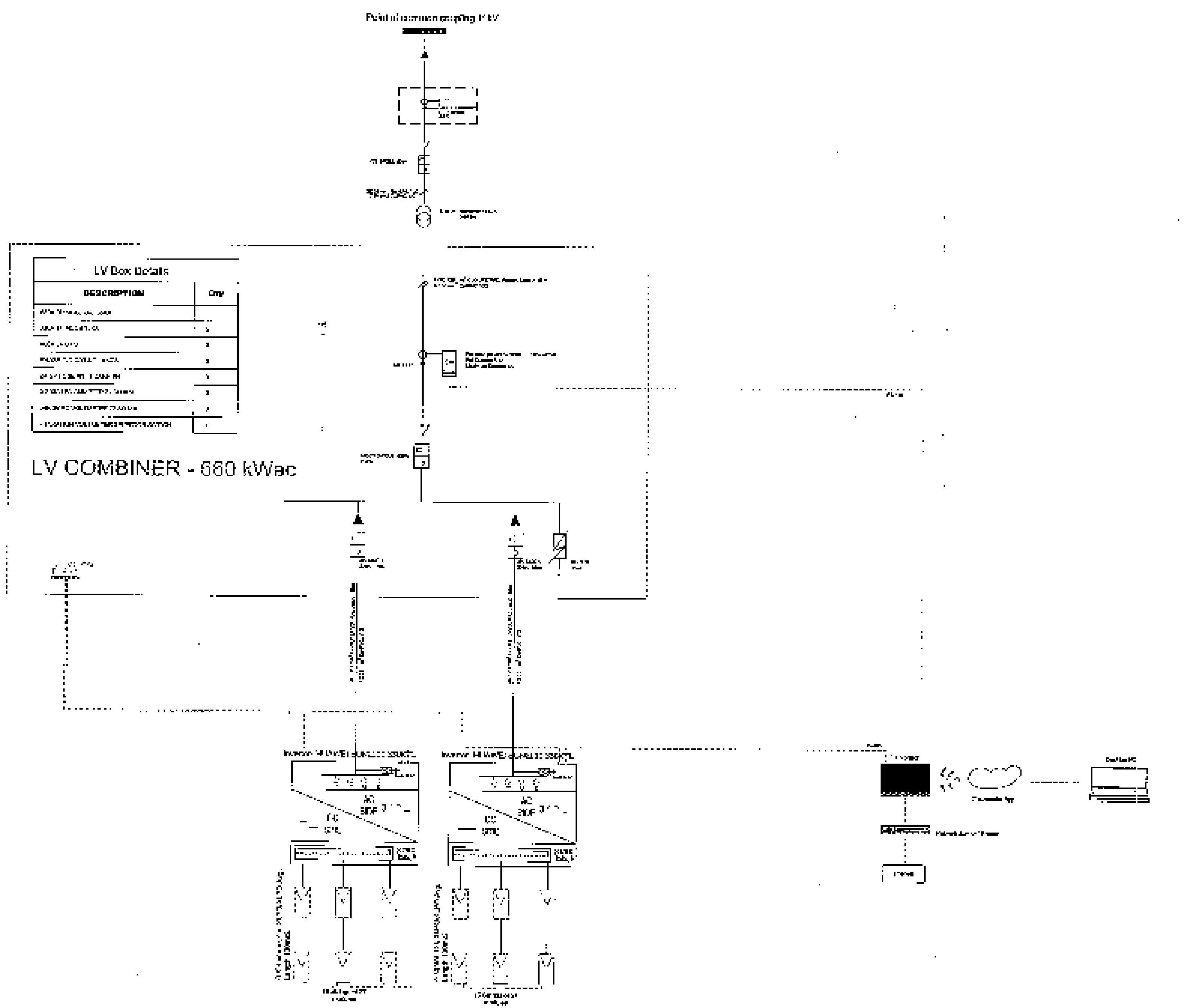
DRAWING:

PV Placement

SCALE: N.T.S | PAPER SIZE: A3 | SHEET: 1/3

DRAWN: | CHECKED: | APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-III
MSG - Lahore

Military Engineering Services

DEVELOPER:

REV | DESCRIPTION | DATE | DRAWN BY

DRAWING: Single Line Diagram

SCALE: N.T.S | PAPER SIZE: A1 | SHEET:

DRAWN: | CHECKED:

Schedule-II - BOQ FOR_0.5_MWp for SITE Name_Lahore Site-4 (MSG)_

Sr Nr	Item	Specifications	Unit	Qty	Model and make	LOCAL/IMPORTED	Country of Origin
SOLAR SYSTEM COMPONENTS							
1	Solar PV Modules (12 years product & 25 years performance warranty)	580Wp Tier-1 Bifacial Mono N Type Technology having efficiency_22.5%	Nr	864	N-type Bifacial 580 w - JA, China	Imported	China
2	Solar PV Inverters (5 years warranty) with Wifi Dongle	330KVA having efficiency of 99.03% with built-in SPD at DC and AC Side	Nr	2	Huawei 330 KTL ; China	Imported	China
3	Datalogger (Five years warranty)	Datalogger for communication	Nr	1	Huawei Smart Logger 3000A ; China	Imported	China
4	Weather sensors set	Weather sensors set (temp, wind, irradiation etc) compatible with the system as per RFP	Set	1	7 sensors - Huawei	Imported	China
5	Solar PV mounting structure as per RFP	Solar PV mounting structure as per RFP complete with Civil and Mechanical work as per drawing approved by consultant.	Job	1	Concrete Pile Structure | 160km/hr | PAKISTAN - General Construction Mechanics	Local	Pakistan
6	Solar PV Cables as per IEC standard 50618 OR IEC 62930 (10 years warranty in case of Local Cable)	Single Core 4mmSq PV Cable tested at 1.5KV withstanding at 120 Degree XLPE/ XLPO insulation must be compliant with IEC standard IEC 62930.2017	Job	1	Pakistan Cables	Local	Pakistan
7	AC Cables from Inverters to KIOSK and then from KIOSK to point of connectivity	Three Core 120 mmSq Cu. AC cable (Inverter to LV) . Three Core MV 95 mmSq Al, AC cable (KIOSK to point of connectivity)	Job	1	Pakistan Cables	Local	Pakistan
8	KIOSK compact station	LV Side Panel 2 x 320A MCCB, 800Volts and 1 x 630A ACB.Transformer 630 kVA. HT Side Panel 630A VCB	Set	1	Tariq Electric	Local	Pakistan
9	Earthing System at DC and AC side seperate with material , drilling upto water level, and labour as per BOQ approved by consultant.	Complete Earthing with pure copper rod. copper electrodes having less than 2 Ohm earth resistance.	Job	1	NRTC ENERGIES	Local	Pakistan
10	Lightening Arrestors	ESE (Early Streamer Emission) Lightening Protection System as per RFP.	Nr	1	CONTRASC CESE LIGHTENING TERMINAL	Imported	Turkey
11	Fencing for protection of Plant	Fencing wall for protection from animals and theft	Job	1	NRTC ENERGIES	Local	Pakistan
12	Control Room	Well-equipped Control room with LED and Furniture	Job	1	Signature Architect	Local	Pakistan
13	SCADA	Scada system for monitoring and Control as per RFP Specifications	Job	1	ICSS	Local	Pakistan
14	Land preparation	Debris removal, cleaning, leveling, paving walkways, foundations, making land ready for SPP.	Job	1	NRTC ENERGIES	Local	Pakistan
15	Energy Meter	2050T	Job	1	MicroStar	Imported	China
16	Studies, approvals and permits	All studies approvals and permits required as per authorities in Pakistan as per laws/directives/SROs	Job	1	NRTC ENERGIES	Local	Pakistan

Annex A-3

Version 7.3.1

PVsyst - Simulation report

Grid-Connected System

Project: Lahore Mes (CMH)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 1001 kWp

Lahore MES (CMH) - Pakistan

Author

PVsyst V7.3.1
VCD, Simulation date:
08/01/24 10:37
with v7.3.1

Project summary

Geographical Site	Situation		Project settings	
Lahore MES (CMH)	Latitude	31.54 °N	Albedo	0.20
Pakistan	Longitude	74.37 °E		
	Altitude	210 m		
	Time zone	UTC+5		

Meteo data
Lahore MES (CMH)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array		Inverters	
Nb. of modules	1726 units	Nb. of units	3 units
Pnom total	1001 kWp	Pnom total	900 kWac
		Pnom ratio	1.112

Results summary

Produced Energy	1201970 kWh/year	Specific production	1201 kWh/kWp/year	Perf. Ratio PR	73.94 %

Table of contents

General parameters

Grid-Connected System | **No 3D scene defined, no shadings**

PV Field Orientation

Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Shade configuration
No 3D scene defined

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	CSI Solar
Model	CS7L-580MB-AG 1500V
(Original PVsyst database)	
Unit Nom. Power	580 Wp
Number of PV modules	1726 units
Nominal (STC)	1001 kWp

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H2
(Custom parameters definition)	
Unit Nom. Power	300 kWac
Number of inverters	3 units
Total power	900 kWac

Array #1 - PV Array

Number of PV modules	868 units	Number of inverters	8 * MPPT 17% 1.3 unit
Nominal (STC)	503 kWp	Total power	400 kWac
Modules	31 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	463 kWp	Max. power (=>30°C)	330 kWac
U mpp	854 V	Pnom ratio (DC:AC)	1.26
I mpp	542 A	No Power sharing between MPPTs	

Array #2 - Sub-array #2

Number of PV modules	858 units	Number of inverters	10 * MPPT 17% 1.7 units
Nominal (STC)	498 kWp	Total power	500 kWac
Modules	33 Strings x 26 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	457 kWp	Max. power (=>30°C)	330 kWac
U mpp	793 V	Pnom ratio (DC:AC)	1.00
I mpp	577 A	No Power sharing between MPPTs	

Total PV power

Nominal (STC)	1001 kWp
Total	1726 modules
Module area	4885 m²

Total Inverter power

Total power	900 kWac
Number of inverters	3 units
Pnom ratio	1.11
No Power sharing	

Array losses

Array Soiling Losses
Loss Fraction 4.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Array losses

Strings Mismatch loss

Loss Fraction	0.1 %

Module average degradation

Year no	10
Loss factor	0.4 %/year

Mismatch due to degradation

Imp RMS dispersion	0.4 %/year
Vmp RMS dispersion	0.4 %/year

IAM loss factor

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

DC wiring losses

Global wiring resistance	10 mΩ
Loss Fraction	1.5 % at STC

Array #1 - PV Array

Global array res.	26 mΩ
Loss Fraction	1.5 % at STC

Array #2 - Sub-array #2

Global array res.	23 mΩ
Loss Fraction	1.5 % at STC

System losses

Unavailability of the system

Time fraction	3.4 %
	12.4 days,
	3 periods

Auxiliaries loss

Proportionnal to Power	6.0 W/kW
0.0 kW from Power thresh.	
Night aux. cons.	500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.08 % at STC

Inverter: SUN2000-330KTL-H2

Wire section (1 Inv.)	Alu 1 x 3 x 240 mm²
Wires length	20 m

Inverter: SUN2000-330KTL-H2

Wire section (2 Inv.)	Alu 2 x 3 x 150 mm²
Average wires length	0 m

MV line up to injection

MV Voltage	11 kV
Wires	Alu 3 x 120 mm²
Length	100 m
Loss Fraction	0.02 % at STC

AC losses in transformers

MV transfo

Medium voltage	11 kV

Transformer from Datasheets

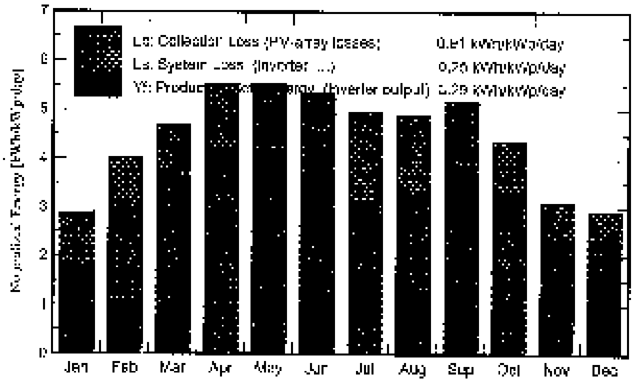
Nominal power	1250 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.08 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	1.60 % at PNom
Coils equivalent resistance	3 x 8.19 mΩ

Main results

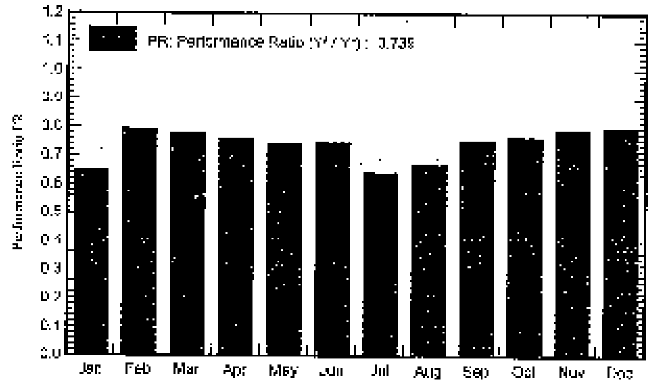
System Production

Produced Energy (P50)	1201970 kWh/year	Specific production (P50)	1201 kWh/kWp/year	Performance Ratio PR	73.94 %
Produced Energy (P90)	1103932 kWh/year	Produced Energy (P90)	1103 kWh/kWp/year		
Produced Energy (P99)	1024030 kWh/year	Produced Energy (P99)	1023 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	PR ratio
January	69.8	43.8	11.97	89.2	84.1	75051	0.848
February	91.5	47.0	16.08	112.8	106.6	93022	0.793
March	130.8	77.5	22.10	145.7	137.2	117704	0.779
April	160.2	87.6	27.05	165.9	156.2	130724	0.760
May	176.0	99.4	33.10	171.5	161.5	132088	0.742
June	169.5	102.6	33.05	160.2	150.7	124093	0.747
July	160.6	102.3	31.57	153.2	144.1	119855	0.641
August	151.4	85.3	30.79	151.6	142.7	118810	0.675
September	141.5	71.5	29.07	154.5	145.6	121017	0.755
October	115.7	69.5	26.00	135.2	127.6	107744	0.768
November	76.5	52.0	19.07	93.4	88.0	76644	0.788
December	68.5	41.9	13.92	90.7	85.5	75726	0.801
Year	1511.9	890.5	24.52	1623.8	1529.9	1292479	0.739

Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	PR	Performance Ratio
T_Amb	Ambient Temperature		
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

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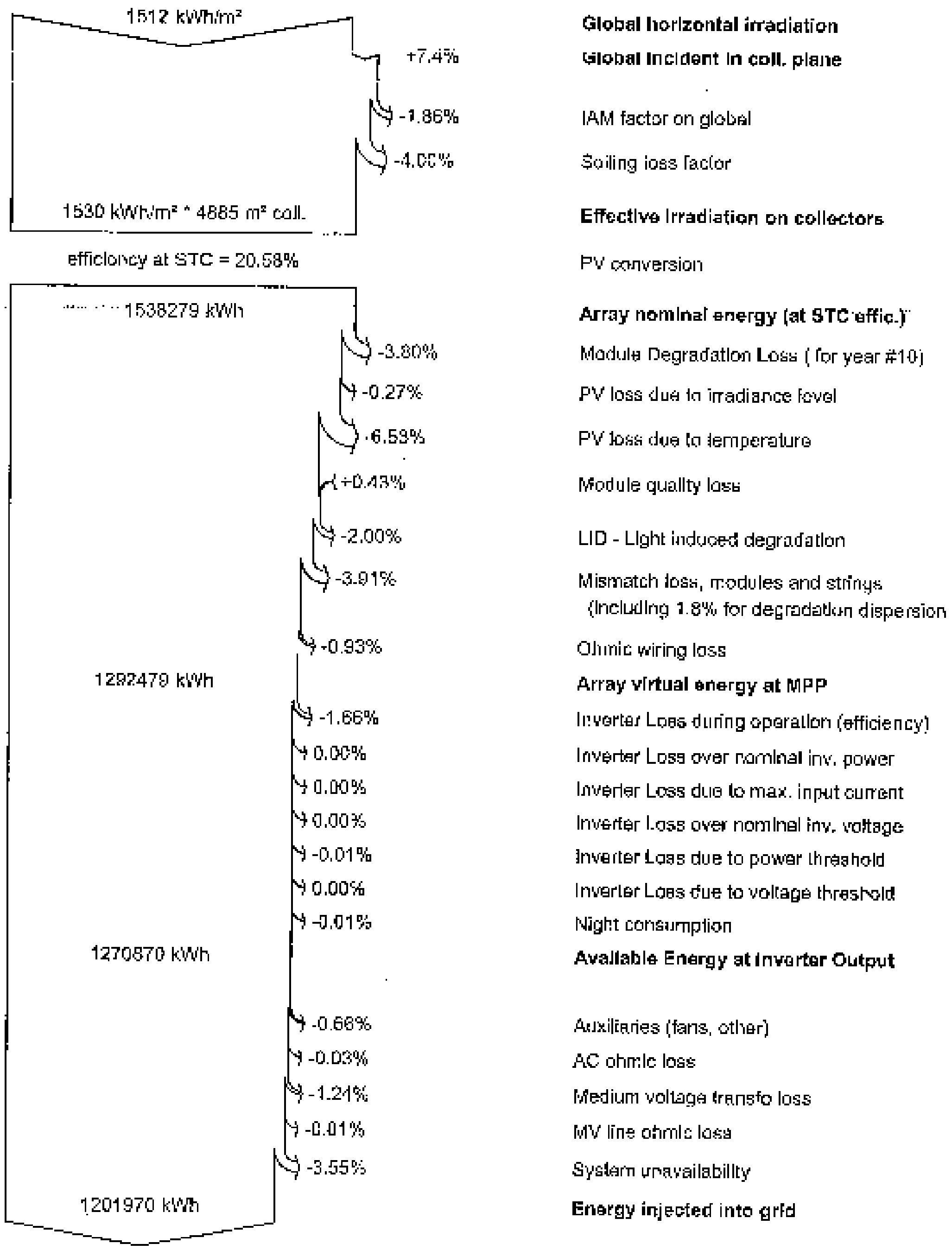
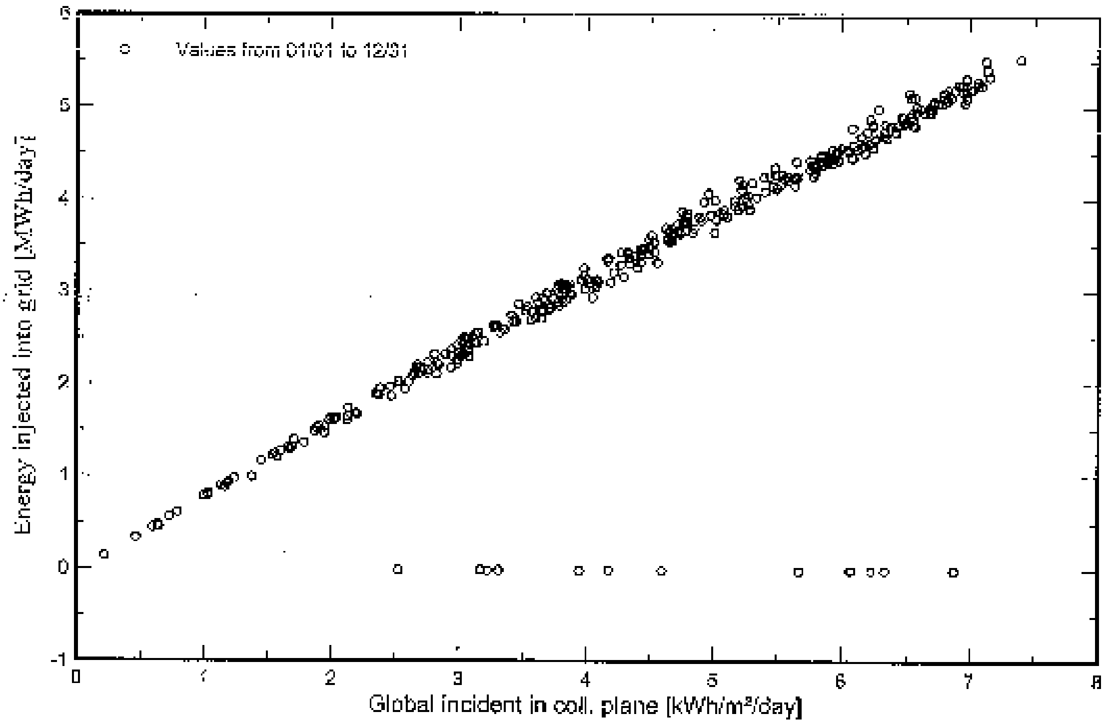
Loss diagram

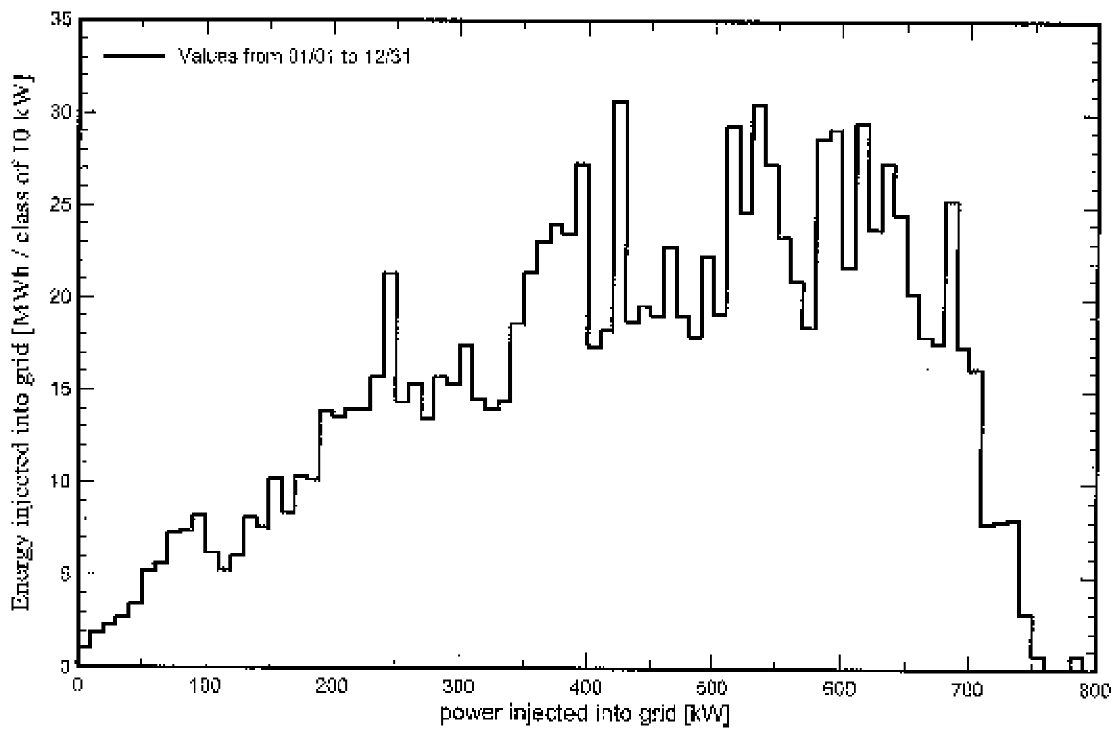


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%	
Kind	Monthly averages	
Synthetic - Multi-year average		
Year-to-year variability(Variance)		6.1 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	6.4 %

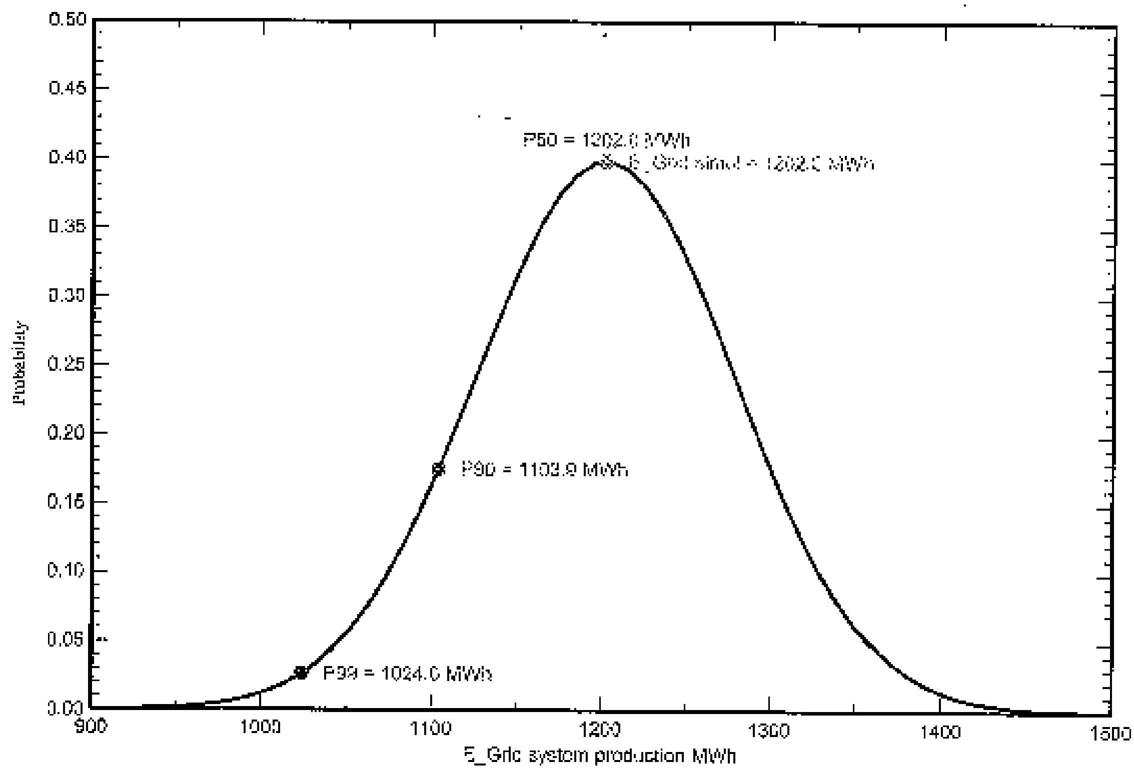
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

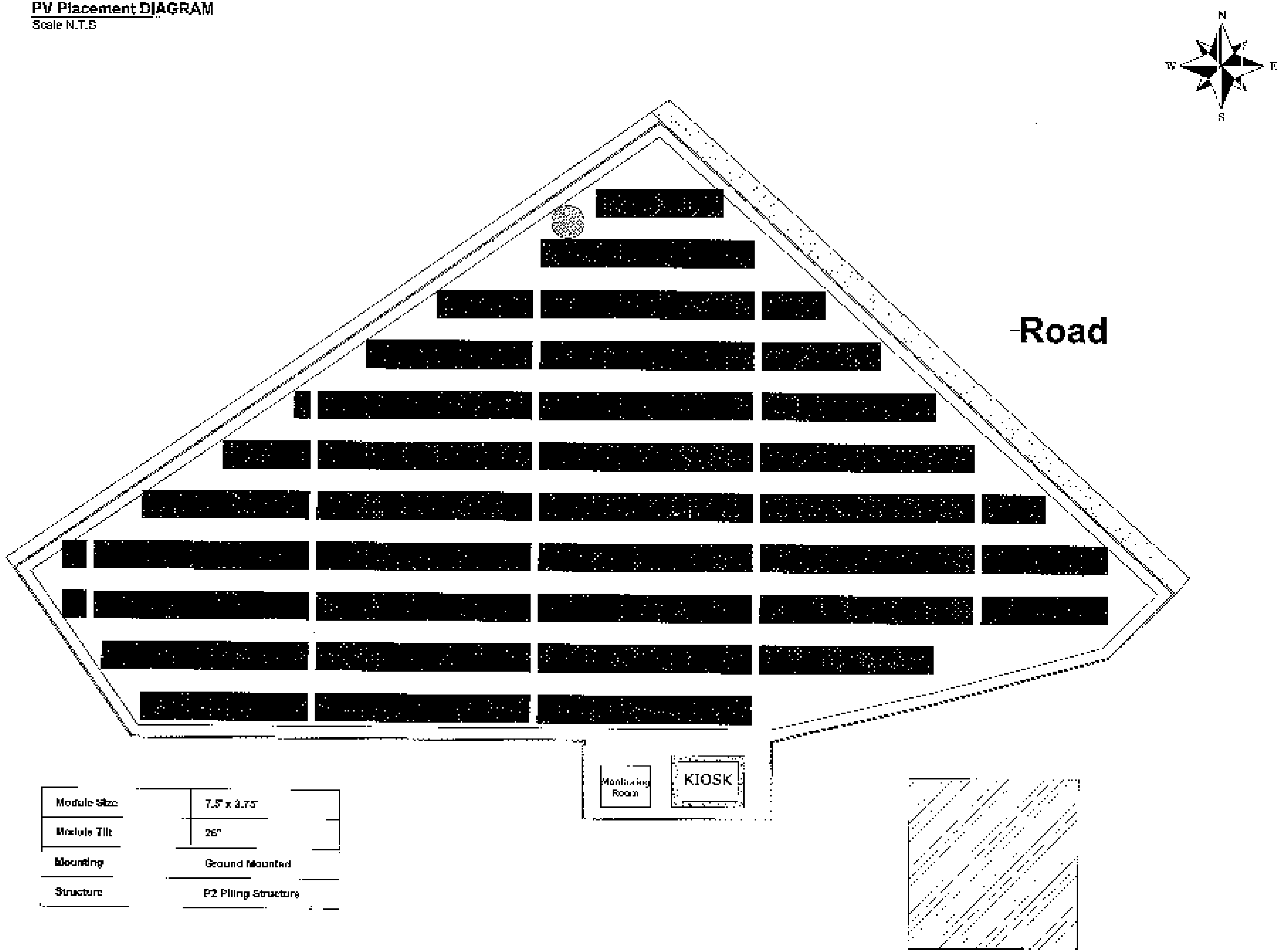
Annual production probability

Variability	76.5 MWh
P50	1202.0 MWh
P90	1103.9 MWh
P99	1024.0 MWh

Probability distribution



PV Placement DIAGRAM
Scale N.T.S



Module Size	7.5' x 3.75'
Module Tilt	26°
Mounting	Ground Mounted
Structure	P2 Piling Structure

SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-II
CMH - Lahore

CLIENT: Military Engineering Services

DEVELOPER:

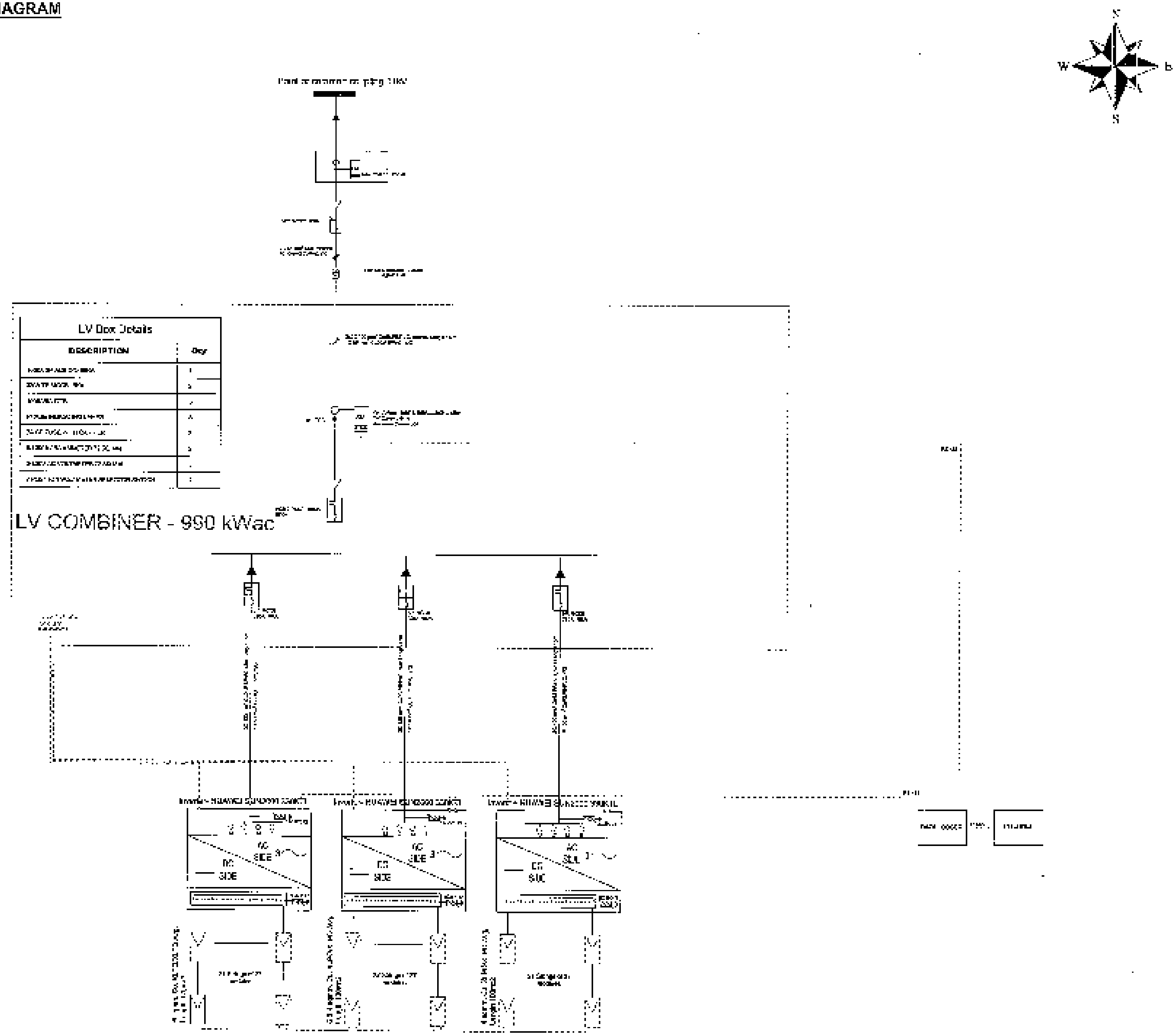
REV | DESCRIPTION | DATE | DRAWN BY

DRAWING: SINGLE LINE DIAGRAM

SCALE: N.T.S | WASH SIZE: A3 | SHEET:

DRAWN: | CHECKED: | APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT: MES Solarization P-III
CMH - Lahore

CLIENT: Military Engineering Services

DEVELOPER:

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REV | DESCRIPTION | DATE | DRAWN BY

DRAWING: SINGLE LINE DIAGRAM

SCALE: N.T.S | PAPER SIZE | SHEET

DRAWN: | CHECKED: | APPROVED:

Schedule-II- BOQ FOR_1_MWp for SITE Name_Lahore Site-1 (CMH)

Sr No	Item	Specifications	Unit	Qty	Model and make	LOCAL/IMPORTED	Country of Origin
SOLAR SYSTEM COMPONENTS							
1	Solar PV Modules (12 years product & 25 years performance warranty)	580Wp Tier-1 Bifacial Mono N Type Technology having efficiency_22.5%	Nr	1726	N-type Bifacial 580 w - JA; China	Imported	China
2	Solar PV Inverters 10 years warranty) with Wifi Dongle	330KVA having efficiency of 99.02% with built-in SPD at DC and AC Side	Nr	3	Huawei 330 KTL ; China	Imported	China
3	Datalogger (Five years warranty)	Datalogger for communication	Nr	1	Huawei Smart Logger 3000A ; China	Imported	China
4	Weather sensors etc.	Weather sensors set (temp, wind, irradiation etc) compatible with the system as per RFP	Set	1	7 sensors : Huawei	Imported	China
5	Solar PV mounting structure as per RFP	Solar PV mounting structure as per RFP complete with Civil and Mechanical work as per drawing approved by consultant	Job	1	Concrete Pile Structure | 150kwvar | PAKISTAN	General Construction Mechanics	Pakistan
6	Solar PV Cables as per IEC standard 50618 OR IEC 62930 (10 years warranty in case of Local Cable)	Single Core 4mmSq PV Cable tested at 1.5KV withstanding at 120 Degree XLPE/ XLPO insulation must be compliant with IEC standard IEC 62930:2017	Job	1	Pakistan Cables	Local	Pakistan
7	AC Cables from Inverters to KIOSK and then from KIOSK to point of connectivity	Three Core 120 mmSq Cu AC cable(Inverter to LV); Three Core MV 95 mmSq Al, AC cable (KIOSK to point of connectivity)	Job	1	Pakistan Cables	Local	Pakistan
8	KIOSK conduct station	LV Side Panel 3 x 320A MCCB, 800Volts and 1 x 1000A ACB,Transformer 1.25 MVA, HT Side Panel 630A VCB	Set	1	Tariq Electric	Local	Pakistan
9	Earthing Sytem at DC and AC side separate with material , drilling upto water level, and labour as per BOQ approved by consultant.	Complete Earthing with pure copper rod, copper electrodes having less than 5 Ohm earth resistance	Job	1	NRTC ENERGIES	Local	Pakistan
10	Lightening Arrestors	ESE (Early Streamer Emission) Lightening Protection System as per RFP	Nr	2	CONTRASC CESE LIGHTENING TERMINAL	Imported	Turkey
11	Fencing for protection of Plant	Fencing wall for protection from animals and theft	Job	1	NRTC ENERGIES	Local	Pakistan
12	Control Room	Well-equipped Control room with LED and Furniture	Job	1	Signature Architect	Local	Pakistan
13	SCADA	Scada system for monitoring and Control as per RFP Specifications	Job	1	ICSS	Local	Pakistan
14	Land preparation	Debris removal, clearing, leveling, paving, walkways foundations, making land ready for SPP	Job	1	NRTC ENERGIES	Local	Pakistan
15	Energy Meter	2000T	Job	1	Microstar	Imported	China
16	Studies, approvals and permits	All studies approvals and permits required as per authorities in Pakistan as per law/directives/SROs	Job	1	NRTC ENERGIES	Local	Pakistan

Annex A-4

Version 7.3.1

PVSYST
PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: Lahore MES (Akram Line)

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 501 kWp

Lahore Mes (Akram Line) - Pakistan

Author

PVsyst V7.3.1
VC0, Simulation date:
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with v7.3.1

Project summary

Geographical Site
Lahore Mes (Akram Line)
Pakistan

Situation

Latitude	31.53 °N
Longitude	74.39 °E
Altitude	217 m
Time zone	UTC+5

Project settings

Albedo	0.20

Meteo data
Lahore Mes (Akram Line)
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	864 units
Pnom total	501 kWp

Inverters

Nb. of units	2 units
Pnom total	600 kWac
Pnom ratio	0.835

Results summary

Produced Energy	595529 kWh/year	Specific production	1189 kWh/kWp/year	Perf. Ratio PR	72.86 %

Table of contents

General parameters

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation

Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Sheds configuration
No 3D scene defined

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	CSI Solar
Model	CS7L-580MB-AG 1500V
(Original PVsyst database)	
Unit Nom. Power	580 Wp
Number of PV modules	864 units
Nominal (STC)	501 kWp
Modules	27 Strings x 32 In series
At operating cond. (50°C)	
Pmpp	460 kWp
U mpp	976 V
I mpp	472 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H2
(Custom parameters definition)	
Unit Nom. Power	300 kWac
Number of inverters	2 units
Total power	600 kWac
Operating voltage	500-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	0.84
Power sharing within this inverter	

Total PV power

Nominal (STC)	501 kWp
Total	864 modules
Module area	2445 m²

Total inverter power

Total power	600 kWac
Number of inverters	2 units
Pnom ratio	0.84

Array losses

Array Soiling Losses
Loss Fraction 4.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 34 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

System losses

Unavailability of the system

Time fraction	3.4 %
	12.4 days,
	3 periods

Auxiliaries loss

Proportionnal to Power	5.0 W/kW
0.0 kW from Power thresh.	
Night aux. cons.	500 W

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	800 Vac tri
Loss Fraction	0.10 % at STC
Inverter: SUN2000-330KTL-H2	
Wire section (2 Inv.)	Alu 2 x 3 x 240 mm²
Average wires length	20 m

MV line up to injection

MV Voltage	11 kV
Wires	Alu 3 x 95 mm²
Length	100 m
Loss Fraction	0.01 % at STC

AC losses in transformers

MV transfo

Medium voltage	11 kV
Transformer from Datasheets	
Nominal power	630 kVA
Iron Loss (24/24 Connexion)	1.00 kVA
Iron loss fraction	0.16 % of PNom
Copper loss	20.00 kVA
Copper loss fraction	3.17 % at PNom
Coils equivalent resistance	3 x 32.25 mΩ

PVsyst V7.3.1
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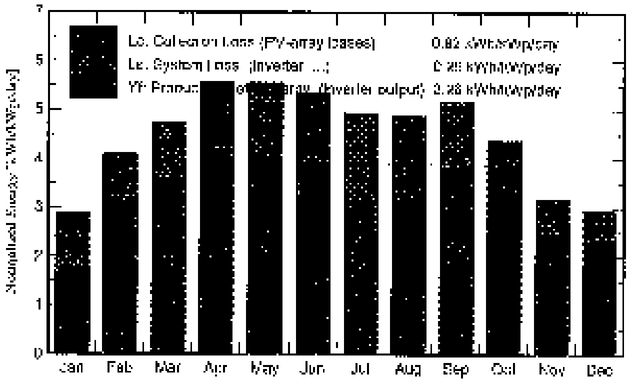
Main results

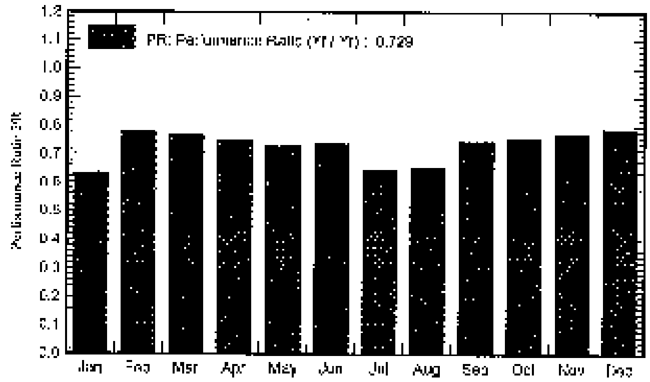
System Production

Produced Energy (P50)	595529 kWh/year	Specific production (P50)	1188 kWh/kWp/year	Performance Ratio PR	72.85 %
Produced Energy (P90)	546955 kWh/year	Produced Energy (P90)	1091 kWh/kWp/year		
Produced Energy (P99)	507367 kWh/year	Produced Energy (P99)	1012 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	69.8	43.8	11.37	89.2	84.1	37528	28371	0.635
February	92.5	46.5	15.69	114.4	108.1	47087	44653	0.779
March	131.6	77.3	21.71	146.8	138.3	59241	56368	0.766
April	161.0	87.2	26.85	166.8	157.1	65640	62526	0.748
May	176.7	99.0	32.94	172.2	162.2	66243	63090	0.731
June	169.5	105.7	32.79	160.3	150.8	62018	59076	0.736
July	160.5	106.1	31.24	153.2	144.0	59825	49633	0.647
August	151.1	95.5	30.47	150.9	142.0	59213	49407	0.653
September	141.8	74.6	28.75	154.3	145.4	60574	57618	0.745
October	116.2	71.3	25.59	135.5	127.9	54007	51303	0.756
November	77.2	50.6	18.59	95.9	90.4	39371	37208	0.774
December	69.1	42.5	13.44	91.7	86.5	38375	36218	0.788
Year	1517.3	899.2	24.16	1631.1	1536.7	649223	595529	0.729

Legends

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

PVsyst V7.3.1
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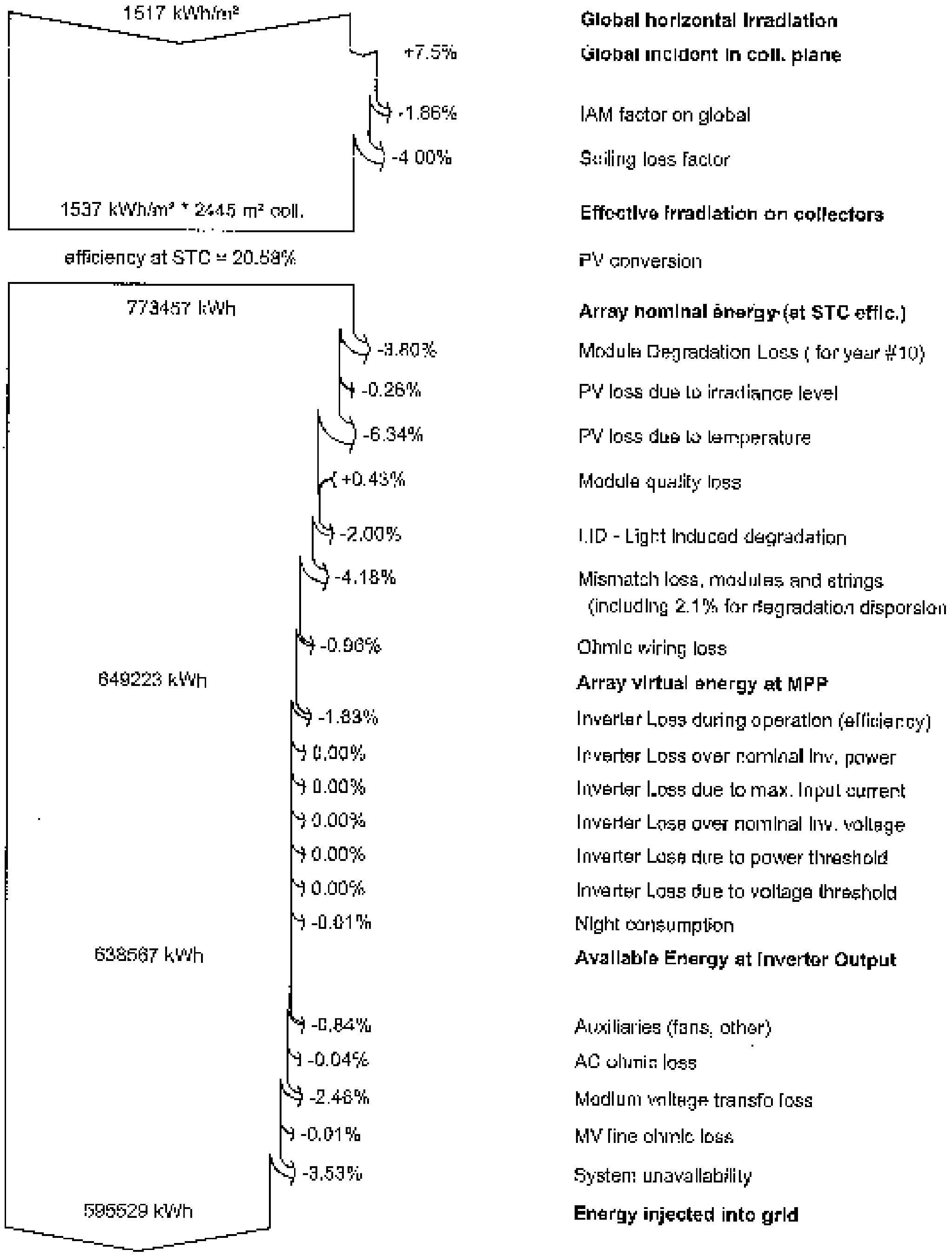
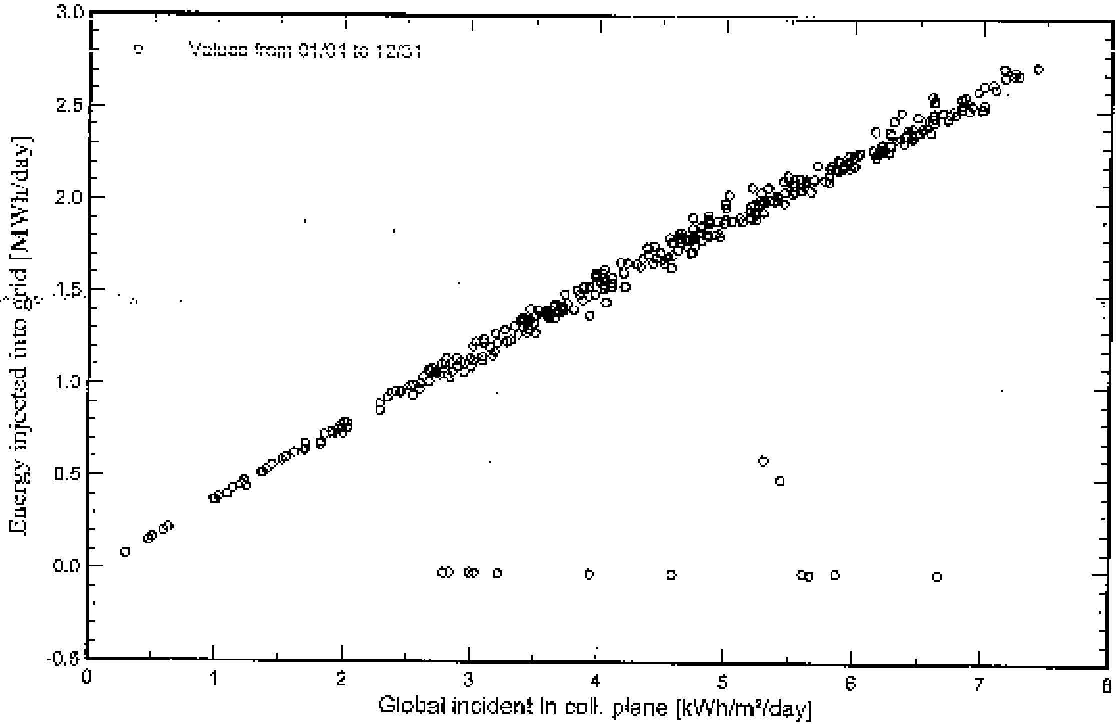
Loss diagram

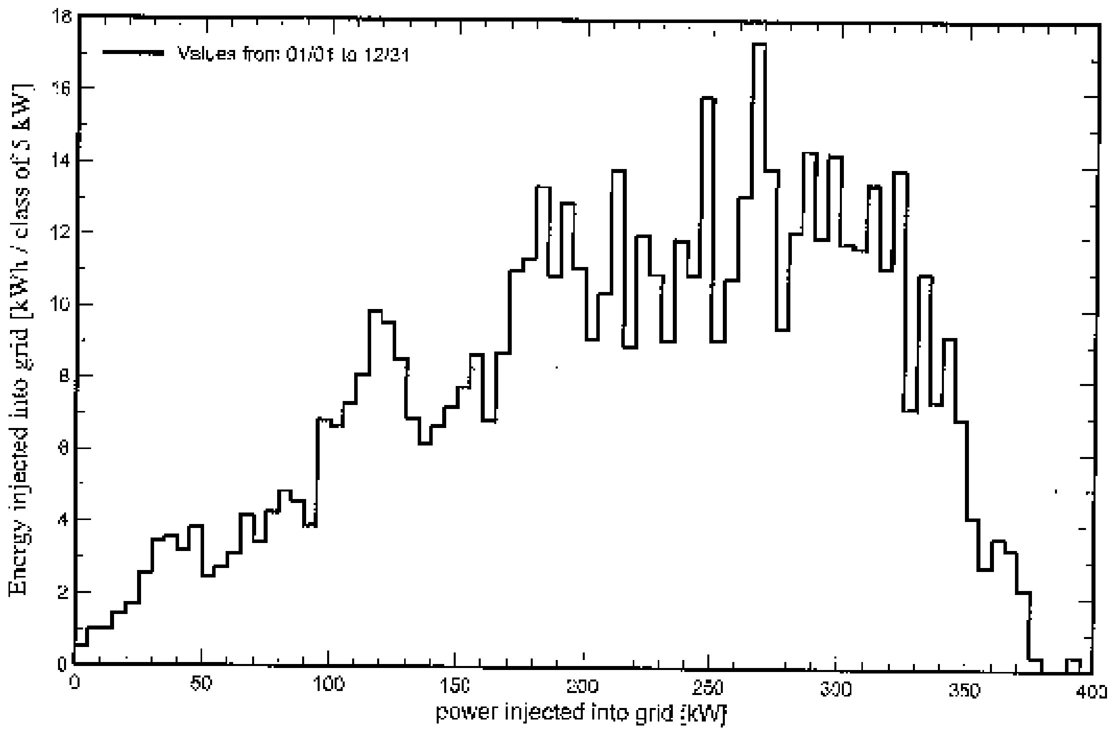


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	6.1 %
Specified Deviation	
Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	6.4 %

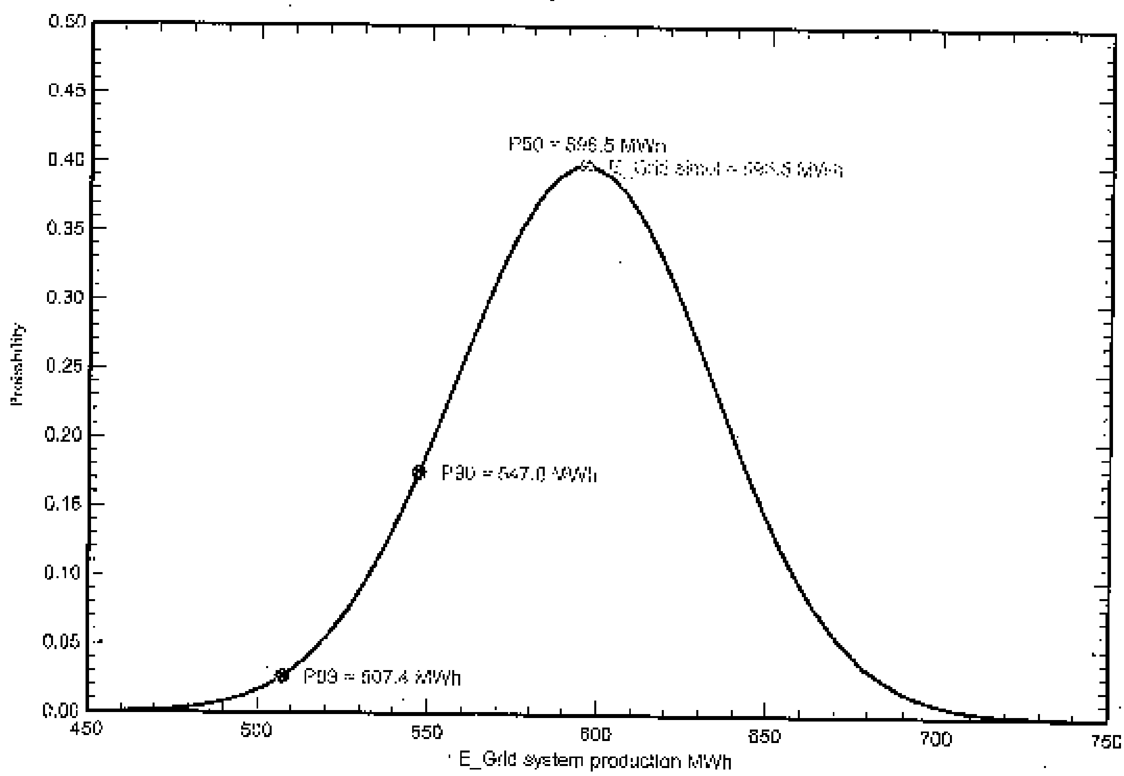
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

Annual production probability

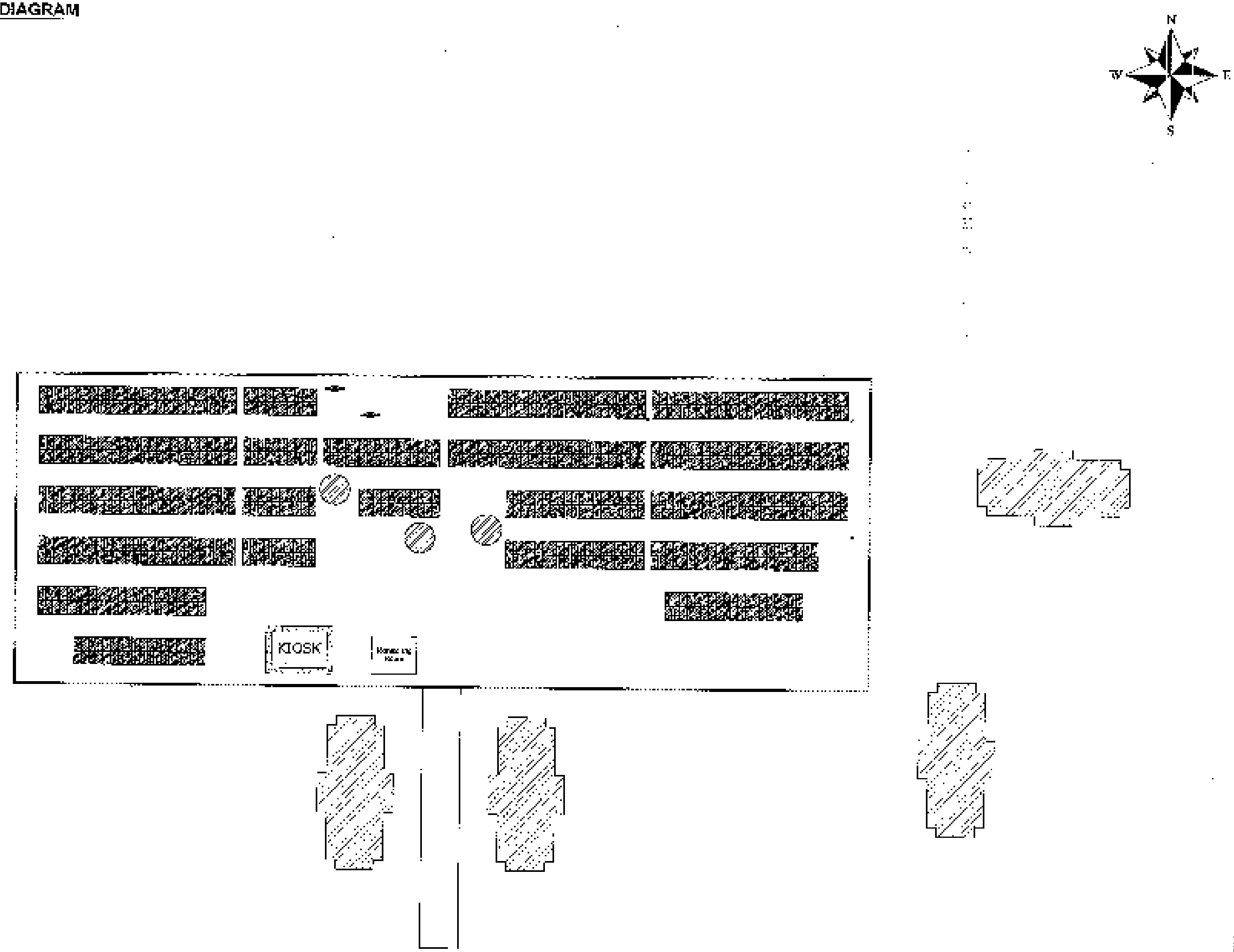
Variability	37.9 MWh
P50	595.5 MWh
P90	547.0 MWh
P99	507.4 MWh

Probability distribution



PV Placement DIAGRAM

Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:

MES Solarization P-III

New Akram Lines - Lahore

CLIENT:

Military Engineering Services

DEVELOPER:

REV | DESCRIPTION | DATE | DRAWN BY

DRAWING:

SINGLE LINE DIAGRAM

SCALE: N.T.S

PAPER SIZE: A3

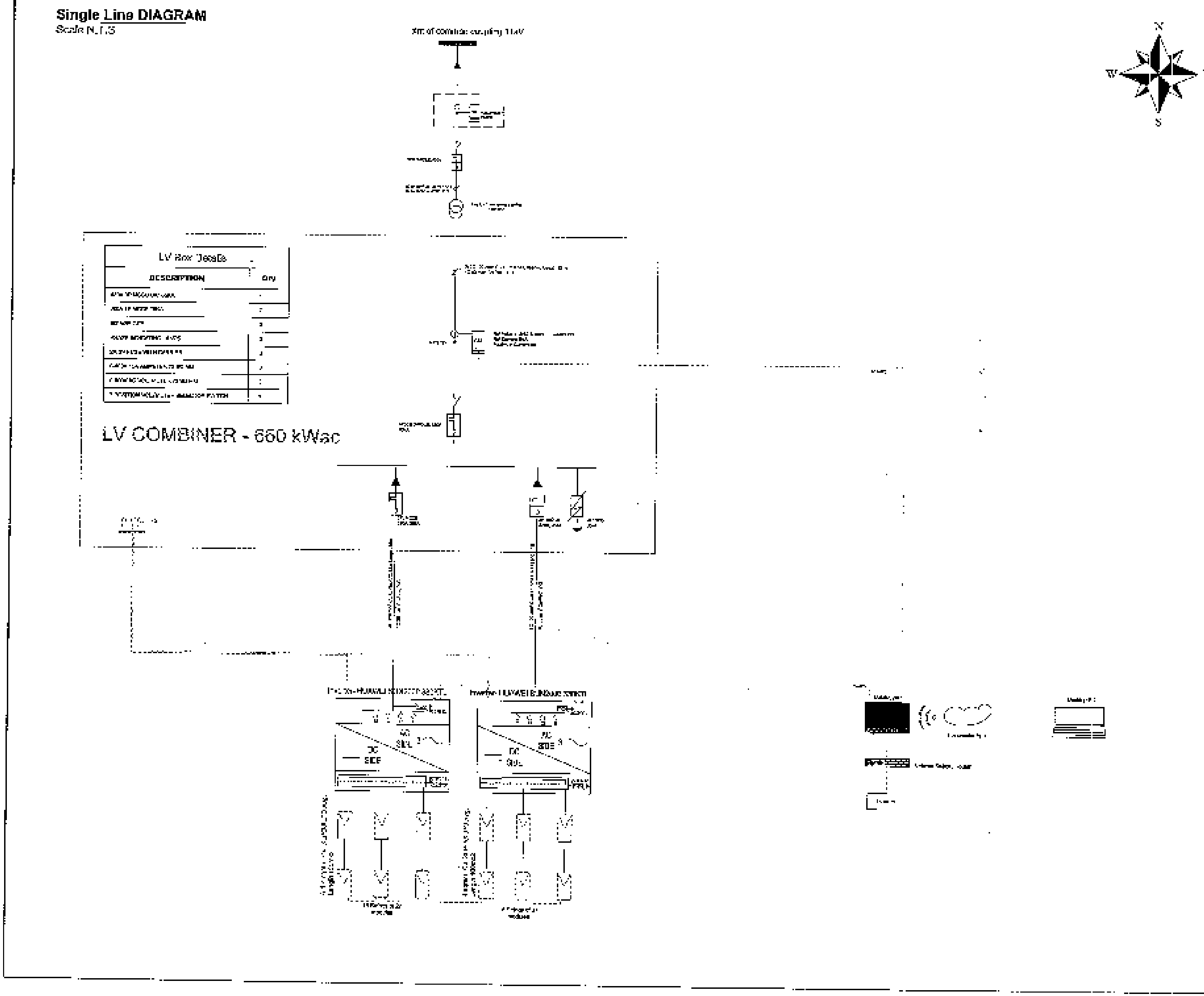
SHEET: 1/2

DRAWN:

CHECKED:

Single Line DIAGRAM

Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:

MES Solarization P-III

New Akram Lines - Lahore

CLIENT:

Military Engineering Services

DEVELOPER:

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REV	DESCRIPTION	DATE	CHECKED BY

DRAWING:

SINGLE LINE DIAGRAM

SCALE: N.T.S

PAPER SIZE: A1

SHEET: 1/3

DRAWN:

CHECKED:

APPROVED:

Schdule-II - BOQ FOR_0.5_MWp for SITE Name_Lahore Site-2 (New Akram Line)_

Sr Nr	Item	Specifications	Unit	Qty	Model and make	LOCAL/IMPORTED	Country of Origin
			SOLAR SYSTEM COMPONENTS				
1	Solar PV Modules (12 years product & 25 years performance warranty)	580Wp Tier-1 Bifacial Mono N Type Technology having efficiency_22.5%	Nr	864	N-type Bifacial 580 w - JA China	Imported	China
2	Solar PV Inverters (5 years warranty) with Wifi Dongle	330KVA having efficiency of 99.03% with built-in SPD at DC and AC Side	Nr	2	Huawei 330 KTL China	Imported	China
3	Datalogger (Five years warranty)	Datalogger for communication	Nr	[illegible]	Huawei Smart Logger 3000A ; China	Imported	China
4	Weather sensors set	Weather sensors set (temp, wind, irradiation etc) compatible with the system as per RFP	Set	1	7 sensors : Huawei	Imported	China
5	Solar PV mounting structure as per RFP	Solar PV mounting structure as per RFP complete with Civil and Mechanical work as per drawing approved by consultant.	Job	1	Concrete Pile structure | 150km/h | PAKISTAN- General Construction Mechanics	General Construction Mechanics	Pakistan
6	Solar PV Cables as per IEC standard 60216 OR IEC 62930 (10 years warranty in case of Local Cable)	Single Core 4mmSq PV Cable tested at 1.5KV withstanding at 120 Degree XLPE/XLPO Insulation must be compliant with IEC standard IEC 62930-2017	Job	[illegible]	Pakistan Cables	Local	Pakistan
7	AC Cables from Inverters to KIOSK and then from KIOSK to point of connectivity	Three Core 120 mmSq Cu AC cable(Inverter to LV) Three Core MV 95 mmSq Al, AC cable (KIOSK to point of connectivity)	Job	1	Pakistan Cables	Local	Pakistan
8	KIOSK compact station	LV Side Panel 2 x 320A MCCB, 800Volts and 1 x 630A ACB Transformer 630 KVA, HT Side Panel 630A VCB	Set	1	Tariq Electric	Local	Pakistan
9	Earthing System at DC and AC side separate with material, drilling upto water level, and labour as per BOQ approved by consultant	Complete Earthing with pure copper rod, copper electrodes having less than 3 Ohm earth resistance.	Job	1	NRTC ENERGIES	Local	Pakistan
10	Lightening Arrestors	ESE (Early Streamer Emission) Lightening Protection System as per RFP.	Nr	1	CONTRA60 CESE LIGHTENING TERMINAL	Imported	Turkey
11	Fencing for protection of Plant	Fencing wall for protection from animals and theft	Job	1	NRTC ENERGIES	Local	Pakistan
12	Control Room	Well-equipped Control room with LED and Furniture	Job	1	Signature Architect	Local	Pakistan
13	SCADA	Scada system for monitoring and Control as per RFP Specifications	Job	[illegible]	ICSS	Local	Pakistan
14	Land preparation	Debris removal, cleaning, leveling, paving, walkways, foundations, making land ready for SPP.	Job	1	NRTC ENERGIES	Local	Pakistan
15	Energy Meter	3G/4G	Job	1	MicroStar	Imported	China
16	Studies, approvals and permits	All studies approvals and permits required as per authorities in Pakistan as per law/directives/SROs.	Job	1	NRTC ENERGIES	Local	Pakistan

Annex A-5

Version 7.3.1

PVsyst - Simulation report

Grid-Connected System

Project: Okara MES

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 1001 kWp

Okara MES - Pakistan

Author

Project summary

Geographical Site
Okara MES
Pakistan

Situation

Latitude	30.75 °N
Longitude	73.35 °E
Altitude	170 m
Time zone	UTC+5

Project settings

Albedo	0.20

Meteo data
Okara MES
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 10

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 26 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	1726 units
Pnom total	1001 kWp

Inverters

Nb. of units	3 units
Pnom total	900 kWac
Pnom ratio	1.112

Results summary

Produced Energy	1353019 kWh/year	Specific production	1352 kWh/kWp/year	Perf. Ratio PR	78.68 %

Table of contents

PVsyst V7.3.1
VC0, Simulation date:
01/08/24 17:58
with v7.3.1

General parameters

Grid-Connected System | **No 3D scene defined, no shadings**

PV Field Orientation

Orientation		Sheds configuration	Models used	
Fixed plane		No 3D scene defined	Transposition	Perez
Tilt/Azimuth	26 / 0 °		Diffuse	Perez, Meteonorm
			Circumsolar	separate

Horizon	Near Shadings	User's needs
Free Horizon	No Shadings	Unlimited load (grid)

PV Array Characteristics

PV module		Inverter	
Manufacturer	CSI Solar	Manufacturer	Huawei Technologies
Model	CS7L-580MB-AG 1500V	Model	SUN2000-330KTL-H2
(Original PVsyst database)		(Custom parameters definition)	
Unit Nom. Power	580 Wp	Unit Nom. Power	300 kWac
Number of PV modules	1726 units	Number of inverters	3 units
Nominal (STC)	1001 kWp	Total power	900 kWac
Array #1 - PV Array			
Number of PV modules	868 units	Number of inverters	9 * MPPT 17% 1.5 units
Nominal (STC)	503 kWp	Total power	450 kWac
Modules	31 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	463 kWp	Max. power (=>30°C)	330 kWac
U mpp	854 V	Pnom ratio (DC:AC)	1.12
I mpp	542 A	No Power sharing between MPPTs	
Array #2 - Sub-array #2			
Number of PV modules	858 units	Number of inverters	9 * MPPT 17% 1.5 units
Nominal (STC)	498 kWp	Total power	450 kWac
Modules	33 Strings x 26 In series		
At operating cond. (50°C)		Operating voltage	500-1500 V
Pmpp	457 kWp	Max. power (=>30°C)	330 kWac
U mpp	793 V	Pnom ratio (DC:AC)	1.11
I mpp	577 A	No Power sharing between MPPTs	
Total PV power		**Total inverter power**	
Nominal (STC)	1001 kWp	Total power	900 kWac
Total	1726 modules	Number of inverters	3 units
Module area	4885 m²	Pnom ratio	1.11
		No Power sharing	

Array losses

Array Soiling Losses		Thermal Loss factor		Serie Diode Loss	
Loss Fraction	2.0 %	Module temperature according to irradiance		Voltage drop	0.7 V
		Uc (const)	29.0 W/m²K	Loss Fraction	0.1 % at STC
		Uv (wind)	0.0 W/m²K/m/s		

LID - Light Induced Degradation		Module Quality Loss		Module mismatch losses	
Loss Fraction	2.0 %	Loss Fraction	-0.4 %	Loss Fraction	2.0 % at MPP

Array losses

Strings Mismatch loss

Loss Fraction 0.1 %

Module average degradation

Year no 10

Loss factor 0.4 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

IAM loss factor

Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

DC wiring losses

Global wiring resistance 10 mΩ

Loss Fraction 1.5 % at STC

Array #1 - PV Array

Global array res. 28 mΩ

Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2

Global array res. 23 mΩ

Loss Fraction 1.5 % at STC

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 800 Vac tri

Loss Fraction 0.03 % at STC

Inverter: SUN2000-330KTL-H2

Wire section (2 Inv.) Alu 2 x 3 x 240 mm²

Average wires length 10 m

Inverter: SUN2000-330KTL-H2

Wire section (2 Inv.) Alu 2 x 3 x 150 mm²

Average wires length 0 m

MV line up to Injection

MV Voltage 11 kV

Wires Alu 3 x 120 mm²

Length 392 m

Loss Fraction 0.08 % at STC

AC losses in transformers

MV transfo

Medium voltage 11 kV

Transformer from Datasheets

Nominal power 1250 kVA

Iron Loss (24/24 Connexion) 1.00 kVA

Iron loss fraction 0.08 % of PNom

Copper loss 2.00 kVA

Copper loss fraction 0.16 % at PNom

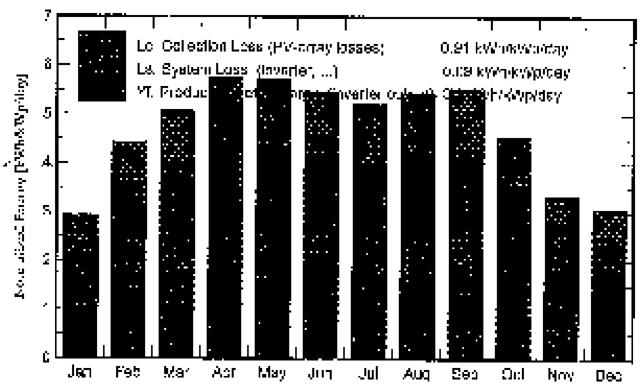
Coils equivalent resistance 3 x 0.82 mΩ

Main results

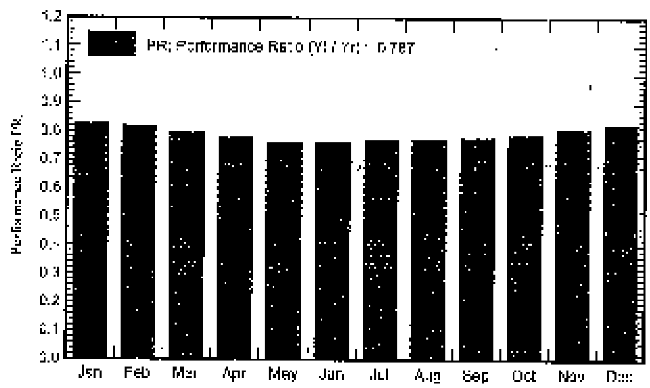
System Production

Produced Energy (P50) 1353019 kWh/year | Specific production (P50) 1352 kWh/kWp/year | Performance Ratio PR 78.68 %
Produced Energy (P90) 1267301 kWh/year | Produced Energy (P90) 1266 kWh/kWp/year
Produced Energy (P99) 1197439 kWh/year | Produced Energy (P99) 1196 kWh/kWp/year

Normalized productions (per installed kWp)



Performance Ratio PR



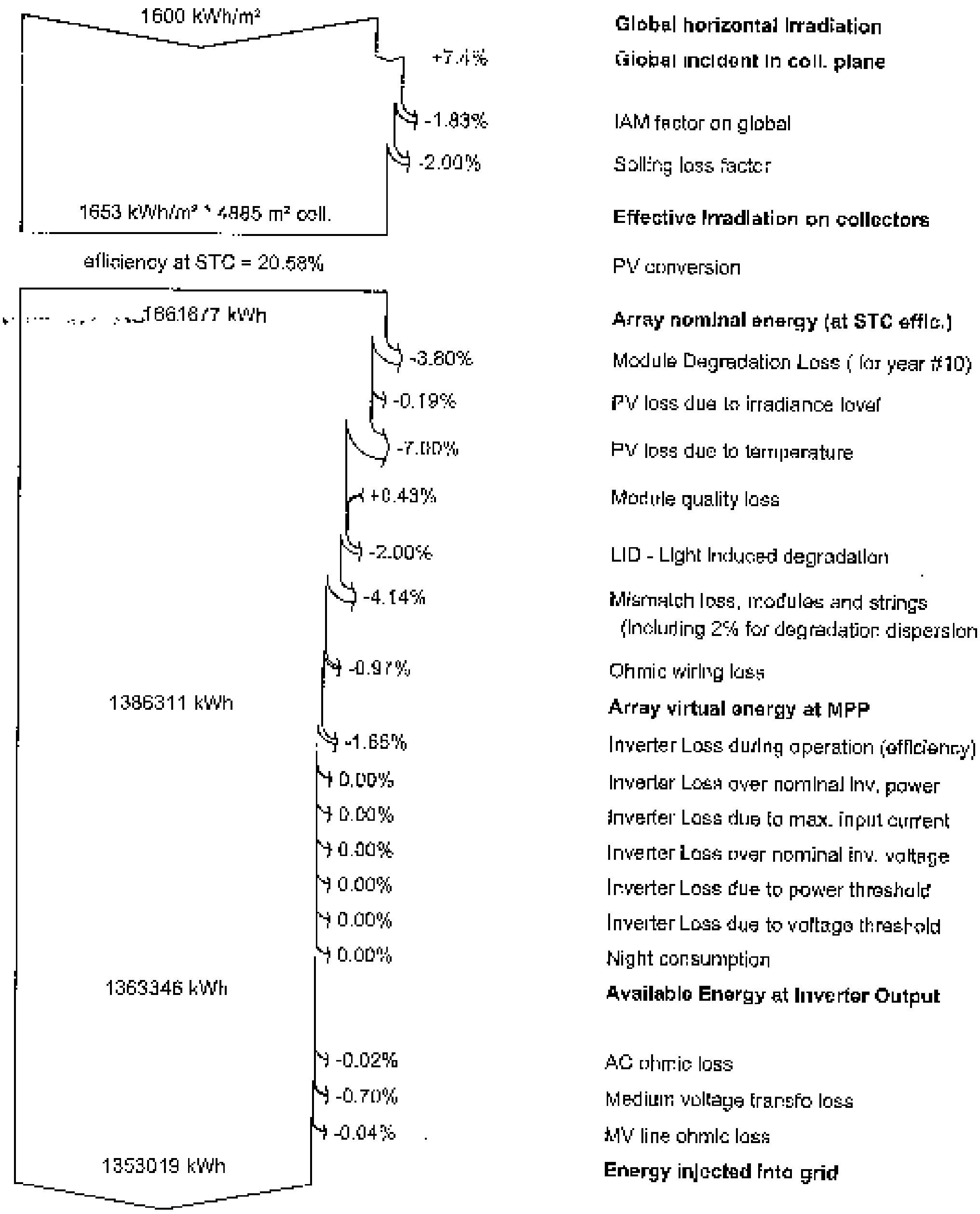
Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	kWh	kWh	ratio
January	72.0	44.1	12.67	90.8	87.4	77537	75382	0.830
February	100.5	52.8	16.58	123.9	119.5	104112	101593	0.819
March	139.6	76.4	22.74	156.9	151.2	128386	125384	0.798
April	166.7	89.5	28.19	172.4	165.8	137437	134293	0.778
May	183.4	101.2	33.85	177.8	170.9	138844	135639	0.762
June	173.7	107.9	34.21	163.3	156.8	128088	125087	0.765
July	170.9	104.8	33.08	162.4	156.0	128382	125359	0.771
August	168.5	99.0	31.92	168.6	162.1	133754	130648	0.774
September	152.3	78.4	29.90	166.1	159.8	132403	129346	0.778
October	120.0	68.2	26.94	141.0	135.9	113872	111127	0.788
November	80.9	52.4	20.30	100.1	96.3	83178	80993	0.809
December	71.7	44.1	14.94	94.6	91.1	80339	78167	0.825
Year	1600.1	919.0	25.49	1717.7	1652.6	1386311	1353019	0.787

Legends

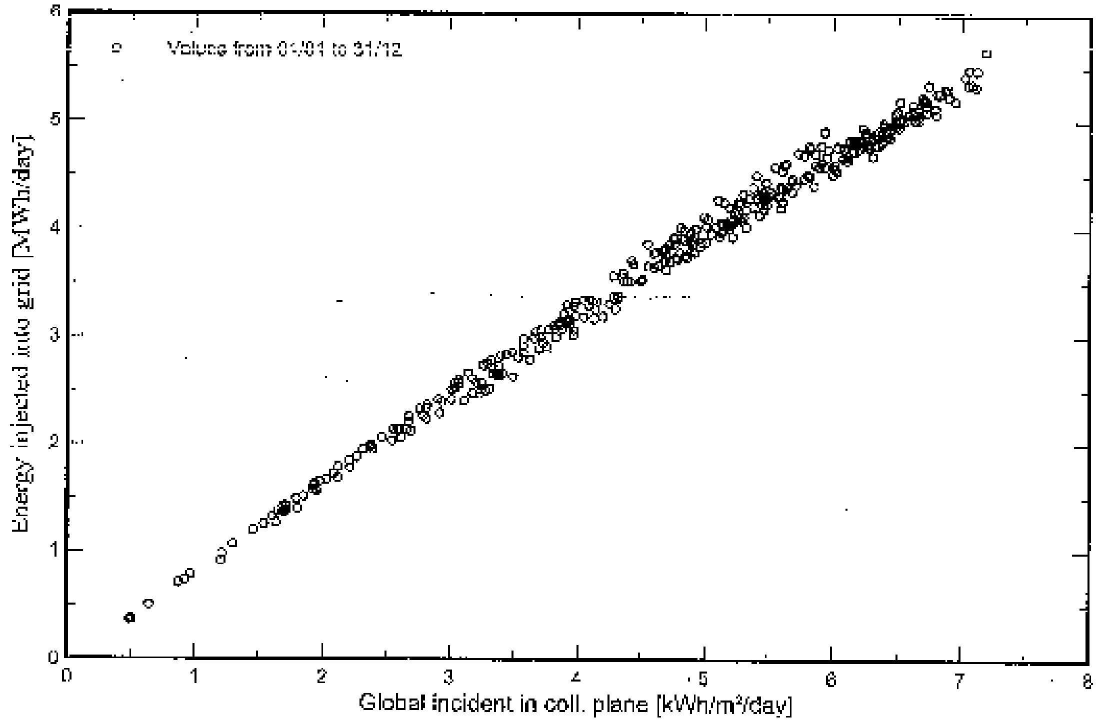
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

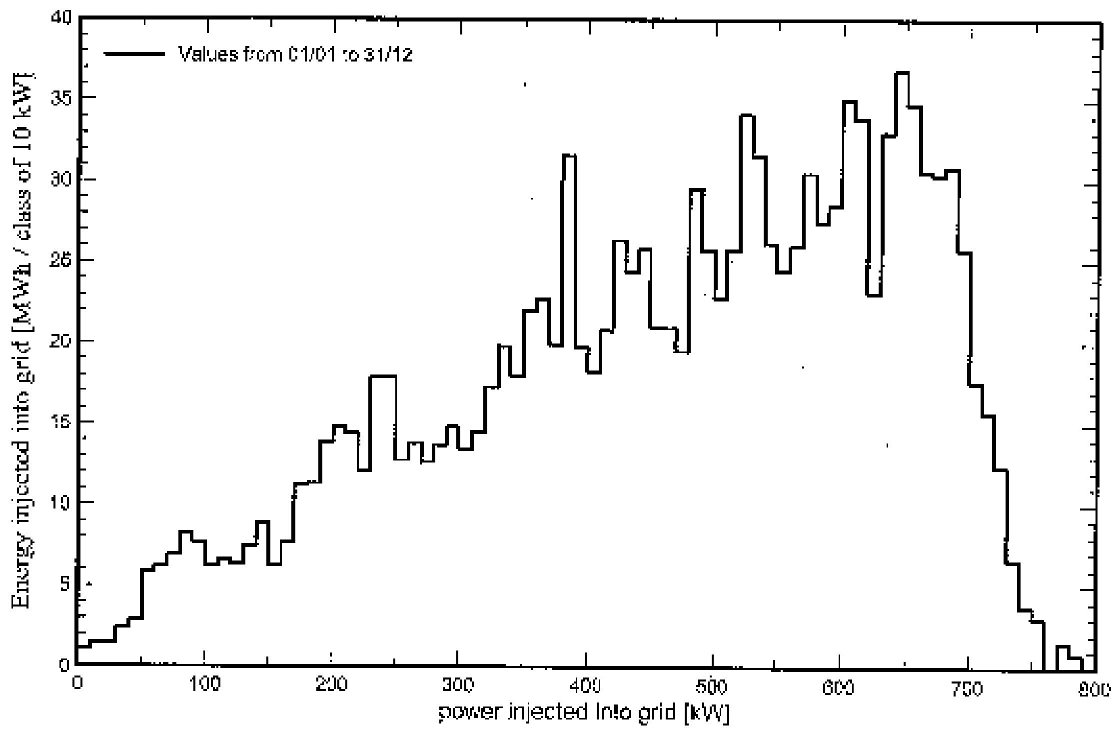


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



PVsyst V7.3.1
VC0, Simulation date:
01/08/24 17:58
with v7.3.1

P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%	
Kind	Monthly averages	
Synthetic - Multi-year average		
Year-to-year variability(Variance)		4.6 %
Specified Deviation		
Climate change		0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.9 %

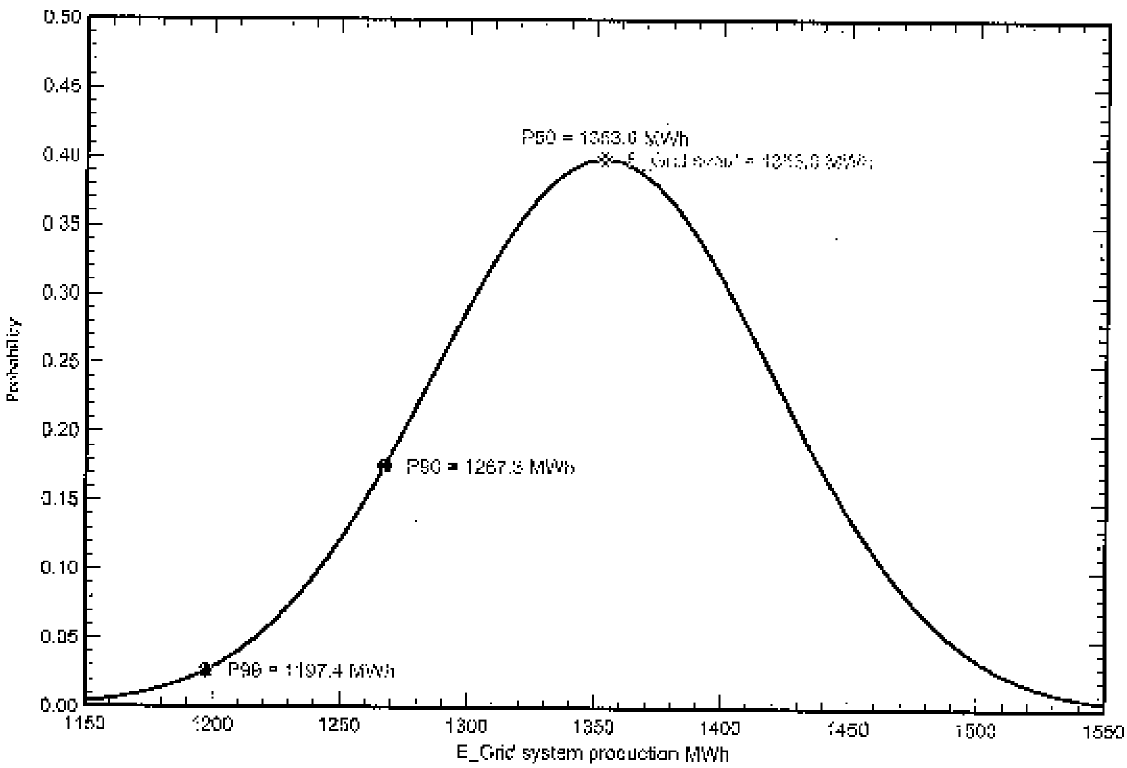
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

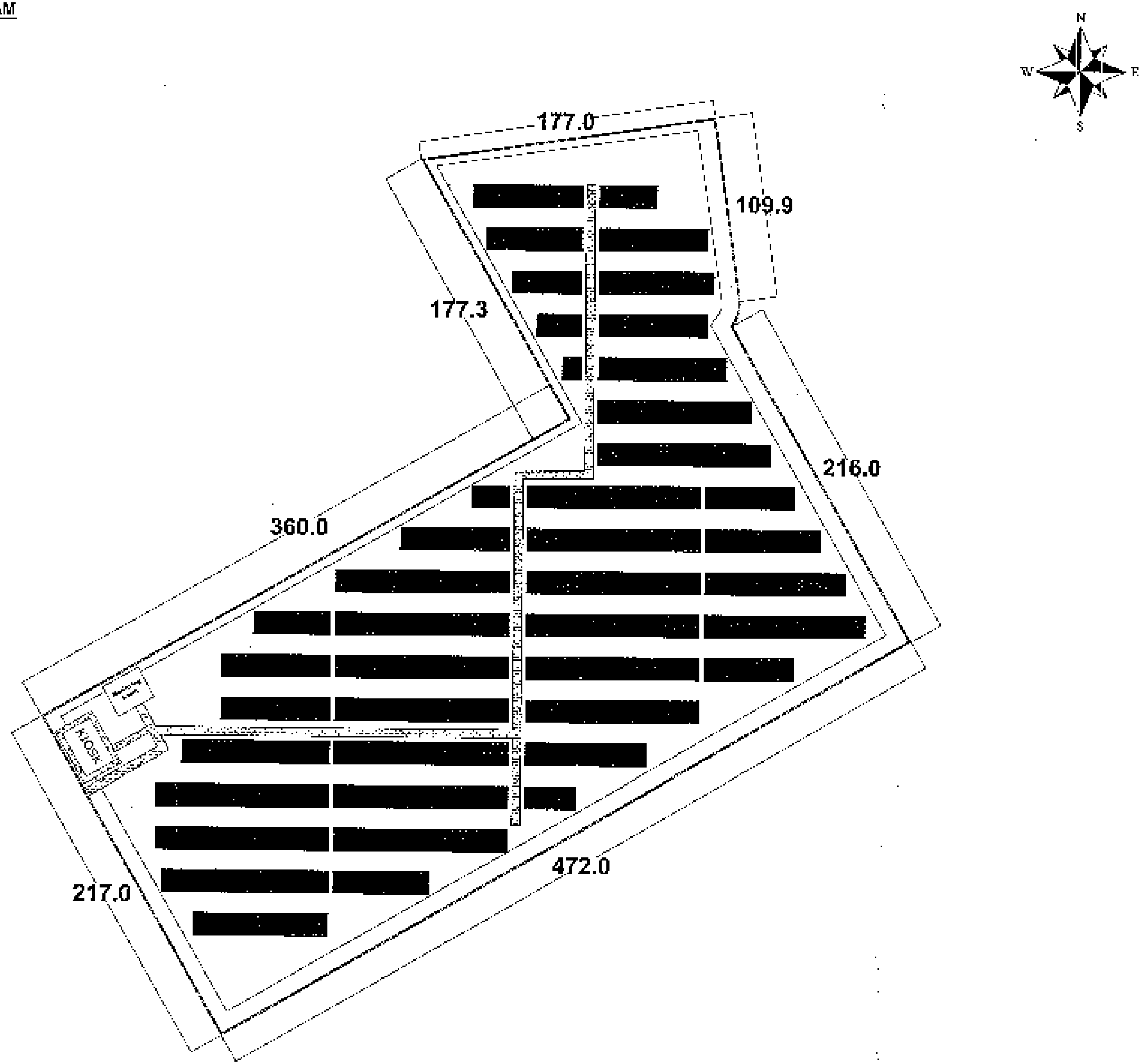
Annual production probability

Variability	66.8 MWh
P50	1353.0 MWh
P90	1267.3 MWh
P99	1197.4 MWh

Probability distribution



PV Placement DIAGRAM
Scale N.T.S



SITE LOCATION

GENERAL NOTES

Notes

ARRAY INFORMATION

PROJECT:
MES Solarization P-III
Okara Cantt

CLIENT:
Military Engineering Services

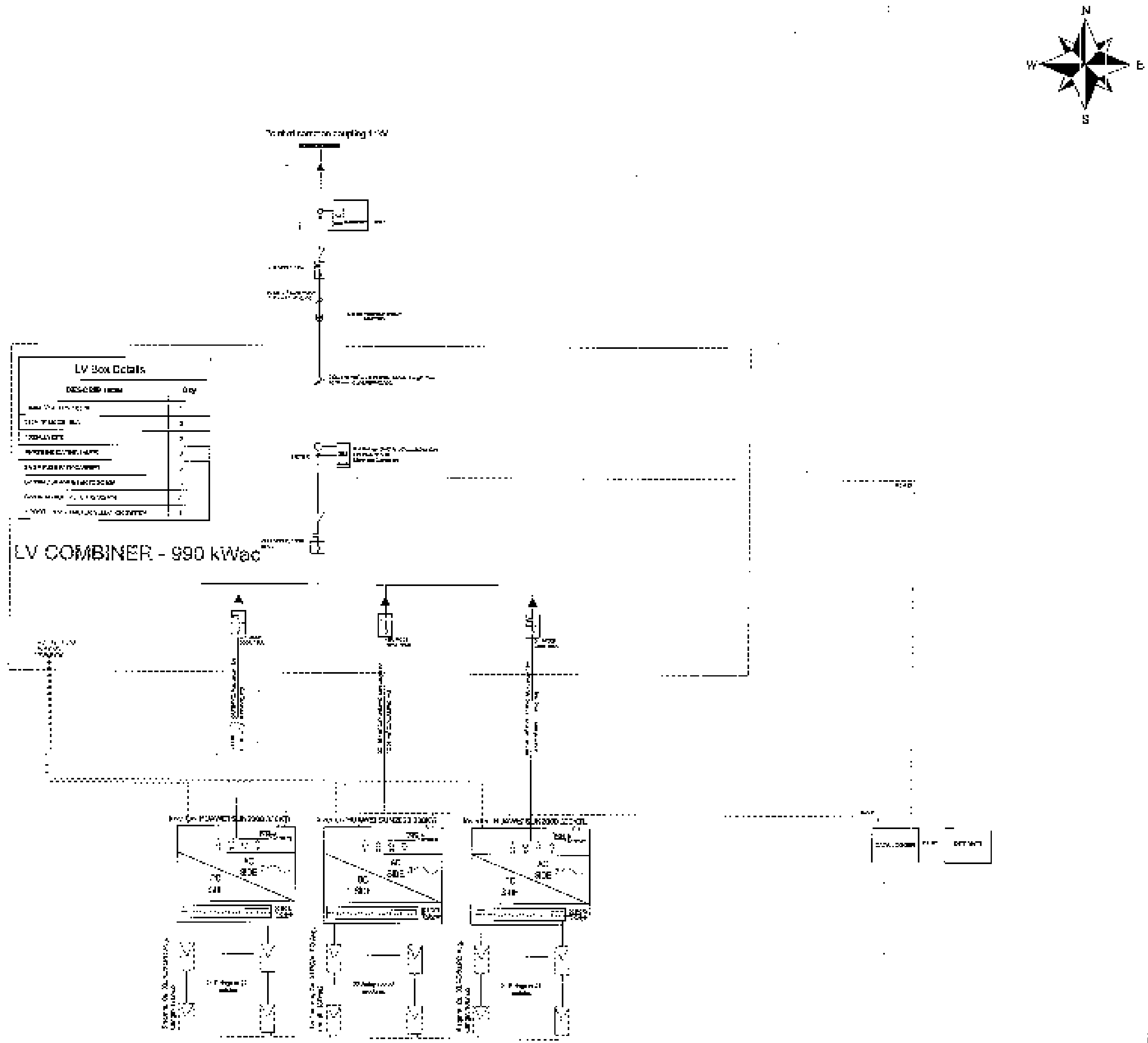
DEVELOPER:

REV	DESCRIPTION	DATE	DRAWN BY
	Preliminary Submission		

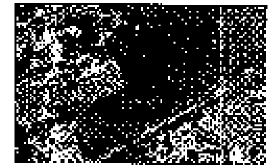
DRAWING:
SINGLE LINE DIAGRAM

SCALE: N.T.S	PAPER SIZE: A3	SHEET 1/3
DRAWN:	CHECKED:	APPROVED:

Single Line DIAGRAM
Scale N.T.S



SITE LOCATION



GENERAL NOTES

Notes

Solar PV Module

ACB / VCB

Contactor

ARRAY INFORMATION

Array

PROJECT:

MES Solarization P-III

Okara Cantt

CLIENT:

Military Engineering Services

DEVELOPER:

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REV	DESCRIPTION	DATE	DRAWN BY

DRAWING:

SINGLE LINE DIAGRAM

SCALE: N.T.S

SHEET:

DRAWN:

CHECKED:

APPROVED:

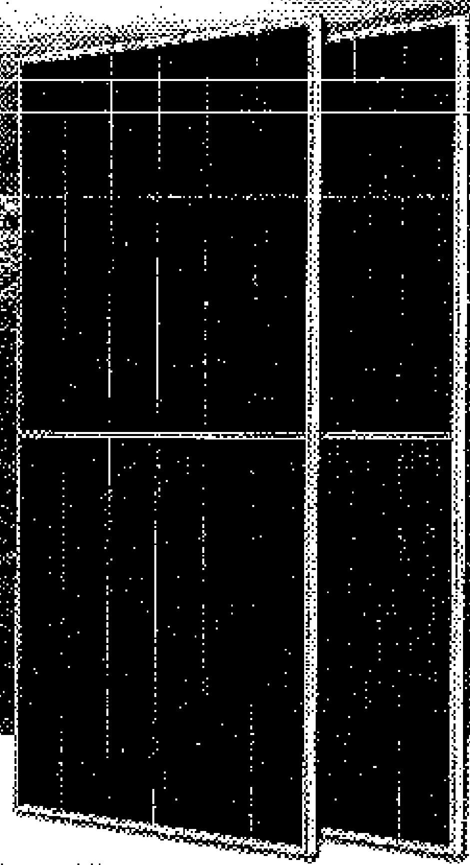
Schedule - II - BOQ FOR_1_MWp for SITE Name_Okara_

Sr Nr.	Name	Specifications	Unit	Qty	Model and make	LOCAL/IMPORTED	Country of Origin
SOLAR SYSTEM COMPONENTS							
1	Solar PV Modules (12 years product & 25 years performance warranty)	530Wp Tier-1 Bifacial Mono N Type Technology having efficiency_22.5%	Nr	1726	N-type Bifacial 530 - JA, China	Imported	China
2	Solar PV Inverters (5 years warranty) with Wifi Dongle	330kVA having efficiency of 99.03% with built-in SPD at DC and AC Side	Nr	3	Huawei 330 kTL ; China	Imported	China
3	Datalogger (Five years warranty)	Datalogger for communication	Nr	1	Huawei Smart Logger 3000A ; China	Imported	China
4	Weather sensors set	Weather sensors set (temp, wind, irradiation etc) compatible with the system as per RFP	Set	1	7 sensors ; Huawei	Imported	China
5	Solar PV mounting structure as per RFP	Solar PV mounting structure as per RFP complete with Civil and Mechanical work as per drawing approved by consultant.	Job	1	Concrete Pile Structure | 150km/hr | PAKISTAN - General Construction Mechanics	Local	Pakistan
6	Solar PV Cables as per IEC standard 50618 OR IEC 62930 (10 years warranty in case of Local Cable)	Single Core 4mmSq PV Cable tested at 1.5KV withstanding at 120 Degree XLPE/XLPO insulation must be compliant with IEC standard IEC 62930:2017	Job	1	Pakistan Cables	Local	Pakistan
7	AC Cables from Inverters to KIOSK and then from KIOSK to point of connectivity	Three Core 120 mmSq Cu AC cable(Inverter to LV) Three Core MV 95 mmSq AL AC cable (KIOSK to point of connectivity)	Job	1	Pakistan Cables	Local	Pakistan
8	KIOSK compact station	LV Side Panel 3 x 320A MCCB, 800volts and 1 x 1000A ACB Transformer 1.25 MVA, HT Side Panel 630A VCB	Set	1	Tariq Electric	Local	Pakistan
9	Earthing Sytem at DC and AC side separate with material, drilling upto water level, and labour as per BOQ approved by consultant.	Complete Earthing with pure copper rod, copper electrodes having less than 5 Ohm earth resistance.	Job	1	NRTC ENERGIES	Local	Pakistan
10	Lightening Arrestors	ESE (Early Streamer Emission) Lightening Protection System as per RFP	Nr	2	CONTRA80 CESE LIGHTENING TERMINAL	Imported	Turkey
11	Fencing for protection of Plant	Fencing wall for protection from animals and theft	Job	1	NRTC ENERGIES	Local	Pakistan
12	Control Room	Well-equipped Control room with LED and Furniture	Job	1	Signature Architect	Local	Pakistan
13	SCADA	Scada system for monitoring and Control as per RFP specifications	Job	1	ICSS	Local	Pakistan
14	Land preparation	Debris removal, cleaning, leveling, paving, walkways foundations, making land ready for SPP	Job	1	NRTC ENERGIES	Local	Pakistan
15	Energy Meter	2000T	Job	1	MicroStar	Imported	China
16	Studies, approvals and permits	All studies approvals and permits required as per authorities in Pakistan as per laws/directives/SROs	Job	1	NRTC ENERGIES	Local	Pakistan

Annex B-1

Harvest the Sunshine

DEEP BLUE 4.0



Mono

580W n-type Bifacial Double Glass High Efficiency Mono Module

JAM72D40 555-580/GB Series

Introduction

Power by the latest SMBB n-type solar cell, half-cell configuration and gapless ribbon connection technology, these modules have higher output power, lower LID, better weak illumination response, and better temperature coefficient.

- Higher power generation better LCOE
- n-type with very Lower LID
- Better weak illumination response
- Better Temperature Coefficient

Superior Warranty

- 12-year product warranty
- 30-year linear power output warranty

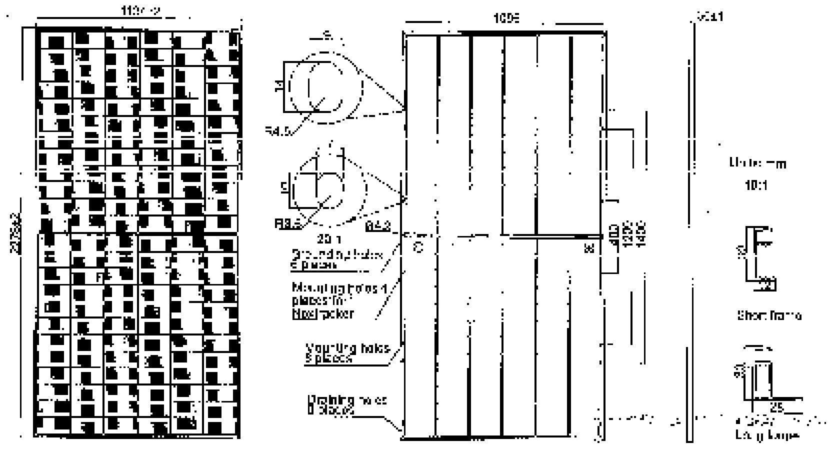
n-type Bifacial Double Glass Module Linear Performance Warranty

Standard Module Linear Performance Warranty

Comprehensive Certificates

- IEC 61215, IEC 61730
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- ISO 45001: 2018 Occupational health and safety management systems
- IEC 62941: 2019 Terrestrial photovoltaic (PV) modules – Quality system for PV module manufacturing

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Mono-182GB
Weight	31.8kg
Dimensions	2278±2mm×1134±2mm×30±1mm
Cable Cross Section Size	4mm² (IEC), 12 AWG(UL)
No. of cells	144(6×24)
Junction Box	IP68, 3 diodes
Connector	QC 4.10-35 / MC4-EVO2A
Cable Length (Including Connector)	Portrait:200mm(+)/400mm(-); Landscape:1300mm(+)/1300mm(-)
Front Glass/Back Glass	2.0mm/2.0mm
Packaging Configuration	36pcs/Pallet, 720pcs/40HQ Container

ELECTRICAL PARAMETERS AT STC

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Maximum Power(Pmax) [W]	555	560	565	570	575	580
Open Circuit Voltage(Voc) [V]	50.53	50.70	50.85	51.00	51.15	51.30
Maximum Power Voltage(Vmp) [V]	42.24	42.40	42.55	42.70	42.85	43.03
Short Circuit Current(Isc) [A]	14.02	14.08	14.16	14.23	14.30	14.36
Maximum Power Current(Imp) [A]	13.14	13.21	13.28	13.35	13.42	13.48
Module Efficiency [%]	21.5	21.7	21.9	22.1	22.3	22.5
Power Tolerance				0~+5W		
Temperature Coefficient of Isc(α_Isc)				+0.046%/°C		
Temperature Coefficient of Voc(β_Voc)				-0.260%/°C		
Temperature Coefficient of Pmax(γ_Pmp)				-0.300%/°C		
STC				Irradiance 1000W/m², cell temperature 25°C, AM1.5G		

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

ELECTRICAL CHARACTERISTICS WITH 10% SOLAR IRRADIATION RATIO

TYPE	JAM72D40 -555/GB	JAM72D40 -560/GB	JAM72D40 -565/GB	JAM72D40 -570/GB	JAM72D40 -575/GB	JAM72D40 -580/GB
Rated Max Power(Pmax) [W]	599	605	610	616	621	626
Open Circuit Voltage(Voc) [V]	50.58	50.73	50.88	51.03	51.18	51.33
Max Power Voltage(Vmp) [V]	42.24	42.39	42.55	42.70	42.86	43.02
Short Circuit Current(Isc) [A]	15.14	15.22	15.29	15.37	15.44	15.51
Max Power Current(Imp) [A]	14.19	14.27	14.34	14.42	14.48	14.56
Irradiation Ratio (rear/front)			10%			

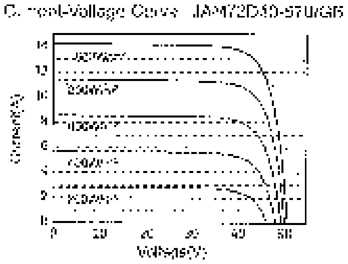
*For NexTracker installations, maximum static load please take compatibility approve letter between JA Solar and Nextracker for reference.
**Bifaciality=Pmax,rear/Rated Pmax,front

OPERATING CONDITIONS

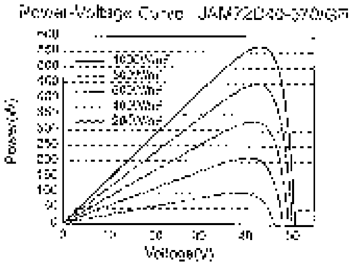
Maximum System Voltage	1500V DC
Operating Temperature	-40°C~+85°C
Maximum Series Fuse Rating	30A
Maximum Static Load,Front* / Maximum Static Load,Back*	5400Pa(112 lb/ft²) / 2400Pa(50 lb/ft²)
NOCT	45±2°C
Bifaciality**	80%±10%
Fire Performance	UL Type 29

CHARACTERISTICS

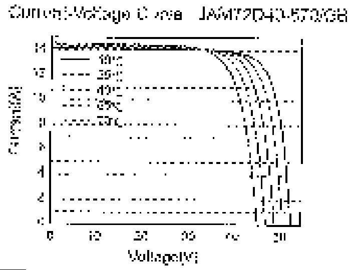
Current-Voltage Curve JAM72D40-570/GB



Power-Voltage Curve JAM72D40-570/GB

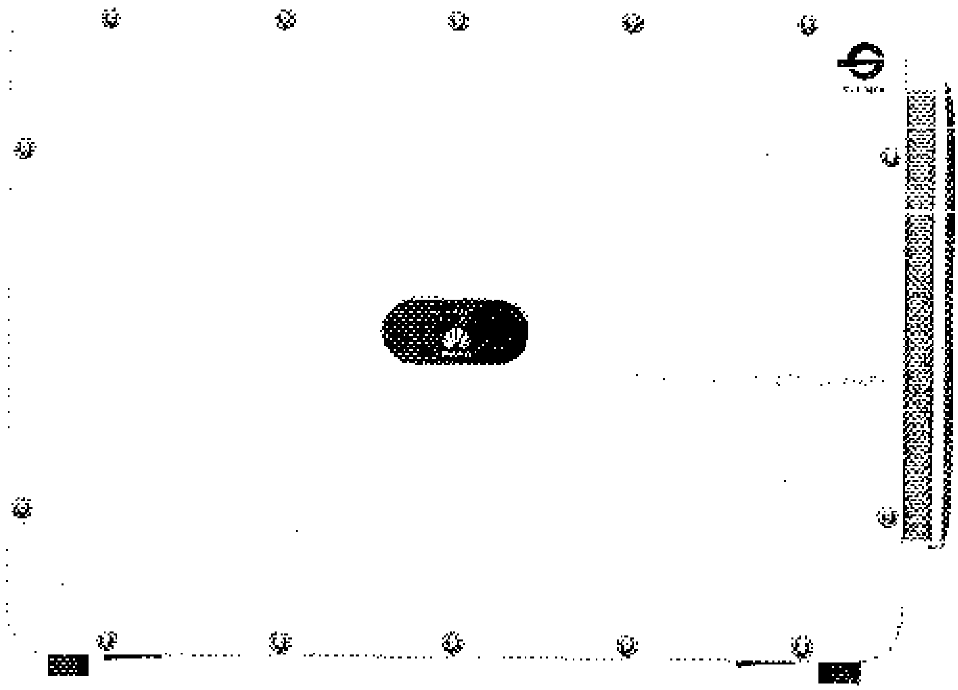


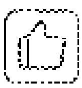
Current-Voltage Curve JAM72D40-570/GB



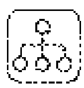
SUN2000-330KTL-H1

Smart String Inverter

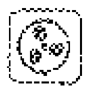




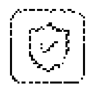
Max. Efficiency ≥99.0%



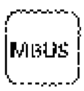
Smart Connector-level Detection (SCLD)



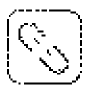
Smart Self-cleaning Fan (SSCF)



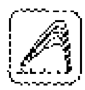
IP66 Protection



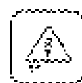
MBUS Supported



Smart String-level Disconnection (SSLD)

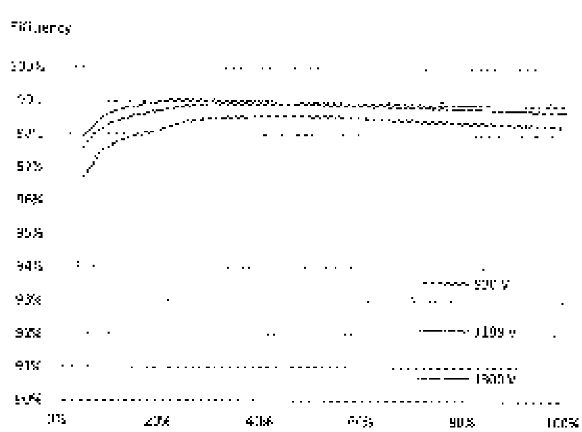


Smart I-V Curve Diagnosis Supported

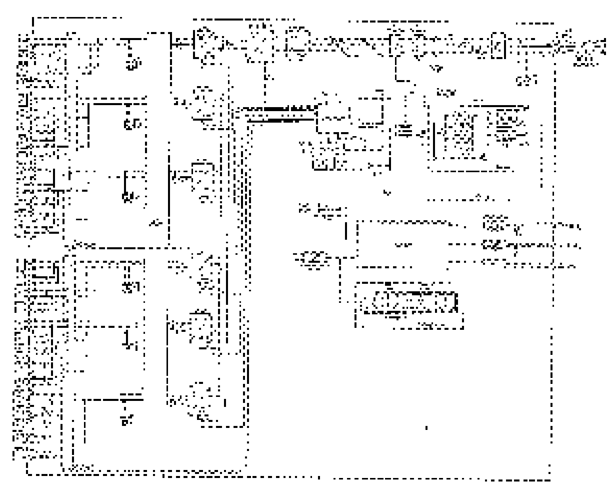


Surge Arresters for DC & AC

Efficiency Curve



Circuit Diagram



Technical Specifications

Efficiency	
Max. Efficiency	≥99.0%
European Efficiency	≥98.8%
Input	
Max. Input Voltage	1,500 V
Number of MPP Trackers	6
Max. Current per MPPT	65 A
Max. Short Circuit Current per MPPT	115 A
Max. PV Inputs per MPPT	4/5/5/4/5/5
Start Voltage	550 V
MPPT Operating Voltage Range	500 V ~ 1,500 V
Nominal Input Voltage	1,080 V
Output	
Nominal AC Active Power	300,000 W
Max. AC Apparent Power	330,000 VA
Max. AC Active Power (cosφ=1)	330,000 W
Nominal Output Voltage	800 V, 3W + PE
Rated AC Grid Frequency	50 Hz / 60 Hz
Nominal Output Current	216.6 A
Max. Output Current	238.2 A
Adjustable Power Factor Range	0.8 LG ... 0.8 LD
Total Harmonic Distortion	< 1%
Protection	
Smart String-Level Disconnector(SSLD)	Yes
Anti-islanding Protection	Yes
AC Overcurrent Protection	Yes
DC Reverse-polarity Protection	Yes
PV-array String Fault Monitoring	Yes
DC Surge Arrester	Type II
AC Surge Arrester	Type II
DC Insulation Resistance Detection	Yes
AC Grounding Fault Protection	Yes
Residual Current Monitoring Unit	Yes
Communication	
Display	LED Indicators, WLAN + APP
USB	Yes
MBUS	Yes
RS485	Yes
General	
Dimensions (W x H x D)	1,048 x 732 x 395 mm
Weight (with mounting plate)	≤112 kg
Operating Temperature Range	-25 °C ~ 60 °C
Cooling Method	Smart Air Cooling
Max. Operating Altitude without Derating	4,000 m (13,123 ft.)
Relative Humidity	0 ~ 100%
AC Connector	Waterproof Connector + OT/DT Terminal
Protection Degree	IP 66
Topology	Transformerless

TECHNICAL DATA SHEET

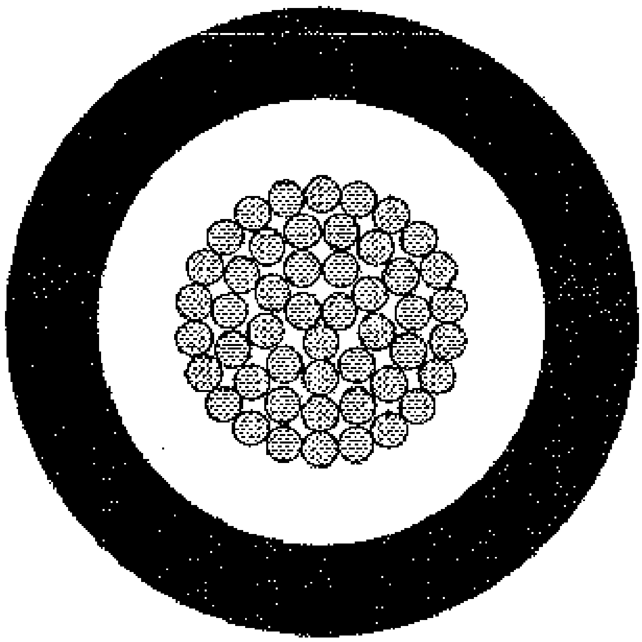
SOLAR CABLE PHOTOVOLTAIC (PV) - EN 50618 H1Z2Z2-K 62930 IEC 131

1x4mm² TCU/XLPO/XLPO, 1.5kV D.C ((NATURAL), BLACK) (BSEN 50618)

FLEXIBLE TINNED COPPER CONDUCTOR, HALOGEN-FREE CROSS-LINKED (XLPO) INSULATION SINGLE CORE HALOGEN FREE FLAME RETARDANT CROSS-LINKED (XLPO) SHEATHED.

Reference Standard	:	BSEN 50618
Other Standard(s)	:	IEC 60228, EN 50395, EN50396, EN 60332-1-2, EN 61034-1/2 & EN 60754-1/2.
Rated Voltage of Cable	:	1.5/1.5kV D.C (Max. Voltage:1.8kV D.C)

Core colour(s) as per Customer Request.



Cable Components

No. of Core(s)	:	1
Cross Section Area of Conductor	:	(≈) 4 mm²
Shape of Conductor	:	Flexible
Conductor Material/Type	:	Tinned Annealed Copper Class 5 Flexible as per IEC 60228
Max Diameter of Single Strand	:	0.31 mm
Diameter of Conductor	:	(≈) 2.6 mm
Insulation Material	:	XLPO
Thickness of Insulation	:	0.7 mm
Temperature Rating	:	-40°C to +90°C (120°C for max. 20,000 hours)
Thickness of Outer Sheath	:	0.8 mm
Overall Diameter of Cable	:	(≈) 5.99 mm (Tolerance Range: ±5%)
Minimum Bending Radius	:	Fixed: 4 X Overall diameter and Flexing: 5 X Overall diameter
High Voltage Test on Cable in Water Dipping	:	6.5 kV A.C. for 5 Minutes
Maximum DC Resistance @ 20°C	:	5.09 Ω/km
Weathering / UV Resistance	:	720 Hrs,. No Cracking

Continuous Current Rating

Ambient temperature: 60°C
Conductor operating Temperature: 90°

Method of Installation:

Single cable free in air	:	55 Amps
Single cable free in surface	:	52 Amps
Two Loaded cables touching, on a surface	:	44 Amps

TECHNICAL DATA SHEET

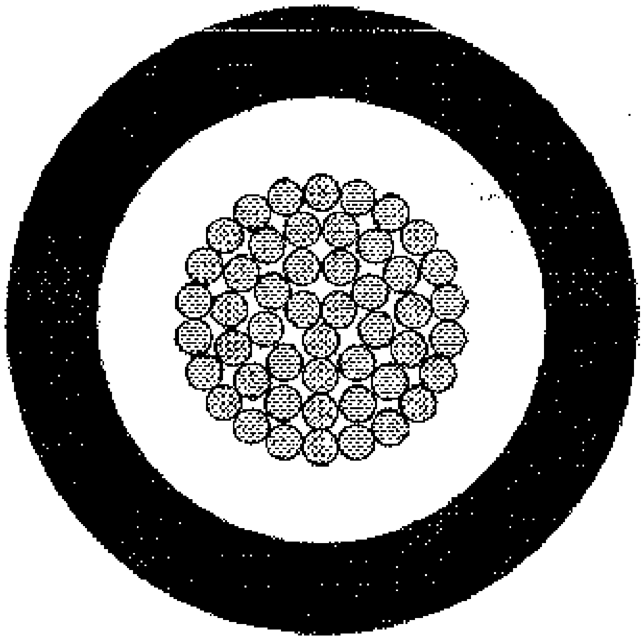
SOLAR CABLE PHOTOVOLTAIC (PV) - EN 50618 H1Z2Z2-K 62930 IEC 131

1x6mm^2 TCU/XLPO/XLPO, 1.5kV D.C ((NATURAL), BLACK) (BSEN 50618)

FLEXIBLE TINNED COPPER CONDUCTOR, HALOGEN-FREE CROSS-LINKED (XLPO) INSULATION SINGLE CORE HALOGEN FREE FLAME RETARDANT CROSS-LINKED (XLPO) SHEATHED.

Reference Standard	:	BSEN 50618
Other Standard(s)	:	IEC 60228, EN 50395, EN50396, EN 60332-1-2, EN 61034-1/2 & EN 50754-1/2.
Rated Voltage of Cable	:	1.5/1.5kV D.C (Max. Voltage:1.8kV D.C)

Core colour(s) as per Customer Request.



Cable Components

No. of Core(s)	:	1
Cross Section Area of Conductor	:	(≈) 6 mm^2
Shape of Conductor	:	Flexible
Conductor Material/Type	:	Copper Class 5 Flexible as per IEC 60228
Max Diameter of Single Strand	:	0.31 mm
Diameter of Conductor	:	(≈) 3.4 mm
Insulation Material	:	XLPO
Thickness of Insulation	:	0.7 mm
Temperature Rating	:	-40°C to +90°C (120°C for max. 20,000 hours)
Thickness of Outer Sheath	:	0.8 mm
Overall Diameter of Cable	:	(≈) 6.65 mm (Tolerance Range: ±5%)
Minimum Bending Radius	:	Fixed: 4 X Overall diameter and Flexing: 5 X Overall diameter
High Voltage Test on Cable in Water Dipping	:	6.5 kV A.C. for 5 Minutes
Maximum DC Resistance @ 20°C	:	3.39 Ω/km
Weathering / UV Resistance	:	720 Hrs., No Cracking

Continuous Current Rating

Ambient temperature: 60°C
Conductor operating Temperature: 90°

Method of Installation:

Single cable free in air	:	70 Amps
Single cable free in surface	:	67 Amps
Two Loaded cables touching, on a surface	:	57 Amps

Ref No: TE-148-012025-R1
Dated: 23-01-2025
No. of Pages: 11

TARIQ ELECTRIC PRIVATE LIMITED

"Annex B"

Technical Submittal
For supply of KIOSK Substations
M/S: Nrtc Energies

General Enclosure Specifications:

- MANUFACTURING STANDARD IEC 61439-2.
- ENCLOSURE PROTECTION OUTDOOR TYPE. FORM - 01 IP-54
- CUBICAL MATERIAL M.S SHEET THICKNESS 14/16-SWG.
- FULLY PAINTED AFTER SURFACE TREATMENT WITH ELECTROSTATIC POWDER PAINT RAL -7035.
- FOLLOWING COPPER BUSBARS DESIGNED ACCORDING TO IEC 61439-2.
- BUS BAR WILL BE **PAK MADE, RATED @ 35°C** & ACCORDING TO BREAKER RATINGS.
- NEUTAL WILL BE 50% OF THE MAIN BUSBAR & EARTH BAR WILL BE 25% OF MAIN BUSBAR.

1)-	KIOSK Substation 500KVA (0.5 MW)			Qty 08 No.
Sr. #	Item Description	Make	Model	Qty
	MV Section:			
1	11KV VCB 630A, 25KA Outgoing Panel as per attached "Annex C"	TE with ABB VCB		01 No.
2	MV Cable (MV Panel to Transformer)	WAPDA approved		01 Job.
3	LV Cable (LV Panel to Aux. Transformer)	WAPDA approved		01 Job.
	Transformer Section:			
1	630KVA Oil Type Step Up Transformer 0.8/11KV	**Client Scope**		01 No.
	Bus Tie Dct Section:			
1	Bus Tie Duct TP 630A 2 x (30 x 05) mm per Phase	TE		01 Job.
	Ventilation Section:			
1	Ventilation System For Transformer (4 Heavy Duty Fan With Control DB)	**TE**		01 Job.
	Marshiling Box:			
1	Marshiling Box For LV, MV & Tarnsformer Signals	TE		01 Job.
	LV Section:			
	Incoming			
1	MCCB TP 320A, RC-32KA @ 800V	ABB - Italy	XT5V-HA 400	02 No.
2	MCCB TP 320A, RC-32KA @ 800V	Space Only		02 No.
	Outgoing			
1	**MCCB TP 630A, RC-32KA @ 800V**	ABB - Italy	XT5V-HA 630	01 No.
2	Aux.Contacts For MCCB	ABB - Italy	XT5	01 No.
3	Digital Energy Analyzer (0.5 class with TCP/IP Port)	Circutor/Eqv.	CVM-C11	01 No.
4	Current Transformers 600/5A (0.5 Class)	Metelx/Eqv.		03 No.
5	Surge Protection Device TP @ 800V	Citel/Eqv.		01 No.

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TARIQ ELECTRIC PRIVATE LIMITED

"Annex B"

Technical Submittal

For supply of KIOSK Substations

M/S: Nrtc Energies

6	Indication Lights ON/OFF/Trip	Schneider/Eqv.		03 No.
7	Indication Lights R,Y,B	Schneider/Eqv.		03 No.
8	Control MCB 6ASP, 6KA	ABB - Germany	SH 201	06 No.
	Panel Accessories:			
1	Panel Light With Micro Switch	Chint		01 Set.
2	Panel Exhaust Fan With Thermostat	Imported		01 Set.
	Auxiliary DB:			
1	MCCB TP 50A, RC-18KA @ 415V	ABB	A1B 125	01 No.
2	Indication Lights R,Y,B	Schneider/Eqv.		03 No.
3	Control MCB 6ASP, RC-06KA	ABB - Germany	SH 201	03 No.
4	MCB TP 10A, RC-06KA	ABB - Germany	SH 203	02 No.
5	MCB SP 10A, RC-06KA	ABB - Germany	SH 201	12 No.
6	MCB SP 06A, RC-06KA	ABB - Germany	SH 201	12 No.
	Misc. Accessories:			
1	Lightning Arrester for KIOSK	Local		01 No.
2	Light Plug Universal (Piano Type)	Imported		01 No.
3	Industrial Plug and sockets 32A 4PIN	Imported		01 No.
4	Photoelectric EE Switch	Panasonic/Eqv.		01 No.
	Alarm Activation System:			
1	Smoke Dectector System	Imported		03 No.
2	Indication Light for Trip	Schneider/Eqv.		01 No.
3	Control MCB 6A SP, 6KA	ABB	SH 201	01 No.
4	Push Button Fault Acknowledge	Camsco/Eqv.		01 No.
5	Control Relays 4NC/ 4NO 220V	Finder/Relpol		02 No.
6	Hooter / Buzzer	Imported		01 No.
7	Revolving Light	Imported		01 No.
8	Temperature Sensor with Alarm Contact	Imported		01 No.
	Panel Accessories:			
1	Tube light 220V (Indoor)	Imported		08 No.
2	Door limit switch	Imported		05 No.
3	Boundry Wall light 220V (Outdoor)	Imported		06 No.
4	Exhaust Fan with Dust filters	Imported		03 Set.
	Temperature Section			
1	Temperature Indicator with Sensor & Alarm Contact For Each Compartment (Signal 04-20mA)	Imported		03 Set.
	Auxiliary Transformer:			

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Ref No: TE-148-012025-R1
Dated: 23-01-2025
No. of Pages: 11

TARIQ ELECTRIC PRIVATE LIMITED

"Annex B"

Technical Submittal

For supply of KIOSK Substations

M/S: Nrtc Energies

1	Auxiliary Transformer 25KVA, 800/415V	TE		01 No.
2	MCCB TP 80A, RC-20KA @ 900V	ABB - Italy	T4V 250	01 No.
	Heat Insulation of KIOSK:			
	Roof, Walls & Doors of KIOSK will be insulated with Glass wool which will be with MS Sheet internally.			01 Job.

2)	**KIOSK Substation 1000KVA (1 MW)**			**Qty 15 No.**
Sr. #	**Item Description**	**Make**	**Model**	**Qty**
	MV Section:			
1	11KV VCB 630A, 25KA Outgoing Panel as per attached "Annex C"	TE with ABB VCB		01 No.
2	MV Cable (MV Panel to Transformer)	WAPDA approved		01 Job.
3	LV Cable (LV Panel to Aux. Transformer)	WAPDA approved		01 Job.
	Transformer Section:			
1	1250KVA Oil Type Step Up Transformer 0.8/11KV	**Client Scope**		01 No.
	Bus Tie Dct Section:			
1	Bus Tie Duct TP 1000A 2 x (60 x 05) mm per Phase	TE		01 Job.
	Ventilation Section:			
1	Ventilation System For Transformer (4 Heavy Duty Fan With Control DB)	**TE**		01 Job.
	Marshliing Box:			
1	Marshlling Box For LV, MV & Tarnsformer Signals	TE		01 Job.
	LV Section:			
	Incoming			
1	MCCB TP 320A, RC-32KA @ 800V	ABB - Italy	XT5V-HA 400	03 No.
2	MCCB TP 320A, RC-32KA @ 800V	Space Only		02 No.
	Outgoing			
1	**ACB TP 1250A, RC-66KA @ 900V (ADJ.) LSI**	ABB - Italy	E2.2H/E9 1250	01 No.
2	Motor Mechanism 220V AC	ABB - Italy	E2.2H/E9	01 No.
3	UVT 220V AC	ABB - Italy	E2.2H/E9	01 No.
4	Shunt Trip (Open/Close)	ABB - Italy	E2.2H/E9	02 No.
5	Digital Energy Analyzer (0.5 class with TCP/IP Port)	Circutor/Eqv.	CVM-C11	01 No.
6	Current Transformers 1200/5A (0.5 Class)	Metelx/Eqv.		03 No.
7	Surge Protection Device TP @ 800V	Citel/Eqv.		01 No.
8	Indication Lights ON/OFF/Trip	Schneider/Eqv.		03 No.

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TARIQ ELECTRIC PRIVATE LIMITED

"Annex B"

Technical Submittal
For supply of KIOSK Substations
M/S: Nrtc Energies

9	Indication Lights R,Y,B	Schneider/Eqv.		03 No.
10	Control MCB 6ASP, 6KA	ABB - Germany	SH 201	06 No.
	Panel Accessories:			
1	Panel Light With Micro Switch	Chint		01 Set.
2	Panel Exhaust Fan With Thermostat	Imported		01 Set.
	Auxiliary DB:			
1	MCCB TP 50A, RC-18KA @ 415V	ABB	A1B 125	01 No.
2	Indication Lights R,Y,B	Schneider/Eqv.		03 No.
3	Control MCB 6ASP, RC-06KA	ABB - Germany	SH 201	03 No.
4	MCB TP 10A, RC-06KA	ABB - Germany	SH 203	02 No.
5	MCB SP 10A, RC-06KA	ABB - Germany	SH 201	12 No.
6	MCB SP 06A, RC-06KA	ABB - Germany	SH 201	12 No.
	Misc. Accessories:			
1	Lightning Arrester for KIOSK	Local		01 No.
2	Light Plug Universal (Piano Type)	Imported		01 No.
3	Industrial Plug and sockets 32A 4PIN	Imported		01 No.
4	Photoelectric EE Switch	Panasonic/Eqv.		01 No.
	Alarm Activation System:			
1	Smoke Dectector System	Imported		03 No.
2	Indication Light for Trip	Schneider/Eqv.		01 No.
3	Control MCB 6A SP, 6KA	ABB	SH 201	01 No.
4	Push Button Fault Acknowledge	Camsco/Eqv.		01 No.
5	Control Relays 4NC/ 4NO 220V	Finder/Relpol		02 No.
6	Hooter / Buzzer	Imported		01 No.
7	Revolving Light	Imported		01 No.
8	Temperature Sensor with Alarm Contact	Imported		01 No.
	Panel Accessories:			
1	Tube light 220V (Indoor)	Imported		08 No.
2	Door limit switch	Imported		05 No.
3	Boundry Wall light 220V (Outdoor)	Imported		06 No.
4	Exhaust Fan with Dust filters	Imported		03 Set.
	Temperature Section			
1	Temperature Indicator with Sensor & Alarm Contact For Each Compartment (Signal 04-20mA)	Imported		03 Set.
	Auxiliary Transformer:			
1	Auxiliary Transformer 25KVA, 800/415V	TE		01 No.

Ref No: TE-148-012025-R1
Dated: 23-01-2025
No. of Pages: 01

TARIQ ELECTRIC PRIVATE LIMITED

"Annex C"

Technical Submittal (MV Switchgear)
For supply of KIOSK Substations
M/S: Nrtc Energies

2)- 11KV 630A, 25KA Outgoing Panel (I/O)(Inside KIOSK) Qty 01 No.

Sr. #	Item Description	Make	Model	Qty
	Breaker Compartment			
1	Motorized VCB 630A, Rated Voltage 12KV withdraw able Type, Operating Voltage 11KV, 25KA, BIL 36/95KV, with Shunt Coil @ 110VAC/DC & Motor Mechanism @ 220VAC	ABB - Italy		01 No.
1	Earthing Switch	JSE - China		01 No.
	Low Voltage Compartment			
1	Digital O/C, E/F & S/C Protection Relay With Auto Recloser Function	ABB	REX-610	01 No.
2	Digital Energy Mater (0.2s accuracy class Compatible with Scada)	Blue Star / Eqv.		01 No.
3	Analogue Voltmeter scaled (0-15KV)	Lumel - Poland		01 No.
4	Analogue Ammeter scaled (0-XXXA)	Lumel - Poland		01 No.
5	Voltmeter selector switch (7-Position)	Camsco / Eqv.		01 No.
6	Ammeter selector switch (4-Position)	Camsco / Eqv.		01 No.
7	LED Type Indication Lights for Phase R/Y/B @ 110VAC	Schneider / Eqv.		03 No.
8	LED Type Indication Lights for C.B On/Off/Trip @ 110VDC	Schneider / Eqv.		03 No.
9	LED Type Indication Lights for E.S On @ 110VDC	Schneider / Eqv.		01 No.
10	Indication Lights for Heater ON @ 220VAC	Schneider / Eqv.		01 No.
11	Push Button ON/OFF	Schneider / Eqv.		02 No.
12	Phase Failure Phase Sequance Relay	Klemsan / Eqv.		01 No.
13	Transformer Status Relay	E-Logics / Eqv.		01 No.
14	Capacitor/DC Trip Unit	E-Logics / Eqv.		01 No.
15	TP MCB 06A	ABB		01 No.
16	DP MCB 10A	ABB		03 No.
	Cable Compartment			
1	Current Transformers Ratio: (XXX/5/5A), Burden: 10VA, 15VA, Class: 0.2s & 5P20, Ith: 25KA	Fico / Eqv.		03 No.
2	Potential Transformers, 11kV/√3/110V/√3, Class 0.2 Burden: 100VA, 12/36/95KV, SC-25KA	Fico / Eqv.		03 No.
3	11KV Surge Arrestor	Nanyang (china)		03 No.
	Panel Accessories			
1	Panel Light + Door limit Switch	Chint - China		01 No.
2	Anti Condenstate Heater 60W With Thermostat	E-Logics / Eqv.		01 No.
3	Auto Manual Selector Switch For Heater ON	Camsco / Eqv.		01 No.
4	Terminal Blocks	Klemsan		01 Set.
Note:	**E/M Scada Register Shall be verified during FAT.**			

Lahore: Taj Garh Road, Yadgar Shuhada Stop, G.T. Road, Manawan, Lahore-Pakistan.
+92-42-36522861-62-63 +92-42-36522864 info@tariqelectric.com
Karachi: 1st Floor, MA Tabba Foundation Building, Gizri Road, Block – 9, Clifton, Karachi.
Cell: +92-301-1163120
www.tariqelectric.com

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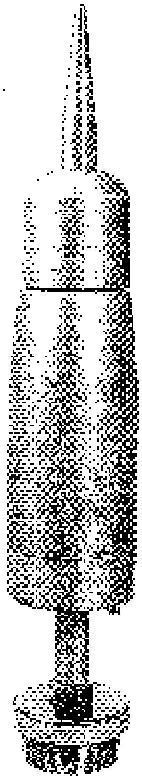


GENERAL DESCRIPTIONS

CONTRA60 Early Streamer Emission (CESE) lightning terminal can anticipate all other elements and items within its protectable range according to its protection level radius by intercepting the lightning strikes and conducting these strikes into the earth through the safest and projected ways. CONTRA60 CESE Terminal work as to principle of creating IONs by its internal ION GENERATION channels. This structure itself allows the terminal to conduct the high voltage lightning strikes, even up to 200kA, to the earthing system then to the earth at the safest way.

CONTRA60 CESE Lightning Terminal is exclusively suitable to install where primary protection is needed like critical points, military zones and aero-space bases at higher protection radiuses range.

Tested and certified according to NFC17-102/2011 Early Streamer Emission Standard including Delta T (ΔT) advance time test, current withstanding test to determine CONTRA60's protection levels.

- > High Salt mist treatment
- > Humid sulphurous atmosphere treatment
- > Current withstanding test: 200kA (10/350μs)
- > Advance time Delta T (ΔT) test

TECHNICAL CHARACTERISTICS

Material	Stainless Steel
Weight	3.00 kg
Ext. Diameter	120 mm.
Lenght (h)	52 cm.
Box Lenght	55 cm.
Rod Diameter	20 mm.
Adapter Diameter	60mm. Male
IP Code	IP67
Working Temperature	-25°C / 90°C
Type of Terminal	Electroatmospheric
Internal Insulation	High Density Polyurethane Resin
Standard	NFC 17-102/2011
Grounding Method	Wire/Tape
Max. Current Withstand (10/350μs) / >2.5 Mj/Ω	200kA
Advance Time (ΔT)	60 μs

PROTECTION LEVEL OF CONTRA60

Height (m)	Protection Radius (m)			
	Level 1	Level 2	Level 3	Level 4
2	31	[illegible]	39	43
4	63	69	78	85
5	79	86	97	107
10	79	88	99	[illegible]

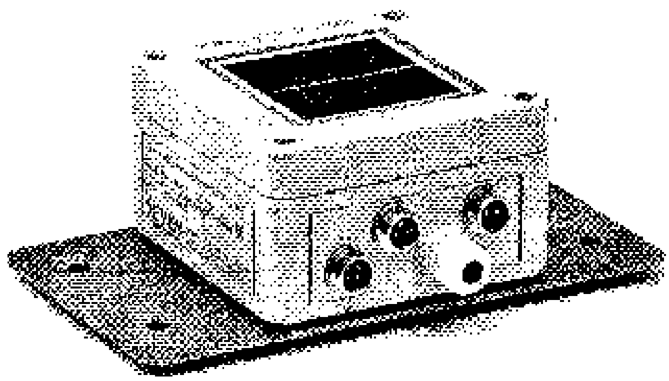
High voltage impulse emitter	ION GENERATOR only
Completely autonomous	Testable with ORBITAL Testers
30% more efficient than passive systems	Fully compatible with the standards
Electroatmospheric capacitor Inside	20 years manufacturer warranty

3S-SR-3T-WS-MB

PROJ-0121-YWM-MS-DWG-0002-00

Solar Radiation Sensor Box

Measurement of Solar Irradiance



MODE OF OPERATION

A silicon solar cell can be used as an irradiance sensor, because the short-circuit current is proportional to irradiance. Our sensors are built out of a monocrystalline solar cell connected to a shunt. Due to the low resistance of the shunt the cell operates next to short circuit.

The temperature coefficient of the short-circuit current creates a small error.

The compensation is realized by using a specific temperature sensor laminated to the rear side of the solar cell. The measuring signals of short- circuit current of the cell and the resistance value of the temperature sensor are measured by a micro controller.

The calculated values of irradiance and temperature given onto a RS485 port with customer specification protocol. The electronic circuit is optimized for low power consumption.

MECHANICAL CONSTRUCTION

The solar cell is embedded in Ethylene- Vinyl- Acetate (EVA) between glass and Tedlar. Plain integration into the top cover of the box Advanced weatherproof junction box made of UV resistant material with cable gland and screw-less terminal for the connection of the measuring cable, therefore, the sensor construction is comparable to that of a standard PV module. The electrical connection is realized by a 3m cable.

3S-SR-3T-WS-MB

7EVEN
SENSOR SOLUTIONS

ALL SENSORS ARE CALIBRATED IN SIMULATED SUNLIGHT AGAINST A REFERENCE CELL OF THE SAME TYPE. THE REFERENCE CELL IS PERIODICALLY CALIBRATED AGAINST A REFERENCE CELL CALIBRATED BY FRAUNHOFER ISE, FREIBURG.

TECHNICAL DATA

General Information	
Solar Cell	Monocrystalline Silicon (52 mm x 52 mm)
Current Shunt	High precision shunt resistor directly soldered to the terminals of the cell
Operating Temperature	-30°C to +70°C
Electrical Connection	3 m PUR Cable, UV and weather resistant
Power Supply	12 to 30 VDC (30 mA typically at 20 VDC)
Interface	RS485 up to 19200 Baud
Protocol	The sensor is connected via a 2-wire RS485 bus with open vendor-independent Modbus RTU protocol
Galvanic Isolation	1000 V between power supply and RS485 bus
Case	Advanced weatherproof junction box made of UV resistant material
Dimensions, Weight	94 mm x 94 mm x 57 mm, approx. 200 g
Protection	IP64

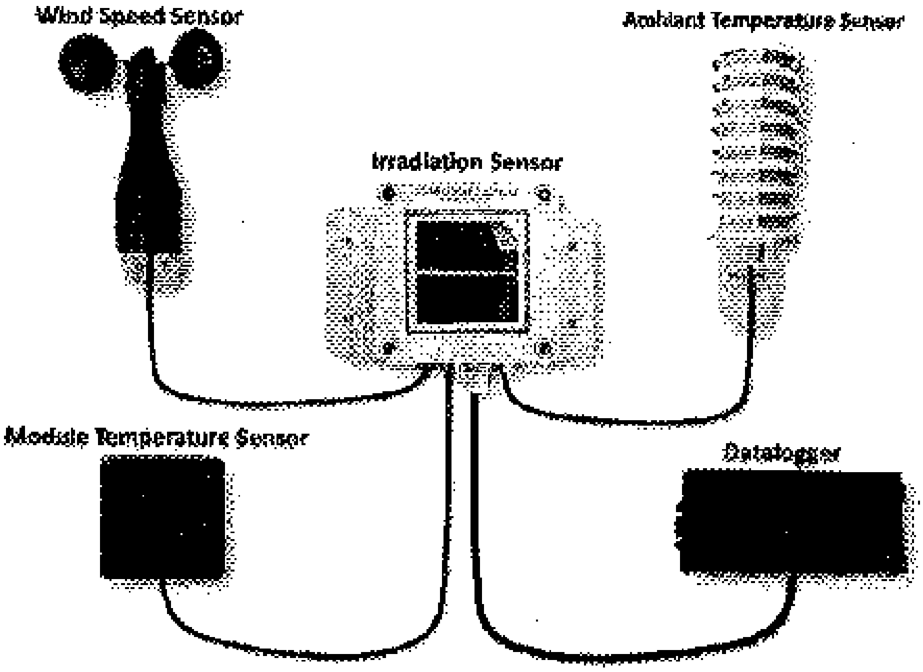
Accuracy	
Irradiance	10...1500W/m², Accuracy of monthly sums compared to a W.M.O. class 1 Pyranometer (e.g. CMP 11) according to ISO 9060: better ±5%
Drift	Very small drift of <0.3%/ year

Electrical Connection	
Brown	Power (+)
White	Power (-)
Green	RS485 Data (+) / A
Yellow	RS485 Data (-) / B
Input 1	3S-WS-PLS, Wind speed sensor, 2 pin connector
Input 2	3S-AT-18B20, Ambient temperature sensor, 3 pin connector
Input 3	3S-MT-18B20, Module temperature sensor, 4 pin connector

Others	
Calibration	Individual calibration of each sensors in the natural sunlight at AM 1,5 spectrum by means of a compatible calibrated reference cell.
Handling Case	The sensor can be cleaned using a smooth cotton cloth, water and a mild cleaning fluid. Opening of the sensor case by the user or installation staff is not necessary. If the case is opened, we cannot guarantee the seal of the case anymore.

Modbus Specification	
Baud Rate	1200, 2400, 9600, 19200, 38400
Parity	No, even, odd
Stop Bit	1, 2 (only at no parity)
Factory Default	9600 Baud, 8N1, address: 1

WIRING EXTERNAL SENSORS



RELATED PRODUCTS

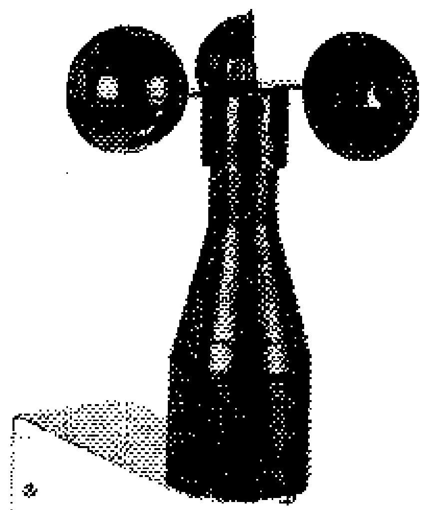
3S-WS-PLS	Wind speed sensor, read contact, pulse
3S-AT-18B20	Ambient temperature sensor, DS18B20
3S-MT-18B20	Module temperature sensor, DS18B20
3S-PS-12VDC	Power supply, 220VAC, 50/60Hz 12VDC, 300mA
3S-Shield-A	Solar Radiation Shield for Ambient Temperature Sensor PT100, PT1000, DS18B20 etc.

3S-SR-3T-WS-MB

Wind Speed Sensor

APPLICATION

Small and economical anemometer with digital output used to measure wind speed at solar power plants as well as at universal applications. Compatible with SEVEN Sensor Box. Supplied with stainless steel mounting bracket and Cable.



TECHNICAL DATA

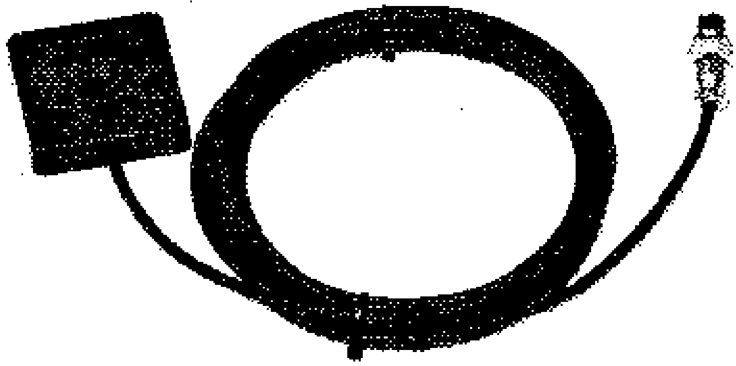
General Information	
Sensor type	UV resistant plastic material cup star anemometer
Output Signal	Reed relays, 2.5 Hz / (m/s) pulse
Measuring Range	0.9...40m/s
Accuracy	±0.5 m/s or ±5 % of measuring value
Resolution	0.4 m wind run
Frequency	0...100 Hz
Contact Load	10 W, max. 42 V DC, max. 0,4 A
Ambient Temperature	-25...+80 °C, ice-free
Cable	3 m LiYY Cable, UV and weather resistant
Protection	IP54
Survival Speed	Max. 60 m/s
Dimensions	134 mm x 176 mm
Weight	0.3 kg

3S-SR-3T-WS-MB

Module Temperature Sensor

APPLICATION

Maxim DS18B20 is an economical digital module temperature sensor for universal application as well as for solar photovoltaics projects. Compatible with SEVEN Sensor Box.



TECHNICAL DATA

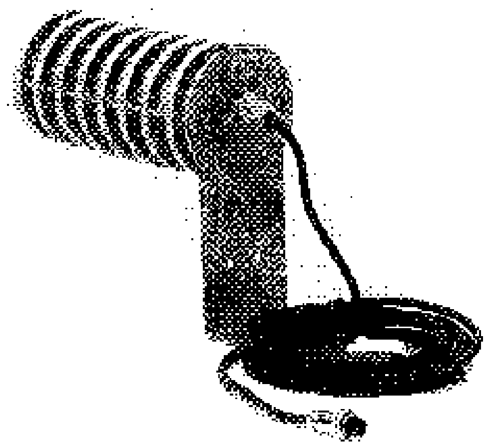
General Information	
Sensor Type	DS18B20 digital temperature probe, for flat surfaces (back side of solar panel)
Measuring Range	-55...+125°C
Accuracy	± 0.5 °C
Sensor Housing	Plastic housing with aluminium plate, H x W x L: 12 mm x 50 mm x 50 mm
Cable	5 m PUR Cable, UV and weather resistant
Protection	IP67
Connection	One-Wire-Bus technique

3S-SR-3T-WS-MB

Ambient Temperature Sensor

APPLICATION

Maxim DS18B20 is an economical digital ambient temperature sensor for universal application as well as for solar photovoltaics projects. Compatible with SEVEN Sensor Box. For this, SEVEN provides a stainless-steel mounting bracket and UV resistant solar radiation shield.



TECHNICAL DATA

General Information	
Sensor Type	DS18B20 digital temperature probe
Measuring Range	-55...+125°C
Accuracy	± 0.5 °C
Sensor Housing	Stainless steel tube, 6 mm diameter, 60 mm length
Cable	3 m or 5 m PUR Cable, UV and weather resistant
Protection	IP68
Connection	One-Wire-Bus technique

3S-SR-3T-WS-MB

Modbus RTU Specifications

Supported Bus Protocol
BaudRate:1200,2400,9600, 19200,38400
Parity: No, even, odd
Stop Bit: 1, 2 (only at no parity)
Factory Default: 9600 Baud, 8N1, address: 1

Transmission mode: MODBUS RTU

Supported function codes:
- 0x04: Read Input Register

The following Mod bus data can be read individually or in blocks:

ID-Dec.	ID-Hex	Value
0	0x00	Irradiance value 0...16000 in 0.1 Watt/m²
1	0x01	Temperature of measuring cell 0...1000 [range -25...75°C] in 0.5°C
2	0x02	External temperature 1 0...1000 [range -25...75°C] in 0.5°C
3	**0x03**	**Wind speed in 1/100 m/s 0...6000**
4	0x04	External temperature 2 0...1000 [range -25...75°C] in 0.5°C
5	**0x05**	**Temperature compensated irradiance value 0...16000 in 0.1Watt/m²**
6	0x06	mV value of irradiance input 0...10000 in 0.01mV (raw data)
7	0x07	Temperature of measuring cell 0...1800 [extended range -55...125°C] in 0.1°C
8	0x08	External temperature 1 0...1800 [extended range -55...125°C] in 0,1°C
9	0x09	External temperature 2 0...1800 [extended range -55...125°C] in 0,1°C
10	0x0A	External humidity (Temp./Humidity sensor) 0...100 [%] -- actual always "0"
11	0x0B	Digit value of the ADC [0...4096] (raw data)
12	0x0C	Wind sensor pulse frequency of last wind measurement cycle (raw data)
13	0x0D	Wind sensor number of pulses since last modbus read out (high-word) (raw data)
14	0x0E	Wind sensor number of pulses since last modbus read out (low-word) (raw data)
15	**0x0F**	**Cell temperature as 'sign value' -550 ... +1250 [range -55 ... +125°C] in 0.1°C**
16	**0x10**	**Ext. temp. 1 as 'sign value' -550 ... +1250 [range -55 ... +125°C] in 0.1°C**
17	**0x11**	**Ext. temp. 2 as 'sign value' -550 ... +1250 [range -55 ... +125°C] in 0.1°C**

Financial Breakup

Regulatory Complaince

[illegible]	Items	[illegible]	Description	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	Generation Licensing	NEPRA	3.5 MW - (5 Sites / 2 Cities)						
2	Design & Engineering	NE	3.5 MW - (5 Sites / 2 Cities)	[illegible]	Job	4,701,420	4,937,426	750,229	5,387,656
3	Environmental Approval	PEPA	LL / As per Regional Environmental Protection Agency						
[illegible]							[illegible]	[illegible]	[illegible]

Civil Works

1	Geo Technical Studies	NE	Unit cost considered for each site mentioned in the zone.	5	Job	1,685,000.00	8,425,000.00	1,340,000.00	9,773,000.00
2	Land preparation	NE	Size 3.5 MW	5	Job	2,215,909.09	11,079,545.45	1,772,727.27	12,852,272.73
3	Roof Civil Works	NE	Size 0 MW	-	Job	2,250,000.00	-	-	-
4	Fencing	NE	Unit cost considered for each site mentioned in the zone.	5	Job	2,600,000.00	13,000,000.00	2,080,000.00	15,080,000.00
5	Drainage	NE	Cumulative 1000 meters also buried length is considered for each site	5	Job	2,625,000.00	13,125,000.00	2,100,000.00	15,225,000.00
6	Shed	NE	Kiosk / Platform & Monitoring room is also made	5	Job	3,000,000	15,000,000	2,400,000	17,400,000
7	Living room	NE	Living room with basic accessories	5	Job	2,500,000	12,500,000	2,000,000	14,500,000
8	Water Network	NE	Unit cost considered for each site mentioned in the zone.	5	Job	1,420,000	7,100,000	1,278,000	8,378,000
[illegible]							[illegible]	[illegible]	[illegible]

PV Plant

1	PV Panels	JA/JINKO/CANADIAN/LONGI/TRINA/YINGLI/HANWHA/UNYANG	Tier 1	3500	kWatt	25,425.25	88,988,375.00	-	[illegible]
2	PV Inverters	Huawei/Sungrow	Smart String Inverter - KTL Series	3500	kWatt	10,000.00	35,000,000.00	6,300,000.00	41,300,000
3	PV Structure	NE	HDG / Pile - 72	3500	kWatt	22,500.00	78,750,000.00	14,175,000.00	92,925,000
4	Cables	[illegible]	DC & AC / AL / XLPE/PVC	1	Job	12,250,000.00	12,250,000.00	2,205,000.00	14,455,000
5	LV Switchgear	NE	LV switchgear for Rooftops systems	0	Job	4,200,000.00		-	-
6	KIOSK	NE	LV/MV Switchgear for ground mounted systems	1	Job	77,350,000.00	77,350,000.00	13,923,000.00	91,273,000
7	Services	NE	Electrical / Mechanical / Civil	1	Job	65,000,000.00	65,000,000.00	10,400,000.00	75,400,000
[illegible]							[illegible]	[illegible]	[illegible]

Total	442,207,848	60,717,956	502,925,804

O&M Manual

NRTC Energies – Operation and Maintenance Plan (O&M Plan)

Contents

Introduction

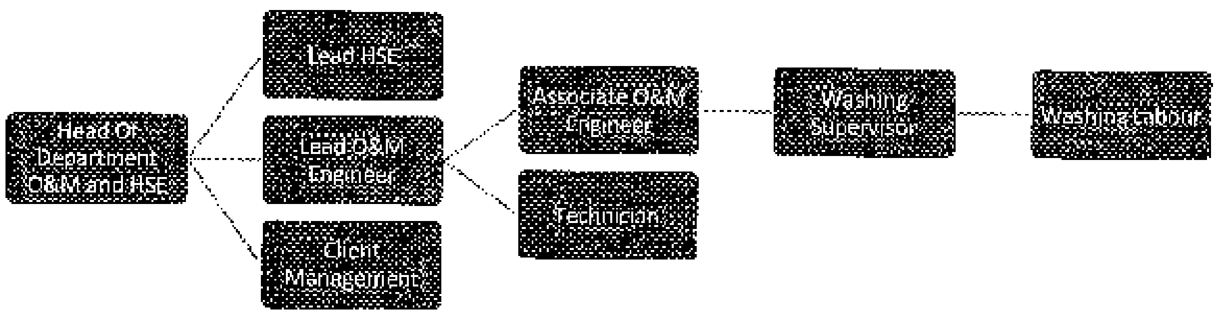
The goal of this plan is to reduce the cost and Improve the effectiveness of operations and maintenance (O&M) for photovoltaic (PV) systems. Reported O&M costs vary widely based on the requirements of the system, but a more standardized approach to planning and delivering O&M has the potential to both decrease costs and make those costs more predictable over time. However, the bigger payoff for improved O&M is increased performance.

1) O&M Services

O&M Services Includes Operations, Maintenance and cleaning of complete plant, 24/7 monitoring of plant through online software, scheduled or Emergency corrective and preventive maintenance, monthly, biannually and annually inspection and testing of plant. Analyze the Data (fact and figures) make the reports on Daily, Weekly and monthly bases.

Detail Description of work is Defined Below

2) O&M team Organogram



3) Responsibilities

3.1) Head of Department (HOD)

- Manage all the operation and Maintenance Activities of plant along with all the resources.
- Manage and report all sites activities to the BOD.
- Review the whole progress of all operational plants on daily, weekly and on annual basis.
- Manage the activities of O&M team.

- Manage and control the operational budget of the plant.
- Ensure the activities performed under HSE compliance.
- Client management.
- Over view the performance of O&M team.
- Ensure the quality of work.
- Engage the EPC-C during handover plant to O&M department and ensure the work done as per BOQ.
- Arrange the audit of hand overing plants to O&M department.

3.2) O&M Engineer

- Report site problems timely to the HOD.
- Materials arrangements and mobilization for the site activities.
- Analyze all quality checks performed during monthly inspection of Solar system.
- Train on site resources for System operation, maintenance and cleaning.
- Maintain monthly report of installed system.
- Able to troubleshoot installed Solar system.
- Ensures that tools and test equipment are properly maintained and fit for purpose.
- Comply with Company health, safety and environmental policies.
- Manage the inventory by regularity checks.
- Keep the performance parameters under observation and perform tests time to time to improve the performance of plant.
- Proactively manage the team in case of fault and always try to minimize the down time or production loss.
- Maintain all kinds of record reports, inspection check lists, inventory and budget record.

3.3) Lead HSE

- Conducting HSE compliance audits on regular basis.
- HSE trainings on weekly basis, physical and virtual.
- Reviewing HSE documentation and its implementation on regular basis.
- Inspection of fire extinguishers on monthly basis.
- Risk evaluation of the site and its prevention.
- PPEs provision to teams and inspection on regular basis.
- Waste management inspection on regular basis.
- Incident investigation and reporting.
- Reporting of HSE statistics to BOD on regular basis.
- Certified safety trainings of employees on annual basis.

3.4) Associate O&M Engineer

- Prepare daily plant operations report.
- Responsible for generating weekly operation and maintenance progress report.
- Lead and supervise washing activities.
- Responsible for generating schedules of plant washing activities and mobilize the manpower accordingly across the fleet of solar plants.
- Identifies washing problems and develops corrective action plans.
- Co-ordinate and update higher management on net washing expenditure.
- Provide timely written review reports from field operation, status and constructive feedback as requested.
- Work with other members of the maintenance team, sub-contractors and other groups to equipment

replacement and installation.

- Record and report all faults, deficiencies, and other unusual occurrences on plants.
- Participate in continuous improvement initiatives and associated periodic meetings

3.5) Technician

- Daily inspection of PV modules, Inverters, LT's, MV's, Transformers and update the Issues accordingly.
- Monitoring a site and its activities with the instruction of Lead O&M engineer.
- Report all the activities/issues to Lead O&M Engineer.
- Able to troubleshoot and installed solar system.
- Manage all the maintenance activities of the plant.
- Report all the Issues to the Lead O&M engineer.
- Perform all the preventive maintenance effectively and the corrective maintenance with the minimum loss Impact.
- Perform all the quality checks during the all kinds of inspections.
- Update the Lead O&M engineer about the stock.
- Maintain the fault reports and inspection record.
- Comply with Company health, safety and environmental policies.
- Handle the labor and train them according to work conditions.

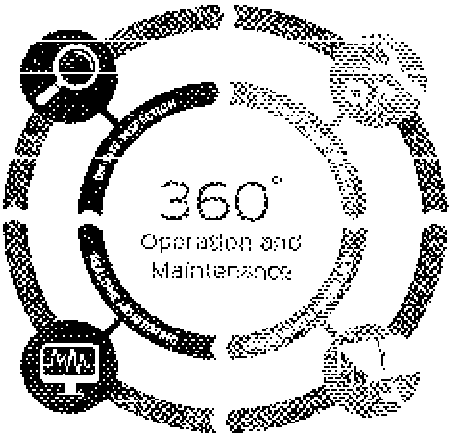
3.6) Washing Supervisor

- Pre-Inspection of PV modules, structure and working area.
- Training of washing labor on regular basis, according to HSE standards.
- Fill the washing Inspection check list after completing the washing activity.
- Ensure the safety of labor and inspection of PPEs on regular basis.
- Inspection of washing equipment's before starting activity.
- Prepare daily report of washing and share the results with pictures.
- After completion of work ensure braker and pressure pumps are proper close and system is isolated.
- Ensure the SOPs of washing are followed.

3.7) Washing Labor

- Inspection of PV modules.
- Inspection of washing tools.
- Washing of solar panels in compliance with washing SOP's.
- Cleaning of inverters.

4)| Scope of Services



The scope of O&M activities comprised of the following:

4.1)|Monitoring

Realtime online monitoring and controlling of the PV System 24/7.

Remote access to all operational data for the PV Power Plant will guarantee the uninterrupted transfer and acquisition of operational data to the remote monitoring system.

Following shall be the features of the gateway and remote monitoring system:

- Online monitoring system.
- Alarms / alerts and timely notification of key performance indicators.
- Monthly and annual reporting including system availability, system output (characterization of spatial and temporal variations), capacity factor, degradation trends, average and cumulative output opening/closing of service tickets, spare parts used, and any deviations from the guaranteed generation.
- Status of equipment and protections (DC & AC).
- Separate monitoring of inverters, DB including PV Module string level (current and voltage) monitoring.
- Any reductions in performance will be logged.
- The data shall present the status of the PV Power Plant, including the Performance Ratio, annual overview, and the current power being generated and exported to the Client.

4.2)|Cleaning Scope/Methodology:

Manual labor cleaning with wipers and pressure water.

This method requires human operator to clean manually with the help of mop or solar wipers. The quality of cleaned surface is judged by visual method by the O&M team and washing supervisor himself for the satisfactory level or till the dust particles get wiped out completely. For Minimum water consumption pressure nozzles and pressure-controlled water pumps are used.

Please check "**Annexure A-Panel cleaning SOPs for more details**".

4.3) Maintenance

The Maintenance activities will be divided into the following parts:

- Operational Maintenance - will include operation of Solar PV Systems.
- Preventative Maintenance - will include inspections and tests of Solar PV equipment to depict their performance.
- Corrective Maintenance - will include troubleshooting and parts replacement (if required) in case of abnormal behavior, component failure or breakdown.

O&M Task Sheet:

Below table summarizes the scope of work of operations and maintenance related work under the Operations and Maintenance of the Solar Equipment:

TASK	WEEKLY	MONTHLY	QUARTERLY	ANNUALLY
System performance monitoring (remote)		✓	✓	✓
System performance analysis and report		✓		✓
Operator training for safe operation	✓	✓	✓	✓
Cleaning of panels	✓	✓		
System monitoring/inspection on-site	✓	✓		
Inspection of modules (Thermal imaging)			✓ *	
Each array voltage and current test	✓	✓	✓ *	
Checking inverter settings and its output				✓*
Inverter power factor settings				✓*
Electrical system and circuit breakers inspection	✓	✓	✓	✓
Analyzing system wiring condition	✓			✓
System grounding test		✓		✓
Inspection of panels mounting structure		✓		✓
Identification of shading on panels by surrounding objects				✓*

** The activity/task may or may not be done, it may depend on the condition and requirement analysis of the plant.*

4.5) Operational Maintenance

Operational maintenance will include,

- Cleaning of solar panels monthly or according to site conditions.
- Checking Inverter Display Parameters.
- Visual Inspection of cable trays against any damage.
- Visual Inspection of solar panels against any damage.
- Checking functionality of installed equipment.
- Checking all the operation equipment status from the online portal.

4.6) Preventative Maintenance

- Mounting Structure inspection for sturdiness and corrosion.
- Visual inspection of Solar Panels and DC Connectors.
- Checking terminal and cable connections of Inverters.
- Monitoring on the online system which includes to check all the currents, inverter status and acknowledge of all the alarms and inform the maintenance team for rectification.
- Checking functionality of Inverters and online system.
- Inspection of LV DB of inverters and main DB.
- I-V characteristic curve measurements of the affected PV Module strings to identify the reason in case of reduced output.
- In addition, detailed Bi-Annual and Annual Inspections of the complete plant shall be performed, and the report shall be submitted.

4.7) Monthly Inspections:

- Inspection of complete solar equipment during the monthly site visit.
- Inspection of Inverter, panels, structure, transformer and all related equipment.
- Testing of stings.
- Inspection of Fire cylinders and HSE equipment.
- PR calculation of PV plant.

Following checklists are filled during monthly inspection site visits:

i- Inspection of washing
ii- Inspection of HSE equipment
iii- Inspection of cables and tables
iv- Inspection of inverter
v- Inspection of PV modules.
vi- Inspection of EMS
vii- Inspection of Transformer
viii- Inspection of electrical DBs

4.8) Bi-Annual Inspections

Following parameters shall be checked and tested during the bi-annual inspections,

- 100% visual inspection of PV Modules regarding damage shall be performed during 1st biannual inspection.
- Random visual PV Module damage inspection during 2nd biannual inspection.
- Random check for loosening of PV Modules.
- Random testing of sturdiness of mounting foundation / system and random substructure corrosion inspection.
- Testing of inverter features according to manufacturer's maintenance schedule.
- Maintenance of inverters according to manufacturer's instructions.
- Inspection and functional check of complete security surveillance system including fences if any, cameras, etc.
- Functionality testing of the monitoring system.
- Maintenance of all PV Plant components according to manufacturer's instructions.
- Checking of expiration date of the fire extinguishers installed on-site.

4.9) Annual Inspections

- Visual damage inspection of all accessible cable trenches and cable trays.
- Visual inspection and random testing of PV Module string connectors.
- Visual inspection of all PV Modules, all components and degree of pollution.
- Thermography of PV Modules to identify hot spots of cells, busbars or connectors.
- Maintenance of sensors of weather station based on manufacturer's instructions.
- Visual inspection of all Breakers.
- Inspection of overvoltage protection regarding external damage.
- Functional check of internal and external overvoltage and undervoltage protection through operation of test terminal.
- Functional insulation monitoring check.
- Check of control and auxiliary voltages.
- Check of the safety circuit for the interruption of the AC-grid protection in the case of failure (emergency shutoff, over-/ undervoltage, over temperature, etc.).
- Visual inspection of AC- and DC clamps for tightness and discoloring, tightening of clamps.
- Maintenance of inverters according to manufacturer's instructions.
- Visual inspection of PV Power Plant regarding accessibility and stability for which would be needed for the replacement of an inverter or PV modules.
- Ground maintenance includes all procedures necessary to avoid PV Module shading. This includes the levelling or any new constructed buildings.
- Grounding continuity and resistive values verification.
- IV curve tracing of whole plant.
- Comparison report with respect to irradiance.
- PR calculations of PV plant.

4.10) Corrective Maintenance

Following corrective maintenance services will be perform during O&M,

- Critical Reactive Repair
- Condition Based Maintenance
- Warranty Enforcement
- Equipment Replacement through Spares (planned/unplanned)
- Complaint Management

4.11) Response to Fault Messages

Every fault message shall be registered and stored in our data record.

- All fault messages and results relevant for the operation of the PV Plant shall be documented in the ticketing system. Any fault messages resulting in fault calls shall be documented in the corresponding monthly reports, indicating start and end of fault, reason and/or any performed repair works, as well as the respective components of the PV Plant fault management / warranty defects.
- Fault management procedures shall include necessary communication of faults, coordination of on-site appointments with service staff, as well as the corresponding and general operational structure.
- Fault management procedures shall include the preparation, handling and support in events covered by insurance provided by OEM, and the enforcement of claims for compensation to third parties, including the component manufacturers.
- All defects shall be documented within the same day of detection, and a summary provided to Company on a monthly basis in the corresponding monthly report. All fault and defect rectification shall be included in the monthly reports, with reference to the initial alarm/notification of occurrence.
- Warranty claim matters will be dealt with the manufacturer of prescribed equipment and will have specified time.

4.12) O&M Strategy in case of the fault

DC Side faults:

To perform any kind of testing/trouble shooting on the DC string in case of any fault, string must be isolated from the system before performing any task verify the Irradiance fall is less then 350 w/m².

- Turn off the AC switch.
- Turn off the DC Isolator.
- Check the current in the string from the clamp meter.
- Separate the string from the MC4 Connector.
- Perform the trouble shooting.

Inverter Trouble Shooting:

Isolate the inverter before any troubleshooting, if the maintenance works will be required then the inverter must be completely isolated from the system, the supply must be turned off from the MV panel prior to perform any activity and must confirm the voltages from the Meter before starting any kind of activity at the inverter.

Inverter Isolation

To perform any kind of the trouble shooting at the inverter it must be completely isolated from the system Always keep in mind that the inverter is powered by dual sources: PV strings and utility grid.

Proceed as follows to stop the inverter during normal maintenance and service work as follows:

- Stop the inverter using stop button instruction sent by the APP. The inverter stops.
- Disconnect the AC circuit breaker.
- Set the DC load-break switch of the inverter to OFF.
- Wait at least 10 minutes for inner capacitors to discharge completely.
- Verify that there is no voltage or current before pulling any connector.
- Wait for the module DC side voltage drops below the safety voltage.

When a fault occurs Proceed as follows to stop the inverter when a fault or emergency occurs as follows:

- Inverter will stop automatically in case of fault.
- Disconnect the AC circuit breaker.
- Set the DC load-break switch of the inverter to OFF.
- Wait at least 10 minutes for inner capacitors to discharge completely.
- Verify that there is no voltage or current before pulling any connector.
- Wait for the module DC side voltage drops below the safety voltage.

Inspection before starting

After the maintenance or service work, you may start the inverter. Restart the inverter only after removing the fault that impairs safety performance.

As the inverter contains no component parts that can be maintained, never arbitrarily replace any internal components.

Inspect the following requirement before starting the inverter:

- All connections are done by strictly following the installation manual and circuit diagram.
- The coverings of the internal devices are fixed and secured.
- Make sure, via suitable instruments, that there is no ground fault of the PV modules.
- Measure the DC and AC current with multimeter to check if they fulfill the module startup conditions and there is no overvoltage hazard.
- After longtime storage, a thorough and professional test is necessary before starting the inverter.

4.13) Performance Reporting

The performance of plant is monitored, recorded and shared on daily, weekly, monthly, half-yearly, and yearly basis.

Performance Reports shall include the following,

- Plant availability
- Daily Generation vs Daily Irradiation
- Actual Monthly Generation corresponding to Actual Irradiation
- Expected Monthly Generation corresponding to Expected Irradiation (PV Syst values)
- Actual Monthly Performance Ratio
- Lost Time log
- Committed Energy
- Inventory Status
- Information about any maintenance activity
- Fault messages and calls

A list of O&M reporting and its frequency is attached as an "Annexure F-List of O&M reporting".

4.14) Security:

- Security of the entire Plant shall be in the Client's scope.

4.15) Safety:

4.15.1 Standard Guidelines for Safety

Disconnection

a) Switching on or off an electrical disconnect is a process often taken for granted as safe, but it can be one of the most dangerous tasks involved in maintaining a PV system.

b) All system components must be assumed to be energized with maximum DC voltages (up to 1500 V) until personnel verify that the voltage has been removed. Wait for at least 05 minutes after turning the inverter off to get the capacitances discharged completely.

c) Workers must wear proper PPEs (Rubber Gloves, Safety Helmet and Safety Shoes) when operating disconnects, and care should be taken to use the proper LOTO technique for throwing switches.

d) A recommended safety protocol is to follow the left-hand rule, which involves standing to the right side of the switch and using the left hand to throw the switch. This ensures that the worker's body is not in front of the switch should an arc flash occur.

4.15.2 Operation

a) Do not touch any live electrical part of PV Panel such as terminals with bare hands, always use appropriately rated safety gloves.

b) Do not touch front side of PV Panel under sunlight this may lead to thermal burn.

c) Do not stand in front of PV panel during operation (this will cause shadows).

d) Do not attempt at making an electrical connection with wet, soiled, or otherwise faulty connectors.

e) Avoid sunlight exposure and water immersion of the connectors.
f) Avoid connectors resting on the ground or roof surface (this might result in the connectors being immersed in water during rainy season).
g) Check that all electrical connections are securely fastened. Make sure that all locking
h) connectors are fully engaged and locked.
i) Do not connect any extra energy sources other than the already installed ones.

WARNING	To avoid product damage, personal injury, or even possible death, anyone installing or handling the equipment must carefully read, understand, and follow all the installation and safety instructions in this document before attempting to install, wire, operate the array, and/or perform maintenance.

WARNING	This document must be read and understood before attempting to handle, install, wire, operate, and/or perform maintenance. The panels produce DC electricity when exposed to sunlight or other light sources. Contact with electrically active parts of the Solar panels can cause injury or death, whether they are connected to other Solar panels or individually.

CAUTION	Observe all electrical safety precautions to prevent electrical shock while installing the solar equipment, and while wiring, testing, and/or performing maintenance of the PV array. Use Insulated tools and proper personal protective equipment to reduce the risk of electric shock.

4.15.3 Safety Warnings and Cautions General

- Potentially lethal DC voltages can be generated whenever solar panels are exposed to a light source, therefore, avoid contact with electrically active parts and be sure to isolate live circuits before attempting to make or break any connections.
- Do NOT proceed if any doubt arises about the correct or safe method of performing any of the procedures found in this document
- NO washing of panels will be allowed during peak hours of sun light (11:00AM to 3:00PM) because of hot surface of the panels.
- During working hour if found any sort of abnormality which could lead to serious issues or unable to understand, personal should inform the condition to the immediate supervisor.
- Always wear appropriate safety and protective equipment, such as:
  - Rubber soled shoes
  - Cut resistant and chemical resistant gloves
  - Safety glasses
  - Hard hat

- When working on electrical connections, remove all metallic jewelry, and use insulated tools
- Wear cut resistant gloves whenever handling Solar panels
- Do NOT drive screws into any part of the photovoltaic laminate. Altering the laminate or improper Installation could cause electric shock, may result in fire, and will void the product Limited Warranty.

4.15.4 Work Site:

Follow all appropriate safety practices for the site.

- Do NOT handle PV laminate assemblies in high wind conditions.
- Do NOT perform maintenance on this product when Solar panels are wet or are in standing water.
- Ensure that the work area is clear of trip hazards. Personal injury can result from tripping over power cords, tools, electrical conduit, natural gas lines, and/or installation materials.
- Provide clear warning signage at each access point to the Installation. This signage should clearly state the dangers associated with a high voltage solar system, the personal protection equipment that should be worn, and emergency telephone numbers for fire and emergency medical service.
- All safety signs as per site to be pasted to different locations.

4.15.5 Additional:

- Try NOT to walk or kneel on the Solar panels. Wear clean (free from small stones) soft soled shoes to avoid possible scratching of the front surface of the Solar panels.
- Avoid dropping sharp objects or placing objects on the Solar panels, and do NOT wheel carts or drag items across them.
- PV Solar panels contain electrical components, and cannot be trimmed or altered in any way.
- Do NOT connect or disconnect quick connect cables under load.
- To reduce the risk of electric shock or arc flash, cover Solar panels with an opaque material before making wiring connections.
- All test equipment, leads, and probes must be rated for maximum system voltage.
- Observe proper polarity when connecting Solar panels into an electrical circuit, as reverse connections may damage the Solar panels and will void the product Limited Warranty.
- Do NOT attempt to concentrate sunlight (via lenses, mirrors, etc.) on the Solar panels to increase output, as damage may occur, which will void the product Limited Warranty.
- Follow all roof manufacturer and material safety data sheet (MSDS) instructions for the safe use of any chemicals.
- Do NOT use any chemical agents on or around Solar panels that are NOT approved by NRTC Energies.

SITE SAFETY

MANDATORY

All Visitors Must Report to Site Office

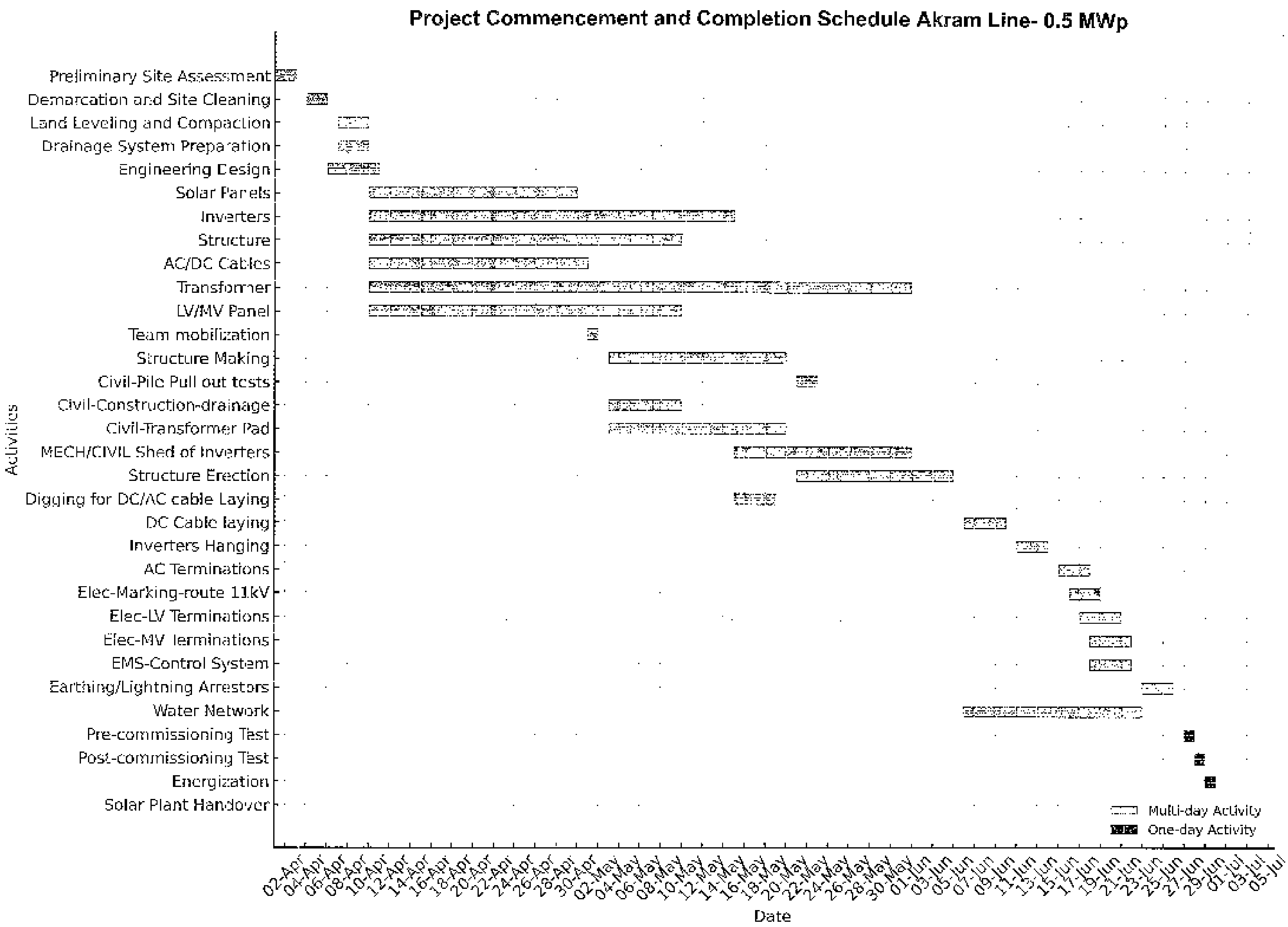
Hard Hats

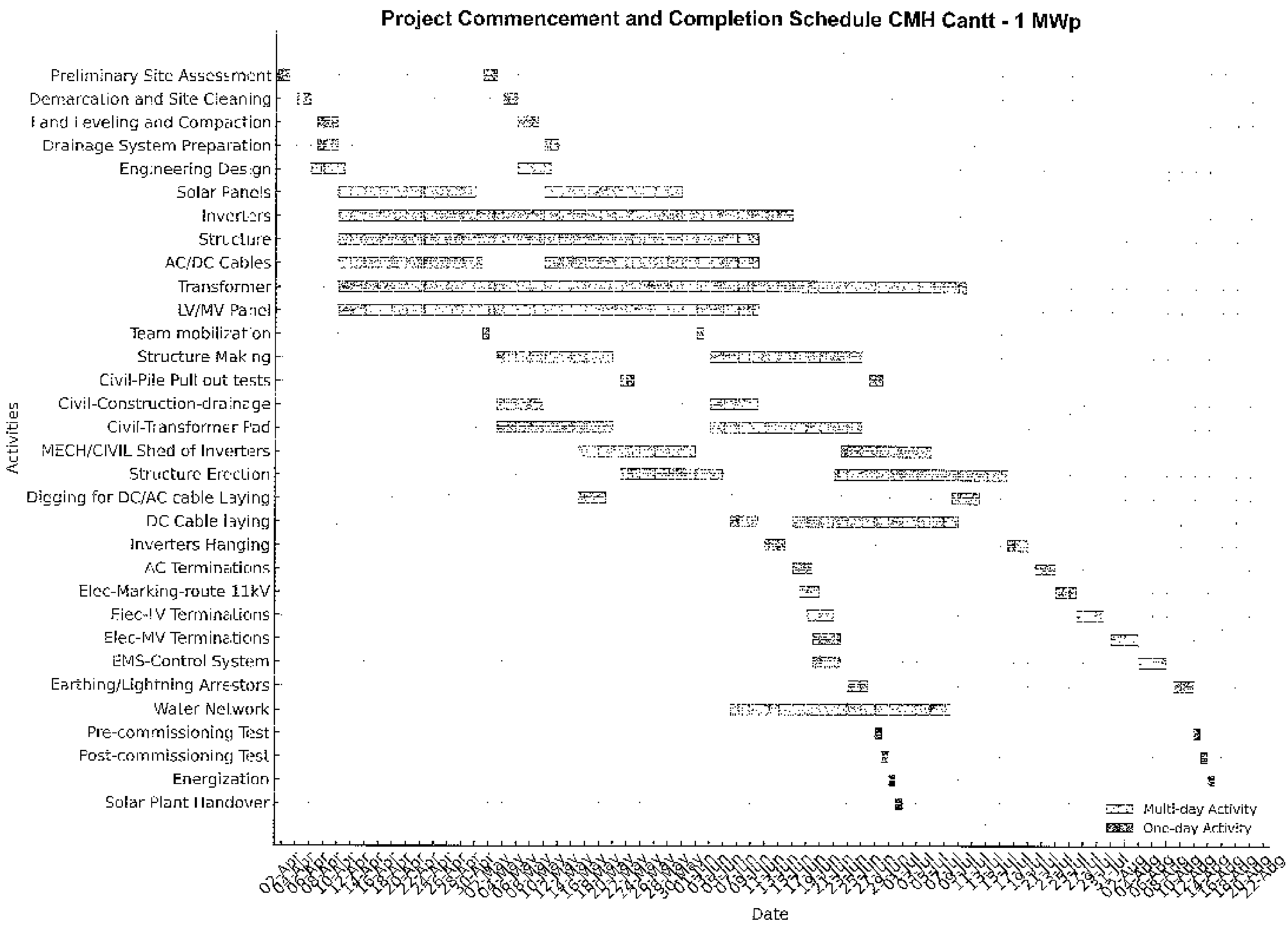
High Visibility Vest

Safety Glasses

Safety Shoes

MUST be worn on this site at all times


Project Commencement and Completion Schedule Akram Line- 0.5 MWp
Preliminary Site Assessment
Demarcation and Site Cleaning
Land Leveling and Compaction
Drainage System Preparation
Engineering Design
Solar Panels
Inverters
Structure
AC/DC Cables
Transformer
LV/MV Panel
Team mobilization
Structure Making
Civil-Pile Pull out tests
Civil-Construction-drainage
Civil-Transformer Pad
MECH/CIVIL Shed of Inverters
Structure Erection
Digging for DC/AC cable Laying
DC Cable laying
Inverters Hanging
AC Terminations
Elec-Marking-route 11kV
Elec-LV Terminations
Elec-MV Terminations
EMS-Control System
Earthing/Lightning Arrestors
Water Network
Pre-commissioning Test
Post-commissioning Test
Energization
Solar Plant Handover
Activities
02-Apr
04-Apr
06-Apr
08-Apr
10-Apr
12-Apr
14-Apr
16-Apr
18-Apr
20-Apr
22-Apr
24-Apr
26-Apr
28-Apr
30-Apr
02-May
04-May
06-May
08-May
10-May
12-May
14-May
16-May
18-May
20-May
22-May
24-May
26-May
28-May
30-May
01-Jun
03-Jun
05-Jun
07-Jun
09-Jun
11-Jun
13-Jun
15-Jun
17-Jun
19-Jun
21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
01-Jul
03-Jul
05-Jul
Date
Multi-day Activity
One-day Activity



Project Commencement and Completion Schedule CMH Cantt - 1 MWp
Activities
Preliminary Site Assessment
Demarcation and Site Cleaning
Land Leveling and Compaction
Drainage System Preparation
Engineering Design
Solar Panels
Inverters
Structure
AC/DC Cables
Transformer
LV/MV Panel
Team mobilization
Structure Making
Civil-Pile Pull out tests
Civil-Construction-drainage
Civil-Transformer Pad
MECH/CIVIL Shed of Inverters
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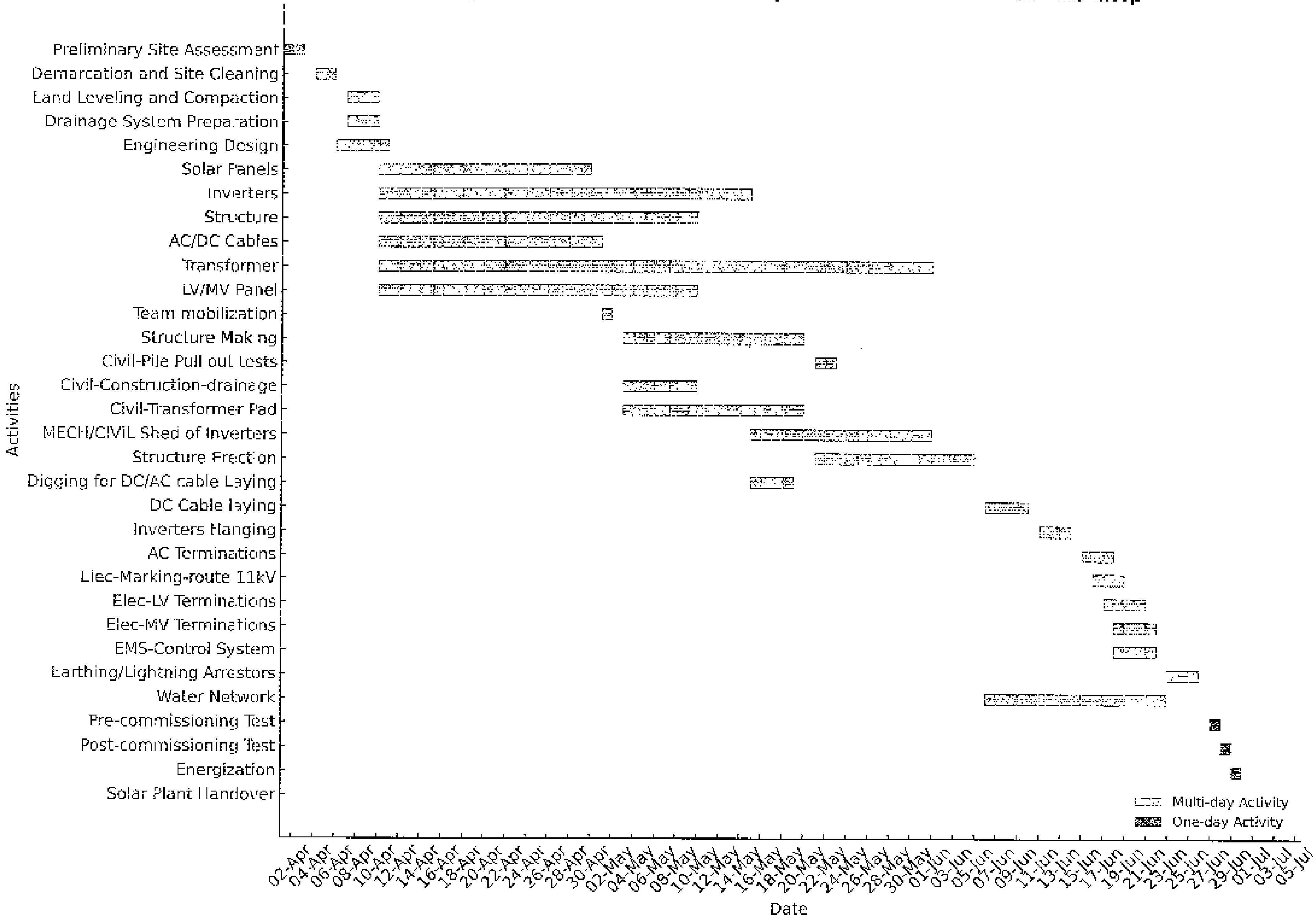
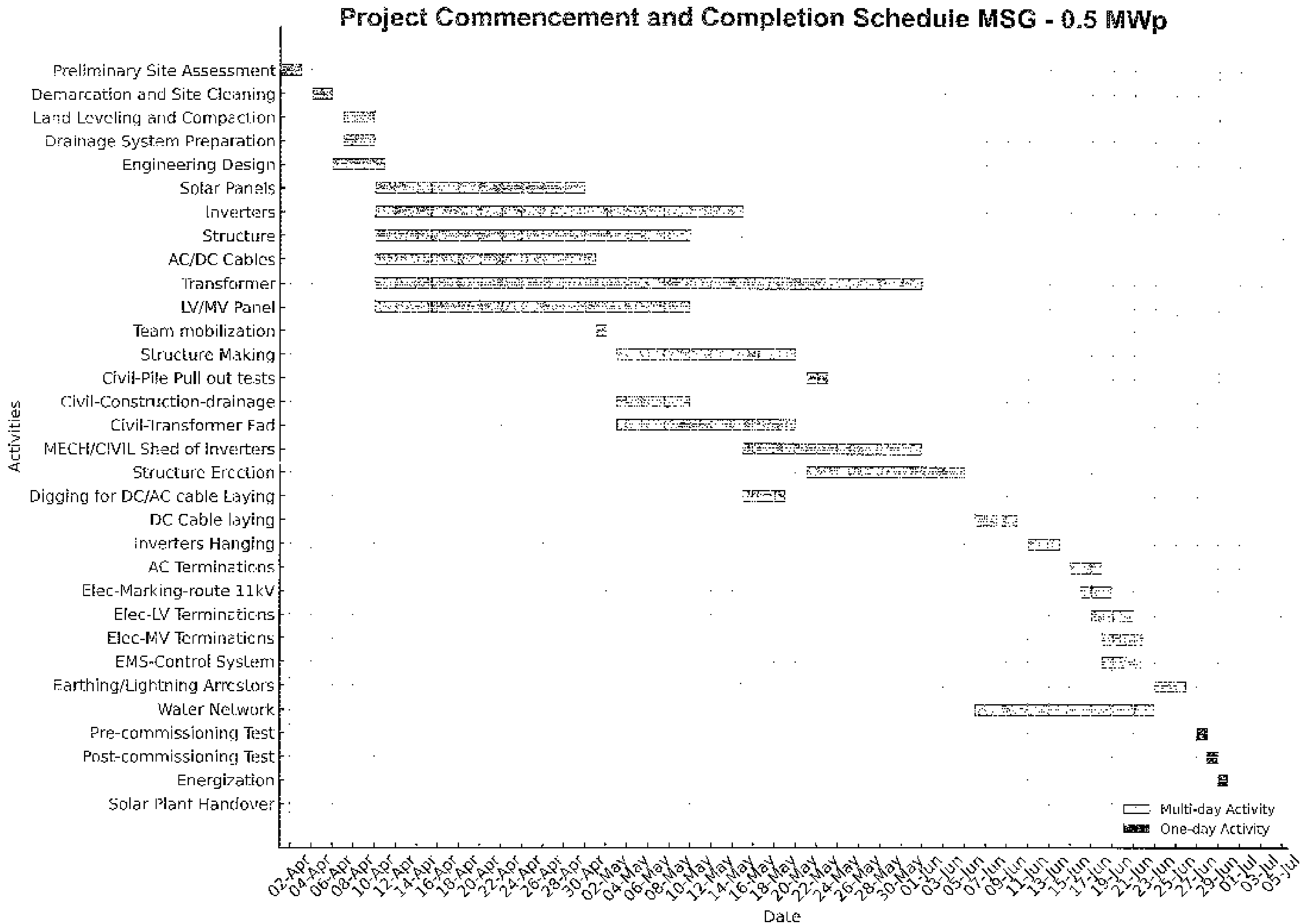
Elec-Marking-route 11kV
Elec-LV Terminations
Elec-MV Terminations
EMS-Control System
Earthing/Lightning Arrestors
Water Network
Pre-commissioning Test
Post-commissioning Test
Energization
Solar Plant Handover
Multi-day Activity
One-day Activity
Date

Project Commencement and Completion Schedule MM Line - 0.5 MWp





Project Commencement and Completion Schedule MSG - 0.5 MWp
Activities
Preliminary Site Assessment
Demarcation and Site Cleaning
Land Leveling and Compaction
Drainage System Preparation
Engineering Design
Solar Panels
Inverters
Structure
AC/DC Cables
Transformer
LV/MV Panel
Team mobilization
Structure Making
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Post-commissioning Test
Energization
Solar Plant Handover
Multi-day Activity
One-day Activity
02-Apr
04-Apr
06-Apr
08-Apr
10-Apr
12-Apr
14-Apr
16-Apr
18-Apr
20-Apr
22-Apr
24-Apr
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01-Jun
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11-Jun
13-Jun
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17-Jun
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21-Jun
23-Jun
25-Jun
27-Jun
29-Jun
01-Jul
03-Jul
05-Jul
Date

Project Commencement and Completion Schedule Okara Cantt - 1 MWp